2024/2025
Mid-Atlantic Commercial Vegetable Production Recommendations

If you are having a medical emergency after using pesticides, always call 911 immediately.

POISON
Help®
1-800-222-1222

In Case of an Accident

- **Remove the person from exposure**
- **Get away from the treated or contaminated area immediately**
- **Remove contaminated clothing**
- **Wash with soap and clean water**
- **Call a physician and/or the National Poison Control Center (1-800-222-1222).**
  Your call will be routed to your State Poison Control Center.
- **Have the pesticide label with you!**
- **Be prepared to give the EPA registration number to the responding center/agency**

Preface

NOT TO BE USED BY HOME GARDENERS

This copy of the 2024/2025 Mid-Atlantic Commercial Vegetable Production Recommendations replaces all previous editions of the Commercial Vegetable Production Recommendations published individually for Delaware, Maryland, New Jersey, Pennsylvania, Virginia, and West Virginia. Information presented in this publication is based on research results from the University of Delaware, the University of Maryland, Rutgers - The State University of New Jersey, The Pennsylvania State University, Virginia Polytechnic Institute and State University, West Virginia University, Delaware State University, Cornell University, the U.S. Department of Agriculture, and other institutions, combined with industry and grower knowledge and experience.

This publication will be revised biennially. **In January 2025, a Critical Update with important updates for this publication will be communicated through local Extension Agents and Vegetable Specialists.** The editors welcome constructive criticism and suggestions from growers and industry personnel who may wish to help improve future editions of this publication.

These recommendations are intended for the commercial vegetable grower who has to make numerous managerial decisions. Although the proper choices of variety, pesticides, equipment, irrigation, fertilizer, and cultural practices are the individual vegetable grower's responsibility, it is intended that these recommendations will facilitate decision-making. Recommended planting dates will vary across the six-state region. Local weather conditions, grower experience, and variety may facilitate successful harvest on crops planted outside the planting dates listed in this guide. This can be evaluated in consultation with the local agents and state specialists. Government agencies and other organizations administrating crop insurance programs or other support programs should contact local Extension agents and/or vegetable specialists for guidance.

Disclaimer

- The label is a legally-binding contract between the user and the manufacturer.
- The user MUST follow all rates and restrictions as per label directions.
- The use of any pesticide inconsistent with the label directions is a violation of Federal law.

Pesticide User Responsibility

Always follow the label and use pesticides safely. For Special Local Needs Label 24(c) registrations or Section 18 exemptions, do not use the material without a copy of the special label or written instructions from your Extension Agent or another recognized authority. **The user is always responsible for the proper use of pesticides, residues on crops, storage, and disposal, as well as for damage caused by drift.**

State and federal pesticide regulations are constantly under revision. Be sure to determine if such changes apply to your situation. Using pesticides inconsistent with label directions is illegal.

Days Between Last Application and Harvest

The minimum number of days between the last application and harvest (**PHI**, Pre-Harvest Interval, in days) and reentry information (**REI**, Restricted Entry Interval, in hours) are listed in the herbicide, insecticide and fungicide recommendation tables in chapter F Commodity Recommendations. Always follow the label to avoid the occurrence of deleterious chemical residues on harvested crops.

Trade or Brand Names

The trade or brand names given herein are supplied with the understanding that no discrimination is intended, and no endorsement is implied. Furthermore, in some instances the same compound may be sold under different trade names, which may vary as to label clearances. For the convenience of our users, both product names and active ingredients are provided, and any product name omissions are unintended.

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2024/2025 Mid-Atlantic Commercial Vegetable Production Recommendations

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https://www.udel.edu/academics/colleges/canr/cooperative-extension/sustainable-production/commercial-crops/vegetable-crops/
Weekly Crop Update Newsletter: *https://sites.udel.edu/weeklycropupdate/*
Delaware Insect Pest Management, Trial Reports, Insect Trapping Program:
https://www.udel.edu/academics/colleges/canr/cooperative-extension/sustainable-production/pest-management/
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Maryland Fruit & Vegetable Farm Blog: *https://blog.umd.edu/umefruitveg/*
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Plant & Pest Advisory: *https://plant-pest-advisory.rutgers.edu*
Mid-Atlantic Commercial Vegetable Production Recommendations: publication E001
https://njaes.rutgers.edu/pubs/publication.php?pid=e001
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Rutgers NJAES Pesticide Safety Education Program
https://pestmanagement.rutgers.edu/PAT (pesticide manuals, record forms, regulations, and safety)
*https://pestmanagement.rutgers.edu/worker-protection/ (*WPS training videos and regulations),
phone 848-932-9802

Rutgers NJAES OCPE Pesticide Applicator Certification Exam Registration (PACER)
https://pacer.rutgers.edu/index.php, phone: 848-932-9271 Option 7; email: *pacer@njaes.rutgers.edu*

State Extension Information

PENNSYLVANIA

The Pennsylvania State University
Penn State Extension, including publications, fact sheets, and more: *http://extension.psu.edu*
Mid-Atlantic Commercial Vegetable Production Recommendations: publication AGRS-028: *https://extension.psu.edu/mid-atlantic-commercial-vegetable-production-recommendations-sections* and *https://extension.psu.edu/catalog/product/view/id/21333/s/commercial-vegetable-production-recommendations/*
Penn State Vegetable Production: *https://extension.psu.edu/forage-and-food-crops/vegetables* (click on the "News" button to see recent articles related to vegetable and small fruit production)

Penn State Vegetable Team Directory
For a complete listing and contact information of Extension offices throughout Pennsylvania, see: *https://extension.psu.edu/county-offices*

Plant Disease Clinic: *https://plantpath.psu.edu/about/facilities/plant-disease-clinic*
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Insect Identification Lab *https://www.ento.vt.edu/idlab.html*
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Abbreviations and Acronyms

Units of Measurement

/A	per acre
bu	bushel(s)
°C	degrees Celsius
cc	cubic centimeter(s)
cu ft	cubic foot (feet)
cu yd	cubic yard(s)
cwt	hundredweight
d	day(s)
°F	degrees Fahrenheit
ft	foot (feet)
fl oz	fluid ounce(s)
g	gram(s)
gal	gallon(s)
gpm	gallons per minute
h	hour(s)
in	inch(es)
lb	pound(s)
min	minute(s)
mph	miles per hour
oz	ounce(s)
ppm	parts per million
psi	pounds per square inch
pt	pint(s)
qt	quart(s)
sq ft	square foot (feet)
tbs	tablespoon(s)
tsp	teaspoon(s)
wk	week(s)
yr	year(s)

Product Formulations

A	acid
CS	capsulated suspension
D	dust
DF	dry flowable
DP	dry prill
DS	dry salt
E	emulsion
EC	emulsifiable concentrate
ES	emulsifiable suspension
EW	emulsion in water
F	flowable
FC	flowable concentrate
FL	fluid
FM	flowable micro-encapsulated
G	granule

Product Formulations *(continued)*

L	liquid
LC	liquid concentrate
LF	liquid flowable
LFR	liquid fertilizer ready
LV	low volatile
ME	micro-encapsulated
OF	oil formulation
SC	spray concentrate, soluble concentrate
SE	suspoemulsion
SG	soluble granules
SL	soluble liquid
SP	soluble powder
W	wettable
WBE	water-based emulsion
WDG	water-dispersible granules
WDL	water-dispersible liquid
WP	wettable powder
WS	water soluble
WSB	water-soluble bag
WSP	water-soluble packet
ZC	CS and SC mixture

Other

ae	acid equivalent
ai	active ingredient
AMS	ammonium sulfate
AP	at planting
COC	crop oil concentrate
FRAC	Fungicide Resistance Action Committee
HRAC	Herbicide Resistance Action Committee
IRAC	Insecticide Resistance Action Committee
K	potassium
K_2O	available potash
MoA	mode of action
MSO	methylated seed oil
N	nitrogen
NIS	non-ionic surfactant
OLF	other labeled formulations
OMRI	Organic Materials Research Institute
P	phosphorus
P_2O_5	available phosphoric acid
PHI	Pre-Harvest Interval (in days)
REI	Restricted Entry Interval (in hours)
TR	Toxicity Rating
WSSA	Weed Science Society of America

A. General Production Recommendations

1. Varieties

New varieties are constantly being developed throughout the world, and it is impossible to list and describe them all; only those that are available and adapted to the Mid-Atlantic region are listed in this publication (see crop sections in chapter F). This list of varieties was created based on research trials at universities in the Mid-Atlantic, our observations of what farmers are growing, and conversations with seed company representatives. It is not a comprehensive list. Check with your state Extension organization for science-based recommendations when available. Farmers also select varieties by talking with other farmers and seed company representatives and going to trade shows. We recommend evaluating new varieties on a small scale before planting them in a large area. The ultimate value of a variety for a particular purpose is determined by the farmer based on performance under their management, adaptation to site-specific environmental conditions, as well as having desired horticultural characteristics for markets.

Some Variety Selection Criteria:

Yield: The variety should have the potential to produce crops at the same or better yield and quality as those already grown. Harvested yield may be much less than potential yield depending on markets and quality factors.

Days to Harvest: Choose varieties that meet market requirements based on days to harvest. Earliness is a major selection factor for first spring plantings, and days to harvest are a critical selection factor for late summer and fall maturing crops, especially in shorter-season areas of the region. Days to harvest in seed guides are based on the most common planting date and may be considerably longer in cooler periods or shorter in warmer periods. A more accurate guide to maturity will be Growing Degree Days (GDD), which are calculated for a specific crop using daily highs and lows and a base temperature. GDD information for different vegetable crops, such as peas and sweet corn, is available from seed suppliers and breeders.

Disease and Insect Resistance, Herbicide Resistance: The most economical and effective means of pest management is through the use of varieties that are resistant or tolerant to diseases caused by fungi, bacteria, viruses, or nematodes. When all other factors are equal, select a variety with needed disease resistance or tolerance. In some vegetables, such as sweet corn, insect resistant varieties are also available and should be considered where they fit your requirements. Herbicide resistant varieties of sweet corn are also available to allow for the use of post emergence non-selective herbicides for weed control. The continuous or intense production of herbicide or pest-resistant varieties can potentially lead to herbicide-tolerant weeds and new, more virulent pest strains. Adherence to vender or Extension recommendations and a long-term crop rotation plan should minimize this risk.

Resistance to Adverse Environmental Conditions: Choose varieties that are resistant to environmental conditions that are likely to be encountered. This includes heat or cold tolerance (bolting or disorders such as tuber heat necrosis or frost tolerance); drought tolerance; resistance to wet weather (disorders such as cracking and edema); and resistance to nutrient-related disorders such as blossom end rot, leaf tip burn, and hollow stem.

Horticultural Quality: Choose varieties that meet produce quality requirements for your market. Quality attributes such as taste, texture, size, shape, color, uniformity, and defects often dictate variety selection. Grades, percentages by grade, or pack-outs are key quality attributes for some markets. Variety test data such as soluble solids (sugars or sweetness), acidity, pungency, fiber content, and consumer preference information can assist in variety selection where available. Processing performance is a major concern for frozen, canned, or pickled vegetables. Other considerations include the ability to handle mechanical harvest or the ability to be packed and shipped distances with minimum damage in contrast to vegetables that are adapted only to hand harvest and local sales or short-distance shipping. Other quality characteristics to consider include holding or storage ability, ripening characteristics, nutritional content, and culinary qualities.

Plant Characteristics: Plant characteristics that may be considered in variety selection include plant form such as bush, upright, or vining; plant height; plant size; location of harvested part on the plant (such as top set in beans); and ease of harvest.

Adaptability: Successful varieties must perform well under the range of environmental conditions and production practices commonly encountered on individual farms. Seasonal adaptation is another selection consideration. Note that varieties listed under the "Recommended Varieties" section for individual crops in chapter F may not be adapted to all areas of the region (*e.g.*, mountain vs. coastal growing areas).

Market Acceptability: The harvested plant product must have characteristics desired by both you and your buyers. Consider the requirements or desires of consumers, packers, shippers, wholesalers, retailers, or processors. Included among these qualities are flavor, pack out, size, shape, color, culinary qualities, nutritional quality, or processing quality. Specialty markets such as ethnic markets, restaurants, or gourmet sales will have very specific variety requirements. Many vegetable seed companies offer varieties that are transgenic or "GMO" (genetically modified organisms). GMO varieties feature a small amount of DNA from a source outside of the crop species gene pool: another plant species, bacterium, virus, or even an animal. This foreign DNA is either the direct source of a new trait such as herbicide, disease, or insect resistance or is needed to assist the gene insertion process. GMO products in the food chain are of concern to a portion of consumers and buyers. Be aware of potential adverse public sentiment before growing and marketing GMO varieties of vegetable crops.

Variety selection is a very dynamic process. Some varieties retain favor for many years, whereas others might be used only a few seasons. Companies frequently replace varieties with newer ones. In the Mid-Atlantic, variety selection often requires special regional consideration due to the wide range of climatic variations. **There are many sources of information for farmers to aid in choosing a variety**. University trials offer unbiased comparisons of varieties from multiple sources. Commercial trials from seed distributors also offer multiple source comparisons. Seed company test results offer information about that company's varieties. Check results from replicated trials and multiple sites, if available. Trials conducted in similar soils and environments and local trials are the most reliable indicators of what will have the potential to perform well on your farm. Visits to local trials can provide good visual information for making decisions. Where quality is a prime concern, look for trials with quality data. Small-scale trial plantings for 2 to 3 years on your farm are suggested for any variety or strain not previously grown. For a true comparison, always include a standard variety, one with proven consistent performance in the same field or planting.

Plant Resistance or Tolerance Listed in Tables

If a specific disease (or insect) is a serious threat to a vegetable crop, genetic resistance is an effective and often low-cost strategy for disease avoidance. Pathogens are highly changeable, and a resistant variety that performs well in one year may not necessarily continue to do so. There are cases where purported resistance to pathogens breaks down. This may be due to genetic shifts in the pathogen, the development of different strains and races of disease-causing organisms, or environmental conditions that favor the organism or reduce natural plant resistance. In Chapter F, variety tables, disease and insect resistances and tolerances are listed in the tables and footnotes. The disease, insect, or insect reactions listed in this book are from seed companies or university trials, as noted, and are not necessarily verified by Cooperative Extension.

2. Seed Storage and Handling

Both high temperature and high relative humidity will reduce seed germination and vigor over time. Do not store seeds in areas that have a combined temperature and humidity value greater than 110, for example 50°F + 60% relative humidity. Ideal storage conditions for most seeds are at a temperature of 35°F (2°C) and less than 40% relative humidity. In addition, primed seeds pretreated with salt or another osmoticum do not usually store well after shipment to the buyer. Seed coating/pelleting may or may not reduce germination rate. When storing coated/pelleted seed, perform a germination test to assess viability before using in subsequent seasons.

Corn, pea, and bean seeds are especially susceptible to mechanical damage due to rough handling. Seed containers of these crops should not be subjected to rough handling since the seed coats and embryos can be damaged, resulting in nonviable seeds. If you plan to treat seeds of these crops with a fungicide, inoculum, or other chemical application, apply the materials gently to avoid seed damage.

3. Specialty Vegetables

Niche Marketing

The term 'specialty vegetables' refers to a broad range of crops that are sold in niche markets. They are sometimes called 'exotic' as they represent a class of vegetables unlike standard tomatoes, peppers, beans, peas, sweet corn, etc.; 'alternative' because they represent new enterprises that traditional vegetable growers might try; or 'designer veggies' that allow the consumer to be creative with their presentation. Recently, the term 'ultra-niche crops' was created to describe very high value specialty crops that provide opportunities to help beginner/small farmers get established. Most fresh-market specialty vegetables and herbs fit this description.

Specialty vegetables can be described as **new or unusual manner in which they are grown** (aeroponic, hydroponic); by the **color, shape or flavor** of the varieties grown (red and oakleaf lettuces, pear tomatoes, heirloom varieties, or unusual greens like radicchio); by their **size** (baby, miniature, micro); or by their **diverse origins and demand** (Asian crucifers and cucurbits, Hispanic peppers, African greens and eggplants).

Specialty Vegetable Markets

Developing a marketing plan is important for any business and is essential to success with specialty vegetables. Important points to consider include:

- Before planting, know where you will be selling your crop.
- Understand all the quality, grading and packaging requirements, and costs for various market outlets (similar ethnic groups may want different varieties/types of the same crop, use the same/similar names for different types of crops, or different names for the same crop).
- Determine consumers will want it *when* you can produce it.
- Assess the costs of production, especially the time and labor required. Conduct on-farm trials to help determine varieties and production systems. Small plantings can help work out problems that can be resolved easily. Accurate records of small plantings can be used to estimate costs and returns for full-scale plantings.
- Increase production as demand grows, but be aware of competitors entering the market (prospective buyers, state and federal crop reporting agencies, and local Extension workers can be good sources of information);
- Project the impact that various levels of competitive supply will have on price to determine if returns will pay for any required capital costs over a specified time period.
- Understand that a specialty crop enterprise may not be limited to a single vegetable but may include a group of complimentary crops that fill a market niche. Several different crops may be required to gain a foothold in the market.

A successful specialty produce business requires knowledge and experience. It is advisable to start small and build the business gradually. Understanding marketing for specialty crops is the first step toward making profitable production decisions.

The following sections describe production practices for specialty vegetables grouped by the general market outlets for the specific crops directing the producer's attention to that critical part of the decision process.

Organic and Hydroponic Production: Organic and hydroponic production which, in and of themselves, create niche-market specialty crops are not the focus of this guide, but most, if not all of the crops described, can be grown using 'organic' practices, *i.e.*, those approved under the USDA National Organic Program. Where appropriate, organic practices and pest control options are provided under each crop throughout this guide (see also section A 4. Organic Production). Using 'hydroponic' techniques to grow crops in a nutrient solution, usually within a controlled environment such as a greenhouse, is also suitable for many vegetable crops where there is sufficient market demand to justify the capital investment. Both production systems require selling to specific niche markets where demand provides the greatest return. 'Hydroponic' specialties should be marketed on their own unique qualities. If producing crops organically check with the certifying organization for requirements.

World Crops: Unfamiliar vegetables that are not conventional in North American markets but are culturally appropriate to many new immigrant populations that have settled throughout the Mid-Atlantic and Northeast provide opportunities for specialty produce farmers to cater to these ethnically diverse consumers. Major retailers are responding to these population shifts as well creating sales opportunities for both retail and wholesale growers.

A. General Production Recommendations

It is critical to understand the ethnic community for which you will be growing to make the correct crop and variety selections, harvest at the correct stage, and to package in appropriate containers. The worldcrops.org website is designed to help growers exploring ethnic crop markets understand the nuances of marketing to such diverse groups (Table A-1). For example, peppers/chilis are popular Hispanic vegetables, but Hispanic consumers from different countries, even different regions of the same country, may prefer very different types of peppers.

Likewise, eggplant is very popular in many Asian and African cuisines, but in Indian, a small, egg size, pink 'brinjal' eggplant is preferred, while in China and Japan, consumers look for long, slender fruit. People in various African countries consume a white or pale green, medium-sized eggplant (a little smaller than the traditional Italian/Sicilian eggplants) that many call 'Bitter Ball' or ‘Garden Egg’. A similar eggplant consumed in Brazil is called ‘Gilo’. West Africans also use a pea-sized, red eggplant for medicinal purposes, known as the 'Ghanan pea' in most countries. That unusual eggplant is called 'Kiteley' in Liberia, while 'Kitley' is the termed used for the 'Bitter Ball' eggplant in Ghana.

Table A-1. World Vegetable Crops for Mid-Atlantic Growers
(see *https://worldcrops.org/* for more information)

Vegetable Types	Community	Culturally Appropriate Crop Name
Solanaceous Eggplant	Brazil	Gilo
	West Africa	Bitter Ball, Kiteley, Ghanan Pea
	India	Brinjal
	France	Aubergine
Pepper/Chili	Mexico	Habanero
	Dominican Republic	Aji Dulce
Husk Tomato	Mexico	Tomatillo
Cruciferous	China, Southeast Asia	Napa/Chinese Cabbages, Pak Choys, Mustards, Flowering Broccoli
Other Greens	West Africa	Jute
	India	Fenugreek (Methi)
	Mexico	Purslane (Verdolaga)
	Universal	Amaranth, Roselle, Malabar Spinach

“Designer Veggies:” Coined to describe unusual produce used by creative chefs to decorate gourmet plates with more than a traditional garnish, “designer veggies” can be any crop grown for its size, shape, color, texture, or flavor. Types of “designer veggies” may include, but are not limited to, any/all the crops described in the following sections. They are usually ‘trendy’ crops that help celebrity chefs stand out from the crowd, so one year’s hot item may be a slow mover a year or two later, especially if several growers add more plantings. Radicchio can be considered one of the original “designer veggies”. When it appeared in produce aisles in the mid-1980s there was nothing like its bright red leaves with contrasting white veins and strong bitter flavor. Radicchio leaves are now common ingredients in many salad mixes, and studies have shown that it qualifies as a nutrient-dense ‘super food’. Coupling nutritional qualities with its ability to stand up to cooking in a variety of ways, along with increasing attention by food marketers, radicchio may once again be propelled into “designer veggie” status.

Success in the “designer veggie” business requires working closely with chefs and gourmand customers, paying close attention to food and trade publications and TV, attending produce and gourmet food shows, and being able to grow and deliver small quantities of labor-intensive produce.

Baby, Miniature and Micro Vegetables

Variety Selection

Demand continues for smaller vegetables among gourmet, restaurant, and specialty food outlets. **Micro-greens** are a trendy niche crop that are popular among small/beginner farmers. **Micro-greens** are seedling plants consumed at a stage (stem and cotyledon as 1 or 2 true leaves appear - smaller than transplant seedlings) between **sprouts** (roots and unopened cotyledons) and **baby** sizes (immature root vegetables or the first 2-4 true leaves of many greens). **Micro-greens** are cut above the soil line, so no roots or seed coats typically found in sprouted crops are included. Many types of vegetables can be harvested at these immature stages and sold as **baby** or **micro-vegetables** (Table A-2). There are other cultivars of vegetables which mature smaller than standard types of the same vegetable. These are referred to as **miniatures** and are grown to full maturity. Most seed companies offering specialty vegetables now also list specific varieties for **micro-greens** or **baby** production, in addition to miniature varieties.

Table A-2. Baby and Miniature Vegetable Varieties and Harvest Stage

Vegetable Type	Harvest Stage[1]	Baby Harvest Varieties	Miniature Varieties
Beans	IF	Filet bean types	Maxibel
Beets	IR, G	Any beet harvested at a small stage	Baby Beet
Carrots	IR	Round types, short types	Adelaide, Atlas, Aranka, Mokum
Corn	IF	Any sweet corn variety harvested within 3 days of silk emergence - supersweet varieties with tendencies to produce multiple ears/plant will increase yields	Baby Asian Corn
Eggplant	M	Fingerling eggplant	
Greens	G	Most greens, including mustards, cabbages (European and Oriental), chicories, amaranth, etc. can be harvested at the 4-6" stage. A mixture of baby greens and lettuces can be sold as "Mesclun" salad mix.	
Lettuce	G	Leaf types harvested before heading, Salanova varieties, one cut types	Little Gem types, Baby bibb types, Mini romaine types
Onions	IR	High density plantings of white, yellow, and red onions for pearl onions	
Peppers	M		Miniature Baby Bell peppers, "snack" peppers, lunchbox peppers
Radish	IR, G	Early harvested radishes	
Squash	IF	Scallop or patty pan types, ball types, early harvested zucchini or yellow squash with blossom	
Tomatoes	M		Cherry, grape, and mini-pear tomatoes
Turnips	IR, G	White Asian types	

[1]IF=immature fruit, IR=immature roots (usually ½ to 1-inch diameter), G=greens (usually 4-6 inches and before head formation), M=miniature mature fruit.

Culture

Micro-greens can be grown in protected culture for year-round, continuous harvesting. Typically, microgreens are planted in the containers in which they will be shipped and/or sold, leaving the 'harvesting' to the end user (chef or consumer). For wholesale customers, plastic transplant trays are lined with rock-wool/coir mats or a thin layer of soilless mix upon which the seeds are spread. Similarly, consumer packages such as clamshells or lidded trays can be used. Germination and 1 or 2 days of growth without light will cause the seedlings to stretch taller for easier harvest. This is followed by 2-3 days in full light which will allow the plant to produce chlorophyll and a dark green color. Un-cut micro-greens can then be delivered directly to chefs/consumers within a week to 10 days. Wheatgrass is grown in a similar manner using untreated wheat seed.

Baby and miniature vegetables are planted and grown much the same as standard varieties. Plant spacing is one major exception because miniatures are physically smaller and baby leaf and root crops are often harvested at the stage a standard variety would be thinned. Higher plant densities are desirable to maximize production. Baby leaf and some root crops can be grown in a solid bed by broadcast seeding since they will be harvested before crowding becomes a factor, or they may be drilled in rows 4-6 inches apart and as many across a bed as will fit. Spacing of miniature varieties will depend on the final size of the dwarfed plant. On the other hand, vegetables grown for their fruit (seeds or pods) such as beans, corn and squash should be grown at standard plant spacing to maximize output per plant. Crowding can affect the production of fruit, reducing yields, even if those fruit are to be harvested at an immature stage.

Field fertility may be modified depending on the crop and harvest stage. Immature, baby vegetables are harvested before they begin drawing significant amounts of nutrients from the soil. Most will perform with little additional fertilizer beyond the reserves left from previous crops. Baby and miniature vegetables production can be scheduled to provide continual year-round harvests by using high tunnels or greenhouses.

Harvesting baby and miniature fruiting vegetables is laborious and time-consuming as many are hand harvested specially for small producers. Conversely, specialty equipment manufacturers, especially in Europe, have developed efficient mechanical harvesters for baby greens. These tools may need to be used in conjunction with matched bed shapers and other implements, so careful analysis of the market and size of production is required to justify the added expense. Smaller scale manual and semi-mechanical harvest tools have been developed for smaller operations.

Post-Harvest Handling

Baby vegetables are immature crops at harvest-time and as such, both fruit and leafy crops tend to have higher respiration rates and are more tender than when they reach maturity. Proper post-harvest handling procedures are critical to maximize shelf-life. Gentle handling and special packaging from harvest on are required to reduce bruising and dehydration. Rapid post-harvest cooling removes field heat and extends shelf-life. This may be combined with triple washing to remove soil and field debris followed by spin-drying as a method of adding value for leafy greens.

Plastic-lined cardboard boxes, clear plastic food-service containers (clamshells) and inflated, resealable, plastic bags are common packaging options. The industry has settled on 3-pound plastic-lined, or wax treated, cardboard boxes for the wholesale trade. Larger bulk boxes/lugs may be suitable to send these products to fresh-cut processors who eventually repackage their finished products in consumer-oriented plastic bags or clamshell boxes. This packing system allows modified atmosphere treatment to reduce decay while providing support throughout the bulk package to reduce bruising/injury caused by the weight of the product itself. Micro-greens that are harvested at the farm are offered the most protection by use of clamshell boxes. Determine the appropriate package for the intended market.

Mesclun (French)/Misticanza (Italian)

Mesclun usually refers to mixed young/baby salad greens and herbs. Ingredients in mesclun blends vary, consisting of many varieties of the crops listed in Table A-3. Seed companies sometimes sell pre-mixed selections for mesclun production, but since different species emerge and grow at different rates, it is recommended to grow each separately and mix after harvest. This allows the grower to create unique blends, as well as timing production to allow harvest of similar stages of growth of each species.

Table A-3. Potherbs and Salad Greens

Leafy greens can be described simply as any plant grown for consumption of its fleshy leaves, petioles, and/or stems, either raw (salad greens) or cooked (potherbs) (see also Greens section in chapter F).

Arugula	Arugula, Astro, Darkita, Esmee
Asian Mustards	Mibuna, Misuna, Mizuna, Pak Choy; Flowering Broccoli
Cabbages	Red, Green and Savoy, Chinese Napa
Edible Flowers	Nasturtium, Viola, Violets, Pansy
Herbs	Parsley, Basils, Borage, Chervil, Chives, Fennel, Salad Burnet
Lettuces	Iceberg, Romaine, Crisphead/Batavia, Leaf, Bibb, Boston
Other Composites	Endive and Frisee, Escarole, Radicchio, Dandelion
Miscellaneous	Beet tops and Chard, Belgian Endive, Mache/Corn Salad, Orach, Claytonia/Miner's Lettuce, Sorrel, Purslane, Pea tips, Nasturtium leaves
Mustards	Cress, Mustard, Turnip tops, Watercress
Other Oriental Greens	Tricolor Amaranth, Shungiku Chrysanthemum
Spinach	Usually Flat leaf varieties

Pest Control

Under Protected Culture Specialty vegetable production can be extended in the field using floating row covers or grown nearly year-round using high-tunnels in most of the Mid-Atlantic states. Pests likely to be encountered in high density plantings growing in high humidity are slugs, white flies, and botrytis. Slugs can be trapped and there are parasites for controlling white flies. Maintaining constant air circulation and adequate ventilation to reduce humidity within the plant canopy will reduce the incidence of botrytis. If making multiple harvests, carefully remove all dropped cut leaves as botrytis and bacterial soft rot get started on injured tissue.

Weed Control

Weed control may be the most difficult aspect of baby leafy green and herb production. Selecting fields with low levels of weed seedbanks and free of perennial species is important. Preventing weeds from producing seeds will help with control in subsequent seasons. Herbicides must be labeled for the specific greens and herbs grown; consult the weed control sections in this publication for herbicide recommendations for specific crops. Consult the herbicide label to determine if the time between herbicide use and harvest is equal to or exceeds the required pre-harvest interval (PHI).

Use cultural weed control methods such as stale seedbeds or plastic mulch when applicable. Mechanical weed control must be done in a planned, timely fashion. Most crops relying on mechanical weed control will require multiple cultivations, which will be more difficult in high density plantings. Resort to hoeing and hand weeding when necessary.

Insect Control

Careful crop monitoring is required to produce insect-free greens. Timing production and using physical insect barriers such as floating row covers can effectively control insects on many of the shortest season crops. Longer season crops usually require insecticides of some type to protect them from an array of root maggots, lepidopteran larvae, aphids, thrips, flea beetles, and more. Additionally, crop rotation and prompt destruction of crop residue help prevent buildup of flea beetles and other localized insect pests. Effective IPM scouting can identify pest population changes and alert the grower when a pest control application may be required. Given the diversity of crops within this group, there may be unexpected pests occurring on small plots of crop plants, making control even more difficult. Read pesticide labels carefully to ensure that a product is registered for use on a specific specialty crop. Many specialty vegetables fall under Crop Grouping labels. Consult the crop specific guidelines in this book for pest control recommendations.

Disease Control

Scout plantings on a regular basis and adopt IPM practices that will help produce a disease-free crop. Use genetic resistance to help limit potential losses due to disease. Many specialty vegetables fall under Crop Grouping labels, therefore consult the fungicide label and crop guidelines in this book for disease control recommendations.

Many specialty vegetables, especially heirloom/ethnic types of eggplants and tomatoes, are not resistant to common diseases that most modern hybrids have been bred to resist. Therefore, sanitation is critical to avoid building up populations of these pests. Solanaceous crops are especially susceptible to soil borne root diseases such as Verticillium and Fusarium, rarely seen in today's hybrid crops, but they are re-emerging as serious pests in heirloom/ethnic crops. In addition to sanitation, grafting a susceptible plant to a resistant rootstock may be an alternative that allows the desirable, susceptible plant to be grown in infested soils. More information on grafting can be found in "Grafting Vegetables" in section A 5. Transplant Production.

4. Organic Production

Organic sales in the U.S. continue to rise, creating an opportunity for certified organic farmers. Upfront costs can be high, due mainly to certification costs, but returns can be higher than for vegetables grown using synthetic fertilizers and pesticides. The United States Department of Agriculture (USDA) regulates the term "organic" to ensure uniform standards are used and protect the industry from dishonesty. To become certified organic, you must follow production and handling practices contained in the **National Organic Standards** (NOS; see *https://www.ams.usda.gov/rules-regulations/organic*) and be certified by a USDA-accredited agency such as the Northeast Organic Farming Association of New Jersey (NOFA_NJ; *https://nofanj.org*), Maryland Department of Agriculture (*https://mda.maryland.gov/foodfeedquality/pages/certified_md_organic_farms.aspx*), or Pennsylvania Certified Organic (PCO; *https://paorganic.org/*). If annual gross income from organic products is $5,000 or less, a farm can be exempted from certification, but production and handling practices must follow the NOS and some restrictions regarding labeling and combination with other organic products apply. Certified organic production typically begins with a 3-year transition phase during which soil and farming practices are adapted to the NOS.

Successful organic production is a long-term proposition. It usually takes a couple of years and may take as many as four years for a site managed organically to reach its full potential for profitability. Organic production is knowledge- and management-intensive. Organic certification can increase market access. However, becoming a certified organic farmer may require learning new production methods and documenting practices and materials used through careful record keeping is mandatory. Test new products and methods on a small scale prior to large-scale adoption. When implemented well, organic methods can improve soil quality and tilth through increased numbers of soil microorganisms and improved organic matter recycling.

Consider the following questions before initiating organic production:

- Does a market for organic vegetables exist?
- Are adequate resources available?
- Would you be able to ride out possible reduced yields without premium prices during the 3-year transition phase?

- Are you willing to devote more time to monitoring pests?
- Are you willing to devote more time to managing soil fertility?
- Are you willing to devote more time to record keeping?

If you answered "yes" to all the above questions, organic production may be for you. If you are beginning the transition phase from non-organic to organic production, consider a pre-transition phase if pest pressures are high in the planting area. A pre-transition phase is a hybrid between organic and non-organic production. During the pre-transition phase, synthetic pesticides are used along with organic-approved tactics to reduce pest pressures. Once pest pressures are reduced, organic pest management tactics are used exclusively.

The steps for becoming certified organic can be found in the publication "Organic Vegetable Production" at *https://extension.psu.edu/organic-vegetable-production*.

5. Transplant Production

These recommendations apply only to plants grown under controlled conditions in greenhouses or hotbeds. Field-grown plants are covered under the specific crop in chapter F.

Producing quality transplants starts with disease free seed, a clean greenhouse and clean planting trays. Many vegetable disease problems including Bacterial Spot, Bacterial Speck, Bacterial Canker, Gummy Stem Blight, Bacterial Fruit Blotch, Tomato Spotted Wilt Virus, Impatiens Necrotic Spot Virus, and Alternaria Blight can start in the greenhouse and be carried to the field. A number of virus diseases are transmitted by greenhouse insects.

Buy disease-indexed seeds if available. To reduce bacterial seed-borne diseases in some crops (*e.g.*, tomatoes, peppers, cabbages), seeds can be hot-water treated. For some crops, chlorine treatment can also be useful, but this will not kill pathogens inside the seed. For more detailed seed treatment recommendations, see section E 4.3. Disease Control in Seeds, Plant Growing Mix, and Plant Beds.

Prior to seeding in greenhouse areas, remove any weeds and dead plant materials and clean floors and benches thoroughly of any organic residue. Shop vacuums are useful in removing debris from concrete and covered floors. Irrigation systems should also be cleaned to remove dirt and microorganism buildup (biofilms). Growing benches should be washed with a detergent to remove soil and residues. Growing areas should then be sanitized with an antimicrobial compound.

Sanitizing Greenhouse Surfaces and Treatment of Flats and Trays:

There are several different groups of sanitizers that are recommended for plant pathogen and algae control in transplant greenhouses. When possible/practical, rotation between these disinfectants is recommended. Make sure to read and follow the label since these products have different properties:

- **Alcohol (70% isopropyl)** is an effective disinfectant that kills microbes on contact. Since it is volatile, its effect is not long-lived. It is best suited for disinfecting propagation and grafting equipment such as knives or shears by dipping or wiping.
- **Quaternary ammonium chloride salts** (Q-salts such as Green-Shield®, Physan 20®, KleenGrow™) are labeled for control of fungal, bacterial, and viral plant pathogens, and algae. They can be applied to floors, walls, benches, tools, pots, and flats as sanitizers.
- **Hydrogen Dioxide, Hydrogen Peroxide, and Peroxyacetic Acid containing products** (*e.g.*, ZeroTol® 2.0, OxiDate® 2.0, SaniDate®12.0 (all 3 are OMRI)) kill bacteria, fungi, algae, and their spores on contact. They are labeled as disinfectants for use on greenhouse surfaces, equipment, benches, pots, trays, and tools.
- **Chlorine bleach (sodium hypochlorite)** may be used for pots or flats, but is not recommended for application to walls, benches, or flooring. When used properly, chlorine is an effective disinfectant. A solution of chlorine bleach and water is short-lived and the half-life (time required for 50 percent reduction in strength) of a chlorine solution may be as little as a few hours. Bleach should be used in a well-ventilated area.

New flats and plug trays are recommended for the production of transplants to avoid pathogens that cause damping-off and other diseases. If flats and trays are reused, they should be thoroughly cleaned and disinfested as described below. Permit flats to dry completely prior to use. Styrofoam planting trays can become porous over time and should be discarded when they can no longer be effectively sanitized.

Sanitizing Trays with Chlorine: First wash out all excess growing medium since organic matter will deactivate the active chlorine ingredients quickly. Dip flats or trays several times in a labeled chlorine sanitizer at recommended rates (3.5 fl oz of a 5.25% sodium hypochlorite equivalent product per gal of water). Cover treated flats and trays with a tarp to keep them moist for a minimum of 20 minutes. Wash flats and trays with clean water or a Q-salts solution to eliminate the chlorine. It is important that the bleach solution remains in the pH 6.5-7.5 range and that a new solution is made up every 2 hours or whenever it becomes contaminated (the solution should be checked for free chlorine levels at least every hour using test strips).

Transplant Production:
Transplant growth is affected by many factors including temperature, growing media, fertilization, water, and spacing. A good transplant is grown under the best possible conditions. A poor transplant usually results in poor crop performance. Transplant production includes germination, growth, and hardening off phases. Table A-4 presents optimum and minimum temperatures for seed germination and plant growth, the time and spacing (area) required to produce a desirable transplant, and number of plants per square foot. Seedless watermelon transplant production has specific requirements (see Watermelons in chapter F). Details on sweet potato plant production can be found in chapter F Sweet Potatoes.

Making a Plant-Growing Mix:
Pre-mixed growing media are available commercially (see below), but a good, lightweight, disease-free, plant-growing material can also be made from peat and vermiculite/perlite. The main challenge of making one's own mix is having uniform and consistent composition, but it can also be less costly. Formulas for simple mixes can be found in chapter G Resources (Tables G-4 and G-5).

Table A-4. Temperature and Planting Recommendations for Transplant Production

Crop	Optimum Day Temperature (F)	Minimum Night Temperature (F)	Weeks to Grow	Square Inch per Plant	Number of Plants per Square Foot	1020 tray size cells
Broccoli	65-70	60	4-7	2-3	48	72
Cabbage	65	60	6-7	2-3	48	72
Cauliflower	65-70	60	6-8	2-3	48	72
Celery	65-70	60	9-12	2-3	48	72
Cucumber[1]	70-75	65	2-4	4	36	50 or 72
Eggplant	70-85	65	6-9	4	36	50 or 72
Endive, Escarole	70-75	70	5-7	2	72	72 or 96
Lettuce	60-65	40	4-6	1	144	96 or 128
Melon[1]	70-75	65	2-4	4	36	50 or 72
Onion	65-70	60	9-12	0.5-0.65	220-288	288 or 312
Pepper	70-75	60	7-9	2-3	48	72
Summer squash[1]	70-75	65	2-4	4	36	50 or 72
Tomato	65-75	60	5-6	2-3	48	50 or 72
Watermelon (seeded)[1]	70-75	65	3-4	4	36	50 or 72

[1]Seed directly in container; do not transplant prior to setting in the field.

Commercial Plant Growing Mixes:
Commercial media are available for growing transplants and are generally recommended to grow vegetable transplants. Most of these mixes will produce high quality transplants when used with good management practices. However, these mixes can vary greatly in composition, particle size, pH, aeration, nutrient content, and water-holding capacity. Commercial growing media will have added lime and may or may not have a starter nutrient charge (added fertilizer). Plants grown in mixes without fertilizer will require supplemental liquid feedings after seedling emergence. Plants grown in mixes with added fertilizers will require liquid feeding starting 3-4 weeks after emergence. If you experience problems with transplant performance, the growing medium should be sent to a testing laboratory. It is recommended to mix 3 to 4 bags of commercial product together before filling trays. Baled commercial mixes must be loosened before mixing. Before filling trays, medium should be moistened so that it feels slightly damp but not wet. Medium should be used in the growing season in which it is purchased.

Transplant Trays and Containers:
Most transplants are grown in plastic trays with individual cells for each plant. Standard 10 x 20-inch plug trays (or more commonly 11 x 22-inch) can have 32 to over 500 cells. Larger cell sizes (32, 50, or 72) are best used for vine

crops and for rooting strawberry tips. 72-cell and 128-cell trays are suitable for tomatoes, peppers, eggplant, and cole crops. Smaller cell sizes (128, 200, 288) may be appropriate for lettuce and onions. Larger Styrofoam and heavy plastic transplant trays are also available in similar cell sizes. Larger cells hold more growing mix/soil and result in better transplant survival in the field but use more greenhouse space and it takes longer to produce the root ball. Individual plant-growing containers may also be used for vine crops and early market crops of tomatoes, peppers, and eggplant. Various types of fiber or plastic pots or cubes are available for this purpose. If plastic pots or trays are reused, disinfest as described previously.

Seed Planting and Germination:
Seeds that are over-sown in flats without cells to be "pricked out" (thinned or transferred bare rooted at a later date) should be germinated in 100% vermiculite (horticultural grade, coarse sand size) or a plant growing mix. It is recommended that no fertilizer is included in the mix or the vermiculite until the seed leaves (cotyledons) are fully expanded, and the true leaves are beginning to unfold. Fertilization should be in liquid form and at one-half the rate for any of the ratios listed in the "Liquid Feeding of Transplants" paragraph below. Seedlings can be held for 3 to 4 weeks if fertilization is withheld until 3 to 4 days before "pricking out." These then can be transplanted into individual cell trays or grown on to use as bare-root transplants. This system can be used for tomatoes, peppers, eggplant, cole crops, and lettuce. Do not use this system for cucurbit crops.

More commonly, one seed is planted per cell directly in planting trays. Seed that is sown in tray cells, pots or other containers can be germinated in a mix that contains fertilizer.

For earlier, more uniform emergence, germinate and grow seedlings on benches with bottom heat or in a floor-heated greenhouse. Minimum growing temperatures are listed in Table A-4. Germination rooms or chambers also ensure even germination where higher temperatures can be maintained for the first 48 hours. Trays may be stacked in germination rooms during this period but must be moved to the greenhouse prior to seedling emergence.

Plant Growing Facilities:
Good plant-growing facilities (greenhouses) provide maximum light to the seedling crop. The greenhouse cover material (glass, rigid polycarbonate, and polyethylene film) should be clean, clear, and in good repair. The ideal greenhouse will provide good heating and ventilation systems for effective environmental control. For hot air heating systems, place thermostats at plant level to maintain proper growing medium temperature. Combustion heating units located inside the greenhouse must be vented and have outside fresh-air intake and exhaust systems to provide air to and from the heater. Ventilation units must be adequate in size, providing 1.2 to 1.4 sq ft of opening for each 1,000 cubic feet per minute (cfm) fan capacity. Bottom-heating systems using circulating hot water, either on the benches or on the floor, are better than hot air systems for germinating seeds and growing uniform transplants. This system heats the area around the plants, not the whole greenhouse and can also result in reduced heating costs.

Liquid Feeding of Transplants:
In most instances, additional nutrients will be needed by growing transplants. Commercially available 100% water soluble greenhouse fertilizer formulations are recommended (see also Chapter C Irrigation Management, section C 3. Fertigation). For most crops use a formulation with lower P than N and K levels (*e.g.*, 21-5-20, 13-2-13, 20-10-20, 17-5-17, 18-9-18). If you plan to fertilize with every watering, begin with N concentrations in the 30 to 50 ppm range and modify the concentration as needed. Use higher rates for tomato, pepper and cole crops and lower rates for cucurbits (*e.g*., watermelon, squash). Use higher rates when temperatures are high (late spring and summer) and lower rates when temperatures are cooler. Fertilizer requirements may vary substantially with crop and growing conditions. For example, if fertigation is scheduled only once a week, N concentrations of 200 to 250 ppm may be required. Some growers may use a growing medium with no starter fertilizer. If that is the case, use 50 ppm N from emergence to first true leaf every 3 days, and 200 ppm N every other day from first true leaf to second true leaf.

For a less sophisticated way of applying nutrients, the following materials can be used for general use on transplants. Over an area of 20 sq ft, use 1 to 2 oz of 20-20-20 dissolved in 5 gal of water, or 2 oz of 20-10-15 dissolved in 5 gal of water. Rinse leaves after liquid feeding. Applications should be made weekly using these rates.

When using starter solutions for field transplanting, follow the manufacturer's recommendation. If concentrations are above recommended levels, they can cause excessive growth and reduce transplant quality. Highly concentrated nutrient solutions often can cause plant salt injury and leaf burning. Over-fertilized transplants will often "stretch" and have impaired field survival. **Caution: High rates of starter solution can become concentrated and burn transplant roots when the soil becomes dry.**

Watering:
Keep mix moist but not continually wet. Water less when the weather is cloudy. Watering in the morning allows plant surfaces to dry before night and reduces the possibility of disease.

Transplant Height Control:
One of the most important considerations is managing "stretch" or height of transplants. The goal is to produce a transplant with a size that can be handled by mechanical transplanters or hand without damage, and that is tolerant to wind.

Most growth regulators that are used for bedding plants are not registered for vegetable transplants. One exception is Sumagic® which is currently registered for use as a foliar spray on tomato, pepper, eggplant, ground cherry, pepino and tomatillo transplants. The recommended label rate is 0.52 to 2.60 fl oz/gal (2 to 10 ppm) and 1 gal should be sprayed so it covers 200 sq ft of transplant trays (use 2 qt per 100 sq ft). The first application can be made when transplants have 2 to 4 true leaves. One additional application may be made at the low rate, 0.52 fl oz/gal (2 ppm), 7-14 days later, but do not exceed 2.60 fl oz per 100 sq ft for a season. Growers are advised to perform small-scale trials on a portion of their transplants under their growing conditions before large scale use.

For other crops, alternative methods for height control must be used, *e.g.*, the use of temperature differential or DIF, the difference between day and night temperatures in the greenhouse. In most heating programs, a greenhouse will be much warmer during the day than the night. The critical period during a day for height control is the first 2 to 3 hours after sunrise. By lowering the temperature during this 3 hour-period, plant height in many vegetables can be modulated. Drop the air temperature to 50-55°F for 2 to 3 hours starting just before dawn, and then return to 60-70°F. Crops vary in their response to DIF, *e.g.*, tomatoes are very responsive, while cucurbits are much less responsive.

Mechanical movement can also reduce transplant height. This may be accomplished by brushing over the tops of transplants twice daily with a tube, pipe or wand made of soft or smooth material. Brush plants when the foliage is dry and if plant damage is seen then reduce the number of times you are brushing the plants. Crops responding to mechanical height control include tomatoes, eggplant, and cucumbers. Tender plants such as peppers may be damaged by this method.

For some vegetables, managing water can be a tool for controlling stretch. After plants have reached sufficient size, expose them to stress cycles, allowing plants to approach the wilting point before watering again. Be careful not to stress plants so much that they are damaged.

Maximizing the amount of light plants receive helps reduce plant stretch. Giving plants adequate space and replacing plastic coverings as needed helps prevent reduction in light levels. Managing greenhouse fertilizer programs is another method for controlling transplant height. Most greenhouse growing media come with a starter nutrient charge, good for about 2 to 3 weeks after emergence. After that, apply fertilizers, usually with a liquid feed program. Fertilizers that are high in phosphorus will promote transplant stretch.

Hardening:
It is recommended that transplants be subjected to a period of "hardening" prior to transplanting to the production field. Reducing the amount of water, lowering temperatures, and limiting fertilizers causes a check in growth (hardening) which prepares plants for field settings. When hardening vine crops, tomatoes, peppers, or eggplants, do not lower temperature more than 5°F (3°C) below the recommended minimum growing temperatures listed in Table A-4. Too low temperature may injure plants and delay regrowth after transplanting. Exposing plants to outside conditions is used for the hardening off process prior to transplanting. You can also use this for transplant height control during the production period. Roll-out benches or wagons that can be moved outside of the greenhouse for a portion of the day can be used for this purpose (see below).

A new tool is available for reducing transplant shock. The chemical 1-methylcyclopropene (1-MCP) which is marketed as the product LandSpring reduces ethylene production and stress on young plants. Ethylene is the plant hormone released when plants are injured or under stress, as is common during transplanting. Excess ethylene can cause leaf drop and wilting and can increase transplant losses. 1-MCP blocks ethylene from causing damage. LandSpring is labelled for broccoli, Brussels sprouts, cabbage, cantaloupe, cauliflower, cucumber, eggplant, muskmelon, bell pepper, non-bell pepper, summer squash, tomato, and watermelon. Apply to seedlings 1-5 days before transplanting,

Common Problems:
Poor growth and yellow or stunted plants may be attributable to the greenhouse growing medium. Greenhouse media manufacturers use good quality control measures, but things can go wrong, *e.g*., through inadequate mixing, missing or the wrong proportions of critical components (wetting agents, fertilizers, lime), or defective components (poor quality). Media can also be affected by poor handling and storage, most commonly when media are stored outside and bales or bags get wet, or if stored past the shelf life. Old media often are dried out and hard to rehydrate. If the medium is over a year old or possibly compromised, it should not be used (contact your supplier for inspections and tests on any suspect media). Avoid using overly dry or caked media, media that are difficult to loosen, media with a bad odor, waterlogged media or media that are resistant to wetting.

Most (but not all) media include a starter lime and fertilizer charge. The fertilizer is designed to provide 3-4 weeks of nutrients. If the fertilizer is missing, improperly mixed, or in the wrong proportions, seeds will germinate but seedlings will remain stunted. In this case, liquid fertilizer applications should start early.

Peat-based media are acidic in nature. Plants will perform well from pH 5.4 to 6.4. Lime is added to peat- based media and reacts over time with water to increase pH. Above pH 6.4, iron deficiencies in transplants are common. This also occurs if irrigation water is alkaline (has high carbonate concentrations).

In high pH situations (over 7.5), use an acidifying fertilizer (high ammonium content) for liquid feeds. Use of iron products such as chelated iron as a foliar application on transplants can accelerate plant recovery prior to the pH drop with the acid fertilizer. In cases with very high media pH, use of iron sulfate solutions may be needed to drop the pH more rapidly. Addition of dilute acid solutions to greenhouse irrigation water may also be considered in cases of excess alkalinity (*e.g*., diluted muriatic acid).

If lime is missing or inadequate from the growing medium, and pH is below 5.2, plants may exhibit magnesium deficiencies or iron or manganese toxicities. This also occurs in media that have been saturated for long periods of time. To correct this situation, apply a liquid lime solution to the medium and irrigate liberally.

Media that are difficult to hydrate may not have sufficient wetting agent or the wetting agent may have deteriorated; additional greenhouse grade wetting agent may be needed.

If the initial medium fertilizer charge is too high, or if excessive liquid or slow-release fertilizer feed is used, high salt concentrations can build up and stunt or damage plants (possible symptoms: leaf edge burn, "plant burn", plant desiccation). Test the media for electrical conductivity (EC) to see if salt levels are too high. The acceptable EC will depend on the type of test used (saturated paste, pour through, 1:1, 1:2) so the interpretation from the lab will be important. If salt concentrations are too high, leaching the growing media with water will be required.
Poor transplant growth or injury can also result from the following:

- Heater exhaust in the house caused by cracked heat exchanger, inadequate venting, use of non-vented heaters
- Phytotoxicity from applied pesticides or plant growth regulator
- Use of paints, solvents, wood treatments, or other volatiles inside the greenhouse
- Use of herbicides in the greenhouse or near greenhouse vents
- Low temperatures due to inadequate heater capacity or heater malfunction or excessively high temperatures due to inadequate exhaust fan capacity or fan malfunction

Grafting Vegetables:
Grafting is the act of joining two plants together. The upper part of the graft (the scion) becomes the top of the plant, the lower portion (the rootstock) becomes the root system or part of the trunk. Grafting has resulted in increased yields, fruit quality, and tolerance to abiotic and biotic stresses. Research on annual vegetable crops was limited until the last decade when the grafting movement started in Asia and Europe. Grafting is used extensively in the production of watermelon, cucumber, melon, tomato, and eggplant. Grafting can overcome tissue damage and/or plant mortality caused by the soil-borne diseases Fusarium and Verticillium Wilt, Bacterial Wilt, and Nematodes. Grafting may reduce or eliminate the use of certain pesticides (especially soil fumigants) because the appropriate rootstocks will provide tolerance to many soil insects and disease pests. Grafting is also used to impart additional vigor to plants and to increase yields. Specific rootstocks have been developed for grafting the vegetables listed above. Selection of rootstocks will depend on the specific goals for grafting. There are often many rootstocks available. Consult your seed suppliers for more information.

Some commercial nurseries are starting to feature grafted transplants. As a rule, they are substantially more expensive than conventional transplants, so there should be reasonable assurance of the economic benefit. Any grower seeking to perform large-scale grafting should first consult technical resources, such as the websites in this section. Upgraded facilities and employee training will likely be necessary.

Two successful and easily performed grafts are the tube and cleft graft. The tube graft uses a 45° cut in the rootstock and the scion. The two pieces are subsequently joined together with the angles complementing each other and held together with a clip. The cleft graft utilizes a 90° cut in the rootstock perpendicular to the soil surface. The rootstock stem is then cut in half down the center; this cut should be around ½ inch depending on the size of the rootstock stem and scion. The base of the scion is then cut to form a "V" that will fit the notch that was cut into the rootstock. A grafting clip is secured around the graft junction. This type of graft often requires a larger grafting clip than the tube graft. It is important that both the scion and rootstock stem diameter are similar. Several trial seedlings should also be grown prior to any large grafting operation to ensure that the rootstock and scion seedlings grow at the same rate; if not, the stem diameters may not coincide, which can lead to a poor graft union.

Cucurbits such as watermelons, cucumbers, and muskmelons are often grafted using the one-cotyledon splice graft method. In this method, rootstock seedlings should have at least one true leaf and scion seedlings should have one or two true leaves. With a single angled cut, remove one cotyledon with the growing point attached. It is important to remove the growing point and the cotyledon together so that the rootstock seedling is not able to grow a new shoot of its own after being grafted. Cut the scion and match the rootstock and scion cut surfaces and hold in place with a grafting clip.

One of the most crucial aspects of producing grafted seedlings is healing the graft junctions. After the grafts are clipped back together, they need to be placed in a high humidity environment known as a healing chamber. A healing chamber can be constructed in various ways using wooden or metal frames and a plastic covering. The goal is to create a closed environment in which the humidity can be increased, and the temperature controlled. Open warm water pans or commercial humidifiers can be used to increase humidity. Propagation heat mats can be placed on the floor to control temperature. For the first several days in the healing chamber, light should be excluded as much as possible. The increase in humidity and decrease in light slow transpiration and keep scions from desiccating while vascular tissue reconnects the scion and rootstock. After 5 to 7 days in the healing chamber, seedlings can harden off in a greenhouse for several weeks before moving to the field. Grafting generally adds 2 weeks to seedling production. Grafting can be performed at various plant growth stages ranging from the 2 true leaf stage on.

6. Conservation Tillage Crop Production (No-Till, Strip-Till)

Conservation tillage crop production systems are beneficial for a variety of reasons, but they require different management than conventionally tilled soils. Some benefits from no tillage can be observed quickly, such as reduced soil erosion, conservation of soil moisture, and reduction in fuel and labor costs. Others benefits occur over time, such as reduction in soil compaction, improved soil structure, and increased soil organic matter. Eliminating tillage can also influence weed and disease severity and produce cleaner harvested products in vegetables growing on the ground.

Conservation tillage crop production systems can also pose several crop management challenges. Soil temperatures do not warm up as quickly in the spring and this can affect seed germination, nutrient cycling from crop residues, and transplant vigor. Type of crop residue, amount of residue, and desiccation timing all impact soil temperature and should be taken into consideration. Modifications to planters and heavier equipment may be needed to accommodate no-till production. Small-seeded crop species may be more difficult to plant in no-till systems.

Conservation tillage systems eliminate mechanical weed control. Since tillage used for seedbed preparation is eliminated, fields receive additional herbicide treatments to control emerged weeds and vegetation prior to or at planting. Thermal weed control (such as flamers) may be an option, but most other tactics (*e.g.*, mowing) are not effective. Interrow cultivation with no-till cultivators has been used with some success in conservation tillage programs for weed management, but these implements are not readily available.

Nitrogen fertilizer must be managed properly when utilizing a conservation tillage production system. Crop residues typically contain an enzyme (urease) which can increase nitrogen volatilization from urea-containing fertilizer sources such as urea, liquid urea ammonium nitrate, or a variety of blends currently available. Management practices such as banding or incorporating nitrogen fertilizer with irrigation or rainfall should be considered to reduce urea-containing fertilizer contact with urease.

Nitrogen management in conservation tillage systems must account for microbial "tie-up". High levels of crop residue, cover crops, or weed vegetation on the soil surface will result in microbes assimilating nitrogen and immobilizing it (*i.e.*, it is unavailable to the crop). Research has shown that 25% or more nitrogen fertilizer may be necessary in the initial conversion years from conventional to conservation tillage until the soil reaches an equilibrium. Previous crop residue (type and amount), current soil nitrogen concentrations, fertilizer sources, application timing, and application methods all need to be considered when making necessary nitrogen rate calculations.

Maintaining proper soil pH is one of the most important crop production considerations in conservation tillage and has a significant impact on nutrient availability and toxicity. Mixing lime into the soil with tillage is not an option with no-till systems, so consider adjusting pH to the optimal level prior to initiating a continuous conservation tillage system. Lime has relatively low water solubility and leaches slowly through the soil profile. Eventually, fertilizer, organic matter decomposition, and rain will lower soil surface pH, but changes to subsoil pH will take a longer time. Continued liming based on soil test recommendations will maintain the proper pH.

Strip-till is a blend of tillage and no tillage within the same field. A narrow strip of soil is mechanically tilled with specialized tools to incorporate fertilizers and plant residues, warm soils, and improve soil to seed contact. The area between the crop rows is managed as no-till.

No-till and strip-till production systems often use cover crops to provide a mulch that the vegetable crops are grown on. Rye, hairy vetch, crimson clover, and mixtures of theses crops provide biomass that forms this mulch. Hairy vetch and crimson clover also provide nitrogen in the system. These mulches are often rolled with a roller-crimper prior to planting to provide the mulch base.

Under conventional tillage the plant residue is incorporated into the soil. However, in no-till systems, the cover crops may add additional plant residue that needs to be considered with management decisions such as preplant vegetation control, slower soil warming, plant residue management at planting, and fertility management. The amount of cover crop biomass (determined by when the cover crop is terminated) will dictate whether additional management is necessary.

7. Mulches and Row Covers

A favorable environment for plant root systems can be achieved by using plastic mulches and drip irrigation. Additional advantages of using row covers early in the season include increasing day time air temperatures and holding ground heat over night. This improvement in temperature can speed plant growth resulting in an earlier harvest. Mulches may discourage weeds and insect pests depending on the type.

Plastic Mulches: Black and white-on-black polyethylene film (0.75-1.25 mil) are the most popular mulches. Other mulches include blue, red, green IRT and metalized. Black mulches are used to warm the soil and white-on-black mulches are used to cool the soil. Different mulch colors and compositions impart new functional properties to mulch. Green 'IRT' types increase soil temperatures more than black plastic and suppresses most weeds including nutsedge. Results for other colored mulches such as red and blue have been inconsistent. Metalized or aluminized mulches repel certain insect pests (aphids, thrips, whiteflies) early in the crop growing cycle due to the reflectance of UV rays, but this benefit is lost once the crop canopy covers the mulch. This can be useful in cucurbit and tomato crops to delay the onset of certain virus diseases vectored by thrips, aphids, and whiteflies. Yellow mulches attract cucumber beetles and may also attract other insect pests. Note that planting date and environmental conditions influence crop responses to mulch color.

Soil fumigation may be used in conjunction with any type of plastic for weed, disease, and insect management, depending on the fumigant label. As the cost of soil fumigation increases, growers will likely need to reduce application rates to maintain profitability. New mulches have been developed that have decreased permeability to fumigants. These "virtually impermeable film" (VIF) mulches keep the fumigant in the ground longer which allows for reduced application rates while maintaining efficacy. VIF mulches come in various colors for fall and spring plantings. Consult the fumigant label for the allowable reduction in use rate under VIF mulch and plant back restrictions. The cost of VIF mulches is higher than that of low-density mulches but this increase is usually offset by the savings gained from reduced fumigant rates. Another mulch type has been developed that is more retentive than VIF mulch, *i.e.*, "totally impermeable film" or TIF. Soil fumigant use rates may be further decreased if used in combination with TIF, consult the fumigant label (see also section E 1.5. Soil Fumigation).

Fertilization: Measure soil pH before considering a fertilization program for mulched crops. If a liming material is needed to increase the soil pH, the material must be applied and incorporated into the soil as far ahead of mulching as practical. For most vegetables, the soil pH should be at or near 6.5. If the pH is below 5.5 or above 7.5 nutrients may be present in the soil, but not available to the plants.

Ideally a drip irrigation system is used with plastic mulch. When using plastic mulch **without** drip irrigation, all plant nutrients recommended for standard cultural practices should be incorporated in the top 5 to 6 inches of soil before laying the mulch. If equipment is available, apply all the fertilizer required to grow the crop to the soil area that will be covered with mulch. This is more efficient and effective than a broadcast application over the entire field. Non-localized nutrients may promote weed growth.

All essential plant nutrients, including major nutrients (N, P, K) as well as secondary and micronutrients, should be applied according to needs from soil test results and incorporated in the manner described above. Placing some of the required N under the mulch and then side dressing the remainder of the needed N along the edge of the mulch or in the row alleys after the crop becomes established has been found to be ineffective.

Applying some of the required N under the mulch and the remainder through the drip irrigation system is an effective way to fertilize. If using drip irrigation, see "Drip/Trickle Fertilization" in the crop sections in chapter F (*i.e*., eggplants, muskmelons, peppers, and tomatoes) for specific application rates.

Soil Conditions for Laying Mulch: Soil texture should be similar, and plastic should be laid so that it is tight against the soil in a firm bed for effective heat transfer. Prepare the soil by incorporating crop residues, minimizing large soil clods, and removing rocks and other debris that could interfere with good contact between the soil and plastic. Plastic can be laid flat against the ground or on raised beds. Raised beds offer additional soil drainage and early warming. Use of a bed shaper prior to laying plastic allows for fertilizer and herbicide incorporation and can assist in forming a firm bed. Combination bedder-plastic layers are also widely used.

Before any mulch is applied, check the soil moisture level. Optimally the soil moisture level is at or near field capacity (field capacity is the amount of moisture left after a rain or irrigation event after surplus water has moved out of the root zone by gravity). Being at field capacity is extremely important when drip irrigation is not used because this moisture is critical for early growth of the crop plants as soil moisture cannot be effectively supplied by rain or overhead irrigation to small plants growing on plastic mulch.

Biodegradable Mulches: Biodegradable plastic mulches have many of the same properties and provide comparable benefits as conventional plastic mulches. They are made from plant starches such as corn or wheat. These mulches are weakened by exposure to sunlight but are designed to degrade into carbon dioxide and water by soil microorganisms when soil moisture and temperatures are favorable for biological activity. Soil type, organic matter content, and weed pressure are other factors affecting breakdown. Unlike petroleum-based mulches, biodegradable mulches will usually be retained on the surface of the soil rather than be blown away from the application site. Most of the biodegradable mulch will eventually degrade or fragmentize, including the buried tucked edges. However, biodegradation is often unpredictable and incomplete. It is recommended that biodegradable mulch be incorporated into the soil at the end of the harvest or growing season. Cover crops can be planted the day after biodegradable mulch has been disked into the soil. In 2012, the National Organic Standards Board passed a motion allowing the use of 'biodegradable bio-based mulch film' provided that the mulch is 'produced without organisms or feedstocks derived from excluded methods' and meet certain degradation standards (at least 90% degraded in 2 years or less). However, currently only certain paper mulch products meet the organic requirements.

Field research has demonstrated that crop yields are comparable between biodegradable and non-degradable plastic mulches. Growers may be apprehensive about the cost of biodegradable mulch and the unpredictability of degradation rate. However, the initial cost is offset because disposal costs are eliminated. Below are some tips on using biodegradable mulch (excerpted from A. Rangarajan, Cornell University):

- **Storage:** Buy what you need each year. Product performance will be best with new products; more rapid degradation may be seen with older products. Store mulch rolls upright, on ends; pressure created from stacking may lead to mulch binding together or to degradation. Store mulch rolls in a cool, dark, and dry location; these products will start to degrade if stored warm, in sunlight and if rolls get wet.
- **Application**: Do not stretch biodegradable mulch as tightly over the bed as standard plastic mulches (contrary to recommendations for standard plastic that performs best when laid tightly over the bed). Stretching starts the breakdown of the biodegradable mulch. and will increase the rate of breakdown. The product will mold to the bed like commercial food wrap soon after application. Apply immediately prior to planting. If applied too far in advance of planting, the mulch may not last as long as needed. Sunlight and moisture will start the breakdown.

- **Incorporation into Soil:** Chisel or till the mulch into the soil as soon as possible after harvest to maximize breakdown; breakdown requires warm soil temperature and moisture. If mulch is incorporated after soil temperatures have dropped it may still be visible in the spring. However, as the soil warms, the product will further degrade and fragment. Rototilling will result in smaller mulch pieces that breakdown faster. Mulches will break down more quickly in soils with higher organic matter content.

Floating Row Covers and Low Tunnels: These systems are being used for frost, hail, and wind protection, to hasten the maturity of the crop and to effectively exclude certain insect pests. Vented clear and translucent plastic covers are being used in low tunnels, supported by wire hoops placed at 3 to 6 feet intervals in the row. Porous floating row covers are made of lightweight spun fibers (polyester or polypropylene). They may be supported with wire hoops, PVC pipes or metal conduit hoops for plants that require a higher volume to grow, or they can be placed loosely over the plants without wire hoops for low growing plants such as vine crops and strawberries. Upright plants have been injured by abrasion when the floating row covers rub against the plants.

Clear plastic can increase air temperatures under the row cover on warm sunny days, resulting in a danger of heat injury to plants. Therefore, vented materials are recommended. Even with vents, clear plastic has produced heat injury, especially when plants have filled a substantial portion of the air space in the tunnel. Heat injury has not been observed with translucent materials.

Row covers are usually installed over plastic mulch using a combination of mechanical application and hand labor. Equipment that will cover the rows in one operation is available. However, farmer-made equipment in conjunction with hand labor is currently the most prevalent method used.

When considering mulches, drip irrigation, and/or row covers weigh the economics involved. Does the potential increase in return justify the additional costs? Are the odds of getting the most benefit in terms of earliness and yield from the mulch, drip irrigation, or row covers favorable? Does the market usually offer price incentives for the targeted earlier time window? Are you competing against produce from other regions? Determine the costs for your situation, calculate the potential return, and come to a decision as to whether these strategies are beneficial.

Plastic Mulch Removal: Several methods of plastic mulch removal have been tried, but on small acreages it is removed by hand by running a coulter down the center of the row and picking it up from each side. Commercial tractor mounted mulch removal equipment is also available. High-quality, plastic mulch can be used for two successive crops during the same season when care is taken to avoid damage to the film. Thin wall (4 to 8 mil) drip irrigation tape cannot be removed and reused. However, high-quality, 16-mil drip tubing can be used a second season if damage is minimal, and emitters do not become clogged. Crop foliage and weeds may hamper mulch removal. Prior to replanting or removing mulch, vegetation may be eliminated by using herbicides (see specific crop sections in chapter F), or delay removal until after frost.

Plastic Mulch Disposal: Dispose of plastic in an environmentally responsible manner. Disposal regulations vary between states and municipalities. Contact your local solid waste authority for recommended methods of disposal in your area. Some states have developed recycling programs for agricultural plastics; consult state authorities.

8. Staking and Trellising

Many vegetable crops benefit from the addition of structural supports in the field. The benefits include: 1) better use of the available space and light; 2) improved air flow and more rapid drying of foliage; 3) reduction in certain disease pathogens; 4) protection against plant breakage; 5) protection of developing fruits and other plant parts against rain, dew, and sun; 6) ease of harvest, and 7) possible higher net yields. The disadvantages include the cost of materials, installation, removal, and disposal. Assess on a case-by-case basis if a structural support system is desirable.

Structural support systems have been used successfully for fresh market slicing, cluster, grape and cherry tomatoes, peppers, eggplants, cucumbers, climbing beans, and peas. The types of materials and how they are assembled differ for each crop. Specifics of the design and installation are included in chapter F. If materials fail during the growing phase, the resulting damage can be catastrophic. Use high quality construction materials and adhere to minimum size and spacing recommendations. For wooden stakes, it is recommended that a clear hard wood source be used.

It is a common practice to re-use wooden stakes over many seasons. Because stakes are in contact with the environment and plant material, there is a significant probability that surfaces will become infested with pathogens, especially bacteria. If left untreated, infested stakes may re-introduce diseases into the field, although the extent of this problem has not been determined. It is recommended that stakes are thoroughly disinfested before re-use.

The preferred (and most expensive) method of stake disinfestation is a heat treatment. Pathogens are eliminated from wooden stakes with exposure to ≥ 220°F for ≥ 15 minutes. This can be accomplished in a large capacity autoclave, or seed dryer. It is unlikely that most growers will have access to such equipment. Alternatively, therefore, stakes may be exposed to disinfectants such as commercial chlorine solutions (sodium hypochlorite) or Oxidate® (hydrogen dioxide; see below). Research has shown that a 20-minute soak in a solution made of 5 to 20 parts by volume sodium hypochlorite (commercial bleach) to 80 to 95 parts by volume water is effective in eliminating pathogens **only from the surface** of wooden stakes. It is crucial to maintain the pH of the bleach solution within the 6.0 to 6.5 range, as effectiveness decreases at lower and higher pH levels.

Studies on stakes treated with bleach solutions show that pathogens may still be present beneath the surface at depths ≥ 1/16th inch. Pathogens embedded within the stake may be able to migrate back to the surface and re-infest plants, although this has not yet been demonstrated. To improve the effectiveness of procedures for removing microbial pathogens from stakes, consider the following: Add a non-ionic surfactant to the disinfesting solution; increase the soaking time to ≥ 1 h; apply a vacuum during the stake soak; use a higher concentration or more potent source of hypochlorite (such as "heavy duty" or swimming pool grade chlorine); or use stakes comprised of non-absorbent stake materials (such as plastic, fiberglass, or metal). Many growers have successfully used the commercial product Oxidate® or chlorine dioxide to disinfest stakes. Oxidate® is OMRI listed and had been demonstrated to be an effective control agent for several important plant pathogens. However, data on the efficacy of this treatment as compared to using heat or commercial chlorine solutions are not available.

9. High Tunnels

High tunnels are relatively low-cost, plastic-covered structures which extend the traditional growing season and protect the crop from stress. High tunnels are either freestanding or connected at the gutters to cover larger areas. Freestanding tunnels are generally between 14-36 ft wide and up to 120 ft long. High tunnels are typically tall enough for a person to stand straight up in at least part of the structure. While high tunnels are not greenhouses (generally no heat or automatic ventilation), the greenhouse principle is the basis for their function and design. In the Mid-Atlantic region, year-round production of specialty crops is possible using freestanding high tunnels.

Taking the time to level the tunnel site prior to construction will make subsequent steps much easier. Spacing between high tunnels should be approximately 1.5 times the height of the nearest structure to facilitate snow removal, to provide for cross ventilation, and to reduce mutual shading. Runoff of rainwater from the structure should be channeled into storage tanks or through drainage pipes to avoid backwashing of water into the high tunnel. For freestanding high tunnels, metal bows approximately 1.75-2 inches in diameter are used as the support frame for a single or double layer of polyethylene covering (typically 6 mil greenhouse plastic that lasts 3-4 years; a double layer of plastic with an air gap between layers is especially recommended in colder areas and for growers wishing to grow produce in winter). The metal bows are spaced 4 feet apart and are connected to metal posts, which are driven at least 2 feet deep into the ground. End walls can have removable framing to allow the use of power tillage and bed maker/mulch layer equipment within the tunnel.

A soil nutrient test should be conducted prior to constructing the high tunnel. Once the high tunnel is covered with plastic film, prepare the soil, apply, and incorporate lime and preplant fertilizer as recommended for the intended crop or crops (see Chapter F). Avoid using excessive levels of organic amendments at one time such as animal manure composts to avoid high concentrations of soluble salts and other nutrients such as phosphorus.

High tunnels can considerably increase yield potential, thereby increasing nutrient requirements. Plant tissue testing should be conducted at important growth stages during the season to ensure adequate fertility requirements are maintained. See Chapter B Soil and Nutrient Management for more details. Make beds, if needed, and install drip irrigation to supply moisture. Using a small bed maker/mulch layer, cover soil or beds with black or clear polyethylene to warm soil for spring crops. When transplanting crops into tunnels during July and August, use white or silver polyethylene mulch on the soil or beds rather than black polyethylene to reduce soil temperature and excessive heat buildup in tunnels. Shade fabric may be needed in areas with high summer temperatures.

For freestanding high tunnels, snow removal from the top of the tunnels may be necessary after heavy snowfalls. Snow may need to be removed from the sides of the tunnels as well to reduce/eliminate outside water intrusion into tunnels and collapse of tunnel sidewalls. Gutter-connected high tunnels are constructed with much lighter posts and bows and cannot be used for crop production during the winter. During the winter season, the plastic on gutter-connected high tunnels must be bundled and moved to the gutters for storage. Low-cost caterpillar tunnels can be used for spring, summer and fall production. Hence, freestanding high tunnels allow for year-round production while gutter-connected and caterpillar tunnels do not.

The keys to successful production of vegetables and other horticultural crops in high tunnels are crop scheduling, fertilization, ventilation, and irrigation. Table A-5 provides a relative planting and harvesting schedule for some vegetable crops produced using freestanding high tunnels in the Mid-Atlantic region. When planting high tunnel crops in the spring, it is generally recommended to transplant vegetable crops 2-4 weeks earlier than the earliest planting date in the field on bare ground. If unusually cold night temperatures are experienced several days to weeks after planting vegetable crops in high tunnels, floating row covers, low tunnels, thermal blankets and/or portable clean burning propane heaters (11,000 to 44,000 Btu per hour) can be placed in high tunnels until more seasonal temperatures return.

The most critical component of the system is ventilation. In freestanding high tunnels, ventilation is accomplished by rolling up the side walls to the batten boards, approximately 5-6 ft above the ground on each side of the tunnel. In gutter-connected high tunnels, ventilation is accomplished by sliding the plastic covering aside creating ventilation openings in the roof bows, as well as by opening the end walls. The use of a ridge vent may significantly reduce relative humidity and temperature fluctuations. Maintaining optimum growing conditions inside high tunnels without having extreme fluctuations in temperature and/or high humidity conditions can lead to early, high yielding and high quality crops. Checking and adjusting high tunnel internal temperature and humidity conditions several times a day will help ensure increased crop yields and profitability.

Depending on the crop to be grown, there are several production systems that can be used in high tunnels. Conventional tillage and establishment of crops may be efficient for cool season crops that can be direct-seeded or transplanted such as, lettuce, onions, Swiss chard, spinach, collards, or kale. For warm season crops, especially cucurbits (cucumbers, squash, cantaloupe, and watermelon) and solanaceous crops, (potato, tomato, pepper, and eggplant) use of raised beds with plastic mulch and drip irrigation is required for optimum yield, maturity, and quality. Warm season vegetable crops dramatically benefit from higher soil temperatures in early spring in high tunnels. In addition, multiple cropping is possible from the initial raised bed/plastic mulch – drip irrigation system established in the spring. Permanent raised beds with a width of 24-48 inches may also be constructed in high tunnels using wooden boards measuring 2 by 12 inches. Use of permanent raised beds may limit crops grown on them depending on the distance between raised beds (center-to-center) within the high tunnel. Some growers successfully use 30-36 quart potting soil bags that are drip irrigated to grow high tunnel crops. These bags are placed end-to-end in rows and on landscape fabric. Either one or two drip irrigation lines are inserted in planting holes in each bag. Additionally, small holes are cut on the bottom of the bags for drainage. Warm season vegetables can be grown using conservation or no till production practices within high tunnels. A winter cover crop is established the previous fall and terminated with silage tarps or mowing. The cash crop can be planted directly in the mulch or planted using woven ground cover as the mulch. High tunnel culture minimizes some diseases by reducing splash dispersal. In addition, appropriate adjustment of the plastic sides will also minimize leaf wetness duration.

Some diseases are prevalent in high tunnel environments. Leaf Mold, Gray Mold, Powdery Mildew, Timber Rot and Fusarium Wilt can become problematic. Cultural practices such as sanitation (removal of plant refuse), grafting and compost amendment can minimize disease. Fumigants can be used to reduce levels of soil borne pathogens. Conventional fungicides and several fungicides approved for organic production are available for in-season management. When high tunnel sides are raised, fungicides and bactericides labeled for field use are allowed. When sides are lowered, fungicides and bactericides labeled for greenhouse use should be used (see Table E-13 "Selected Fungicides Labeled for Greenhouse Use" for specific disease and crop recommendations). See also Rutgers Cooperative Extension Fact Sheet No. 358 titled: "Important Diseases of Tomatoes Grown in High Tunnels and Greenhouses in New Jersey" (*https://njaes.rutgers.edu/fs358/*). This information is applicable to all states in the Mid-Atlantic U.S. region.

Integrated Pest Management in High Tunnels is based on the principle of economic thresholds. Random plant inspection and use of sticky cards is encouraged in the semi-enclosed plant production spaces. The hot and dry environment can elevate certain pest problems as compared to the field situation. Many studies show that the use of beneficial insects or mites biocontrols is an effective pest management technique in high tunnels. It is important to know the right biocontrol agent, recommended release times and adequate temperatures and humidity at which they function best. Using habitat plants and banker plants in a biocontrol program is beneficial and contributes to plant diversity in the high tunnels.

Table A-5. Planting and Harvesting Schedule for Freestanding High Tunnel Vegetable Crop Production

Crop	Method[1]	Average High Tunnel Planting Dates	Average High Tunnel Harvest Dates
Beet	TRP or DS	February-April; August-October 15	October-May
Bean (Snap)	TRP or DS	April-September 1	June-October
Bok Choi	TRP or DS	February-November	Year-round
Broccoli (crown)	TRP or DS	March-April; August	May-June; October- November
Broccoli (sprouting)	TRP or DS	March-April; August-October	May-June; October-April
Cabbage (Chinese)	TRP or DS	February 15-April 15; August 1-September 30	April-June; October-December 10
Cabbage (Green)	TRP or DS	March 15-May 15; August-September	May-December
Cantaloupe	TRP or DS	March 21-July	June-October
Carrot	DS	February 1-April 15; August-October	March-June; November-April
Cauliflower	TRP or DS	March 15-April 15; August	May-June; October-December 10
Chard	TRP or DS	Year-round	Year-round
Collards	TRP or DS	March-April; August-September	April-May; October-February
Cucumber	TRP or DS	April-September 1	May-October
Eggplant	TRP	April 15-August 15	July-October
Garlic	DS	October-November	June-August
Kale	TRP or DS	January-April 15; August-November 1	February-June; September-January
Kohlrabi	TRP or DS	March-April; August-September	May-June; October-December
Leek	TRP or DS	February 15-November 15	April-May; November-April
Lettuce	TRP or DS	Year-round	Year-round
Onion (Bulb)	TRP	February-March; October-November	April-July
Onion (Bunching Green)	TRP or DS	September-December; February-June	March-December
Pea	TRP or DS	February-April	May-June
Pepper (Bell)	TRP	April-July 20	June-November
Potato (Irish)	DS	February 14-March 15; August	May-June; October-December
Radish	DS	February-April; September-December	February-May; November-January
Spinach	DS	January 1-May 1; August-December	January-May; October-December
Summer Squash	TRP or DS	April-May	May-June
Tomato	TRP	March 15-July 15	June 1-December 5
Turnip	DS	February-April; September-December	February-May; November-January

[1]TRP=Transplanting, DS=Direct Seeding.

10. Greenhouse Production

Many growers have an interest in increasing productivity and quality as well as having seasonal products such as tomato, sweet pepper, cucumber, lettuce, arugula, and herbs in the off seasons or year-round. To do this in the Mid-Atlantic U.S., a temperature-controlled greenhouse structure might be needed. Greenhouse production requires a much greater level and often entirely different management strategies than field production. There are multiple greenhouse designs in the market, each with its own advantages and disadvantages, depending on the farmer's needs, environmental conditions, and level of economic investment. Greenhouse production generally requires different varieties (often of indeterminate growth habit), nutrient sources and regimens, plant training, and pest management than field production. Hydroponic systems are commonly used, although production in soil is also possible. Other fully lighted "warehouse" or vertical production systems under artificial light have been developed.

The extensive differences between greenhouse and field production preclude the inclusion of these techniques in this guide. There are many complete guides for the production of vegetables in greenhouses that have been developed and distributed through the cooperative extension service in various states. Links to some guides are provided below. This list is not all-inclusive and does not endorse these guides exclusively.

https://edis.ifas.ufl.edu/collections/book_florida_greenhouse_vegetable_production_handbook
https://ceac.arizona.edu/resources/intro-hydroponics-cea

11. Wildlife Damage Prevention

Philosophy of Damage Management

To wildlife, farms constitute viable, and often attractive, habitat, because these lands offer opportunities to find food and shelter. Although many wildlife species do not damage agricultural crops, some can inflict serious economic losses on growers. Resolution of wildlife conflicts also can be difficult for growers because they have little direct control over what happens on surrounding lands, areas that potentially can provide refuge for the wildlife causing damage on their farms.

One of the realities of running a farm is that interactions with wildlife on agricultural lands are inevitable. Therefore, having a well-designed **wildlife damage management plan** is recommended, one that proactively (not reactively) attempts to prevent or reduce damage to a tolerable level if implemented appropriately. Such a plan should delineate areas of the property where zero tolerance for damage exists as well as areas where some level of damage can be tolerated; this allows one to prioritize allocation of resources to areas of highest value or concern. Growers should recognize that eliminating all damage attributed to wildlife is not realistic and that some level of wildlife damage simply represents another of the basic costs of doing business; it is those severely damaging or repetitive episodes of wildlife inflicted loss that we seek to avoid. Additionally, an effective management plan should identify the full suite of legally compatible damage management techniques and strategies germane to the type of conflicts being experienced and establish when or under what conditions those identified options could be employed.

Wildlife damage management practices fall into 3 categories: husbandry methods, non-lethal techniques, and lethal techniques. This categorization also represents the hierarchical order in which these methods should be implemented - start with the simple, less costly, and easy-to-implement behavioral or operational modification approaches, whereas lethal techniques are methods of last resort, not options of first choice. Different damage abatement strategies obviously will have varying levels of effectiveness and inherent risks. Generally, a damage management approach that proactively integrates several damage abatement techniques will be more effective than a reactive strategy that relies on only a single technique. Although a variety of damage management options exists, not all may be suitable for use in all cases or on all wildlife species. By design, some options are more effective for temporary, short-term, or localized use, whereas others are better suited to permanent, long-term needs. Each situation of human-wildlife conflict can be unique, so management options usually need to be tailored to the needs of a specific site.

Acquisition and implementation costs associated with each management option can also vary substantially. Before deciding on a particular management technique, estimate both the direct and indirect costs you actually experience from wildlife damage. A direct cost would be the estimated annual loss of value from reduced yield or production through consumption or ruin of the crop by wildlife. An indirect cost would be the annual monetary investment (in time and/or labor) expended in monitoring or detecting damage and then treating that damage. Calculating this estimated total annual cost, in terms of the actual economic loss *due only to wildlife*, will help you decide which, if any, strategies are cost-effective. Remember, if you are spending more in your attempts to acquire and implement preventive techniques than you are experiencing in actual damage, you likely are losing money. In some instances, it may be more practical and economically feasible to simply tolerate some damage than to attempt to eliminate it. To determine if control is feasible and to inform your decision-making on selecting appropriate control techniques, you must have good estimates of the level of economic damage you are incurring and reliable estimates of what each abatement technique costs to implement. More importantly, to assess whether the techniques you utilized actually provided cost-effective management of your damage, you must have good pre- and post-treatment economic estimates of the amount of damage for comparison. If you spend more on the effort to manage damage than you realize in savings by investing in fighting those losses, you're losing money. You need to re-examine the available methods to find a more cost-effective approach or accept that trying to reduce this damage is not economically feasible.

Prior to employing any damage abatement practice, you must be sure that you have correctly identified the species doing the damage. Do not assume that, simply because you see an animal on your farm, it is the culprit responsible for any damage you detect. Because wildlife populations are regarded as a public resource, many of the animals that can cause damage on your farm are managed and/or protected by state and federal laws, regulations, and elements of Code. Most of the restrictions imposed on the use of damage management practices (*e.g.*, trapping, shooting, pesticide applications) are specific to individual species and can become quite technical. If you mistakenly assign blame for damage to the wrong wildlife species and employ a technique that is not authorized for use on that species, you can be cited for violation. Therefore, before employing any management practices, check with your county extension agent, local conservation police officer/game warden, or your district wildlife biologist to review depredation permit requirements and/or legal issues related to "take" or use of wildlife.

Below you will find information on managing conflict situations involving some of the more commonly recognized wildlife species known to be responsible for agricultural damage. This presentation is not intended to be a comprehensive summary of all possible options - the objective is to provide sufficient understanding that can assist decision-making of affected growers. Because this presentation purposefully takes a generic overview approach, given the breadth of the geographic region covered, the best and most legally accurate advice should come from authorities in your local area.

Bears

Damage caused by black bears (*Ursus americanus*) to field crops often is characterized by trampled, pulled down, or broken plants. In corn fields, bears usually create localized, circular patches within the field where the stalks are pulled down toward the center of the circle and most of the kernels on an ear of corn are consumed before it moves on to another ear. Bears are known to climb fruit trees to access the maturing fruits and, in the process, may cause substantial damage by breaking or cracking the branches of affected trees. Small fruit growers (*e.g.*, blueberries, brambles) similarly can witness bear-caused damage in the form of broken branches or splintered bushes from the bear pulling down branches to gain better access to the berries. In livestock settings, bears typically attack from the rear and try to take down its prey forcibly using its weight and strength; strafing claw marks often are present on the carcass. Scat (feces) and footprints are usually present in the area of feeding activity. There are no guaranteed bear management strategies that offer complete protection against all types of damage, but several strategies used in combination may offer some relief.

Cultural practices and habitat modification can help to deter bears. First and foremost: Do Not Feed Bears! Restricting access to potential food resources, such as storing feed in bear-resistant containers, timely collection, and disposal of animal carcasses (via deep burial), and removing fruit drops and other organic wastes, often can reduce the attractiveness of the site to bears. Containing livestock in pens away from wooded areas may reduce negative interactions, particularly during calving/lambing season. Because bears generally avoid open areas away from protective cover, maintaining a mowed buffer approximately 50 yards wide around crop fields, particularly where fields are adjacent to the woods, may reduce bear activity. Alternating or strip planting row crops may help reduce protective cover afforded to bears.

Fencing is effective in reducing bear damage; however, fencing can be expensive and may not be cost-effective for all farmers. Electric fencing is the most effective design to deter bears and would be recommended in most instances, where allowed by law. Electric fences should utilize high voltage (~6,000 volts), low-impedance (short pulsed) charger systems. When first installed, all electric fences should be baited with an attractant (*e.g.*, peanut butter, sardines) to lure bears close so they learn to associate the fence with a negative consequence. These attractants should be placed at the bear's head height (approximately 3 ft.) along the entire perimeter to better deliver the shock to the bear's muzzle.

Sensory deterrents or harassment techniques have been used to deter black bears from crop fields. Pyrotechnics, horns, bright lights, propane cannons, and other devices provide both visual and auditory stimulation. When damage coincides with the "bear chase season," allowing a local bear hunt club to run dogs through a field often provides temporary relief against bears that are using those fields. The success of these techniques is highly variable. Bears can become habituated to constant or repetitive disturbance, so a rotation of several types of sensory deterrents should be used and their position in a field should be relocated frequently. Where bears have become tolerant of human activity, sensory deterrents often will not be effective. Human-conditioned bears can be dangerous, and caution is advised.

Aversive conditioning techniques are intended to more forcibly change or eliminate undesirable bear behavior. Options that potentially may be available to harass a troublesome bear include using paint balls, projected bean bags, or rubber bullets, all of which are intended to send a strong message, but not injure or maim the animal. These approaches may not be allowed in all states, so check with your state wildlife department before use.

Shooting problematic black bears is viewed as a last resort management practice, but one that may be necessary to reduce persistent crop damage caused by a single returning individual or family group. Special "kill permits" are required to shoot a bear outside the regulated open season, so farmers need to work closely with their state wildlife agency. Farmers having persistent damage should develop relationships with local bear hunters or chase clubs to increase the level of pursuit activities on or adjacent to the farm as a means of reducing future losses. **This practice is not permitted in some jurisdictions. Consult your local Wildlife Management Authority.**

Birds

Bird damage often takes the form of the total consumption of grains and/or small fruits or the creation of holes or other surface blemishes inflicted from the birds' pecking at ripening fruits and vegetables or on woody stems. Proper identification of the offending bird species is necessary before implementing any management strategy because most bird species are protected under federal statutes (*e.g.*, the Migratory Bird Treaty Act). That said, growers who face serious damage events may be allowed certain latitude under special nationwide permits to use certain techniques that might otherwise be prohibited. For example, managing damage inflicted by flocking blackbirds often falls within the provisions of a Nationwide Permit. "Blackbirds" generically refers to a group of about 10 species, often including Common Grackles (*Quiscalus quiscula*), Brown-headed Cowbirds (*Molothrus ater*), and European Starlings (*Sturnus vulgaris*). However, growers need to apply for and receive authorization from the U.S. Fish and Wildlife Service before any lethal action is taken. Starlings, House Sparrows (*Passer domesticus*), and Common Pigeons (*Columba livia*) also are common to farms, where they inhabit the rafters of barns, warehouses, and other structures or contaminate feed bunks with their droppings while foraging on livestock feed; these species are considered exotic or introduced species and typically have no legal protection under these statutes. Birds inside packinghouses represent a serious source of fecal contamination, which may violate USDA food standard guidelines. Fecal contamination of fruits and vegetables in the field can occur if fields are located near a bird roost where large numbers of birds congregate and can complicate a producer's ability to fulfill Good Agricultural Practices (GAP) standards. It is imperative to check with the state Fish and Wildlife authority before implementing any management to ensure compliance with state and federal wildlife laws.

Cultural practices and habitat modification may reduce some crop damage. Because the most severe instances of blackbird damage commonly occur within 5 miles of a roost, planting highly attractive crops outside this radius is recommended wherever established roosts are known to exist. Blackbirds generally do not prefer soybeans, hay, wheat, or potatoes. Planting multiple smaller crops at the same time in nearby fields, as opposed to large fields of a single crop, may reduce damage overall. Modifying the physical structure of roosts or encouraging birds to abandon existing roosts may reduce the number of birds in the area. For example, eliminating stands of introduced bamboo or thinning dense stands of conifer trees have been shown to reduce crop damage by removing favored roosting spots. Removal of about 1/3 of a tree's crown or 1/3 of a stand of trees has been successful in reducing or dispersing birds from a roost. Keep in mind, though, that you also will modify habitat used by other non-destructive and potentially desirable bird species. Installing artificial hunting perches in or adjacent to fields to enhance the success of raptors that feed on other birds may reduce blackbird numbers as a result of the threat of predation.

Exclusion (*e.g.*, netting) typically is practical only on small acreages or for high-value crops. Lightweight netting has been used successfully to prevent bird damage either by draping it over individual plants or constructing a frame and stretching netting over an entire block of plants. To prevent birds from entering packinghouses, netting or some other type of barrier should be placed over openings larger than 1/2 inch. In doorways where frequent pedestrian, vehicle, or machinery traffic occurs, hang heavy plastic or rubber strips, or install self-closing doors to prevent birds from accessing the building.

Repellents can be used to mitigate bird damage. Methyl anthranilate, the primary ingredient of artificial grape flavoring, is registered by EPA for use as a bird repellent for certain species. However, methyl anthranilate remains viable for only short periods of time as it loses efficacy when exposed to UV radiation and weathering. Sucrose solutions may be applied to fruits to deter birds, but the efficacy of this method is not well documented and actually may attract other pests, such as Japanese beetles.

Scare tactics usually are effective only when providing short-term protection for crops, often immediately just before peak harvest would occur. Blackbirds are intelligent animals and quickly will habituate to repetitive or predictable patterns and disturbances. Frightening methods must be changed and/or relocated often to maintain the desired effect. Frightening devices include both visual and auditory deterrents. Pyrotechnics (*e.g.*, propane cannons and shotguns), Mylar balloons and reflective metallic tape, raptor-shaped kites, scarecrows, flashing lights, water sprayers, and tape-recorded bird-distress calls or predator attack calls all represent examples of harassing techniques; success among these devices varies substantially. Based on some success in repelling fish-eating birds in aquaculture facilities, research on the use of lasers to reduce bird damage in other settings is on-going and may offer another viable option for growers in the near future. In general, scare tactics should be activated early to mid-morning and mid- to late afternoon, when birds are most active. For maximum effectiveness, it is best to use two or more devices in combination, vary the times and places these devices are employed, and be persistent.

Lethal Methods typically are tightly controlled by regulation or statute, so caution is advised here. Chemical frightening agents mixed into bait piles may be applicable in specific situations. Birds that ingest the treated bait fly in an erratic fashion, produce distress calls, and usually die. This unusual behavior triggers an alarm response among the remaining birds in the flock, causing them to vacate the area. Dead birds should be collected and disposed of properly. NOTE: use of such chemicals typically is restricted only to certified applicators (usually representatives of USDA APHIS-WS), so check with your local pesticide program agent about the legality and possibility of employing chemical frightening agents on your farm.

Some states allow growers to shoot crows that are in the act of damaging crops. Farmers may be allowed to shoot other species (often with a permit), but it is recommended that farmers check with local wildlife authorities before doing any shooting. Also, it helps to maintain good working relations with authorities; farmers should alert local authorities and/or abutting neighbors about their intention to conduct a shooting strategy as a way to avoid having unsuspecting individuals make unnecessary calls to the local "911" Emergency Dispatch system when the shooting starts.

Deer

Deer damage may take the form of direct foraging, antler rubbing, and/or trampling of crops. Foraging damage from deer is characterized by a torn, jagged appearance on vegetation or a ragged break on woody stems. Most browsing damage occurs from ground level and up to a height of about 6 ft. Residual damage may occur from the trampling or matting down of vegetation as deer travel through crop fields or bed down to rest. Antler rubbing damage occurs as males try to shed the velvet coating from their antlers each autumn and typically leaves behind scarred saplings, broken limbs, bruised bark, and/or exposed wood. Rubs usually are located about 2-3 ft. above the ground on the trunks of small trees or widely-branched shrubs.

Effective management of deer damage often requires using several deterrent strategies and should embrace options from within the full suite of available husbandry, non-lethal, and, where warranted, lethal options. Each method carries certain benefits and inherent drawbacks; therefore, an accurate assessment of management needs and desired outcomes is critical to selecting the most appropriate techniques.

Habitat modification is a form of husbandry that involves changing the landscape to make an area less attractive to deer. White-tailed deer (*Odocoileus virginianus*) are creatures of edge habitats; they prefer locations where two or more vegetation types or age classes meet. Habitat modification usually involves eliminating preferred types of vegetation, planting non-palatable ("deer-resistant") species, or creating alternative foraging areas to attract deer away from crops. Although these strategies have been used to reduce incidences of deer-vehicle collisions and browsing on residential vegetation and commercial landscaping, habitat manipulation alone is unlikely to significantly reduce damage in agricultural crop fields or nurseries.

Harassment or scare tactics are intended to persuade deer to leave an area where they are not desired. Examples of hazing and scare techniques include dogs, auditory deterrents (such as propane cannons and sonic devices), and visual deterrents (such as bright lights). An increase in the use of dogs contained within invisible fencing has brought some success to farms but is dependent on the number and aggressiveness of dogs used relative to the size of the area needing protection. Dogs tied to chains or ropes are not effective because deer can detect that the dog's movement is restricted. Hazing campaigns need to be relentless and persistent and generally are better suited to small areas where damage from deer is minor or where other strategies (*e.g.*, hunting) may be prohibited.

Fencing can be an effective management tool for eliminating or reducing deer damage and, in many cases, may be the most effective damage abatement option. When attempting to protect large areas, permanent high-tensile wire (HTW) fences are recommended. These fences consist of a series of electrified smooth wires spaced about 8 inches apart that extend to an overall height of 10 ft. HTW fences are durable and long-lived but do require regular monitoring (to check voltage) and periodic maintenance (*e.g.,* removal branches or other material that may short-out the flow of current). Temporary HTW electric fencing or fences that use polytape strands are available, but usually are better suited for use on smaller acreages or where protection is needed for only a short period of time. When using any form of electrified fencing, it should be charged at all times to prevent deer from becoming emboldened or gaining confidence from its lack of shocking during down times. Electric fences that have been baited with an attractant (*e.g.,* peanut butter) demonstrate noticeable enhanced success over non-baited fences, as deer are more likely to develop an immediate association between the fence and its negative consequence when drawn in by baiting. The addition of cloth strips, flagging, and reflectors certainly increase the visibility of a fence, but these additions display only marginal improvement in efficacy over fences lacking such visual cues. Although other fencing alternatives exist, such as double-barrier fencing (2 rows of fence placed approximately 4 ft apart), heavy plastic fencing, and strands of monofilament line decorated with flagging tape streamers, none provide the level of protection or cost-effectiveness of a well-designed and properly installed and maintained electric HTW fence. It is important to note that no type of HTW fence will eliminate all penetration by deer. If absolute protection from deer is desired, the only fence design that can guarantee that outcome is a 10-ft tall (minimum) woven wire fence. However, in most situations, producers typically cannot justify the costs of procurement and installation of such a fencing system.

Repellents are products that have strong or repugnant tastes, odors, or a combination of both taste and odor. Those that animals find most offensive will encourage them to avoid the area being protected. There are 2 types of repellents: contact repellents and area repellents. Contact repellents are applied directly to vegetation or objects via spray, shakable powder, or brush. Area repellents are applied in the general vicinity of the object for which protection is desired and repellency is derived primarily by odor. Repellents can be expensive, based on the initial cost of materials, but more so by the need for frequent reapplication. Rain eventually will wash a repellent off vegetation, even if a "sticker" is used. Based on multiple research studies, products derived from or containing a high concentration of putrescent egg solids and/or animal fat-based products provided greater repellency than those without these active ingredients. The level of attractiveness (*i.e.*, palatability) of a food resource to deer, the density of deer in the area, and the availability (or lack thereof) of other natural foods in the area all will influence the effectiveness of repellents. Many repellents are labeled for use only on dormant vegetation or on non-consumable products, so growers must be sure to follow the manufacturer's instructions. Repellents used during the growing season must be applied frequently to keep pace with the emergence of new, but as yet unprotected, growth. Regardless of the type of repellent used, all repellents are intended to reduce, rather than eliminate, deer damage; repellents should be used in conjunction with other damage abatement techniques to maximize overall success.

Results from recent research on the use of an auditory repellent offer some encouragement for those seeking to protect small acreage plots from deer (see Hildreth, A.M., S.E. Hygnstrom, and K.C. VerCauteren. 2013. *Deer-activated bioacoustic frightening device deters white-tailed deer*. Human-Wildlife Interactions Vol. 7 (1): 107-113, available at: *https://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=1128&context=hwi*).
Tests examining the efficacy of bioacoustics revealed that entry by deer to a protected area was reduced by 99% and acquisition by deer of bait materials placed within the plot was reduced by 100% following deployment of the device. Pre-recorded playback of distress calls made by deer, triggered by activation of motion detectors as deer approached the test area, caused deer to immediately flee the area. There were limitations on the size of the area over which protection successfully was extended by a single device, so the suitability of this approach to large acreages likely would be reduced.

Reproductive abatement: Although there is great interest in and much research being conducted on the use of contraceptives (chemicals given to female deer to disrupt reproductive behaviors), only specially trained wildlife professionals are permitted to administer this treatment (typically through use of a dart gun). To date, no effective reduction in population numbers, and thus a concurrent reduction in damage, has been achieved using contraceptives in free-roaming populations of deer. Success has been realized only in isolated contained populations where access to nearly all members of the population can be attained (*e.g.*, on islands, in confined city parks, etc.). This is a labor-intensive and costly strategy, and because individuals consistently move into and out of a population, it is extremely difficult to treat a sufficient number of individuals or to know which individuals already may have been treated. Research to improve fertility control methods is ongoing.

Trap and transfer methods involve trapping deer in a specific area and physically moving them to another location. There are several techniques for trapping deer, including box traps, Clover traps, netted cage traps, drive nets, drop nets, rocket nets, corral traps, net guns, and immobilization drugs delivered through a dart. This strategy is labor-intensive, costly, impractical at large scales due to a lack of suitable relocation sites and carries the risk of spreading disease. Most states ban the translocation of deer due to concern about the spread of disease and the potential for injury to trapped animals. **This practice may not be permitted in some jurisdictions (*e.g.*, Virginia). Consult your local Wildlife Management Authority.**

Trap and euthanasia is a process that involves trapping deer and euthanizing the animals according to methods approved by the American Veterinary Medical Association. Deer are baited to a trap site and captured using box traps, Clover traps, drop nets, or rocket nets. Once captured, deer are anesthetized and immobilized prior to euthanasia. Trap and euthanasia methods are labor intensive and more expensive than other management strategies. **This practice may not be permitted in some jurisdictions (*e.g.*, Virginia). Consult your local Wildlife Management Authority.**

Because deer populations range over multiple parcels or farms, management of deer numbers often cannot be implemented effectively on a single property. Research clearly indicates that greater success in attaining population objectives can be achieved by developing and implementing a comprehensive **Community-Based Deer Management Program**, especially in environments where traditional population management methods are not an option. Under this program, the state Fish and Wildlife authority cooperates with municipal, county, and, if applicable, other federal agencies to provide technical assistance in developing alternative deer management options. Some options include employing baiting and sharpshooting, use of noise-suppressed firearms, and other methods that otherwise would not be legal under traditional hunting approaches. State authorities can issue permits to conduct special deer management activities in areas where regulated hunting is not possible or deemed safe. **This practice may not be permitted in some jurisdictions. Consult your local Wildlife Management Authority.**

Regulated hunting involves the use of hunters to harvest deer in accordance with defined seasons, bag limits, and population objectives. Hunting legally takes place during any of the various deer hunting seasons (archery, muzzleloaders, shotguns, and general firearms) established by the state Fish and Wildlife authority. Regulated hunting is the most cost-effective and efficient method to manage deer populations and is the only effective means to manipulate deer numbers statewide. See your state Fish and Wildlife authority for details on when the regulated season is open. Many states offer additional deer tags ("bonus tags") to farmers who then distribute them to hunters who offer to harvest additional deer beyond what normally would be allowed on an individual's hunting license. Check with your local wildlife authority to see if this option is available.

Permits to Shoot, commonly referred to as a "Depredation Permit" or "Kill Permit," are issued by the state Fish and Wildlife authority to owners or lessees of land who are experiencing crop damage. These special permits are highly variable among jurisdictions, but, where available, allow growers a mechanism to manage damage situations during times of the year when the regulated hunting season is closed and "take" normally would not be allowed. Depredation permits can help regulate local deer populations, particularly in areas that receive only limited hunting pressure (*i.e.*, farms surrounded by residential properties). For more information or to apply for a depredation permit, contact your state Fish and Wildlife authority.

Controlled hunts combine conventional deer hunting methods with more stringent controls and restrictions on hunter activities. Participants in controlled hunts are chosen by various methods, ranging from selection by random lottery of interested licensed hunters to a more rigorous process involving assessment of hunting skill and weapon proficiency. Specific restrictions and controls applied to hunting activities depend upon the needs and concerns of landowners, elected officials, and other stakeholders, but usually will be similar to hunting regulations imposed during the normal deer hunting season.

Feral Swine

The appearance of feral swine on the landscape likely is an unfamiliar threat that many commodity producers in the Mid-Atlantic region have never experienced before. However, new populations of hogs can appear overnight and spread rapidly as a result of illegal importation and release of animals trapped elsewhere, creating a serious vertebrate threat for producers. Whether from direct foraging or rooting behavior, the amount of damage inflicted by feral swine can be extensive and devastating in a short period of time, depending on the size of the sounder (*i.e.*, the family or social grouping) that takes up residence in the area.

Being an introduced, non-native species, the feral swine has no protection under wildlife or game laws in most states, so hogs may be taken by legal methods at any time where such restrictions do not exist. However, it can be difficult to distinguish true feral animals from domestic swine that recently escaped and still constitute "property" to the swine owner. Thus, in some states, population management and damage mitigation have become complicated by questions of ownership and the legalities related to the take of property - caution is urged before any hog removal action is implemented.

That said, growers confronted by the presence of feral swine should immediately contact the USDA-APHIS Wildlife Services Office that serves their state and request assistance in devising an effective hog eradication plan. Trap and bait techniques currently have proven to be the most reliable and successful approach to manage hog populations, but such operations take time and persistence to achieve the desired outcome. Shooting alone often proves ineffective in that only a small number of hogs in a social group can be taken at once and those that escape quickly learn to avoid hunters in the future. Although on-going research on potential toxicants has been encouraging, registration of an approved material remains years away. At this time, keen observation, and attentiveness to the first signs of hog presence are imperative to stay ahead of this threat.

Groundhogs

The most obvious signs of groundhog (*Marmota monax*) presence, aside from actually seeing the animal, are the entrances to a groundhog burrow system. Groundhog burrow systems are characterized by a large mound of excavated earth distributed about the main entrance and several discretely located secondary exits. The diameter of the main entrance may measure 10-12 inches. There are usually 2 or more additional entrances to a burrow system, which are well hidden and do not display the apron of excavated soils distributed around the opening. Although groundhogs prefer leafy green vegetable crops, they will use many different crops throughout the growing season. Seasonal or cyclic reproductive patterns may influence groundhog abundance and the extent of damage from year to year.

Habitat modification, such as thinning or removing dense vegetation that provides protective cover, typically is not a feasible strategy for minimizing groundhog damage at the commercial scale of most farms, and rarely proves to be cost-effective.

Exclusion with fencing can be an effective short- or long-term strategy, depending on the type of fence and the size of the area to be protected. An electric wire placed 3-4" above the ground can deter groundhogs from entering a protected area. However, a determined groundhog eventually will dig under the wire and gain access to the area.

Woven mesh or chicken wire fencing provides a more permanent solution. Mesh openings should be < 2 inches, and the fence should extend at least 3 ft. above the ground. The top 15 inches of the fence should extend outward at a 45° angle to prevent individuals from climbing over the top. To prevent groundhogs from digging under the fence, the bottom edge of the fence should be buried at least 10 inches beneath the ground, with an additional 6-8" section bent outward at the bottom of the trench. Groundhogs are excellent climbers, so fence posts should be placed on the inside of the fence and greater deterrence has been achieved where the fence material is not drawn taut or rigid, but instead left somewhat loose.

Fumigants are effective in reducing groundhogs. Gas cartridges (sodium nitrate) currently are registered for this purpose. Ignited gas cartridges are placed in the burrow system after all but the primary entrance are sealed. As the cartridge burns, thick fumes are emitted and fill the burrow system. Burrows can be treated with gas anytime of the year, but this method is most effective in the spring before the first litter of young emerges. Gas cartridges are a General Use Pesticide (GUP) and can be purchased at most farm supply stores. A note of caution when using gas cartridges – because the gas cartridge must be ignited for proper use, a fire hazard does exist. Therefore, gas cartridges should not be used in burrows located under wooden sheds, buildings, or near combustible materials. New resident animals may recolonize an empty or recently vacated burrow system, so continued vigilance is recommended.

Aluminum phosphide tablets, placed deep inside the main burrow entrance, are another type of fumigant that can provide effective groundhog control. The tablets react with moisture in the soil, creating hydrogen phosphide gas. Soil moisture and tightly sealed burrow entrances are important for the fumigant to be used effectively. The tablets are approved for outdoor use on non-cropland and orchards. Aluminum phosphide should not be used within 15 ft of any occupied building or in areas where gas could escape into areas occupied by animals or humans. Aluminum phosphide is a Restricted Use Pesticide (RUP) and can be applied only by a certified pesticide applicator.

Trapping is effective in removing particularly problematic individuals. However, new groundhogs from the surrounding area will quickly reoccupy the territory. Steel leg-hold traps are illegal in some states, so check with your state wildlife agency to determine what is legal. However, a medium-sized live trap baited with a variety of baits (*e.g.*, lettuce, apples, or fresh beans) can attract a groundhog's attention if placed close to the burrow entrance. Traps should be placed at main entrances or along major travel corridors and checked at least once every 24 hours. Once captured, the groundhog may be killed humanely or released elsewhere on the property. If the groundhog is to be released, many states regulate where and how the live animal is to be handled. No releases are allowed on federal, state, county, or municipal land. **This practice may not be permitted in some jurisdictions (*e.g.*, Virginia). Consult your local Wildlife Management Authority.**

Shooting groundhogs that are damaging crops or farmland is approved at any time of the year. Although groundhogs are considered a game species in some states (it is a "nuisance species" in VA), farmers do not need a valid hunting license to shoot nuisance groundhogs on their own property. Growers should verify with the state wildlife agency which weapons are legal for this purpose in your state.

Rabbits

Rabbits can damage vegetation by clipping branches, stems, and buds. Damage may become especially pronounced during periods of heavy snow or in the spring when plants are emerging from the ground. Vegetation that has been clipped by rabbits is characterized by a cleanly snipped, 45° angle cut at the point of damage. Rabbit tracks and their pelleted scat often are found in areas of recent damage.

Growers should adopt **cultural practices** and conduct **habitat modification** to maintain well-groomed plots and eliminate brush piles, heavy vegetation, and other cover that serves as nesting and hiding sites in and adjacent to crop production sites. However, removal of such cover may be detrimental to other desirable wildlife species that also depend on brush piles for protection or shelter. Habitat modification techniques that enhance the success of rabbit predators (*i.e.*, fox, coyote, and raptors) will help regulate rabbit numbers. Planting alternative crops in adjacent tracts has been suggested as a means to deter rabbits from high-value crops, but this approach typically serves to attract or support higher numbers of rabbits.

Exclusion of rabbits through use of fencing can be effective. A 2-foot high fence consisting of 1-inch or smaller mesh and constructed of any metal (rabbits will gnaw through plastic) will eliminate most rabbit damage. To prevent rabbits from accessing snow-covered fields, consider increasing the height of the fence to accommodate the effect of deep snow. The bottom of the fence should be buried 12 inches in the ground and bent outward away from the crops at a 90° angle. Larger areas can be protected with “hot” double-strand electric fencing, with the lower strand set close to the ground (*i.e.*, within 2-3 inches) and the second strand 2-4 inches above.

Rabbit guards made of metal wire with ¼- to ¾-inch mesh may be effective in protecting individual high value specimens. Hardware cloth can also be used. Rabbit guards should be placed 1-2 inches away from the plant. Do not allow debris to accumulate inside these screen guards as this creates an ideal environment for borer infestation and may attract voles. All guards should be anchored to the ground.

Miscellaneous methods: Harassment techniques, such as dogs and motion detector activated water sprayers, provide only short-term protection. Contact (*e.g.*, thiram-based) and area (*e.g.*, naphthalene) repellents have been used for rabbit control with variable effectiveness; however, most rabbit repellents are not approved for use on foods grown for human consumption, so check the product label and active ingredients before use. Rabbits are classified as a game species and, as such, can be hunted during open rabbit seasons. Finally, trapping rabbits (but excludes relocation and release of captured animals on property you do not own) may be a viable option if damage is not too extensive. Consult the state Wildlife agency prior to implementing any hunting or trapping program to assure compliance with existing regulations.

Voles

It is important to determine which species of vole occurs in your crop production sites. Vole species most associated with depredation issues in the Mid-Atlantic region are the **meadow vole** (*Microtus pennsylvanicus*) and the **woodland vole** (*Microtus pinetorum*). Meadow voles, also called meadow mice, are about 5½ to 7½ inches long, with fur that ranges from gray to yellow-brown with black-tipped hairs; they also display a bi-colored tail. Woodland voles are about 4-6 inches long, have red-brown fur, and a tail about the same length as the hind foot. Vole populations are cyclic, where cycle peaks last approximately 1 year before the population abruptly crashes. It is during these peak times where the potential for significant crop damage is greatest.

Because voles remain active year-round, the damage they cause to crops can occur at any time, depending upon the crop. In vegetable crops, damage usually occurs in spring, as young plants are emerging. Voles are generalist herbivores, so they feed on roots, shoots, tubers, leaves, and seeds of many different plants. Meadow voles spend more time above ground than do woodland voles, but both species inflict serious damage by feeding on the subsurface root systems of plants. Above ground damage frequently consists of gnawing and girdling of the main stems of woody perennial plants or the sprouts and suckers that emerge from the base of such plants. Meadow voles construct surface runways (approx. 1½ to 2 inches wide) under or within the accumulated organic matter and duff layer that exists in fields; these runs often terminate at a 1-inch diameter wide hole that drops into an underground burrow network. In contrast, pine voles remain underground and inflict damage in the form of root girdling, which often goes unnoticed until severe damage already has occurred, and the affected plant is in rapid decline. Both species are known for constructing burrows that follow trickle irrigation lines or areas where the soil has been loosened by mechanical planters.

Cultural practices and habitat modification measures are helpful in deterring vole populations. Voles avoid areas with few food resources and little protective cover. Control of ground vegetation with herbicides, mowers, or disking is effective, although voles will travel under snow cover in these areas. Herbicides are the preferred method to eliminate sod. Cultural practices that reduce the amount of organic litter around plants are essential. All areas should be kept clear of debris or stored objects on the ground (such as bags, boxes, pruned branches) because these items provide protection to voles and can hinder mowing and proper bait placement. Plastic or synthetic weed barriers will encourage the establishment of vole populations, so use of these materials should be avoided. A final close mowing of the row middles, after harvest, should be utilized annually to further reduce habitat and cover for rodents and to enhance the effectiveness of natural predators (such as hawks and owls).

Exclusion methods are feasible only at small scales and to protect high-value crops. Hardware cloth or woven wire fences (≤ 1/2 inch mesh) can be installed to a height of 1 ft. above ground and buried to completely contain the rooting system of the plant. There are newer products composed of sharp-edged rock or pumice granules that can be used to line the planting hole and will act much like a barrier against digging. This requires significant hand installation, so an analysis of cost-effectiveness is necessary before considering such methods.

Repellents that contain predator urine (coyote and fox) have demonstrated some limited effectiveness in reducing vole numbers, primarily through the effects of induced stress on reproduction. However, repellents are expensive and offer only short-term relief from damage. Repellents that contain thiram and capsaicin are not approved for use on plants grown for human consumption.

Trapping may be useful only where vole damage is localized (<1 acre). Place snap traps perpendicular to the runway with triggers in the runway at a frequency of 2 to 3 traps per runway. All traps should be covered by a weighted box or pail to prevent non-target captures. Multiple-catch mouse traps also have been used to trap voles. Because the trap holds multiple individuals, fewer traps are necessary. In addition, non-target animals can be released unharmed. Bait multiple-catch trap entrance points with seed. If a trap is unsuccessful for 2 consecutive nights, move the trap to another location.

Toxicants often are the preferred method used to control large vole populations and such strategies typically use toxicants that are classified as Restricted Use Pesticides (RUPs); these products can be applied only by a pesticide applicator who possesses both a general applicator certification and the advanced certification for vertebrate application (Category 7D). In most cases, voles must feed on treated baits multiple times to sustain a lethal dose. Therefore, properly located bait stations (*i.e.,* within an area of current infestation) must be stocked and maintained to ensure success.

Zinc phosphide is a single-dose RUP available as a concentrate or in pelleted or grain bait applications. Because of its noticeable garlic odor and taste, voles eventually may shy away from or avoid bait stations stocked with ZP. Pre-baiting stations with untreated food for 2 to 3 days prior to applying the pesticide may increase success. Anticoagulants also can be effective in controlling vole damage. However, anticoagulant baits are slow acting and may take up to 15 days to be successful. Furthermore, most anticoagulants require more than one feeding for maximum effectiveness.

To avoid danger to non-target species, the use of bait stations is recommended and may be required in some states. Broadcasting toxicant baits across the ground surface, or placing these baits in piles on bare soil, is not allowed. Placing bait beneath asphalt shingles or tires cut in half and used as bait stations may be an acceptable practice under some state Pesticide Laws. However, bait rarely stays dry and can lose efficacy when coming in contact with moist soil. In-furrow placement of zinc phosphide pellets is recommended for corn and soybeans under a no-till management system. Hand placement of baits directly in enclosed runways and burrow openings within the tree drip line is essential for woodland vole control because of their subterranean behavior.

To ensure the legality of using a particular toxicant in your state, contact your state's Pesticide Control Program. As with all use of toxicant products, follow the product's labeling guidelines explicitly.

12. Pollination

Seed and fruit production in many vegetable crops is dependent on pollen transfer within or between flowers. In most cases, pollen transfer is accomplished by insects such as bees or flies, and it is often beneficial to release pollinating insects into the crop during the flowering stage to achieve desirable fruit set and mature quality. Some crops like cucurbits require multiple pollination events for normal fruit development. The size and shape of a mature fruit is usually related to the number of seeds, and each seed is the result of a pollination event. Generally, as the number of bee visits increases there will be an increase in fruit set, number of seeds per fruit, fruit weight, and improved fruit shape. In strawberries, sufficient pollination also results in fruits with a longer shelf life and better color. Delay in pollination affects the timing of fruit set, while lack of adequate pollination usually results in small or misshapen fruit in addition to low yields. Even some crops that are capable of self-pollination (*e.g*., eggplant, lima beans, okra, peppers) often benefit from pollen transfer by insects.

Integrated Crop Pollination

Bees are the most important group of insects for crop pollination. Today's approach integrates managed and wild bee species. More information is available in several online resources, *e.g*.,

- "What is Integrated Crop Pollination" at *https://youtu.be/yMP5dTDRi6g,*
- "The Integrated Crop Pollination Project" at *http://icpbees.org/tools-for-growers/* and *https://vimeo.com/101962669,*
- "Integrated Crop Pollination for Squashes, Pumpkins and Gourds" *at http//icpbees.org/wp-content/uploads/2014/05/Integrated-Crop-Pollination-for-Cucurbita-crops.pdf,*
- Penn State College of Agricultural Sciences Center for Pollinator Research at *http://ento.psu.edu/pollinators*.

European honey bees (*Apis mellifera*) and commercial bumble bees are most used for managed pollination services because they can be moved. Populations of wild bees can also be important for vegetable pollination. Wild bees include bumble bees (*Bombus* species), the squash bee (*Eucera pruinosa*), orchard bees (*Osmia* species), and many species of solitary bees, most of which nest in soil. Surveys of wild bees reveals over 500 species in the Mid-Atlantic U.S., but not all will necessarily be visiting any given crop. The community of managed or wild bees visiting a crop varies among crops and can be influenced by other flowering plants competing for these same bees.

Activity of managed or wild bees on crop flowers at the correct time will enhance pollination. Individual cucurbit and strawberry flowers are usually open and attractive to bees for a day or less. The opening of the flower, release of pollen, and commencement of nectar secretion normally precede bee activity, and the timing is coordinated with receptivity of the stigma. Pumpkin, squash, and watermelon flowers normally open around daybreak and close by noon, whereas cucumber, strawberry, and muskmelon flowers generally remain open the entire day. Pollination usually takes place on the day the flowers open due to the short periods of pollen viability and stigmatic receptivity.

Activity and behavior vary with the species of pollinator. Bumble bees are active over a wide range of weather conditions and can tolerate foraging in cooler temperatures. Honey bee activity is determined primarily by weather and conditions outside the hive. Honey bees rarely leave the hive when the outside temperature is below 55°F (13°C). Flights seldom intensify until the temperature reaches 70°F (21°C). Wind speed more than 15 mph seriously impedes bee activity. Cool, cloudy weather and threatening storms reduce honey bee flights. Squash bees are active soon after sunrise in July and August. Most of the feeding of female squash bees is completed by midmorning (9 or 10 AM) after which they return to their nests in the soil. Male squash bees will continue to feed on flowers, often overnight.

Populations of wild bee species vary in abundance from year to year. Regular pesticide applications may reduce the abundance and diversity of these pollinators, and some agricultural practices such as tillage may destroy wild bees that nest in the soil. The implementation of conservation tillage practices may reduce nest damage.

Most Mid-Atlantic states have completed or are in the process of implementing **State Managed Pollinator Protection Programs (MP3s).** Consult your State Apiarist (Table A-6) or the Department of Agriculture for your State requirements. **See also section D.6.3.1 Protection of Pollinators in this guide for state-specific initiatives and regulations on pollinator protection from pesticides, including MP3s and labels/regulations/laws related to applications of pesticides and protection of pollinators.**

Table A-6. State Apiarist Contact Information The state regulatory agency, state apiarist, and the web link to the managed pollinator protection plan made available by each state agency. New Jersey has recognized pollinator protection measures that can be found on the State bee inspection site linked below.

Delaware Department of Agriculture, **Emily Wine** (*emily.wine@delaware.gov*), *https://agriculture.delaware.gov/wp-content/uploads/sites/108/2017/12/ DelawarePollinatorPlan2016.pdf*
Maryland Department of Agriculture, **Cybil Preston** (*cybil.preston@maryland.gov*), *https://mda.maryland.gov/plants-pests/Documents/MP3-Pollinator-Plan.pdf*
New Jersey Department of Agriculture, **Meghan McConnell** (*Meghan.McConnell@ag.nj.gov*), *https://www.nj.gov/agriculture/divisions/pi/prog/beeinspection.html*
Pennsylvania Department of Agriculture, **Karen Roccasecca** (*kroccasecca@pa.gov*), *https://ento.psu.edu/pollinators/publications/p4-introduction*
Virginia Department of Agriculture and Consumer Services, **Keith Tignor** (*keith.tignor@vdacs.virginia.gov*), *https://www.vdacs.virginia.gov/pdf/BMP-plan.pdf*
West Virginia Department of Agriculture, **Shanda King** (*sking@wvda)* *https://agriculture.wv.gov/SiteCollectionDocuments/WVPollinator.pdf*

Commercially Available Honey Bees

For crops readily visited by honey bees, the most reliable way to ensure pollination is to own or rent strong colonies of European honey bees from a reliable beekeeper. European honey bees are the primary managed pollinators because colonies with large populations can be easily moved to the field each year. With the arrival of parasitic honey bee mites (mainly *Varroa destructor*) along with likely impacts of pathogens, insecticides, and fungicides, the numbers of overwintering European honey bee colonies have significantly decreased in the last 20 years. Abundant colonies of feral honey bees (wild colonies nesting in trees or other cavities) are now uncommon to rare in most areas, and beekeepers are losing large numbers of colonies to mites, disease, and other stress factors. As a result, fewer beekeepers are providing honey bee colonies for pollination services, and some colonies may be of marginal quality for pollination.

The **Mid-Atlantic Apiculture Research and Extension Consortium** is a regional group focused on addressing the crisis facing the beekeeping industry (*https://canr.udel.edu/maarec/about-2/)*. Additional relevant websites are the Center for Pollinator Research (*http://ento.psu.edu/pollinators*), and the Honey Bee Health Coalition (*https://honeybee healthcoalition.org/*).

A brief introduction to best management practices for honey bees can be found at *https://honeybeehealthcoalition.org/hivehealthbmps/*. Best practices include: (1) Locating colonies in areas with sufficient flower forage and protected from exposure to sunlight (an east or southeast hive entrance encourages bee flights); (2) Elevating the colony to have the front entrance free of grass and weeds; and (3) Allowing a clean water supply within a quarter mile of the hive.

The number of colonies per acre for adequate pollination varies with location, attractiveness of the crop, density of flowers and length of blooming period, colony strength, and competitive plants in the area. In vine crops and strawberries, recommendations are to place 1 to 2 colonies per acre, with more hives required for higher density plantings.

To ensure adequate quality and numbers of honey bee colonies, growers should:

- **Have a written and signed contract between the grower and the beekeeper.** This will ensure that enough pollinators are provided and that beekeepers are protected from pest control practices that may injure bees. The contract should specify the number and strength of colonies, rental fee, time of delivery, and distribution of bees in the field, as well as a plan to manage weeds that may act as competitive bloom. A sample contract is provided at *http://edis.ifas.ufl.edu/aa169*. When entering into a pollination contract, there are some basic guidelines for beekeepers and growers alike (for more detailed information, see: *https://honeybeehealthcoalition.org/growers-and-beekeepers-role/*).
- **Obtain an adequate number of colonies**. This varies among crops, location, attractiveness of the crop, density of the flowers and length of the blooming period, colony strength, and competitive plants in the area. A rule of thumb is to start with one colony per acre and adjust from there. Areas well populated with wild bees will not need as many rented honey bee hives.
- **Obtain bees at the appropriate time**. For melons, cucumbers, squash, and strawberries, honey bees should be moved in when the crop is flowering adequately to attract bees. Competing food sources from other flowers (*e.g.*, dandelions), should be eliminated by mowing, cultivation, or herbicides (prior to bees being moved there).
- **Locate colonies for maximum effect**. Place colonies in groups of 4 to 8 in favorable locations throughout the farm or field to provide an even distribution of the bees. In large fields, pollination is effective if groups of 10 to 20 hives are distributed in sunny, wind-protected spots. Bales of straw or packing boxes stacked behind colonies offer wind protection. Be aware of the pollination requirements of your specific crop varieties. Some varieties may require “pollenizers” (sources of viable pollen for sterile varieties) to achieve adequate fruit set. Bees must be located so that they will encounter pollenizers and carry their viable pollen to the production varieties.
- **Rent honey bee colonies that are healthy and contain a large enough population to do the job**. Packaged bees (bees purchased through the mail) and small hives are inferior to strong, overwintered colonies. Two weak colonies are not equal to one strong colony. However, in some areas, colony loss has been so high that it may not be realistic to exclusively rely on overwintered colonies for pollination services. More information is available at: *https://beeinformed.org/citizen-science/loss-and-management-survey* and *https://agdev.anr.udel.edu/maarec/about/contact-2/*.
- **Consider the use of bee attractants**. Sugar-based attractant sprays are generally ineffective. Bees collect the sugar off the leaves, usually without visiting flowers. Although this brings more bees into the field, supplemented pollination does not necessarily occur, and the sugar may serve as a medium for sooty molds. Other attractants containing bee derived communication pheromones, such as geraniol, have proven more successful, but further testing is needed. One of the most promising attractants, “Fruit Boost”, contains honey bee queen mandibular pheromone. U.S. distributors of “Fruit Boost” are in the Pacific Northwest. For more information, contact Phero Tech, Inc., 7572 Progress Way Delta, BC, Canada V4G 1E9; phone: 604-940-9944; fax: 604-940-9433.
- **Contact beekeepers early**. Colonies may be in short supply. If you do not have a past relationship, make initial contact with the beekeeper the previous fall. Beekeepers usually assess the survival and strength of their colonies from mid-February to mid-March.
- **Requests for hive relocation should be given before application, ideally 48 hours or more. However, some states, such as New Jersey have notification regulations of 24 hours in advance, which is enforceable.** Some states have employed a hive registration program or an online voluntary registration tool that can help applicators locate and contact nearby beekeepers; contact your State Apiarist **(see Table A-6).**
- See **Section D. 6.3.1 Protection of Pollinators** for detailed information about FieldWatch online hive mapping services which has been sponsored by all Mid-Atlantic States. **Currently, the neonicotinoid pesticide labels prescribe a 48-hour notification in label-prescribed circumstances.**

Honey bee colony size and strength can be assessed in several ways:

1. Inspect hives:

This method is most time-consuming, but also most accurate. Colonies used for springtime pollination should have at least: a laying queen, 1½ or 2 stories (hive bodies or boxes), and 4 to 6 frames of brood; and enough adult bees to cover 6 to 8 frames. These are the minimum requirements. Stronger colonies with larger populations make superior pollination units and may command a higher price. As these stronger colonies are opened, bees will "boil out" or cover the tops of the frames. When smoked, however, the bees move down onto the frames and may not cover the frame tops. In this case, the frames themselves should be covered with bees. Note that there will be some variability in the quality of the colonies you rent. Generally, a group of colonies where 10% fall below the minimum standard is acceptable, only if also 10% are above the minimum standard. Also, for a variety of reasons, some colonies may become queen-less for a time; however, if these colonies meet all the other minimum requirements, they will still be effective pollination units.

You can request hives to be inspected. In most states, this is a general requirement for sale and interstate transport; see Table A-6 for your state apiarist contact information. Requests should be made as early as possible to facilitate scheduling. The beekeeper will be informed if an evaluation is requested by the grower. Colonies are inspected to determine the colony size (number of supers), the presence of a laying queen, the number of frames of brood and adult bees, and the presence of disease and parasites. At least 10% of the colonies in an apiary, or a minimum of 5 colonies, are selected at random for inspection. Inspected colonies are identified by stickers. If selected colonies are banded or stapled, these are not refastened by the inspector. A copy of the evaluation report is given to both the grower and the beekeeper.

2. Assess traffic at hive entrance:
This method is less time-consuming but also less accurate. On a calm, warm (70-80˚F, 21-27°C) day between 11 AM and 3 PM, bee traffic at hive entrances should be heavy. During a one-minute observation period, strong colonies should have 50-100 or more bees arriving and leaving the hive. Bees also should be seen arriving with pollen pellets on their back legs. In weak colonies, fewer than 40 bees will be seen arriving and leaving per minute. Colonies that are being used for summer pollination should have heavier traffic at the hive entrance.

Another crude way to assess colony strength is to observe entrances when temperatures are cool (55-60˚F, 13-16°C). In strong colonies, flights will be observed at these cool temperatures, but in weaker colonies bees rarely fly when temperatures are below 60°F. Honey bees very rarely fly when the temperature is below 55°F.

3. Assess bee density on the crop:
This method allows you to assess the contribution of feral or other honey bee colonies in the area in addition to rented bees. If you are using rented colonies, however, this method tells you little about the quality of the bees. We suggest that if you use this technique and find that the number of bees on the crop is small, you then use options (1) or (2) to assess colony strength before renting additional bees.

4 Additional information:
Other sources of information for bee guides in your area are:
- State of NJ Department of Agriculture at: *http://www.state.nj.us/agriculture/divisions/pi/*
- The Virginia Fruit Web site at: *http://www.virginiafruit.ento.vt.edu/VAFS-bees.html*
- NCAT - ATTRA Sustainable Agriculture at: *https://attra.ncat.org/*
- Farm Management for Native Bees, A Guide for Delaware at: *https://agriculture.delaware.gov/wpcontent/uploads/sites/108/2017/12/FarmManagementforNativeBees-AGuideforDelaware.pdf*
- Managing Alternative Pollinators, A handbook for Beekeepers, Growers and Conservationists, SARE Outreach at: *https://www.sare.org/resources/managing-alternative-pollinators/*

Commercially Available Bumble Bees
Common Eastern bumble bee (*Bombus impatiens*) colonies may be purchased commercially to use as pollinators in vegetables and small fruits. The behavior, physiology and morphology of bumble bees make them ideal pollinators because of the speed at which they transfer pollen, the efficiency with which they gather pollen within various crops, and their ability to fly in adverse weather for longer periods of time. Bumble bees can also "buzz" pollinate, vibrating their wing muscles at a frequency that dislodges pollen from the flower, a technique not seen in honey bees. Due to their robust body size bumble bees begin foraging earlier and end later in the day and at lower temperatures. Bumble bees are effective in greenhouse and high tunnel settings to pollinate tomatoes and strawberries. They also have been successfully used for field pollination in blueberries and watermelon. However, in pumpkins, efforts to increase pollination by adding commercial bumble bee colonies are not always successful, perhaps due to the presence of adequate wild bee (wild bumble bee or squash bee) populations.

Place bumble bee colonies in the field after crops have begun to bloom. Bees that have found unintended forage in the beginning of the season are likely to continue to forage on this unintended source, especially if it is more favorable than the intended crop. Follow instructions provided by the bee supplier. Give the allotted time before opening up the colonies for the first time. Although bumble bees will need to excavate from natural enclosures to begin foraging, colonies should be given at least 30 minutes to settle after being handled during shipment and placement. Check each colony 2-3 hours later to ensure that the bees have successfully released and exited the nest. On occasion, bees are not released successfully and will need to be cut out.

Growers are urged to reduce each bumble bee colony entrance to one open hole at least two hours before each pesticide application. This will allow bumble bees to return to the hive and be kept in the colony to decrease exposure to pesticides. Bumble bees accumulate pesticides very easily within the wax and their bodies.

Place bumble bee colonies under shade to increase their productivity and longevity. Units placed in natural shade (along forest/field edges) or fitted with a shade structure last longer and are significantly more productive than those in full sunlight, especially during the warm summer months. Bumble bees constantly and actively strive to keep their colony temperature at around 86°F (30°C). Colonies exposed to direct sunlight use more energy for colony cooling.

Bumble bee colonies should be placed as far from honey bee hives as possible, especially when crops are not in bloom. When forage is low, colonies of pollinators should be more than 1 mile apart. Honey bees are very resourceful, and a bumble bee colony is a great source of pollen and nectar. If surrounding forage is low or not agreeable to honey bees, bumble bees will be susceptible to honey bee pollen theft resulting in weakened honey and bumble bee colonies. Bumble bees may be transferred to another field for additional pollination services throughout a season. Before moving, close the plastic opening tab to the one-hole open position. Allow forager bees at least two hours to return to the colony. The bumble bee colony may then be transferred to another site.

Follow the supplier's recommendations for the number of hives to use in a particular crop. Commercial bumble bee hives live for 6 to12 weeks (about 3 months) and must be replaced each year. Dispose of bumble bee colonies in a timely and humane fashion. There is a risk of commercial bees breeding with native populations. Commercial bumble bees are mass reared, and therefore have less genetic diversity than native bees. The genetic integrity of wild bees is important because it allows for adaptation to a wide variety of environmental conditions and various pathogens that they may encounter. Disposal of commercial colonies may also minimize potential transmission of pathogens.

All bees are vulnerable to many chemicals used to control insects, pathogens, and weeds.

Related to pesticides and the use of commercial pollination services:

- Avoid pre-bloom pesticides just before bees are brought onto a crop. If one is needed pre-bloom, select a material with lower bee toxicity and apply only when bees are not foraging, preferably late evening.
- Do not apply pesticides post-bloom until after managed colonies are removed.
- Honey bees need water for temperature regulation and brood production. Provide a clean water supply near the hives. Keep wheel ruts and areas around the sprayer fill point drained to eliminate a possible insecticide-laden water source.

Wild Bees

Many wild bees, including squash bees (*Eucera (Peponapis) pruinosa*), multiple bumble bee species (*Bombus* sp., predominantly *Bombus impatiens*), orchard bees (*Osmia* sp.) and an assortment of other solitary bees (sweat bees, mining bees) are excellent crop pollinators. In the Mid-Atlantic regions, wild pollinators have provided sufficient pollination for small, diversified farms located in complex landscapes that include wood lots and unmanaged (fallow) lands in close proximity. The landscape can strongly influence bee populations through the availability of nesting substrates (open soil, fallen logs, abandoned rodent burrows). In diversified farmscapes with a history of growing cucurbits, bumble bees and/or squash bees have provided sufficient pollination to pumpkins regardless of whether managed commercial bees were present. Landscapes utilizing conservation tillage tend to have higher populations of squash bees, presumably due to less habitat disruption.

Availability of additional food resources in nearby wild lands or a diverse (flowering) cropping system can help support wild bee populations throughout the growing season. The USDA National Resources Conservation Service is building efforts to supplement farms with perennial plantings (pollinator strips) or cover cropping schemes designed to provide timely floral resources.

A. General Production Recommendations

Wild bumble bees live in colonies founded by a queen. The workers, who are daughters of the queen, do the foraging, brood-rearing and defend the nest. New queen bumble bees (called "gynes") emerge from their natal nest in late summer or autumn. Each gyne will mate, forage, and then hibernate through the winter in a small, insulated cavity. In the spring the gyne will emerge and search for a larger cavity to establish her nest in such as an old rodent nest or beneath clumps of bunchgrass. Colonies will increase in numbers over the spring and summer, reaching a peak of 250-450 individuals (in *Bombus impatiens*) before producing new gynes and males. These new reproductive individuals will disperse and start the cycle over, while their natal colony dies out, leaving the gynes as the only carry-overs to the next year.

Most native bees do not live in groups like honey and bumble bees. Each female solitary bee establishes her own nest which may be in the ground, an old beetle burrow in wood, or in a pithy stem (elderberry or brambles). Each female gathers pollen and nectar and feeds nest cells, making a pollen ball and laying a single egg in each cell. She repeats this process many times over the duration of her life and will die before her offspring mature. The offspring overwinter in the cell within the nest, emerging the following spring or summer. Female solitary bees are reliable pollinators, visiting many flowers in their lifetime.

Snags or brush piles, along with undisturbed tall grassy areas, provide nesting sites for tunnel-nesting bees and bumble bees. Hedgerows, shelterbelts, and windbreaks containing flowering trees and shrubs can provide nesting habitat for bees as well as food. Deep soil tillage can block or harm ground-nesting bees.

Bees can vary greatly in their foraging range depending on body size and resource availability. Large species like bumble bees can fly long distances, but probably forage within 1 to 3 miles from the colony. Most species stay closer to their nest, no farther than about 0.5 mile. When resources are plentiful, bees are more likely to forage over shorter distances. It may be advantageous to manage farmscapes with these pollinators in mind, reserving bee habitat to benefit the crops and surrounding landscape.

Information for managing wild bees, along with the biology of relevant species can be downloaded at:

- Farm Management for Native Bees, A Guide for Delaware at: *https://agriculture.delaware.gov/wp-content/uploads/sites/108/2017/12/FarmManagementforNativeBees-AGuideforDelaware.pdf*
- Using integrated crop pollination for pumpkins and squash: *http://icpbees.org/wp-content/uploads/2014/05/Integrated-Crop-Pollination-for-Cucurbita-crops.pdf* and *https://content.ces.ncsu.edu/squash-bees-in-the-home-garden*
- Squash Bee Biology, Biology and Pollination Services of the Squash Bee, *Eucera (Peponapis) pruinosa* at: *https://lopezuribelab.com/squash-bee-biology/,* and *https://content.ces.ncsu.edu/squash-bees-in-the-home-garden*.
- Managing Alternative Pollinators, A handbook for Beekeepers, Growers and Conservationists, SARE Outreach at: *https://www.sare.org/resources/managing-alternative-pollinators/*.

Collections of resources are compiled at:

- The Integrated Crop Pollination Project, Resources for Growers: *http://icpbees.org/tools-for-growers/*
- The Center for Pollinator Research: *http://ento.psu.edu/pollinators/information-for-growers*. There is ongoing research to determine whether reliance on wild bees will be adequate for pollination of large acreages grown for commercial production.
- The Xerces Society provides guidelines for developing landscapes and farmscapes that encourage conservation of communities of pollinators at: *http://www.xerces.org/pollinator-conservation/*.

NOTE:
In this guide, this section addresses Pollination while Section D.6.3.1 Protection of Pollinators addresses specific practices for growers to follow to protect all pollinators from pesticide applications.
Section D.6.3.1 also includes an in-depth discussion of Product-Specific Labeling for the neonicotinoid class of pesticides, current state-specific pollinator protection activities, including MP3s, laws, and regulations.

13. Food Safety Concerns

Reports of foodborne illness attributed to consumption of fresh fruits and vegetables have increased. Unlike processed foods, fresh fruits and vegetables are not heat-treated to eliminate potentially harmful microorganisms. Larger and more centralized farming and improved storage methods have resulted in the distribution of produce over vast geographic areas. Raw fruits and vegetables are also handled more frequently in the distribution chain. Cases of foodborne illness that once were limited to localized areas can now be spread over many states or countries. In addition, new minimal processing technologies have been brought to the marketplace, for example fruits and vegetables that have been washed, peeled, and cut into convenient ready-to-eat products. Since these products are subject to more handling and typically are not heat-processed to eliminate harmful bacteria, they are at a greater risk of becoming contaminated and subsequently leading to foodborne illness. Most fresh fruits and vegetables are grown, harvested, and packed under safe and sanitary conditions. However, several highly publicized cases of foodborne illness have been associated with consumption of lettuce, salad mixes, green onions, tomatoes, sprouts, cantaloupe, cabbage, cucumbers, herbs, and carrots. Implicated in most of these outbreaks have been the human pathogens: *Salmonella enterica*, *Escherichia coli* O157:H7, *Listeria monocytogenes*, and *Shigella* bacteria; *Cryptosporidium* and *Cyclospora* parasites; and Hepatitis A and Norovirus viruses.

In response to increasing concerns about the safety of fresh produce grown in the United States, the Food and Drug Administration (FDA) published "The Guide to Minimize Microbial Food Safety Hazards for Fresh Fruits and Vegetables" in 1998. This guide is intended to assist growers, packers, and shippers of unprocessed or minimally processed fresh fruits and vegetables by increasing awareness of potential food safety hazards and providing suggestions for practices to minimize those hazards. Many Internet resources on food safety are also available that feature updated information from this guide and other sources.

In 2002, the United States Department of Agriculture (USDA) developed an audit/certification program known as "Good Agricultural Practices" (GAPs) to verify conformance to the 1998 guide. This is a voluntary program, although an increasing number of distribution networks are mandating GAPs or Harmonized Audit certification from each participating grower.

More recently, in 2011, the Food Safety Modernization Act (FSMA) was signed into law. There are seven sections to FSMA with the Produce Safety Rule applying to many growers and packers. The final Produce Safety Rule (under FSMA) was released November 2015, with the first compliance date in January 2018 with complete compliance required by 2020 except for sections under review, *i.e.*, water. The Produce Safety Rule (*https://www.fda.gov/food/food-safety-modernization-act-fsma/fsma-final-rule-produce-safety*) establishes mandatory practices operations must take to prevent microbial contamination of fresh produce. Whether a produce operation needs to comply with the Produce Safety Rule depends on whether it produces fresh fruits and vegetables and sales volume. To help operations prepare for an inspection, state departments of agriculture and cooperative extension in each state are providing individual farm assessments (On Farm Readiness Review). These assessments are free, confidential and take on average 2 hours to complete.

In the current food safety climate, increased record-keeping, and adherence to strict procedures of human hygiene are inevitable. All three resources (the 1998 guide, GAPs and FSMA Produce Safety Rule) identify potential hazards and discuss possible control methods in various aspects of pre-harvest, harvest, and post-harvest production, including: 1. Water, 2. Manure and Municipal Biosolids, 3. Wild and Domesticated Animals, 4. Worker Health, Hygiene and Training, 5. Sanitation, 6. Transportation, and 7. Product Trace-back. Each section is summarized below.

1. Water:

Water has the potential to be a source of microbial contamination. Growers and packers should be aware of the source and quality of water that contacts fresh produce and consider practices that will protect water quality. Growers should periodically test irrigation water for the quantity of fecal indicator organisms specifically generic *E. coli* (often represented by colony forming unit (CFU) or most probably number (MPN) of generic *E. coli* per 100 ml water). Frequency can be based on regulations and buyer requirements. For example, groundwater should be tested at least once per year and surface water three times per year under most Good Agricultural Practices programs). If fecal indicator organisms in irrigation water exceed the agricultural water standards, water treatment with effective disinfectants will be necessary before continuing to use the water source. Application of SaniDate 5.0 or 12 and calcium hypochlorite tablets (Accutab) have been shown to be effective on the decontamination of bacterial foodborne pathogens. These products are approved by the Organic Materials Review Institute (OMRI) for use in irrigation water. Check the label to make sure the product can be used for this purpose; **the label is the law!** Growers often irrigate field crops using surface water, water obtained from rivers, lakes, ponds, or irrigation ditches. However, surface water can become contaminated by upstream animal operations, sewage discharge, or runoff from fields. Drip, trickle, underground, or low volume spray irrigation techniques are ways to minimize irrigation water contact with harvestable portions of the crop. Groundwater is less likely to become contaminated, although wells should be maintained in good working condition including proper backflow devices and be constructed and protected so that surface water or runoff from manure storage areas cannot enter the system.

During harvest and post-harvest operations, when water is used in the field during the harvest process or in postharvest when water is used to cool, wash, or move produce, only water that meets the standard of no detectable generic *E. coli* based on a 100 ml water sample can be used. Untreated surface water cannot be used for harvest and post-harvest activities. Water in dump tanks and flume systems should be changed regularly to prevent the buildup of organic materials. Contact surfaces should be cleaned and sanitized to help prevent cross-contamination. Sanitizers, such as chlorine and peroxyacetic acid may be added to water but should be routinely monitored and recorded to ensure they are maintained at appropriate levels (*e.g*., water should be monitored for proper chlorine efficacy; 100 to 150 ppm of free chlorine, and a pH in the range of 6.5 to 7.5).

2. Manure and Municipal Bio-solids:

Manure may be contaminated with human pathogens and should be properly treated and stored before field application. Store manure and compost away from produce fields and packinghouses to protect the produce crop from seepage and runoff. Physical barriers such as ditches, mounds, grass/sod waterways, diversion berms, and vegetative buffer areas may also help to prevent runoff. Current recommendations are to maximize the time between application of manure to production areas and harvest. For non-composted or raw manure, the recommendation is to wait at least 120 days (4 months) between manure application and harvest and at a minimum two weeks before planting. Growers should be aware that the FSMA Produce Safety Rule regulations for manure of animal origin have not yet been finalized. The Food and Drug Administration allows the use of the National Organic Standards for manure application until the final regulations are written. The National Organic Standards are 1. Incorporated into the soil at least 120 days (about 4 months) before harvest when the edible portion of the crop has soil contact; OR 2. Incorporated into the soil at least 90 days (about 3 months) before harvesting all other food crops. Recommendations, guidance, regulations may change; growers are encouraged to consult relevant online resources or county extension offices about up-to-date manure recommendations and regulations.

Although municipal bio-solids (sewage sludge) are approved for certain agricultural uses, they are not recommended for application to soils used for vegetable production. This is due to the potential for human health issues. See “Sewage Sludge” in section B 4 Nutrient Management.

3. Wild and Domesticated Animals:

Wild animals, although more difficult to control, should be discouraged from entering fields; especially where crops are destined for fresh markets. Wildlife prevention may include noise makers, decoys, hunting, fencing, or netting. However, the FDA does not authorize farms to take action(s) that would violate the Endangered Species Act or other federal, state, or local animal protection requirements (check with county extension on animal protection requirements). Domestic animals (including livestock and pets) may be a source of contamination and should be excluded from fields during the growing and harvesting season. Growers who use animals (such as horses) during production are advised to do a risk assessment of their operation and have a written plan in place to address possible sources of contamination.

4. Worker Health and Hygiene:

Human pathogens can be transferred to produce by workers who harvest or pack fresh produce. Growers should provide sanitary facilities that are accessible, clean, and well equipped (bathrooms or portable toilets with an adequate supply of toilet paper; handwashing stations with basin, microbially safe water, soap, disposable paper towels or other appropriate hand drying devices, and a waste container). All employees (field workers to office administration) should be trained in good hygiene practices, such as toilet use and proper handwashing. Any worker who shows signs of an illness including diarrhea, coughing, fever, sneezing, sores, or infected wounds should not be allowed to handle produce.

5. Sanitation (includes field harvesting and packing facilities):

Fresh produce can become contaminated through contact with soils, pests, equipment, and chemicals. Harvesters, knives, pruners, pallets, containers, or bins, among others, should be cleaned and sanitized before use. They should be replaced if they cannot be cleaned or are damaged (poor condition). Equipment, packing, and storage areas should be kept clean; empty or unused pallets, bins, or containers should be kept in a covered location to prevent contamination. Additionally, all equipment should be regularly serviced and inspected for general maintenance. Food contact surfaces should be cleaned and sanitized at the end of each day. A pest control program must be established to prevent or limit rodents, birds, and insects from nesting in equipment and entering the packing and storage facilities/areas. Sanitizers, such as chlorine or peroxyacetic acid, may be added to water to prevent cross-contamination of produce during washing or transporting in dump tanks and flumes. If using a sanitizer, monitor the concentration on a regular schedule. It is recommended the water be changed when it becomes too soiled or saturated with organic material. For more information on sanitizers labeled for produce and the difference between cleaning and sanitizing visit the Produce Safety Alliance website at: *https://cals.cornell.edu/produce-safety-alliance/resources#sanitation*

6. Transportation:

Fresh produce can become contaminated during loading, unloading, and shipping. Inspect transportation vehicles for cleanliness, pests, odors, and obvious dirt or debris before loading. Make sure that fresh produce is not shipped in trucks that have previously been used to transport animals, fish, chemicals, or waste. Refrigeration units in trucks should be turned on before loading to ensure that proper temperatures are maintained during loading and transport.

7. Trace-back:

Traceability is defined as a procedure which tracks where a food product came from (for example farm, field, row, date harvested) to where a food product is going (market, distribution center, consumer). Usually adequate trace-back procedures require a grower to track one step backwards and forwards. Growers should be able to trace each lot with the date of harvest, farm identification, and who handled the produce from grower to receiver. The ability to trace the distribution history of food items from grower to consumer will not prevent a foodborne outbreak or recall from occurring; however, traceability procedures may limit the public health and economic impacts of an outbreak or recall.

Additional information to help vegetable growers adopt Good Agricultural Practices on the farm and in the packinghouse; as well as information on the FSMA Produce Safety Rule can be obtained from extension offices or the governmental agriculture authority in your state.

B. Soil and Nutrient Management

1. Soils

The best soils for growing vegetables have well-drained, deep mineral topsoil with a relatively high organic matter (> 2%) content. Soil pH has been fine-tuned through adjustments with lime as needed and fertility levels (N-P-K) have been improved as needed. Sandy loam or loamy sand soil textures are generally best suited for growing early market crops since they are easier to work with machinery and by farm employees during periods of high moisture. Loam and silt loam soils are generally better suited for growing crops for later fresh market use or for processing. Deep, well-drained muck soils are ideally suited for growing leafy vegetables, bulb, and root crops. The better suited the crop is to your soil, the greater chance of producing a successful crop. If you plant crops that require well-drained soils on poorly drained soils, your chances of failure are high regardless of your growing skills.

Typical BMPs (Best Management Practices) include a good soil management program, proper liming and fertilization, good tillage practices, crop rotation, annual additions of organic matter, and adequate irrigation. Using winter cover crops and periodically resting the land with the use of summer cover crops or rotations with grain, oilseed, or fiber crops between vegetable plantings are essential to maintain good soil structure, to retain topsoil, and promote system diversity for other production problems (*i.e.*, disease). Note: BMPs are similar to Good Agricultural Practices (GAPs) and share many elements. BMPs are aimed at consistently high crop yields and quality, whereas GAPs are focused on avoidance of food safety problems (see section A 13. Food Safety Concerns).

Soil Tests

The best way to determine the lime, phosphorus, potassium, calcium, and magnesium needs of your soil is to have it tested. Soil testing should be performed for every field every 1 to 3 years. You can obtain soil sample kits or containers and instructions through your local Extension Office or a private lab.

If you do not know the present fertility level of the soil in a field, your application rates of lime and fertilizer materials are likely to be inaccurate. Application rates of lime and fertilizer materials should consider the current soil fertility level, past cropping and soil management practices, and the crop you will grow. Taking a scientific approach minimizes the potential for plant damage, reduces water pollution potential, and can save money.

Lime and fertilizer recommendations from soil testing laboratories are based on soil test results, the crop to be grown, past cropping, past liming, and fertilization practices. This is information you supply on the soil sample questionnaire when submitting the sample. For this reason, it is very important to supply accurate information about the history and future use of the field along with the soil sample.

If you have a special problem related to soil drainage, tillage, or past history, inform laboratory personnel or your Extension Agent/Educator when you pick up the soil sampling kit or container, so they can advise you if any special tests are needed. They will also be aware of the cost of the various soil testing services performed by the soil testing laboratory.

2. Liming Soils

Most soils in the Mid-Atlantic region are naturally acidic or become acidic under crop production systems and with rainfall. If soils become too acidic (generally pH less than 6.0), crop performance is hindered by many factors, including reduced availability of plant nutrients. A regular liming program is required to neutralize soil acidity and to supply crops with calcium and magnesium. The first step in a liming program is knowing the optimum or target soil pH value of the crop to be grown. Many crops will grow over a wide range of soil pH, but most vegetable crops perform best when soils are in the 6.0 to 6.8 pH range. Plan rotations such that all crops grown on a given field have similar pH and nutrient requirements. The target pH values and the low pH limits suitable for vegetable crop production are listed in Table B-1.

Soil pH alone cannot be used to determine the amount of liming material needed to adjust soil pH. Soil test results provide all the data needed (*i.e.*, soil texture, total acidity, calcium and magnesium levels) to determine the lime requirement and type of lime to use. Many state and private labs use buffer solutions to extract active and reserve acidity for pH determination. Buffer solutions reduce interference that commonly occurs when substantial amounts of soluble salts are in the soil solution. When using buffer pH, calibrated charts along with the buffer pH for that particular test can solely be used for lime requirement determination.

Table B-1. Target Soil pH Values for Vegetable Crops

Crop	Target pH	Apply lime when pH falls below	Crop	Target pH	Apply lime when pH falls below
Asparagus	6.8	6.2	Okra	6.5	6.0
Beans - lima, snap	6.2	6.0	Onions - green, bulb, scallions	6.5	6.0
Beets	6.5	6.2	Parsley	6.5	6.0
Broccoli	6.5	6.2	Parsnips	6.5	6.0
Brussels sprouts	6.5	6.2	Peas	6.5	6.0
Cabbage	6.5	6.2	Peppers	6.5	6.0
Carrot	6.0	5.5	Potatoes, sweet	6.2	5.5
Cauliflower	6.5	6.2	Potatoes - white, scab susceptible	5.2	5.0
Collards	6.5	6.2	Potatoes - white, scab resistant	6.2	5.5
Cantaloupes	6.5	6.0	Pumpkins	6.5	6.0
Celery	6.5	6.0	Radish	6.5	6.2
Cucumber	6.5	6.0	Rhubarb	6.5	5.5
Eggplant	6.5	6.0	Rutabaga	6.5	6.2
Endive - escarole	6.5	6.0	Spinach	6.5	6.0
Horseradish	6.5	5.5	Squash - winter, summer	6.5	6.0
Kale	6.5	6.2	Sweet corn	6.5	6.0
Kohlrabi	6.5	6.2	Strawberries	6.2	5.8
Leeks	6.5	6.0	Tomatoes	6.5	6.0
Lettuce - leaf, iceberg	6.5	6.0	Turnips	6.5	6.0
Mixed vegetables	6.5	6.0	Watermelon	6.2	5.5
Muskmelons	6.5	6.0			

Lime Requirement

Most soil testing laboratories provide recommendations for increasing soil pH with lime. These recommendations take into account that the lime requirement of a soil depends on total acidity that must be neutralized to raise the pH to the desired level. It is important to understand that a water-soil pH measurement only indicates the concentration of active acidity in soil solution. Total acidity represents the active acidity in solution plus exchangeable acid cations bound to clay and organic matter (reserve acidity). For the purpose of lime recommendations using soil-water pH, total acidity is estimated from soil texture plus soil pH, or it is measured directly by titration (which is referred to as buffer pH or lime requirement index). Buffer pH or lime requirement index measurements that appear on soil test reports are used to determine lime requirements and should not be confused with soil-water pH. The interpretation of buffer pH is specific to the buffer method employed by the laboratory and the properties of the soils in the region.

Lime requirement is also commonly determined by soil pH measurement and soil texture classification. Soil texture (*e.g.*, loamy sand) may be considered a fixed soil property because it is not readily changed. Portable pH meters or colorimetric paper strip kits (less expensive but also less precise) may be helpful for planning your liming program. Once soil texture and pH are known, the lime requirement can be determined by referring to the appropriate table for the crop to be grown. Consult Table B-2 for lime requirements for crops with a target soil pH of 6.3 to 6.5 (the majority of crops), for crops with a target soil pH not exceeding 6.2 (*e.g.*, snap beans grown on sandy Coastal Plain soils), and crops with a target soil pH of 5.2 (*e.g.*, scab susceptible potatoes). Note: On soils with high organic content (> 6%) many crops with a desired soil pH of 6.5 can tolerate a lower soil pH (typically pH 5.6) than on mineral soils.

Typical soil test results will include pH and relative availability of magnesium (Mg) and calcium (Ca) to help determine what lime type should best be used. While most vegetables grow best in soils that are slightly acid (pH 6.0-6.8), some (*e.g.*, sweet potato and some white potato varieties) are best grown at soil pH of 5.2. Soil test reports will usually report Mg and Ca levels as “above optimum” or “exceeds crop needs”, “optimum”, and “below optimum” or “deficient”, and may further specify “low/high” and “very low/very high”. These qualifications indicate the relative need to remediate the soil by adding or withholding supplements of the indicated nutrient and by recommending a specific lime (*i.e.*, dolomitic lime for more Mg and calcitic lime for more Ca). Note: Excessively high soil pH increases the possibility of nutrient deficiency in sensitive crops (*i.e.*, Mn, P, etc.).

Calcium Carbonate Equivalent

Calcium carbonate is a popular form of liming material. Soil test recommendations for liming should be given in pounds of calcium carbonate equivalent per acre (lb CCE/A). Pure calcium carbonate ($CaCO_3$) has a CCE of 100% and is the standard against which all liming materials are measured. Since the CCE of liming materials may vary from 40 to 179%, the amount of liming material needed to supply a given quantity of CCE will vary considerably. By law, the CCE of a liming material must be stated on the product label. To determine the application rate of liming material in CCE, refer to Table B-3 or use the following calculation:

Actual amount of liming material required = Soil test CCE recommendation ÷ % CCE of liming material x 100

Example: A soil test recommends applying 2,000 lb CCE/A and the liming material purchased has 80% CCE.
Actual amount of liming material required per acre = 2,000 ÷ 80 x 100 = 2,500 lb/A

Table B-3 may be used instead of the formula to convert soil test recommendations for lb CCE/A to lb of the actual liming materials to be applied. Find your soil test limestone recommendation in the left-hand column, then read across the table on the line until you come to the column headed by the percent CCE nearest to that of your liming material. Application rates may be rounded off to the nearest 500 lb/A practical for spreading equipment. Although liming recommendations should now be given in lb CCE/A, recommendations that are given as total oxides can be converted to CCE by multiplying by 1.79.

Example: If the recommendation calls for 2,000 lb/A of total oxides, the recommendation for lb CCE/A is:
2,000 x 1.79 = 3,580 lb CCE/A.

Selection of Liming Material

Liming materials neutralize soil acidity, supply calcium (Ca) and supply or increase available magnesium (Mg). Selection of the appropriate liming material based on its Ca and Mg concentrations is a key to furnishing crops and soils with sufficient amounts of these nutrients. The goal of a liming program is to establish the desired soil pH and to maintain the soil fertility levels for Mg and Ca in the *optimum* range.

Fine-sized liming materials are recommended when rapid neutralization of soil acidity is desired. Medium and coarse-sized liming materials are best suited for maintenance of soil pH once the desired soil pH range has been attained using fine-sized liming material. When soil pH is low, soil test levels of Ca and Mg may be *below optimum* or *deficient*. It is important to choose a liming material that contains a significant concentration of Mg; these liming materials are commonly referred to as dolomitic type or dolomite. If the soil Mg level is expressed as *below optimum-very low* or *-low*, use a liming material that has a minimum concentration of 9% Mg. If the soil Mg level is *below optimum -medium*, use a dolomitic liming material that has 3.6 to 9% Mg. If the soil Mg level is *optimum* or *above optimum* or *exceeds* crop needs, use a calcitic or calcite liming material that has less than 3.6% Mg.

Occasionally soils test *below optimum* or *deficient* in Mg or Ca, but do not need lime for pH adjustment. For soils needing Mg, apply Epsom salt (9.9% Mg) or sulfate of potash magnesia (21.8% Mg). If soil pH is appropriate for the crop, but the soil test Mg level is expressed as *below optimum-very low*, apply 30 lb/A of Mg from a Mg fertilizer. If Mg is *below optimum-low*, apply 15 lb/A of Mg. If soil pH is satisfactory for the crop, but the Ca level is *below optimum--very low*, apply 350 lb/A of Ca (=1500 lb/A of gypsum). If the pH is satisfactory, but Ca is *below optimum--low*, apply 175 lb/A of Ca (=750 lb/A of gypsum).

Timing of Application

Lime is slow to react in soil. It may take several months after application for soil pH to reach desired levels. Thus, it is important to plan ahead and apply lime several months in advance of planting. Lime can be applied at any time of the year. Apply lime well in advance of planting crops that are sensitive to soil acidity. Fall applications have the advantage of allowing the lime to react in the soil prior to the start of the next growing season.

Careful attention to liming prior to planting perennial crops, such as asparagus, or laying polyethylene mulch is important. Once the plastic mulch is installed or the crop is established, it is virtually impossible to correct a soil pH problem using surface applications of lime. Lime should be applied at least six months to a year in advance of planting perennial crops to ensure that the target pH has been achieved.

Soils naturally become more acidic over time. The frequency of prescribed lime application varies with soil characteristics, cropping system, and fertilizer practice. Heavy use of ammonium and urea N fertilizers accelerates soil acidification. Test your soil pH every 1 to 3 years. Relime soils before pH drops below the desired range to avoid development of excess acidity.

Lime Placement

Lime applications are most effective at neutralizing acidity when they are spread uniformly and thoroughly mixed with the soil by plowing, disking, and harrowing. When applying large amounts of lime, it is best to use split applications. Apply half the lime and plow it under. Next, apply the other half to the plowed surface and disk it into the soil as deeply as possible up to 24 inches.

Whenever conventional tillage is not practiced (*e.g*., perennial crops, conservation tillage systems), surface applications are recommended but pH will change much slower than for conventionally tilled soils. Monitor soil pH change and the need for lime to avoid higher lime requirements. Surface lime application rates should not exceed 3,000 lb CCE/A.

For crops using plastic or organic mulches, lime should be applied and incorporated prior to bedding rows. It is ineffective and not recommended to apply lime after plastic mulch has been laid.

Special Considerations

Potato scab

Potato scab is caused by the soil-inhabiting fungus *Streptomyces scabies*. The disease is suppressed in acid soils (pH <5.2), so increasing soil pH with lime favors development of scab. When lime is needed, it is best to apply the lime after potato harvest and before other crops are grown in rotation. The optimum soil pH for growing scab susceptible potato varieties is about 5.0 to 5.2. Scab resistant potato varieties may be grown at pH 5.5 to 6.2.

Cabbage, broccoli, and leafy greens are subject to infection by the clubroot fungus *Plasmodiophora brassicae*. If clubroot has been a problem in the past, cole crops should be grown at pH 6.5 to 7.0. The disease is also suppressed at pH 7.2 to 7.4 but crop production and/or quality may be decreased at the higher pH range.

Spinach

Spinach requires an initial pH of 6.5 to 6.7 for good growth and leaf quality. Soil Ca levels should be medium or optimum and in balance with Mg. Plan ahead and adjust pH, Ca, and Mg the season before planting spinach.

Lime and Fertilizer

Lime and fertilizer work together to produce high yields and better crops. Lime is not a substitute for fertilizer, and fertilizer is not a substitute for lime. Proper use of the two together creates optimal nutrient availability for vegetables. The rate and frequency of their use depends on the crop to be grown, type of soil, soil acidity, and past use of fertilizer materials. The availability of nutrients is adversely affected by pH less than 5.0 or greater than 7.0.

Table B-2. Pounds of Calcium Carbonate Equivalent (CCE) Recommended per Acre

For Crops with a Target Soil pH of 6.5					
	Soil Texture and Fertility				
Initial Soil pH	**Loamy Sand**	**Sandy Loam**	**Loam**	**Silt Loam**	**Clay Loam**
4.1-4.4	4,500	5,400	9,800	11,600	23,300
4.5-4.8	3,600	4,500	8,100	9,800	18,800
4.9-5.2	2,700	3,600	6,300	8,100	15,200
5.3-5.6	1,800	2,700	4,500	6,300	12,500
5.7-6.0	900	1,800	3,600	4,500	8,100
6.1-6.4	500	900	1,800	3,600	5,400
Above 6.5	0	0	0	0	0
For Crops with a Target Soil pH of 6.2					
	Soil Texture and Fertility				
Initial Soil pH	**Loamy Sandy**	**Sandy Loam**	**Loam**	**Silt Loam**	**Clay Loam**
4.1-4.4	4,000	4,500	8,000	8,900	20,600
4.5-4.8	3,100	3,600	6,300	7,100	16,100
4.9-5.2	2,200	2,700	4,500	5,400	12,500
5.3-5.6	1,300	1,800	2,700	3,600	9,800
5.7-6.0	500	900	1,200	1,800	5,400
Above 6.5	0	0	0	0	0

Table B-2. Pounds of Calcium Carbonate Equivalent (CCE) Recommended per Acre - *continued next page*

Table B-2. Pounds of Calcium Carbonate Equivalent (CCE) Recommended per Acre - continued

For Potato Varieties with a Target Soil pH of 5.2				
	Soil Texture and Fertility			
Initial Soil pH	**Loamy Sandy**	**Sandy Loam**	**Loam**	**Silt Loam**
4.5	630	990	1,350	1,790
4.6	540	810	1,160	1,520
4.7	450	630	940	1,250
4.8	360	540	760	990
4.9	270	450	540	760
5.0	180	270	400	490
5.1	90	100	180	270
5.2	0	0	0	0

Table B-3. Conversion of Recommended Calcium Carbonate Equivalent to Recommended Limestone. Find your soil test limestone recommendation in the left-hand column, then read across the table on the line until you come to the column headed by the percent CCE nearest to that of your liming material. Application rates may be rounded off to the nearest 500 lb/A practical for spreading equipment.

CCE (lb/A) Recommended by Soil Test	**Percent Calcium Carbonate Equivalent (% CCE) of Liming Material**							
	70	**75**	**80**	**85**	**90**	**95**	**100**	**105**
	Actual Limestone Recommendation (lb/A)[1,2]							
1,000	1,400	1,300	1,200	1,200	1,100	1,100	1,000	1,000
2,000	2,900	2,700	2,500	2,400	2,200	2,100	2,000	1,900
3,000	4,300	4,000	3,700	3,500	3,300	3,200	3,000	2,900
4,000	5,700	5,300	5,000	4,700	4,400	4,200	4,000	3,800
5,000	7,100	6,700	6,200	5,900	5,600	5,300	5,000	4,800
6,000	8,600	8,000	7,500	7,100	6,700	6,300	6,000	5,700
7,000	10,000	9,300	8,700	8,200	7,800	7,400	7,000	6,700
8,000	11,400	10,700	10,000	9,400	8,900	8,400	8,000	7,600
9,000	12,000	12,000	11,200	10,600	10,000	9,500	9,000	8,600
10,000	14,300	13,300	12,500	11,800	11,100	10,500	10,000	9,500
11,000	15,700	14,700	13,700	12,900	12,200	11,600	11,000	10,500
12,000	17,100	16,000	15,000	14,100	13,300	12,600	12,000	11,400
13,000	18,600	17,300	16,200	15,300	14,400	13,200	13,000	12,400
14,000	20,000	18,700	17,500	16,500	15,600	14,700	14,000	13,300

[1]The amounts of CCE recommended in the table are for increasing the pH of an **8-inch soil layer** to the desired pH value. Multiply the numbers in the table by 1.25 to adjust a 10-inch plow layer to the desired pH. [2]**It is not advisable to apply more than the following lb/A of CCE as a topdressing:** loamy sand 2,000, sandy loam 3,000, loam 4,000, and silt loam 5,000. If fields are to be plowed and the CCE recommendation exceeds 3,000 lb/A, plow under half the needed amount and apply the other half after plowing and then disk in as deeply as possible.

3. Plant Nutrients

Many factors influence the nutrient requirements for optimum yield and quality of a given vegetable crop. The original source of soil particles, texture, cation exchange capacity, organic matter content, and drainage are important soil properties that influence the rates of nutrients applied to vegetables. In addition, rainfall amounts and distribution, irrigation types and management, and soil and air temperatures during the growing season can affect retention, availability, and uptake of nutrients. Varieties of the same crop often differ significantly in their nutrient requirements. Test soils to determine the kinds and amounts of phosphorus, potassium, calcium, and magnesium required for optimum production. During the growing season, sap and tissue testing should be used, when they have been shown to be effective, to adjust nutrient applications to current growing conditions and the nutrient status of the crop.

Pennsylvania growers will receive soil test results directly from the Agricultural Analytical Services Laboratory, College of Agriculture, The Pennsylvania State University; *https://agsci.psu.edu/aasl*. **In years when soil tests are not taken, growers in Pennsylvania should use Tables B-4a, as described below. Growers in New Jersey, Virginia, and West Virginia should use Table B-4a, as described below. Growers in Delaware should**

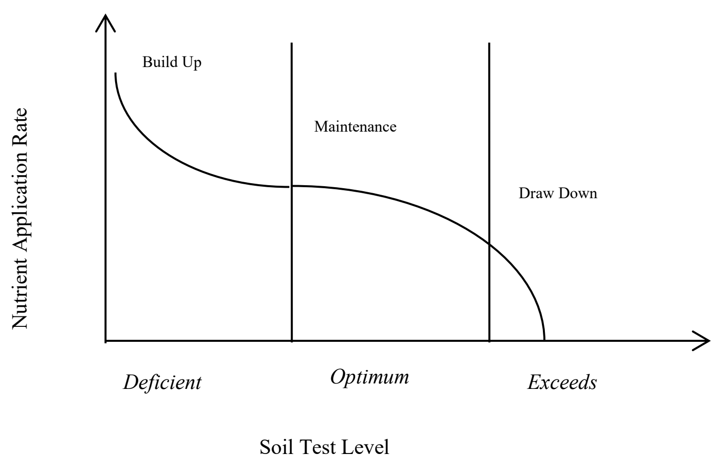
use Table B-4b. Growers in Maryland should use Table B-4b with adjusted FIV values (see *https://extension.umd.edu/sites/default/files/publications/74.%20%28reposting%29%20SFM-4_Soil%20Fertility%20Management_1.pdf*). See important notes and discussion in the Plant Nutrient Recommendations section below to adjust nutrient rates and timing based on soil type, cation exchange capacity, cropping and manure history, and soil temperatures.

Soil Test Categories

The basic soil test categories for management of soil Calcium (Ca), Magnesium (Mg), Phosphorus (P) and Potassium (K) are: "**below optimum**" or "**deficient**", "**optimum**", and "**above optimum**" or "**exceeds crop needs**". For limestone recommendations, these categories indicate the concentrations of Ca and Mg most suitable for use as a liming material. **Soil test categories, along with crop nutrient requirements, are the basis for nutrient recommendations**. For example, when the soil test category for K is *below optimum -low* or *deficient,* the recommendation will indicate how much K to apply. The amount of K recommended however, depends on the crop.

Various crops accumulate different amounts of nutrients. Generally, crops that produce large yields of harvestable material will remove large amounts of nutrients from the soil and will have a higher nutrient recommendation. If the soil fertility category is *below optimum* or *deficient*, the nutrient recommendation for a particular crop is designed to achieve its full crop yield potential and to build the soil fertility level into the *optimum* range over time. If the soil fertility level is already in the *optimum* range, the nutrient recommendation is designed to replace the amount of nutrient removed by the crop to maintain optimum soil fertility. In general, no nutrient application is recommended if the soil test category is *above optimum* or *exceeds crop needs*. This allows "draw-down" of the nutrient level to the *optimum* range. However, certain crops (*e.g.*, potatoes and tomatoes) still benefit from low fertilizer applications of root stimulating nutrients (*e.g.*, phosphorus) that should be applied as a "starter" fertilizer. These concepts are illustrated in Figure B-1.

Figure B-1. Nutrient Application Rates Vary in Relation to Soil Test Category



Soil Test Method and Interpretation

A common misconception is that a soil fertility test is a direct measurement of the total nutrient content of a soil that is available to the plant. Soil test values have historically been expressed in units of pounds per acre (lb/A), but they have no meaning in terms of actual quantity of nutrients available to crop plants. A soil test only provides an index of soil nutrient availability that is correlated with plant response. This correlation is determined by soil test calibration research and is the foundation for soil test interpretation.

Many different types of soil test extraction methods are in use, but only a few are appropriate for our local soils. The Mehlich-1 and Mehlich-3 soil tests are most appropriate for soil types found in the Mid-Atlantic region. Soil test results and interpretations are specific for the soils of a region and for the particular soil test method used. The soil test values for the Mehlich-1 and Mehlich-3 categories (Tables B-4a and B-4b) were established based on research conducted on soils in the Mid-Atlantic region. The categories were developed from crop yields that were observed during nutrient response studies conducted over a range of soil test levels.

B. Soil and Nutrient Management

Reading and understanding the soil report from any particular laboratory depends on knowing what soil test method is being used and what units are used to express the soil nutrient levels. If the soil test report does not state the method used, call the laboratory to find out. This information is needed before interpreting the soil test results.

Table B-4a. Soil Test Categories for Nutrients Extracted by Mehlich 3 and 1 (for growers in Pennsylvania, New Jersey, Virginia, and West Virginia)

Soil Test Category	Phosphorus (P)	Potassium (K)	Magnesium (Mg)	Calcium (Ca)[1]
	Mehlich 3 Soil Test Value (lb/A)[2,3]			
Deficient (very low)	0-24	0-40	0-45	0-615
Deficient (low)	25-45	41-81	46-83	616-1007
Deficient (medium)	46-71	82-145	84-143	1008-1400
Optimum (high)	72-137	146-277	144-295	1401-1790
Exceeds Crop Needs (very high)	138+	278+	296+	1791+
	Mehlich 1 Soil Test Value (lb/A)[2]			
Below Optimum (very low)	0-3	0-15	0-24	0-240
Below Optimum (low)	4-11	16-75	25-72	241-720
Below Optimum (medium)	12-35	76-175	73-144	721-1440
Optimum (high)	36-110	176-310	145-216	1441-2160
Above Optimum (very high)	111+	311	217+	2161+

[1] Calcium values are for sandy loam soils. Multiply the calcium values in the table above by 0.625 to use for loamy sand soils; by 1.25 for loam soils; by 1.5 for silt loam soils, and by 1.75 for clay loam soils.
[2] Values are reported in elemental forms.
[3] Soil tests that are based on Bray-1 extractable P and neutral, 1N ammonium acetate extractable, K, Ca, and Mg are very similar to the Mehlich-3 extractable concentrations of these nutrients.

Table B-4b. Soil Test Categories for Nutrients Extracted by Mehlich 3 and Mehlich 1, University of Delaware (UD) (for growers in Delaware and Maryland). Note: growers in Maryland should use adjusted FIV values (see *https://extension.umd.edu/sites/default/files/publications/74.%20%28reposting%29%20SFM-4_Soil%20Fertility%20Management_1.pdf*).

Soil Test Category	UD Fertility Index Value (FIV)	Phosphorus (P)	Potassium (K)	Magnesium (Mg)	Calcium (Ca)
		Mehlich 3 Soil Test Value (lb/A)			
Low	**0 – 25**	0 – 50	0 – 91	0 – 65	0 – 500
Medium	**26 – 50**	51 – 100	92 – 182	66 – 131	501 – 1000
Optimum (High)	**51 – 100**	101 – 200	183 – 364	123 – 262	1001 – 2000
Excessive (Very High)	**101+**	201+	365+	263+	2001+
		Mehlich 1 Soil Test Value (lb/A)			
Low	**0 – 25**	0 – 25	0 – 70	0 – 55	0 – 450
Medium	**26 – 50**	26 – 50	71 – 140	56 – 110	451 – 900
Optimum (High)	**51 – 100**	51 – 100	141 – 280	111 – 220	901 – 1800
Excessive (Very High)	**101+**	101+	281+	221+	1801+

Soil Test Category	UD FIV	Soil Test Category Interpretation - University of Delaware (UD)
Low	**0-25**	The nutrient concentration in the soil is inadequate for the growth of most plants and will very likely limit plant growth and yield. There is a high probability of a favorable economic response to additions of the nutrient.
Medium	**26-50**	The nutrient concentration in the soil may be adequate for plant growth but should be increased into the optimum range to ensure that plant growth and yield are not limited. There is a low to moderate probability of a favorable economic response to additions of the nutrient.
Optimum (High)	**51-100**	The nutrient concentration in the soil is in the range recommended for the growth of all plants. Since there is a very low probability of a favorable economic response, nutrient additions are rarely recommended.
Excessive (Very High)	**101+**	The nutrient concentration in the soil is above the range recommended for the growth of all plants. Additions of the nutrient will be unprofitable, may have undesirable effects on plant growth, and hence are not recommended. Erosion and runoff from soils that are excessive in phosphorus (P) can have negative effects on surface water quality.

Plant Nutrient Recommendations

To obtain the highest yields with the least negative environmental impacts, ALWAYS base plant nutrition decisions on a current soil test and current recommendations. Fertilizer is expensive and soil tests are relatively cheap and the only indicator of true nutrient needs.

Refer to Tables B-4a or b to interpret the relative levels of P and K in the soil based on the soil test report from the laboratory. When a current soil test is available, use recommendations for the specific commodity listed in Recommended Nutrients Based on Soil Tests tables in chapter F.

The following adjustments to the nutrient recommendations in chapter F are recommended based on soil type and cation exchange capacity.

1. For most vegetables grown on Mid-Atlantic soils, apply the total recommended P_2O_5 and K_2O together with 25 to 50% of the recommended N before planting. The remaining N can be sidedressed or applied with drip irrigation using a fertilizer containing N only. Sidedressing or topdressing potash (K_2O) is recommended only on extremely light sandy soils with very low cation exchange capacities.
2. It may be desirable to build up the P and K levels in very low-fertility loam and silt loam soils more rapidly than provided by these recommendations. In such instances, add an additional 40 to 50 lb/A of P_2O_5 and K_2O, respectively, to the recommendations listed in the table for soils testing low in P and K. Apply additional amounts in broadcast and plow down or broadcast and disk-in application.

Plant nutrient recommendations listed in tables in chapter F (Recommended Nutrients Based on Soil Tests tables) are expressed in terms of nitrogen (N), phosphate (P_2O_5), and potash (K_2O), rather than in specific grades and amounts of fertilizer. When soil test results are available, the phosphate (P_2O_5) and potash (K_2O) needs for each cropping situation can be determined by selecting the appropriate values under the relative soil test levels for phosphorus and potassium: low, medium, optimum, or very high.

The cropping and manuring history of the field must be known before a fertilization program can be planned. This history is very important in planning a N fertilization program. Certain crop residues and animal manures release nutrients into the soil over a long period of time as they are degraded.

Plant nutrient recommendations listed in the Recommended Nutrients Based on Soil Tests tables in chapter F were developed for fields where no manure is being applied and where no legume crop residue is being incorporated prior to planting a new crop. If manure and/or legume crops are being used, the plant nutrient recommendations for the specific crop should be reduced by the amounts of nitrogen (N), phosphate (P_2O_5), and potash (K_2O) being contributed from these sources, see Table B-10.

When warm season crops, such as sweet corn, tomatoes, peppers, eggplants, and vine crops are seeded or transplanted and soil temperatures are below 65°F (18°C), 20 lb/A of P_2O_5 may be applied to replace phosphorus removed by the crop when soil test levels for phosphorus are *above optimum* or *exceeds crop needs*.

Once final fertilizer nutrient needs are determined, it will be necessary to determine the grade and rate of fertilizer needed to fulfill these requirements. For example, if the plant nutrient requirements that need to be added as a commercial fertilizer are 50 lb of N, 100 lb of P_2O_5, and 150 lb of K_2O, you would need a fertilizer with a 1:2:3 ratio, *e.g*., a 5-10-15, 6-12-18, or 7-14-21. Once you have selected the grade of fertilizer, the amount needed to fulfill the plant nutrient requirement can be determined by dividing the amount of the nutrient needed per acre by the respective percentage of N, P_2O_5, or K_2O in the fertilizer, and multiplying the answer by 100. For example, if you choose a 5-10-15 fertilizer grade to supply the 50 lb of N, 100 lb of P_2O_5, and 150 lb of K_2O needed, you can calculate the amount of 5-10-15 fertilizer needed as follows: Divide the amount of N needed per acre (50 lb) by the percentage of N in the 5-10-15 fertilizer (5%), and multiply the answer by 100; the answer is 1,000 lb.

This same system can be used for converting any plant nutrient recommendations into grades and amounts of fertilizer needed. When you use this system, it is possible for you to select fertilizers based on the least costly fertilizer grades available. In cases where the preferred grade is not available, it is also possible to change from one fertilizer grade to another, providing the plant nutrient ratio is the same. This flexibility may be necessary because of a shortage of some fertilizer materials.

4. Nutrient Management

Plants remove substances from the soil and air to enable them to grow and reproduce. The specific substances they remove are termed nutrients. Certain nutrients (**macronutrients**) are generally required in larger quantities. Nutrients needed in smaller quantities (**micronutrients**) are often as important as macronutrients for achieving desired results. Most commercial fertilizers contain the macronutrients N, P, and K, expressed as a weighted percentage (N-P_2O_5-K_2O). Micronutrients may be supplied along with macronutrients.

Nitrogen Management

Nitrogen (N) is one of the most difficult nutrients to manage in vegetable production. N is readily leached or can be tied-up by soil microbes, can be lost to the atmosphere if not quickly incorporated, and is lost under water-saturated soil conditions. Due to the numerous N loss pathways, N is not routinely tested by state soil testing laboratories for making crop recommendations. Instead, N recommendations are based on years of fertilizer research and yield potential. N application timings, application methods, and sources are also commonly researched and have resulted in recommendations for splitting N fertilizer applications for increased fertilizer use efficiency.

Heavy rainfall, higher than normal yield, and following non-legume cover crops are just a few examples of situations where N fertilizer may be tied-up, lost from the production system, or another application of N is needed. Tissue testing is the best option when deciding if and how much more N is needed to meet expected yields. Soil testing laboratories can provide N concentrations of plant materials with quick turnaround times to aid in N application decisions.

Nitrogen Management with In-Season Soil Nitrate Testing

An in-season soil test for N availability can be used in special soil fertility situations to predict the need for sidedress N fertilizer for some vegetable crops. This special soil test is called the pre-sidedress soil nitrate test or PSNT. The soil sampling for the PSNT must be done early in the growing season shortly after the crop has been planted.

The PSNT is most useful when farmers have implemented soil fertility practices that increase the ability of soil to supply N. Practices such as applications of compost, manures, or crop rotations with legume cover crops are examples of field conditions where the PSNT can be useful.

When the N supplying capacity of the soil may be expected to be good because of organic amendments, the PSNT often predicts that soil N availability is sufficient to produce the crop without sidedress N fertilizer. Where the PSNT identifies N sufficiently, growers can confidently save on the cost of unnecessary fertilizer. However, occasionally the PSNT finds that the N supply is less than expected and sidedress N fertilizer is still recommended.

The PSNT is not recommended to be used in fields where the soil organic matter content is low and when there is no recent history of organic cultural practices that build up the N supplying capacity of soil. Fields that are very likely to be deficient in available N can be easily predicted based on soil type and field history. Thus, consider soil conditions as a guide to decide where to perform the PSNT soil test. Where soils can be known to be low in N availability, PSNT testing is a waste of time and effort.

Research has demonstrated that the PSNT soil test works well for annual type vegetable crops such as sweet corn and late planted cabbage on soils rich in organic matter content. For sweet corn the PSNT soil samples should be collected when plants are about six-inches tall and for cabbage at about two weeks after transplanting into the field. Unlike a traditional soil fertility test, soil cores for PSNT are taken from the 0 to 12-inch soil depth. Also soil samples need to be dried and delivered promptly to the agricultural laboratory. The test results also need to be promptly communicated to the vegetable grower so that a timely decision about applying sidedress N can be made. When the PSNT finds 25 ppm or greater level of nitrate-N, a zero rate of N fertilizer is recommended.

A fact sheet about how to implement the PSNT is on the web at Rutgers NJAES: Soil Nitrate Testing as a Guide to Nitrogen Management for Vegetable Crops *https://njaes.rutgers.edu/pubs/publication.php?pid=E285*.

Phosphorus Management

In general, crops are very likely to respond to phosphorus (P) fertilization if found to be needed by soil testing. Soil test P levels of *deficient* or *below optimum-very low*, *low*, or *medium* indicate a strong response to adding P fertilizer. Crops in soils testing *optimum* may or may not respond to further additions, but P may be applied to maintain the fertility level in the *optimum* range (P fertilizer applied at crop removal rates). Crops in soils with levels in the *exceeds crop needs* or *above optimum-very high* categories may also respond to P fertilizer if conditions are favorable for high yields or plants have slow growing and/or shallow root systems. Tomato and potato are classic examples of crops benefiting from P fertilizer additions on very high soil test P concentrations.

It is often recommended that a band of P fertilizer be placed near the seed/transplant as a starter fertilizer regardless of the P fertility level. Banded P is especially helpful at low soil test P levels; however, overall field rates should not be decreased. When the soil test level is *deficient* or *below optimum*, P should generally be applied as a combination of broadcast and banded methods. Even at P soil test levels that are *very high-above optimum* or *exceeds crop needs*, a small amount of banded P may benefit crop establishment. Many test results describe soils as *above optimum* or *exceeds crop needs* due to previous fertilizer and manure applications. When applied in excess of crop removal, P accumulates in the soil. P is strongly adsorbed to soil particles and very little is subject to loss via leaching. In high concentrations, soil P will also interact with ionic micronutrients, such as zinc, to alter availability of P to the plant. If the soil test report indicates that P levels are *above optimum* or *exceeds crop needs,* crop and site-specific factors will determine if P fertilizer should still be applied, but the general recommendation under those circumstances is that soils should receive very little or no P fertilizer.

Potassium Management

Crops are very likely to respond to K fertilizer when the soil test indicates that K is *deficient or below optimum, -very low* or *low*. A soil testing *below optimum-medium* in K may or may not respond to K fertilizer. Soils testing *optimum*, *above optimum* or *exceeds crop needs* are unlikely to respond to K fertilizer, but it may be recommended to apply K to maintain the soil fertility level in the *optimum* range.

In general, most of K fertilizer should be broadcast. When the fertility level is *below optimum* or *deficient*, it may be advantageous to apply a portion of the total K application as a band. There is generally no benefit to applying banded K when soil fertility levels are *optimum* or *above optimum* or *exceeds crop needs*. In loamy sand and sand textured soils, split applications of K may be beneficial and may be applied using sidedress applications or applied through drip- irrigation.

Crops remove larger amounts of K than P from the soil during a growing season. In addition, sandy soils have low reserves of K, and K is susceptible to leaching. Therefore, frequent applications of K are needed to maintain K at optimum levels.

Secondary and Micronutrient Management

Calcium (Ca), magnesium (Mg), and sulfur (S) are included in the secondary element group. Ca may be deficient in soils that were not properly limed, where excessive amounts of potash fertilizer were used, and/or where crops are subjected to drought stress. Dolomitic or high-Mg limestone should be used for liming soils that are low in Mg. On low-Mg soils where lime is not needed, Mg should be applied in fertilizer. Magnesium may be applied as a foliar spray to supply Mg to crops in emergency situations. Contact your county Extension Agent/Educator for recommendations regarding scenarios that do not conform to these common soil nutrient ranges.

Sulfur is an important plant nutrient, especially for the onion family and cole crops. S may become deficient on light, sandy soils. S deficiencies may develop as more air pollution controls are installed and with the continued use of high-analysis fertilizers with low S content. S concentrations greater than 5 ppm are associated with increased pungency in sweet Spanish onions, and low soil S will result in reduced pungency. S can be supplied by application of S-containing fertilizers, *e.g.*, Gypsum (Calcium Sulfate) or Epsom Salt (Magnesium Sulfate), see Table B-5.

Micronutrients

Boron (B) is the most widely deficient micronutrient in vegetable crop soils. Deficiencies of this element are most likely to occur in the following crops: asparagus, most bulb and root crops, cole crops, and tomatoes. See Table B-7 for B recommendations for various crops based on soil or plant tissue test results. Use of excessive amounts of B can be very toxic to plant growth. **DO NOT** exceed recommendations listed in Table B-7 and in the Recommended Nutrients Based on Soil Tests tables for specific commodities in chapter F (note: in chapter F, Boron recommendations may be listed in a footnote under the Recommended Nutrients Based on Soil Test table).

Manganese (Mn) deficiency often occurs in plants growing on soils that have been over-limed with a pH above 7.0. The deficiency is most common on sandy coastal plain soils. Legume crops, such as beans tend to be more sensitive to Mn deficiency. Soybean is especially sensitive. Where Mn deficiency has been observed on a soybean crop, be on the lookout for Mn deficiency in rotation vegetable crops grown in that same field. Sometimes Mn deficiency occurs in sensitives crops at soil pH levels near 6.5.

A broadcast application of 20 to 30 lb/A or a band application of 4 to 8 lb/A of Mn will usually correct the deficiency. When Mn is applied as manganese sulfate, foliar application of 0.5 to 1 lb/A of Mn in 20 gal of water/A in one to three applications usually will help relieve the deficiency. Typical symptoms are interveinal chlorosis (yellow tissue between green leaf veins). Apply the first foliar spray of Mn fertilizer as soon as deficiency symptoms are visible. After treatment with a foliar spray of Mn fertilizer, deficient plants should turn noticeably green within a few days. When Mn deficiency is severe, repeated foliar applications of Mn may be necessary over the course of the growing season. Use manganese sulfate or a chelated of Mn fertilizer.

Do not apply lime or poultry manure to such soils until the pH has dropped below 6.5 and be careful not to over-lime again. Application of ammonium sulfate, where it is an appropriate choice for a N fertilizer, can help to lower soil pH and improve the availability of Mn.

Molybdenum (Mo) deficiency in cauliflower (whiptail) may develop when this crop is grown on soils that are more acid than pH 5.5. Liming acid soils to a pH of 6.0 to 6.5 will usually prevent the development of Mo deficiencies in vegetable crops.

Deficiencies of other micronutrients in vegetables in the Mid-Atlantic region are rare; and when present, are usually caused by over-liming or other substandard soil management practices. Contact your county Extension Agent/Educator for advice if you suspect a micronutrient deficiency of zinc, iron, copper, chlorine, or nickel. Sources of fertilizers for the essential plant nutrients may be found in Tables B-5 and B-6.

Table B-5. Composition of Principal Macronutrient Fertilizer Materials

Material	N Nitrogen (%)	P_2O_5 Phosphorus (%)	K_2O Potassium (%)	Mg Magnesium (%)	Ca Calcium (%)	S Sulfur (%)	$CaCO_3$ Equivalent (lb/ton)
Ammonia, Anhydrous	82						-2960
Ammonium Nitrate	33 to 34						-1180
Ammonium Phosphate Sulfate	13 to16	20 to 39				13	-1520 to -2260
Ammonium Polyphosphate (APP)	10 to 11	34 to 37					+1000 to 1800
Ammonium Sulfate (Granular)	21					24	-2200
Ammonium Sulfate (Liquid)	8					9	
Ammonium Sulfate Nitrate	26					15	-1700
Ammonium Thiosulfate	12					26	-2000
Calcium Nitrate	15				19		+400
Calcium Sulfate (Gypsum)					23	17	
Diammonium Phosphate (DAP)	18	46					-1400
Limestone, Calcite					32		+1700 to 2000
Limestone, Dolomite				11	22		+1900 to 2160
Magnesium Oxide (Magnesia)				55			
Magnesium Sulfate (Epsom Salt)				10	2.2	14	
Monoammonium Phosphate (MAP)	11	52					-1160
Nitric Phosphates	14 to 22	10 to 22			8 to 10	0 to 4	-300 to -500
Phosphoric Acid		52 to 54					-2200
Potassium Chloride (Muriate)			60 to 63				
Potassium Magnesium Sulfate			22	11		22	
Potassium Nitrate	13		44				-460
Potassium Sulfate			50 to 53			18	
Potassium Thiosulfate			25			17	
Rock Phosphate		30 to 36			33		+200
Sodium Nitrate	16						+580
Sulfur Elemental						32 to 100	
Superphosphate, Concentrated (Triple)		44 to 53			14		-3200
Superphosphate, Normal		16 to 22			20	12	
Urea	45 to 46						-1680
Urea Formaldehydes	35 to 40						-1360
Urea-Ammonium Nitrate Solutions	21 to 49						-750 to -1760

Table B-6. Chemical Sources of Secondary and Micronutrients

	Material	Chemical Formula	% B
Boron Sources	Borax	$Na_2B_4O_7{\bullet}10H_2O$	11
	Boric acid	H_3BO_3	17
	Fert. borate-46	$Na_2B_4O_7{\bullet}5H_2O$	14
	Fert. Borate-65	$Na_2B_4O_7$	20
	Sodium pentaborate	$Na_2B_{10}O_{16}{\bullet}10H_2O$	18
	Solubor	$Na_2B_{10}O_{16}{\bullet}10H_2O + Na_2B_4O_7{\bullet}5H_2O$	20
	Material	**Chemical Formula**	**% Ca**
Calcium Sources	Calcitic lime	$CaCO_3$	31.7
	Calcium nitrate	$Ca(NO_3)_2$	19.4
	Dolomitic lime	$CaCO_3+MgCO_3$	21.5
	Gypsum	$CaSO_4{\bullet}2H_20$	22.5
	Hydrated lime	$Ca(OH)_2$	46.1
	Superphosphate, normal	$Ca(H_2PO_4)_2$	20.4
	Superphosphate, triple	$Ca(H_2PO_4)_2$	13.6
	Material	**Chemical Formula**	**% Cu**
Copper Sources	Copper ammonium phosphate	$Cu(NH_4)PO_4{\bullet}H_2O$	32
	Copper chelates	$Na_2CuEDTA$ $NaCuHEDTA$	13 9
	Copper sulfate	$CuSO_4{\bullet}5H_2O$	25
	Material	**Chemical Formula**	**% Fe**
Iron Sources	Ferrous ammonium phosphate	$Fe(NH_4)PO_4{\bullet}H_2O$	29
	Ferrous sulfate	$FeSO_4{\bullet}7H_2O$	19
	Iron ammonium polyphosphate	$Fe(NH_4)HP_2O_7$	22
	Iron chelates	$NaFeEDTA$	5 to 14
		$NaFeDTPA$	10
		$NaFeEDDHA$	6
	Material	**Chemical Formula**	**% Mg**
Magnesium Sources	Dolomitic lime	$MgCO_3+CaCO_3$	11.4
	Epsom salt	$MgSO_4{\bullet}7H_2O$	9.6
	Magnesia	MgO	55.0
	Potassium-Mg sulfate	$K_2SO_4{\bullet}2MgSO_4$	11.2
	Material	**Chemical Formula**	**% Mn**
Manganese Sources	Manganese chelate	$MnEDTA$	12
	Manganese oxide	MnO	41 to 68
	Manganese sulfate	$MnSO_4{\bullet}4H_2O$	26 to 28
	Material	**Chemical Formula**	**% Mo**
Molybdenum Sources	Ammonium molybdate	$(NH_4)6Mo_7O_{24}{\bullet}2H_2O$	54
	Molybdenum trioxide	MoO_3	66
	Sodium molybdate	$Na_2MoO_4{\bullet}2H_2O$	39
	Material	**Chemical Formula**	**% S**
Sulfur Sources	Ammonium sulfate	$(NH_4)_2SO_4$	24
	Ammonium thiosulfate	$(NH_4)_2S_2O_3$	26
	Gypsum	$CaSO_4{\bullet}2H_2O$	16.8
	Potassium-Mg-sulfate	$K_2SO_4{\bullet}2MgSO_4$	22.0
	Potassium thiosulfate	$K_2S_2O_3$	17
	Sulfur, elemental	S	32 to 100
	Material	**Chemical Formula**	**% Zn**
Zinc Sources	Zinc carbonate	$ZnCO_3$	52
	Zinc chelates	$Na_2ZnEDTA$ $NaZnHEDTA$	14 9
	Gypsum	$CaSO_4{\bullet}2H_2O$	16.8
	Zinc oxide	ZnO	78
	Zinc sulfate	$ZnSO_4{\bullet}H_2O$	35

Table B-7. Boron Recommendations Based on Soil Tests for Vegetable Crops

<table>
<tr><th colspan="3">Interpretation of Boron Soil Tests</th><th rowspan="2">Crops that often need additional Boron[1]</th><th rowspan="2">Boron (B) Recommendations (lb/A)[2]</th></tr>
<tr><th>Parts per Million</th><th>Pounds per Acre</th><th>Relative Level</th></tr>
<tr><td rowspan="3">0.0-0.35</td><td rowspan="3">0.0-0.70</td><td rowspan="3">Low</td><td>Beets, broccoli, Brussels sprouts, cabbage, cauliflower, celery, rutabaga, and turnips</td><td>3</td></tr>
<tr><td>Asparagus, carrots, eggplant, horseradish, leeks, muskmelons, okra, onions, parsnips, radishes, squash, strawberries, sweet corn, tomatoes, and white potatoes</td><td>2</td></tr>
<tr><td>Peppers and sweet potatoes</td><td>1</td></tr>
<tr><td rowspan="2">0.36-0.70</td><td rowspan="2">0.71-1.40</td><td rowspan="2">Medium</td><td>Beets, broccoli, Brussels sprouts, cabbage, cauliflower, celery, rutabaga, and turnips</td><td>1.5</td></tr>
<tr><td>Asparagus, carrots, eggplant, horseradish, leeks, muskmelons, okra, onions, parsnips, radishes, squash, strawberries, sweet corn, tomatoes, and white potatoes</td><td>1</td></tr>
<tr><td>>0.70</td><td>>1.40</td><td>High</td><td>All crops</td><td>0</td></tr>
</table>

[1]If boron deficiency is suspected in vegetable crops not listed above, a soil and/or plant tissue test should be made and used as a basis for treatment recommendations. [2]Approximate conversion factors to convert elemental boron (B) to different boron sources:
Boron (B) x 9 = borax (11.36% B); boron (B) x 7=fertilizer borate granular (14.3% B); boron (B) x 6.7 = fertilizer borate 48 (14.91% B); boron (B) x 5 = fertilizer borate 65 (20.2% B) or Solubor (20.5% B); boron (B) x 4.7 = fertilizer borate 68 (21.1% B).

Note.
The most practical way to apply boron as a soil application is as an additive in mixed fertilizer bought specifically for the crop or field where it is needed. Do not use fertilizer containing more than 0.5 lb B per ton of fertilizer for crops not listed above, unless specifically recommended. To avoid possible boron toxicity damage to crops, apply boron in broadcast fertilizer rather than in bands or as a sidedressing. Boron may be broadcast preplant as a soluble spray alone or with other compatible soluble chemicals.

Plant Tissue Testing

Plant tissue testing is an important tool in assessing vegetable nutrient status during the growing season. The following methods are commonly used: 1. Testing leaf tissue, 2. Testing whole petioles, and 3. Testing petiole sap.

1. Collecting leaf tissue for analysis:

- Sample the most recently matured leaf from the growing tip; the sample should not contain any root or stem tissues. For sweet corn or onions, the leaf is removed just above the attachment point to the stalk or bulb. For compound leaves (*e.g.*, carrots, peas, tomatoes) the whole leaf includes the main petiole, all the leaflets and their petioles. For heading vegetables, it is most practical to take the outermost whole wrapper leaf. When sampling particularly young plants, the whole above-ground portion of the plant may be sampled.
- A proper leaf sample should consist of about 25 to 100 individual leaves. The same leaf (*i.e.*, physiological age and position) should be collected from each sampled plant.
- Avoid sampling plants damaged by pests, diseases, or chemicals.
- Sample across the field, from different rows, and avoid problem areas (*e.g.*, low spots, ridges, washed out areas).
- Sample when the plants are actively growing (typically between 9 a.m. and 4 p.m.). Do not collect samples from water stressed plants.
- Send samples to a laboratory in a paper bag; **do not use plastic bags** (your samples may rot in plastic).

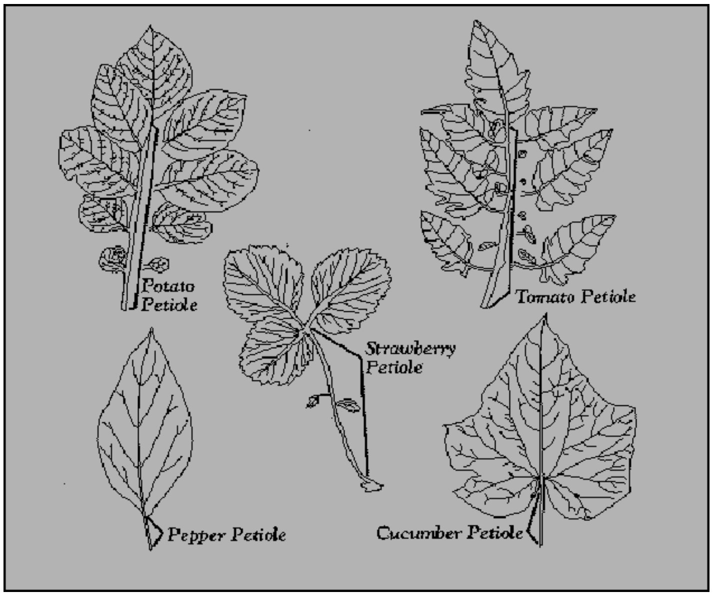
2. Collecting whole petiole samples for analysis:

- Sample the most recently matured leaf. Throw away the leaflets or leaf blade. (see Fig. B-2). Sample from 30 to 50 plants.
- Sample across the field, from different rows, and avoid problem areas (*e.g*., low spots, ridges, washed out areas).
- Sample between 10 a.m. and 2 p.m. Do not collect samples from water stressed plants.
- Send samples to a laboratory in a paper bag; **do not use plastic bags** (your samples may spoil in plastic)

3. Collecting petiole sap samples for analysis:

- Sample petioles from most recently matured leaves. Discard the leaflets (see Fig. B-2). Sample 30 to 50 plants.
- Sample across the field, from different rows, and avoid problem areas (*e.g.*, low spots, ridges, washed out areas).
- Sample between 10 a.m. and 2 p.m. Do not collect samples from water stressed plants.
- After collection, squeeze collected petioles with a garlic press to extract sap. Use a handheld nitrate meter, (available widely from nutrient management supply companies) to read the sap nitrate concentration. Make sure you record the correct units as either NO_3^{-1} or NO_3^{-1}-N. Petiole sap sufficiency ranges are found in Table B-9.

Figure B-2 Petiole Delineation for Several Plant Species.



Interpreting Tissue Tests

Tissue tests will be reported as *adequate* or *sufficient* or *normal* in a range; *low or deficient* below that range; *high or excessive* above that range; and *toxic* (if applicable) if in excess. Test interpretation for most vegetable crops can be found at this University of Florida website *https://edis.ifas.ufl.edu/publication/ep081*. Test interpretations for selected crops can also be found in chapter F. **Petiole sap** sufficiency ranges can be found in Table B-9. The concentrations in the sufficiency range are measured in plants that have adequate amounts of nutrients available. Plants with nutrient concentrations in the high range are indicative of over-fertilization. Excessive values for micronutrients may result in phytotoxicity.

Correcting Deficiencies

Recommendations for correcting nutrient deficiencies are presented in the previous sections and in table B-8.

Table B-8. Recommendations for Correction of Vegetable Crop Nutrient Deficiencies

Nutrient	Fertilizer	Method	Application Rate (Nutrient) lb/A
Nitrogen (N)	Urea-ammonium nitrate solutions	T,S,D[1]	30 to 40
	Calcium nitrate	T,S,D	30 to 40
Phosphorus (P_2O_5)	Ammonium phosphates	T,S,D	20
	Triple superphosphate	T,S	20
	Phosphoric acid	S,D	20
Potassium (K_2O)	Potassium chloride	T,S,D	30
	Potassium nitrate	T,S,D	30
Calcium (Ca)	Calcium nitrate	T,S,D	30
	Calcium chloride	D	30
Magnesium (Mg)	Magnesium sulfate	T,S,D	20
	Potassium magnesium sulfate	T,S	20

Table B-8. Recommendations for Correction of Vegetable Crop Nutrient Deficiencies - continued next page

Table B-8. Recommendations for Correction of Vegetable Crop Nutrient Deficiencies - continued

Nutrient	Fertilizer	Method	Application Rate (Nutrient) lb/A
Sulfur (S)	Ammonium Sulfate	T,S,D	20
	Gypsum	T,S,D	20
Boron (B)	Borax, Solubor[2]	D,F[1]	0.1 to 0.2
Copper (Cu)	Copper sulfate	D,F	0.1 to 0.2
Iron (Fe)	Ferrous sulfate, chelated iron	D,F	0.2 to 0.5
Manganese (Mn)	Manganous sulfate, chelated manganese	D,F	0.5 to 1.0
Molybdenum (Mo)	Sodium molybdate	D,F	0.01 to 0.05
Zinc (Zn)	Zinc sulfate, chelated zinc	D,F	0.1 to 0.2

[1]T=topdress, S=sidedress, D=drip irrigation, F=foliar. [2]Mention of a trade name does not imply a recommendation over similar materials.

Table B-9. Sufficiency Ranges for Fresh Petiole Sap Concentrations in Vegetable Crops

Crop	Stage of Growth	Concentration (ppm) K	Concentration (ppm) NO_3-N	Crop	Stage of Growth	Concentration (ppm) K	Concentration (ppm) NO_3-N
Cucumber	First blossom	N/A	800-1000	**Potato**	Plants 8 in. tall	4500-5000	1200-1400
	Fruit (3 in.)	N/A	600-800		First open flowers	4500-5000	1000-1400
	First harvest	N/A	400-600		50% flowers open	4000-4500	1000-1200
Broccoli	Six-leaf stage	N/A	800-1000		100% flowers open	3500-4000	900-1200
	Just prior to harvest	N/A	500-800		Tops falling over	2500-3000	600-900
	At first harvest	N/A	300-500	**Squash**	First blossom	N/A	900-1000
Eggplant	First fruit (2 in)	4500-5000	1200-1600		First harvest	N/A	800-900
	First harvest	4000-5000	1000-1200	**Tomato (Field)**	First buds	3500-4000	1000-1200
	Mid harvest	3500-4000	600-800		First open flowers	3500-4000	600-800
Muskmelon (Cantaloupe)	First blossom	4000-5000	1000-1200		Fruit (1 in. diameter)	3000-3500	400-600
	Fruit (2 in.)	3500-4000	800-1000		Fruit (2 in. diameter)	3000-3500	400-600
	First harvest	3000-3500	700-800		First harvest	2500-3000	300-400
Pepper	First flower buds	3200-3500	1400-1600		Second harvest	2000-2500	200-400
	First open flowers	3000-3200	1400-1600	**Watermelon**	Vines (6 in. long)	4000-5000	1200-1500
	Fruit half-grown	3000-3200	1200-1400		Fruit (2 in. long)	4000-5000	1000-1200
	First harvest	2400-3000	800-1000		Fruit (half mature)	3500-4000	800-1000
	Second harvest	2000-2400	500-800		At first harvest	3000-3500	600-800

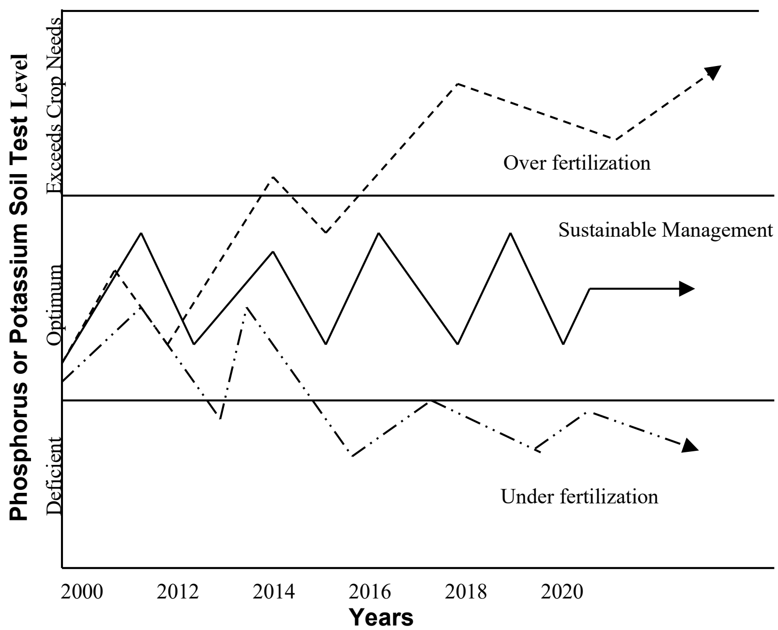
Sustainable Nutrient Management

A major objective of nutrient management is to bring the soil fertility level into the *optimum* range and to sustain that fertility level during crop growth. Once soil fertility has reached the *optimum* level, the nutrient application rate should be only large enough to maintain the *optimum* level. This can be accomplished by applying nutrients at a rate that closely matches the rate of nutrient removal in the harvested crop. The rate may need to be slightly higher to account for other losses such as leaching.

Keeping records of soil test results enables you to track changes over time and to adjust recommendations as needed to maintain soil fertility in the optimum range. Meaningful records require a consistent approach to soil testing in terms of sample collection, sampling depth, and laboratory submission. Soil test concentrations can vary somewhat from sample to sample and having records helps to spot unusual soil test values that should be rechecked. Although soil fertility concentrations naturally fluctuate from year to year due to crop rotation and manure application, average concentrations of nutrients over time should remain in the optimum range, as shown in Figure B-3. If soil fertility levels are observed to fall in the *below optimum* or *deficient* category, under-fertilization is indicated. The nutrient recommendation should be adjusted so that the application rate is sufficient to meet the needs of the current crop, and to gradually rebuild the nutrient supply to the optimum level. If soil fertility concentrations are observed to climb into the *above optimum* or *exceeds crop needs* category, good crop yields may be obtained without adding the nutrient. Yield and quality are likely to be reduced by reapplying a nutrient already present in very high amounts. Over time, nutrient removal by crops should allow soil fertility concentrations to fall back into the optimum range (Figs. B-1 and 3).

Very high soil nutrient levels can be as detrimental to crop performance as low or deficient levels. High soil nutrient levels may not only result in economic loss, but they may also cause problems to animals and/or the environment. Very high soil P levels may lead to deficiencies of other nutrients, especially of iron and zinc. High K levels can induce magnesium or calcium deficiency through competition for plant uptake and vice versa. Use best management practices to avoid increasing soil nutrient levels that are already high.

Figure B-3. Changes in Soil Test Levels over Time under Different Nutrient Management Scenarios



Foliar Fertilization

Plants usually obtain nutrients from the soil through roots, but plants can also absorb a limited amount of some nutrients through aerial organs, such as leaves. Properly managed soils are usually able to supply the essential mineral nutrients the crop will need during its development. If one or more soil-supplied nutrients become deficient or unavailable during the development of the crop, foliar nutrient applications may be beneficial. Care should be taken to use approved tank mixes if nutrients are combined with fungicides, insecticides, herbicides, or any other additive. Chelated nutrient sources are often optimal for tank mixes, but make sure to **read the label and conduct a jar test**. Generally, it is difficult to supply ample macro- and secondary nutrients through foliar fertilization, and application of this strategy should be focused on micronutrients only. If a nutrient deficiency occurs, efforts should be made to correct this deficiency via soil fertilization prior to the next growing season.

5. Soil Improvement and Organic Nutrient Sources

Cover cropping is an important practice for sustainable vegetable production; some reasons to consider cover crops:

Return organic matter to the soil: Vegetable rotations are tillage intensive and organic matter is oxidized at a high rate. Cover crops help maintain soil organic matter concentrations, a critical component of soil health and productivity.
Provide winter cover: By having a cover crop - including roots - growing on a field in the winter you recycle plant nutrients (especially N), reduce N leaching losses, reduce erosion by wind and water, and reduce surface compaction and the effects of heavy rainfall on bare soils. Cover crops also compete with winter annual weeds and can help reduce weed pressure in the spring.
Reduce certain diseases and other pests: Cover crops help maintain soil organic matter concentrations. Cover crop residues can help increase the diversity of soil organisms and reduce soil borne disease pressure. Some cover crops may also release compounds that help suppress certain soil borne pests, *e.g.*, nematodes.

Provide nitrogen for the following crop: Leguminous cover crops, such as hairy vetch or crimson clover, can provide significant amounts of nitrogen, especially for late spring planted vegetables.
Improve soil physical properties: Cover crops help maintain or improve soil physical properties and reduce compaction. Roots of cover crops and incorporated cover crop residue will help improve drainage, water holding capacity, aeration, and tilth.

Small Grains and Ryegrasses

Seeding spring oats at 60 to 100 lb/A during August or early September provides a good cover crop that will winter-kill in the colder areas but may overwinter in warmer areas. Rye, triticale, barley, or winter wheat can be seeded at 80 to 110 lb/A after early September. These crops can also provide strips for wind protection during the early part of the next growing season. Spring oats also works as a spring planted cover. Annual and perennial ryegrass or a mixture of the two seeded at 15-20 lb/A by early September are also good cover crops.

Legumes

Legumes such as hairy vetch, crimson clover, field peas, subterranean clover, and other clovers are excellent cover crops and can provide significant amounts of N for vegetable crops that follow. Good examples are hairy vetch drilled at 25-60 lb/A, crimson clover at a rate of 15-30 lb/A, or field peas such as Austrian Winter planted at 50-70 lb/A. Subterranean clover is an option for the southern part of the region. Hairy vetch works very well in no-till vegetable systems where it is allowed to reach flowering or early fruiting and then is killed by herbicides or with a roller-crimper. It is a common system for planting pumpkins in the region, but also works well for late plantings of other vine crops, tomatoes and peppers. Hairy vetch, crimson clover, field peas and subterranean clover can provide from 80 to well over 100 lb/A of N equivalent. See Table B-10 for estimated N credits from legumes. Remember to inoculate the seeds of these crops with the proper Rhizobia inoculants. All these legume species should be planted as early as possible, from the last week in August through the end of September to get adequate fall growth. Legume cover crops should be planted a minimum of 4 weeks before a killing frost.

Red clover planted late winter or early spring can be used ahead of early summer vegetables. Summer legume cover crops can be used for soil improvement and provide N prior to planting fall vegetable crops. These include sun hemp, cowpeas, soybeans, annual lespedeza, and several medic (alfalfa) species.

Summer Annual Grasses

Summer grass cover crops such as sudangrass, forage sorghum or sorghum x sudangrass crosses, seeded at 20 to 40 lb/A, are good green manure crops. Several millet species including forage-type pearl millet, teff, German or foxtail millet, and Japanese millet are also good cover crops. They can be planted as early as field corn is planted and as late as August 15 in MD and VA, and July 25 to August 1 in cooler areas of NJ and PA. These crops should be clipped, mowed, or disked to prevent seed development that could lead to weed problems. Summer cover crops can be disked and planted in wheat or rye in September or allowed to winter-kill and tilled in the spring.

Brassicas

There has been increased interest in the use of certain brassicas, including both fully hardy overwintering species and species that will winter-kill but that can be planted in the spring ahead of crop production. They provide significant amounts of organic matter, recycle N, can reduce compaction (larger rooted types), and offer the potential for biofumigation (mustards and rapeseed). Plant by September 15 or in March-April. The following Brassicas are available:

Rapeseed and Canola - overwinter and are good biofumigants.
Forage, Oilseed, and Daikon Radish - very good for reducing compaction in soils; forage radish winter kills, oilseed radish is hardier.
Mustards (brown and yellow mustards as well as garden mustard) - offer good biofumigant potential; half hardy.
Turnips (forage and garden types) - good biomass production; half hardy.
Kale (forage and garden types) - winter hardy; good biomass production.
Hybrid Forage Brassicas (such as 'Typhon') - these are hybrid crosses of two or more species that will produce excellent fall growth, and some will overwinter. Rapeseed has been used as a winter cover (when planted by early September) and has shown some promise as a biofumigant, reducing certain nematode levels in the soil. Several mustard species also have biofumigation potential. To take advantage of biofumigation properties (rapeseed and

several mustards) plant in late summer or spring. Allow plants to develop until just before going to seed. Decomposing leaves release fumigant-like chemicals. Mow using a flail mower and plow down the residue immediately. Never mow down more area than can be plowed under within two hours. Mowing injures the plants and initiates a process releasing biofumigant chemicals into the soil. Failure to incorporate mowed plant material into the soil quickly, allows much of these available toxicants to escape by volatilization.

Several mustard species can be used for fall cover but not all species/varieties will winter over into the spring. A succession rotation of an August planting of biofumigant mustards that are tilled under in October followed by small grain can significantly reduce diseases for spring planted vegetables that follow. **Make sure to mow and disk rapeseed and mustard in advance of seed maturation, since they can become serious noxious weeds.**

Other Cover Crops/Special Considerations

Several other cover crops may be useful. Buckwheat is a quick summer cover crop noted for its ability to smother out weeds. Marigold species have been used as nematode controls.

Many soils that are not very productive due to poor physical properties can be restored and made to produce good crops using a good rotation program. This practice also helps to counteract the buildup of many diseases and insects that attack vegetable crops. Small grains, sudangrass, sorghum x sudangrass, timothy, orchardgrass, ryegrass and other grass hay species are good soil-resting crops. Consult your state field crop or agronomy recommendations for details on seeding rates and management practices.

Intensive cropping, working the soil when it was too wet, and excessive traffic from using heavy-tillage equipment has severely damaged many soils. These practices cause soils to become very hard and compact, resulting in poor seed germination, loss of transplants, and shallow root formation. Also, such soils crust easily and compact severely, making them very difficult to irrigate properly. This results in poor plant stands, poor crop growth, low yields, and loss of income. Subsoil tilling in the row may help improve aeration and drainage of soils damaged by several years of excessive traffic from heavy equipment.

Alfalfa can aid in breaking up deep soil compaction. It is useful as a soil-resting crop and in crop rotations. However, it should not be used in rotation with other legumes such as: soybeans; peas; and snap, dry, and lima beans; and especially where soil-borne diseases have been a problem. Forage radish and oilseed radish are also very well suited to improving compacted soils.

Proper management of living cover crops can reduce nutrient loss during the winter and early spring. Living cover crops should be disked or plowed to return nutrients to the soil and before they seriously deplete soil moisture.

Sewage Sludge

Sewage sludge, or biosolids, is a by-product of the purification of wastewater. This type of material supplies organic matter and contains micro- and macronutrients essential for plant growth. Sewage sludge can also contain contaminants such as heavy metals, organic contaminants, radioactive substances, pharmaceuticals, and human pathogens. Before it can be used for land application, sewage sludge must undergo stabilization and disinfection. After appropriate treatment, federal and some state regulations allow the use of sewage sludge on vegetables. However, Extension does not recommend applying sewage sludge biosolids to land used for vegetable production due to environmental and public health concerns. In some states and in USDA Certified Organic Agriculture, land application of sewage sludge biosolids is prohibited. If you elect to use biosolids despite warnings, the material should not be applied to steeply sloping land, soils with bedrock near the surface, highly leachable soils, soils having a pH less than 6.0, soils with high water tables, or fields near surface water. When considering the land application of sewage sludge biosolids, carefully review the regulations and consult with the United States Department of Agriculture (USDA) and the Natural Resources Conservation Service (NRCS).

Manure and Compost

Manures can be used in vegetable production but must be applied with sufficient time ahead of harvest to minimize the risk from pathogens that cause foodborne illness (*e.g.*, *E. coli* 0157:H7, *Listeria*, *Salmonella*). See Table B-10 for estimated available nutrient content for different manure types by animal. Manure testing is recommended for developing nutrient management plan as the organic source of N in the manure will be available slowly. According to the US Department of Agriculture's National Organic Program, current guidelines for organic producers are to apply un-composted animal manures at least 90 days prior to harvest for crops whose harvestable portions <u>do not</u> come in contact with the soil and at least 120 days prior to harvest for crops whose harvestable portions do come in contact with the soil.

According to the US Food and Drug Administration's Food Safety Modernization Act Produce Safety Rule, current standards for subpart F (112.50-60) are under a deferred action on the application interval until FDA can perform a risk assessment to understand what effectiveness the integration of an appropriate interval or intervals may have on protecting public health.

An alternative to direct application of manure is to compost the manure. Properly composted manure can be applied to produce at any time before harvest.

Application and incorporation of compost to soils will increase soil organic matter and certain soil nutrient concentrations. Compost ingredients can include animal manures, scrap table foods, food wastes, leaves, grass, wood products, or other waste materials. Compost composition, nutrient analysis, and quality should be considered when used in vegetable production. Ingredients which make up specific compost may be alkaline (*e.g.*, lime is often added), resulting in a high pH of 7.5 to 8.5. Composts that have been made from manures may have high salt concentrations. Therefore, application rates of compost must be determined by considering nutrient content, salt levels, crop use, and pH before field applications are made. Composts are generally applied from 1 to 6 ton/A. Higher application rates may be deleterious. Compost analysis is essential to determine safe application rates.

A good extension web reference on the making and use of compost for vegetable production is *https://aggie-horticulture.tamu.edu/vegetable/guides/composts-vegetable-fruit-production/*. For more information on using organic nutrient sources including calculating how much to apply see: *Using Organic Nutrient Sources* at: *https://extension.psu.edu/using-organic-nutrient-sources*.

Table B-10. Plant Nutrient Value Credits to Be Allowed for Manure Applications and Crop Residues

Manure Applications	Pounds per Ton				Crop Residues	Pounds per Acre		
	N	**P_2O_5**	**K_2O**			**N**	**P_2O_5**	**K_2O**
Cattle manure	5-10[1]	3	3		Alfalfa sod	50-100[2]	0	0
Horse manure	6-12[1]	3	6		Birdsfoot trefoil	40	0	0
Liquid poultry manure (5-15% solids)	7-15[1]	5-10	5-10		Crimson clover sod	50	0	0
					Hairy vetch	50-100[2]	0	0
Pig manure	5-10[1]	2	2		Ladino clover sod	60	0	0
Poultry manure	25-50[1]	40-80	30-60		Lespedeza	20	0	0
					Red clover sod	40	0	0
					Soybeans - grain harvest residue	15	0	0
					Soybeans - tops and roots	40	0	0

[1] Lower values for fall- and winter-applied manure and higher values for spring applied manure. Use these data only if manure being used has not been analyzed.
[2]75% stand = 100-0-0, 50% stand = 75-0-0, and 25% stand = 50-0-0

Herbicide Carryover in Compost

It is important to know the source and composition of any soil amendment or compost that is used on or around vegetable crops. Compost that contains hay, straw, grass clippings, and/or cow or horse manure may potentially be a carrier of herbicide residue. Several herbicides commonly used in pasture and turf production may be present in straw or hay and can pass through the digestive system of animals and remain in manure. These herbicides are toxic in very low concentrations to many vegetable crops. Symptoms are often similar to growth regulating herbicides and include twisted or cupped leaves, misshapen fruit, reduced yields, or plant death. Additional information can be fo*und at: https://content.ces.ncsu.edu/herbicide-carryover*.

Organic Production

Nutrient sources used for certified organic production must be included in the National List of Allowed and Prohibited Substances, which can be found at: *https://www.ams.usda.gov/about-ams/programs-offices/national-organic-program*. The Organic Materials Review Institute (OMRI; see *https://www.omri.org*) reviews products submitted by companies against the National Organic Standard (NOS) and can help identify which products are allowed in organic production. Certifying agencies also review products for compliance with the NOS. Before using any product, it is best to check with your certifying agency to make sure the product is allowed and thereby avoid compromising your organic certification. See Table B-11 for a list of various products useable on organic farms.

Table B-11. Status for Organic Production, Mineral Nutrient Value, and Relative Availability of Various Materials Check with your certifying agency before using any of the listed materials, as the status for organic production may have changed.

Material[a]	Status for Organic Production[b]	Percent Nutrients[c]			Relative Availability
		N	P_2O_5	K_2O	
Animal Tankage (dry)	Allowed	7	10	0.5	Medium
Bone Meal (raw)	Allowed	2 to 6	15 to 27	0	Slow
Bone Meal (steamed)	Allowed	0.7 to 4.0	18 to 34	0	Slow Medium
Cocoa Shell Meal	Allowed	2.5	1.0	2.5	Slow
Compost (not fortified)	Allowed[d]	1.5 to 3.5	0.5 to 1.0	1.0 to 2.0	Slow
Cottonseed Meal (dry)	Allowed[e]	6	2.5	1.7	Slow Medium
Dried Blood (dry)	Allowed	12	1.5	0.57	Medium Rapid
Fish Emulsion	Allowed	5	2	2	Rapid
Fish Meal (dry)	Allowed	14	4	0	Slow
Fish Scrap (dry)	Allowed	3.5 to 12	1 to 12	0.08 to 1.6	Slow
Garbage Tankage (dry)	Allowed	2.7	3	1	Very Slow
Grain Straw	Allowed	0.6	0.2	1.1	Very Slow
Guano (Bat)	Restricted[f]	5.7	8.6	2	Medium
9Kelp[g]	Allowed	0.9	0.5	4 to 13	Slow
Manure[h] (fresh) - Cattle	Restricted[i]	0.25	0.15	0.25	Medium
Manure[h] (fresh) - Horse	Restricted[i]	0.3	0.15	0.5	Medium
Manure[h] (fresh) - Sheep	Restricted[i]	0.6	0.33	0.75	Medium
Manure[h] (fresh) - Swine	Restricted[i]	0.3	0.3	0.3	Medium
Manure[h] (fresh) - Poultry (75%)	Restricted[i]	1.5	1	0.5	Medium Rapid
Manure[h] (fresh) - Poultry (50%)	Restricted[i]	2	2	1.0	Medium Rapid
Manure[h] (fresh) - Poultry (30%)	Restricted[i]	3	2.5	1.5	Medium Rapid
Manure[h] (fresh) - Poultry (15%)	Restricted[i]	6	4	3	Medium Rapid
Marl	Allowed	0	2	4.5	Very Slow
Mushroom Compost[j]	Allowed[k]	0.4 to 0.7	5.7 to 6.2	0.5 to 1.5	Slow
Peanut Hulls	Allowed	1.5	0.12	0.78	Slow
Peat and Muck	Allowed[l]	1.5 to 3.0	0.25 to 0.5	0.5 to 1.0	Very Slow
Pomaces[m] - Apple (fresh)	Allowed	0.17 to 0.3	0.4 to 0.7	0.2 to 0.6	Slow
Pomaces[m] - Apple (dry)	Allowed	0.7 to 0.9	1.2 to 2.1	0.6 to 1.8	Slow
Pomaces[m] - Castor	Allowed	5.0	1.0	1.0	Slow
Pomaces[m] - Winery	Allowed	1.5	1.5	0.80	Slow
Sawdust	Allowed[n]	4	2	4	Very Slow
Soybean Meal (dry)	Allowed	6.7	1.6	2.3	Slow Medium
Tobacco Stems (dry)	Allowed	2	0.7	6.0	Slow
Wood Ashes[o]	Allowed[p]	0	1 to 2	3 to 7	Rapid

[a] Some materials may not be obtainable because of restricted sources.
[b] Must be produced in accordance with the National Organic Standard to be allowed. Organic status was determined through listing with the Organic Materials Review Institute (OMRI; https://www.omri.org/). Brand used may affect allowability; check with your certifier before using any product to avoid compromising your certification.
[c] The percentage of plant nutrients is highly variable, mean percentages are listed.
[d] Must be produced in accordance with the National Organic Standards to be used in organic production.
[e] Brand used must not be derived from genetically modified cotton or contain prohibited substances.
[f] Allowed guano is decomposed and dried deposits from wild bats or birds. Must meet requirements for using raw manure.
[g] Contains common salt, sodium carbonates, sodium and potassium sulfates.
[h] Plant nutrients are available during the year of application. Nutrient content varies with the amount of straw and method of storage.
[i] Uncomposted or raw animal manure must be used on fields with crops not to be consumed by humans or incorporated into the soil a minimum of 90 days before harvesting a product to be consumed by humans provided that the edible portion of the crop does not contact the soil or integrated into the soil a minimum of 120 days before harvesting a product to be consumed by humans that does come into contact with the soil. Using sewage sludge is prohibited in certified organic production.
[j] Use only after composting in compliance with the National Organic Standard. Fresh mushroom compost is usually too high in soluble salts.
[k] Must meet compost requirements.
[l] Not allowed if contains synthetic wetting agents.
[m] Plant nutrients are highly variable, depending on the efficiency and the processing techniques at the processing plant.
[n] Allowed only if wood is untreated and unpainted.
[o] Potash content depends upon tree species burned. Wood ashes are alkaline, containing about 32% CaO.
[p] Only from untreated and unpainted wood. Wood stove ash - only if not contaminated with colored paper, plastics, or other synthetic sources.

C. Irrigation Management

1. Basic Principles

Moisture management throughout the growing season is a critical factor for the production of high-quality vegetables. Even relatively short periods of inadequate soil moisture can adversely affect crops. Supplemental irrigation is beneficial in most years since rainfall in the Mid-Atlantic region is rarely uniformly distributed throughout the growing season, even in years with above-average precipitation.

Moisture stress has varying effects on plants depending on developmental stage and type of stress. Moisture deficiencies occurring early in the crop cycle may delay maturity and reduce yields and quality. Shortages later in the season often decrease produce quality, as well as yields, or even result in irreversible crop damage. Over-irrigation, especially late in the season, can reduce the quality and post-harvest life of the produce. Table C-1 shows the periods of crop growth when an adequate supply of water is critical for high-quality vegetable production.

Applying the proper amount of water at the correct time and location is critical for achieving the optimum benefits from irrigation. The crop water requirement, termed evapotranspiration, or ET is equal to the quantity of water lost from the plant (transpiration) plus that evaporated from the soil surface. Knowledge of ET is the most important factor for effective irrigation management. Many factors must be considered when estimating ET. The most important factor is the amount of solar radiation (sunlight), which provides the energy to evaporate moisture from the soil and the plant. Other important factors are air temperature, wind speed, and humidity level. Different crops also have different transpiration rates.

Instruments that measure soil moisture content or soil water potential are commonly used to measure changes in soil moisture and adjust irrigation schedules (see “Scheduling Irrigation with Soil Moisture Sensors” in section C 2. Drip (Trickle) Irrigation below).

Table C-1. Most Critical Periods of Water Needs by Crops

Crop	Most Critical Period	Crop	Most Critical Period
Asparagus	Brush (period following fern mowing)	Onions: dry	Bulb enlargement
Beans: lima	Pollination and pod development	Peas	Seed enlargement and flowering
Beans: snap	Pod enlargement	Peppers	Flowering and fruit development
Broccoli	Head development	Potatoes: white	Tuber set and tuber enlargement
Cabbage	Head development	Potatoes: sweet	Root enlargement
Carrots	Root enlargement	Radishes	Root enlargement
Cauliflower	Head development	Strawberries	Establishment, runner development, fruit enlargement
Corn	Silking and tasseling, ear development		
Cucumbers	Flowering and fruit development	Squash: summer	Bud development and flowering
Eggplants	Flowering and fruit development	Tomatoes	Early flowering, fruit set, and enlargement
Lettuce	Head development	Turnips	Root enlargement
Melons	Flowering and fruit development		

Crop Water Requirement

Plant factors affecting the crop water requirement are crop species and variety, canopy size, leaf characteristics (size, shape, wax coating, and orientation), plant population density, rooting depth, and stage of growth and development of the crop. The plant canopy size and shape influences transpiration, light absorption, reflection, and the rate at which water evaporates from the soil. Crops that feature a canopy with more surface area for transpiration and sunlight interception (mature corn, potatoes, snap beans) use more water than crops that do not have an extensive canopy (onions, immature plants, recently transplanted crops). Rooting depths vary with crop species and may be affected by soil compaction, hard pans, and pH. Rooting depth determines the volume of soil from which the crop can draw water and is important when determining to what depth the soil must be wetted by irrigation. For most vegetables, the effective rooting depth is approximately 12 inches.

Plant growth stage influences vegetable susceptibility to moisture stress. Irrigation is critical when establishing newly seeded or transplanted crops. During the first 1-2 weeks of seedling or transplant growth, the root system is not yet established in surrounding soil and irrigation can significantly increase plant survival, especially when soil moisture is marginal. Irrigation can also increase the uniformity of emergence and final stand of seeded crops. For seeded crops, reduce the rate of application and the total volume of water per application to avoid crusting (cohesion of soil particles at the surface). If crusting is present, continue to apply low rates at high frequency while seedlings are emerging. Keeping the soil surface moist will reduce the force necessary for seeding emergence. Water use by vegetable crops increases up to full canopy and then will decrease thereafter. For warm season crops, peak water use can be as much as 0.30 inches per day in mid-summer.

Cultural practices also influence ET. Cultivation, mulching, weed growth, and method of irrigation are factors to consider. Cultivation generally increases soil evaporation, but if crop roots are pruned or damaged by the cultivator, water uptake and transpiration may be reduced. Shallow cultivation may help eliminate soil crusts and improve water infiltration from rainfall or irrigation. Weeds compete with the crop for water and increase the volume lost through transpiration. Sprinkler irrigation wets the entire crop area and results in greater evaporation loss than trickle/drip irrigation, which wets only the area in the region of the plant root system. Trickle/drip irrigation systems require more frequent operation to prevent plant stress due to the relatively small, wetted area.

Soil factors must also be considered. Soils with high levels of silt, clay, and organic matter have greater available water-holding capacities than do sandy soils or soils that are compacted (Table C-2). Available water refers to the amount of water that a plant can withdraw from the soil. Soils with high available water-holding capacities require less frequent irrigation than soils with low available water-holding capacities. Low water holding capacity soils like loamy sands and sandy loams require frequent irrigation in smaller amounts due to the low holding capacity.

Another soil factor that influences irrigation practices is the soil infiltration rate. Water should not be applied to soils at a rate greater than the rate at which soils can absorb water. This can be problematic in silt and clay loam soils, particularly with sprinkler irrigation. Excessive irrigation may lead to erosion from runoff and promote disease development. Table C-3 lists the typical infiltration rates of several soils.

Table C-2. Available Water Holding Capacity Based on Soil Texture

Soil Texture	Available Water Holding Capacity (inch of water/ inch depth of soil)
Coarse sand/compacted sands	0.02 - 0.06
Fine sand	0.04 - 0.09
Loamy sand	0.06 - 0.12
Sandy loam	0.11 - 0.15
Fine sandy loam/compacted loams	0.14 - 0.18
Loam and silt loam	0.17 - 0.23
Clay loam and silty clay loam	0.14 - 0.21
Silty clay and clay	0.13 – 0.18

Table C-3. Soil Infiltration Rates Based on Soil Texture

Soil Texture	Soil Infiltration Rate (inch/hour)
Coarse sand	0.75 - 1.00
Fine sand	0.50 - 0.75
Fine sandy loam	0.35 - 0.50
Silt loam	0.25 - 0.40
Clay loam	0.10 - 0.30

Irrigation Principles

There is no simple method to accurately schedule irrigations since all the above factors interact to determine actual ET. In the absence of reliable methods to estimate ET, the following should be kept in mind when deciding when and how much to irrigate:

1. Soils vary greatly in water-holding capacity and infiltration rate. Silt and clay soils and soils high in organic matter can hold much more water than sandy soils low in organic matter.
2. Water loss from plants and the soil surface is much greater on clear, hot, windy days than on cool, overcast,

humid days. During periods of hot, dry weather, when the crop is at full canopy, ET rates may reach 0.3 inch/day or higher.

3. Research shows that irrigating to maintain soil moisture levels in a narrow range, just below field capacity (60 to 80% available soil moisture), results in better crop performance than if the range is broader. Soil moisture monitoring is therefore a more accurate way to determine irrigation needs.
4. Plastic mulches reduce evaporation from the soil but also reduce the amount of water that can reach the root zone from rain. Thus, much of the natural precipitation should be discounted when scheduling irrigations for crops grown using plastic mulch.
5. On moderate moisture-holding capacity soils, apply 0.25-0.75 inches of water per irrigation. This will ensure that water reaches active areas of the root zone. The exception is during early crop growth and establishment when lower rates may be appropriate. With sandy soils, daily irrigation applying only what can be used that day is best. Splitting or pulsing the daily application with a 2+ hour break between applications has shown benefits, particularly in very coarse soil.
6. If irrigation water has a high salt content (for example, wells in coastal aquifers or tidal streams), excess water should be applied during each irrigation event to leach any salts before they are concentrated by evaporation. It is necessary to regularly measure the salinity of tidal surface water to prevent crop damage.
7. Total weekly water needs for vegetable crops will increase up to full canopy and decrease thereafter. Irrigation rates should be adjusted accordingly. Critical crop stages such as fruiting, or tuber bulking should also be considered in determining weekly irrigation rates.

2. Drip (Trickle) Irrigation

Drip (or trickle) irrigation is used on a wide range of vegetable crops. Drip irrigation is a method of slowly applying small amounts of water directly to the plant root zone. Water is applied frequently, often daily or several times a week, to maintain favorable soil moisture conditions. The primary advantage of drip irrigation systems is that water use is more efficient than with overhead sprinkler irrigation systems. In many cases, one-half or less of the water applied with sprinkler or surface systems is required with drip systems because there is no evaporation loss from the soil surface. Most of the water conservation from drip irrigation occurs in the early season. The difference in water use between drip and sprinkler is negligible once a full canopy is achieved. In addition, substances applied through the drip irrigation system, such as pesticides and fertilizers, can be conserved along with water, provided the drip system is managed correctly.

Drip irrigation systems have several other advantages over sprinkler and surface irrigation systems. Low flow rates and operating pressures are typical for drip systems. These characteristics lead to lower energy and equipment costs. Once in place, drip systems require little labor to operate, can be automatically controlled, and can be managed to precisely apply the amount of water needed by the crop, which also reduces operating costs. With most drip systems, disease and insect damage is reduced because leaves are not moistened by irrigation water. In addition, the areas between rows remain dry, which reduces weed growth and water use, as well as pests and pathogens in these areas of the field. Another advantage is that field management operations can continue during irrigation.

There are also potential problems with drip irrigation systems. Most drip irrigation systems require a higher level of management than other irrigation systems. Moisture dispersal throughout the soil is limited, and usually a smaller soil water reserve is available to plants. Under these conditions, the potential to stress plants is greater than with other types of irrigation systems. Drip systems must be carefully managed to avoid localized moisture stress.

The equipment used in drip systems can present potential problems. Insects, rodents, and people can damage drip irrigation equipment. Pressure regulation is critical, and filtration is required. The drip system, including the pump, headers, filters, and connections, must be checked and ready to operate before planting. Failure to have the system operational could result in costly delays, poor plant survival or irregular stands, and reduced yield. Drip systems cannot be used for frost control. Calculating the length of time required to apply a specific depth of water with a drip irrigation system is more difficult than with sprinkler systems. Drip systems add an additional cost for processing vegetables, are not adapted to drilled crops such as peas, and, therefore, may not be economical for these crops.

Drip irrigation is especially effective when used with plastic or organic mulches. Unlike sprinkler systems, drip systems apply water to only a small portion (wetted zone) of the total crop acreage. Usually, a fair assumption to make is that the mulched width approximates the extent of the plant root zone and should be used to calculate system run times for most vegetables. Table C-4 shows the amount of water applied per hour with a drip irrigation system based on the drip tube flow rate and the total cropped area (excluding drive rows). The use of this table requires that the drip system be operated at the pressure recommended by the manufacturer.

Table C-4. Irrigation Applied per Hour per Cropped Acre (Inches)

Drip Tape Flow Rate (gpm/100')	Tape Spacing (ft)						
	2.5	**3**	**4**	**5**	**6**	**7**	**8**
0.22	0.08	0.07	0.05	0.04	0.04	0.03	0.03
0.34	0.13	0.11	0.08	0.07	0.05	0.05	0.04
0.45	0.17	0.14	0.11	0.09	0.07	0.06	0.05
0.67	0.26	0.21	0.16	0.13	0.11	0.09	0.08

Table C-5 presents the maximum recommended irrigation period for drip irrigation systems. The irrigation periods listed assume that 50% of the available water in the root zone is depleted (see next section on the use of soil moisture monitoring equipment for determining when this occurs). Soil texture directly influences the water-holding capacity of soils and, therefore, the depth reached by irrigation water.

Table C-5. Maximum Number of Hours per Application for Drip Irrigated Vegetables
Based on a 12-inch-deep root zone and irrigation at 50% soil moisture depletion during the day.
Cut the maximum run times in half for nighttime irrigation and when active crop water use is not occurring.

Soil Texture	Estimated Wetted Width (in)	Maximum Run Time (hours) by Tape Flow Rate (gpm/100')			
		0.22	**0.34**	**0.45**	**0.67**
Coarse Sand	**8**	1.5	1.0	0.7	0.5
Fine Sand	**10**	3.3	2.1	1.6	1.1
Loamy Sand	**12**	5.1	3.3	2.5	1.7
Sandy Loam	**16**	9.8	6.4	4.8	3.2
Fine Sandy Loam	**20**	15.1	9.8	7.4	5.0
Loam and Silt Loam	**24**	22.7	14.7	11.1	7.4
Clay Loam	**24**	19.3	12.5	9.4	6.3
Silty Clay and Clay	**24**	17.0	11.0	8.3	5.6

Scheduling Irrigation with Soil Moisture Sensors

Irrigation scheduling is a management practice used to determine how often to irrigate and how much water to apply with each irrigation event. Irrigation duration was discussed in the previous section and should be based on soil available water-holding capacity and soil moisture depletion level. Soil moisture sensors are tools used to measure soil water. This can then be used to determine how much soil moisture has been depleted and when irrigation should be scheduled.

Determining Soil Moisture Levels:

Hand-Feel Method

This is the easiest and cheapest method to determine soil moisture levels for irrigation scheduling. Soil samples are collected using a soil probe or shovel, and the moisture level is estimated by "feeling" the soil and comparing it to known conditions. This method can allow for multiple depths of samples and is not susceptible to equipment failures; however, it does require an experienced operator to get consistent results. The United States Department of Agriculture Natural Resource Conservation Service, USDA-NRCS, provides an excellent guide to using the hand feel method, available at your local NRCS office or at: *https://nrcs.usda.gov/sites/default/files/2022-09/Estimating%20Soil%20Moisture%20by%20Feel%20and%20Appearance.pdf*.

Tensiometers

Tensiometers are excellent tools for determining irrigation frequency because they indirectly measure water available in the crop root zone. Tensiometers are glass or plastic tubes filled with water hermetically sealed with a porous ceramic tip submerged in the soil at one end and a vacuum gauge at the other end. As the soil dries, its capillary action will try to suck the tensiometer water through the ceramic tip creating a vacuum. This vacuum is a measure of soil tension or "soil suction" or "matric potential." Soil tension is a measure of how tightly water is held in the soil and is measured in pressure units of centibars (cb) or kilopascals (kPa). These are different units of measurement of the same condition: soil vacuum. The soil tension measured with tensiometers is an indirect indication of soil moisture content and can be used as an indicator of irrigation need.

Table C-6 contains guidelines for using soil tension data to schedule irrigation events. Field capacity is the moisture content at which a soil is holding the maximum amount of water it can against the force of gravity. This moisture content is reached 24 to 72 hours after saturating rain or irrigation. Field capacity corresponds to soil tension levels ranging from 5 to 10 cb in coarse-textured soils and as high as 40 cb in fine-textured soils.

Table C-6. Irrigation Guidelines for Tensiometers

Soil Texture	Soil Tension (cb)	Soil Moisture Status and Irrigation Requirement
Sand, Loamy Sand	5 – 10	Soil at field capacity; no irrigation required
Sandy Loam, Loam, Silt Loam	10 – 20	
Clay Loam, Clay	20 – 40	
Sand, Loamy Sand	20 – 40	50% of available water depleted; irrigation required
Sandy Loam, Loam, Silt Loam	40 – 60	
Clay Loam, Clay	50 – 80	

The soil tension range corresponding to the time when irrigation should begin is also influenced by **soil texture**. In coarse-textured soils, irrigation should begin at soil tensions of 20 to 40 cb. In extremely coarse-textured soils, irrigation may be necessary at even lower tensions (see Table C-6). Conversely, medium- and fine-textured soils do not need to be irrigated until soil tensions reach higher values, as shown in Table C-7. For all soil types, irrigate when a maximum of 50% of available water has been depleted. Lower depletion allowances may be used depending upon specific crop and management needs.

The utility of tensiometers in fine-textured soils is limited due to the range of detection. When soil dries beyond the 80 cb tension level, the column of water in the tensiometer "breaks," allowing air to enter the device. After breaking tension, the device ceases to operate correctly until it is serviced. Thus, tensiometers are the most practical in sandy or coarse-textured soils where normal soil tension levels are well below the point of breaking tension. In sandy soils it is often desirable to use ½ bar gauges that read in the 0-50 cb range rather than the standard 0-100 cb.

Ideally, four tensiometers per management zone should be used to account for variability in soil texture and other factors within the field. Install at least one tensiometer in the area that will likely require water sooner than other areas of the field (*e.g.*, sandier soils and high areas). The remaining tensiometers should be placed to inscribe a triangle within the area to be irrigated but inside field edges. The inherent variability of the irrigation system should also be considered as the overlaps of sprinklers or the reduced output of drip emitters due to run length or slope will affect the reading. Irrigation decisions are based on the average of all the readings.

Tensiometer placement influences measured soil tension levels. Tensiometers should be placed where plant roots are actively growing. It is appropriate to monitor soil tension 6-12 inches below the soil surface and within 6-12 inches from the plant base. If using drip irrigation, place the tensiometer axis close to the drip tape and the sensor (tip) buried 6-12 inches below the soil surface. This ensures that readings reflect moisture in the root zone and decrease when irrigation occurs. Placement near the drip tape is even more important when growing in coarse-textured soils and on raised, mulched beds. In these situations, the bed shoulders often remain very dry and placing tensiometers there will not give an accurate measure of soil tension in the active crop root zone.

Tensiometers can also be used in other ways. Placing tensiometers at various soil depths at the same location is useful for determining whether an irrigation or rainfall has reached a certain depth. Placing tensiometers at various depths is also useful for determining the depth from which plants draw the most water.

Resistance Meters

Electrical resistance meters determine soil water by measuring the electrical resistance between two wire grids embedded in a porous matrix such as gypsum, ceramics, glass fibers, or nylon cloth. To measure soil moisture, sensors are buried in the crop root zone in the soil. The electrical resistance of sensors varies with water content, which in turn is dependent upon the water content of the soil in contact with them. As the soil dries, the sensor loses water and the electrical resistance increases. Therefore, resistance changes within the sensor as measured by the meter can be interpreted in terms of soil water content. New generation "matrix" sensors are more accurate and consistent than are older "gypsum" sensors. The sensors, which have embedded stainless steel electrodes are installed at desired locations and depths in the soil during the growing season. Insulated wires from each sensor are brought above the soil surface where they can be plugged into a portable meter for reading.

Resistance sensors are generally calibrated in terms of soil water tension so that readings are applicable across soil textures. Sensors should be calibrated for each soil type. The way different commercial sensors respond to changes in soil water tension varies considerably, and manufacturers provide calibration curves for their equipment. When sensor readings are expressed as soil water tension, the irrigation chart in Table C-6 can be used as a guide.

Prepare resistance matrix sensors according to manufacturer's recommendations before installation. This normally requires soaking in water. Soaking removes air from the sensors and ensures accurate meter readings.

Using a soil probe or auger, bore a hole in the row slightly larger than the sensor. Make a separate hole for each sensor to the desired depth. Crumble up at least 3 inches of soil removed from the hole and put it back into the hole. Pour about ½ cup of water into the hole to form a slurry of mud at the bottom. Push the sensor firmly to the bottom of the hole, forcing the slurry to envelop the sensor. A good way to do this is to use a section of ½-inch electrical conduit or pipe and slip the conduit over the lead wire and against the top of the sensor. Backfill the holes with soil 3 or 4 inches at a time, tamping firmly as the hole is filled. Drive a stake midway between the filled holes and tie the wire that leads to the stake. Be sure to mark the wires in some manner so that you can identify which one is for the shallow sensor and which one is for the deeper sensor. Install and locate resistance sensors and meters in a similar manner to tensiometers to give accurate information on soil water depletion.

Volumetric Soil Moisture Sensors

Volumetric soil water sensors such as TDR (Time Domain Reflectometry) and FDR (Frequency Domain Reflectometry) sensors can measure soil water accurately. They require power sources to operate (battery, solar, wired) and are typically much more expensive than tensiometers and resistance blocks. For irrigation scheduling, sensors at various depths and locations in the field are installed and monitored. Soil moisture is recorded as volume of water per volume of soil. This then can be related to the available soil water percent based on a specific soil type by calibration to produce a soil water curve.

Maintaining Drip Irrigation Systems

Water is carried through plastic tubing and distributed along the tubing through orifices or devices called emitters. The emitters dissipate the pressure from the system by forcing the water exiting from an emitter through orifices, tortuous flow paths, pressure reducing flow paths, or long low paths, thus allowing a limited flow of water to be discharged. The pressure-reducing flow path also allows the emitter diameter to remain relatively large, allowing particles that could clog an emitter to be discharged.

Insect damage to thin-walled polyethylene drip tubing or "tape" can be a major problem. Ants, wireworms, earwigs, mole crickets, field crickets, grubs and other insects typically damage drip tape by chewing holes through the side walls. This damage destroys the integrity of the tape, resulting in small to massive leaks that may result in poor moisture distribution and soil erosion.

Other types of drip tape damage may be mistaken for insects. For example, rats, mice, gophers, and birds can chew, gnaw, or peck holes in thin-walled polyethylene tapes. Damaged tape should be inspected under magnification to provide clues to the source prior to taking action to remediate the responsible agent.

Although modern emitter design reduces the potential for trapping small particles, emitter clogging remains the most serious problem with drip irrigation systems. Clogging can be attributed to physical, chemical, or biological contaminants. Filtration and occasional water treatment may be necessary to keep drip systems from clogging.

Bacteria can grow inside drip irrigation tubes and form a slime, known as a biofilm, that can clog emitters and can serve as a source of plant and human disease-causing pathogens. Algae present in surface waters and in high iron wells can also clog emitters. Biofilms and algae can be effectively controlled by chlorination of the trickle system. Periodic treatment **before** clogging develops can keep the system functioning efficiently. The frequency of treatment depends on the quality of the water source. Generally, two or three treatments per season are adequate.

Irrigation water containing high concentrations of iron (greater than 1 ppm) can also result in clogging problems due to the types of bacteria that "feed" on dissolved (ferrous) iron. The bacteria secrete a slime called ochre that may combine with other solid particles in the drip tape and plug emitters. The precipitated (ferric) form of iron, known commonly as rust, can also physically clog emitters. Treating water containing iron with chlorine will oxidize the dissolved iron, causing the element to precipitate so that it can be filtered and removed from the system.

Chlorine treatment should take place upstream of filters in order to remove the precipitated iron and microorganisms from the system. Take care when adding chlorine to drip irrigation systems, however, since concentrations at or above 30 ppm can be toxic to growing plants.

Chlorine is available in either gas, liquid, or solid forms. Chlorine gas is extremely dangerous and not recommended for agricultural purposes. Solid chlorine is available as granules or tablets containing 65 to 70 percent calcium hypochlorite. Liquid chlorine is available in many forms, including laundry bleach and post-harvest wash materials. Liquid forms typically contain between 5 and 15 percent sodium hypochlorite. **Use chlorine only if the product is labeled for use in irrigation systems**.

Because chlorination is most effective in water at pH 6.5 to 7.5, some commercial chlorination equipment also injects buffers to maintain optimum pH for the effective killing of microorganisms. This type of equipment is expensive but more effective than simply injecting a sodium hypochlorite solution. The rate of chlorine injection required is dependent on the number of microorganisms, the amount of iron in the water source, and the method of treatment being used.

For managing dissolved iron and microbes in the water source, one of the following basic strategies is suggested as a starting point:

For iron treatment:

- Inject liquid sodium hypochlorite continuously at a rate of 1 ppm for each 1 ppm of iron in irrigation water. In most cases, 3 to 5 ppm is sufficient.

For bacteria and algae treatment:

- Inject liquid sodium hypochlorite continuously at a rate of 5 to 10 ppm where the biological load is high.
- Inject 10 to 20 ppm during the last 30 minutes of each irrigation cycle.
- Inject 50 ppm during the last 30 minutes of irrigation cycles one to two times each month. Super chlorinate can be used (injected at a rate of 200 to 500 ppm) once per month for the length of time required to fill the entire system with this solution and shut down the system. After 24 hours, open the laterals and flush the lines.

Chlorine can be injected using many types of fertilizer/pesticide injectors, including positive displacement injection pumps. These types of pumps are powered by gasoline or electric motors and include piston, diaphragm, gear or lobe, and roller (or peristaltic) types.

The injection rate for positive displacement injection pumps can be calculated from the following equation:

Injection rate of chlorine solution in gallons per hour =
[(0.006) x (desired chlorine concentration in ppm) x (irrigation gal per minute)] / % chlorine in bleach or concentrate

As an example, assume household bleach (5.25% sodium hypochlorite) is being used as a chlorine solution, that a treatment level of 5 ppm of chlorine is desired, and that the trickle system has a 200 gal per minute flow rate.

Injection rate of chlorine solution in gallons per hour =
[(0.006) x (5 ppm) x (200 gal/minute)] / 5.25% = 1.14-gal chorine per hour

Proportional injectors are also commonly used to inject chlorine. Proportional injectors are powered by the water pressure of the irrigation system and inject materials at a rate which is proportional to the irrigation system flow rate or system pressure. Injection rates are often adjustable and are usually specified as ratios, percentages, or ppm. Table C-7 lists equivalent values of these injection rate units.

For proportional injectors, the following equation can be used to calculate the required chlorine solution injection rate:

Injection rate of chlorine solution in ppm concentrate=
[(100) x (desired chlorine concentration in ppm)] / % chlorine in bleach or concentrate

As an example, assume post-harvest wash material (12.5% sodium hypochlorite) is being used as a chlorine solution and that a treatment level of 10 ppm of chlorine is desired.
Injection rate of the chlorine solution in ppm concentrate = [(100) x (10 ppm)] / 12.5% = 80 ppm

It is important to note that both liquid and solid forms of chlorine will cause water pH to rise. This is critical because chlorine (sodium hypochlorite) is most effective in water at pH 6.5-7.5. If water pH is above 7.5, it must be reduced to 6.5-7.5 for chlorine injection to be effective as a disinfectant.

Important Notes

1. **Approved backflow control valves and interlocks must be used in the injection system to prevent contamination of the water source. This is an absolute requirement if a public water source is used.**
2. **Chlorine concentrations above 30 ppm may cause phytotoxicity.**

Table C-7. Equivalent Injection Proportions

Ratio	ppm	Percent
1:10,000	100	0.01
1:5,000	200	0.02
1:2,000	500	0.05
1:1,000	1,000	0.1
1:500	2,000	0.2
1:200	5,000	0.5
1:100	10,000	1
1:50	20,000	2
1:20	50,000	5
1:10	100,000	10

3. Fertigation

Drip-irrigated crops are usually fertilized during the growing phase through the irrigation system, termed fertigation. Before considering a fertilization program for mulched and drip-irrigated crops, have the soil pH checked. If a liming material is needed to increase the soil pH, the material should be applied and incorporated into the soil as far ahead of mulching as practical. For most vegetables, adjust the soil pH to around 6.5 (see Table B-1).

When using drip irrigation with plastic mulch, apply the recommended amount of preplant fertilizer and incorporate it 5-6 inches into the soil before laying the mulch. If equipment is available, apply the preplant fertilizer only to the soil area the mulch will cover. This is more efficient than a broadcast application to the entire field.

The most efficient method of fertilizing an established mulched row crop is through a drip tape installed with the plastic layer (see below). Due to the very small emitters in the drip tape, a completely soluble fertilizer or liquid solution must be used through the irrigation system. While in the past, a 1-1-1 (N-P_2O_5-K_2O) ratio of completely soluble fertilizer, such as a 20-20-20, has been used successfully, in most cases, lower P concentrations are now recommended (for example, 2-1-2 or 4-1-4 ratio). Solutions are often used without P_2O_5 (1-0-1 ratio), and this is specifically recommended where there is a high likelihood of P precipitating out of the irrigation water and clogging drip emitters (hard irrigation water supplies). If water sources contain high levels of calcium, calcium phosphate may precipitate, which can clog drip emitters.

Including the essential micronutrients with the completely soluble N-P_2O_5-K_2O fertilizer has resulted in positive yield responses. Including boron with the completely soluble N-P_2O_5-K_2O fertilizer on sandy loam soils testing low to low-medium in boron is highly recommended for medium and high boron demand vegetable crops.

Liquid fertilizer concentrates are available for direct injection. Soluble fertilizer nutrients to be applied to plants through the drip irrigation system are first completely dissolved in water to produce a concentrate. These concentrates are usually introduced into the irrigation system following filtration using a fertilizer injector designed for this purpose.

Fertigation Rates for Drip Irrigated Plasticulture Crops

All rates of soluble fertilizers applied through the drip irrigation system are based on crop recommendations (see individual vegetable crops in Chapter F). Suggested fertigation programs for common drip irrigated crops are given in Chapter F for the standard linear bed feet contained in an acre of that crop. This is called the Linear Bed Foot (LBF) system for fertilizer application. Rates are adjusted if crops are planted in row widths different from the standard (more or less linear bed feet per acre). All fertigation recommendations are expressed in lb./A. The use of LBF as a fertilizer rate assures that an appropriate rate of fertilizer will be applied, regardless of the total number of LBF in the cropped area. The use of lb./A to express the fertilizer rate requires an adjustment based on the actual cropped area. The goal is to provide a specific concentration of nutrients to plant roots or a specific amount of fertilizer within a certain volume of soil. This approach assumes that most plant roots are confined within the volume of soil comprising the bed under plastic mulch. Fertigation can occur with each irrigation event, weekly, or prior to important crop growth stages.

Calculating the fertilizer requirements for a fertigated acre based on 6-foot bed centers
a. Example for a soluble dry fertilizer to be dissolved and distributed through drip fertigation.
If 40 pounds of N, 40 pounds of P (P_2O_5), and 40 pounds of potash (K_2O) per 7,260 linear bed feet (standard acre) per application are recommended, select a dry, completely soluble fertilizer with a 1-1-1 ratio, such as a 20-20-20. To determine the amount of 20-20-20 needed per acre, divide the percent N, P_2O_5, or K_2O contained in the fertilizer into the quantity of the respective plant nutrient needed per acre and multiply the answer by 100:
[40 lb. nitrogen needed / 20% N in fertilizer] x 100 = 200 lb. 20-20-20 per acre

b. Example for a liquid fertilizer distributed through drip.
Assume the same 40 lb. N-P_2O_5-K_2O and a 6-6-6 liquid is used.
If one gal of this fertilizer weighs 10 lb., 67 gal of 6-6-6 liquid fertilizer per acre per application is required.
1 gal (10 lb.) of 6-6-6 contains:
10 lb. x .06 (6% N) = 0.6 lb. N in each gal
40 lb. N per acre needed / 0.6 lb. N per gal 6-6-6 = 67 gal of 6-6-6 needed per acre

4. Subsurface Drip Irrigation Systems

Sub-surface drip irrigation, most commonly known as SDI, is the practice of using drip tape buried at depth for multi-year irrigation applications. These systems are easily automated and can significantly decrease labor requirements. Water quality is a critical component of the success of an SDI system. Maintaining adequate water quality will maximize both system performance and longevity.

SDI is best addressed in two separate categories: Short-term SDI and Long-term SDI. Short-term SDI (ST SDI) is defined by a life expectancy ranging from 3 to 10 years. However, system life alone does not define Short-term SDI. These systems are typically used on mid-valued vegetable crops (for example, processed crops). ST SDI systems are commonly designed to deliver peak ET water demand to crops, giving greater control in meeting the crop's water needs. Typically, drip tape is installed between 3 inches and 10 inches deep along each crop row on a raised bed. The headers of the drip tape can be supplied with water via a surface hose or permanently buried PVC pipe; the other end of the drip lateral is typically left exposed for flushing. ST SDI offers many of the advantages of surface drip irrigation without the annual expense of drip tape replacement. After year one, insect damage from mole crickets and wireworms can be a problem with few chemical controls. These problems are reduced with deeper tape placement.

Long-term SDI (LT SDI) is characterized by a life expectancy of 10 years or greater. These systems are primarily designed for commodity crops (for example, corn and cotton). The LT SDI systems are designed to efficiently deliver water to large expanses of acreage. Due to limited water availability and high crop water demand, LT SDI systems are not typically designed to replenish peak volume needs but rather used to manage soil moisture profile during periods of peak water demand. Drip tape is installed from 12 inches to 18 inches in depth, depending primarily on soil characteristics. Drip tape is typically centered between rows of the crop. The drip tape is attached on each end to permanently buried PVC pipe, with one pipe serving as the water supply and the other pipe providing the flushing function. LT SDI offers many of the advantages of surface drip irrigation; however, water is applied in a manner to best economize the application while fulfilling the needs of crops. In sandy soils, LT SDI becomes less ideal as the capillary of the soil is low, thus limiting the ability of the deep tape to wick moisture to the surface. Disadvantages include the inability to activate surface-applied herbicides, the inability to irrigate the shallow root zone to improve germination, difficulty locating tape leaks in season, and the need to prevent field rutting by equipment during harvest.

5. Chemigation

Chemigation is the application of any pesticide through any irrigation system and includes furrow, border, overhead, and drip irrigation systems. Certain pesticides are labeled for application through irrigation systems (insecticides and fungicides commonly). Posting of areas to be chemigated is required when (1) any treated area is within 300 ft of sensitive areas such as residential, labor housing, businesses, hospitals, or any public zones such as schools, parks, and playgrounds, or (2) when the chemigated area is open to the public such as golf courses or retail greenhouses.

Prior to chemigation, first charge the irrigation system, then introduce the pesticide uniformly over the crop being irrigated. After chemigation, flush the irrigation system with fresh water. In drip systems, do not overwater during the flush phase to retain the pesticide in the root zone. The label must allow the use of chemigation before any pesticide can be applied in the irrigation system. **Consult the label for all rates and restrictions before use**. **Note that some labels specify that chemigation can be done only with certain types of irrigation, *i.e.*, drip or sprinkler.**

Chemigation Systems Connected to Public Water Systems

These systems must contain a functional, reduced-pressure zone, backflow preventer, or the functional equivalent in the water supply line upstream from the point of pesticide introduction. The pesticide injection pipeline must contain a functional, automatic, quick-closing check valve to prevent the flow of fluid back toward the injection pump.

- The pesticide injection pipeline must also contain a functional, normally closed, solenoid-operated valve located on the intake side of the injection pump connected to the system interlock to prevent fluid from being withdrawn from the supply tank when the system is automatically or manually shut down.
- A functional interlocking control to automatically shut off the pesticide injection pump when the water pump motor stops is also required, or in any situation where the water pressure decreases to the point where pesticide distribution is adversely affected.

Chemigation systems must use a metering pump, such as a positive displacement pump capable of being fitted with a system interlock.

Chemigation with Drip and Overhead Irrigation Systems

A safe and effective chemigation system must include the following components: a functional check valve, vacuum relief valve, and low-pressure drain on the irrigation pipeline to prevent water source contamination from backflow. The pesticide pipeline must contain a functional, automatic, quick-closing check valve to prevent the flow of fluid back to the injection pump.

- The pesticide injection pipeline must also contain a functional, normally closed, solenoid-operated valve located on the intake side of the injection pump and connected to the system interlock to prevent fluid from being withdrawn from the supply tank when the system is automatically or manually shut down.
- Further, the system must contain a functional interlocking control to automatically shut off the pesticide injection pump when the water pump motor stops.
- Finally, the water pump must include a functional pressure switch, which will stop the water pump when the water pressure decreases to the point where pesticide distribution is adversely affected.

D. Pesticide Safety

1. General Information

Pesticides are hazardous substances that can cause serious harm if used improperly. Federal and state pesticide laws and regulations control product sale and distribution, storage, transportation, use, and disposal of pesticides. For food and feed crops, EPA establishes legal amounts of pesticide residue allowed on a crop at harvest (or in processed foods). State pesticide laws and regulations may be more restrictive and would take legal precedence over federal.

1.1. Pesticide Registration

All pesticides sold or distributed in the United States are required to be registered by the United States Environmental Protection Agency (EPA) under the requirements of the **Federal Insecticide Fungicide Rodenticide Act As Amended (FIFRA)**, unless they qualify for an exemption. State product registration is also required and can be more restrictive. For example, some states require state registration of "minimum risk pesticides" which are exempt from federal registration. But, in no case can a State allow registration of a pesticide, or a use of it, without prior registration or exemption by federal EPA.

Pesticides have an inherent toxicity, or capacity to cause harm to living organisms. Under FIFRA, EPA may only register those pesticide uses that do not pose unreasonable risk of harm to human health and the environment. EPA's determination of whether and how a pesticide is registered for sale is based on evaluation of scientific data and assessment of risks and benefits of a product's use.

The process of registering a pesticide is a scientific, legal, and administrative procedure through which EPA examines: the ingredients of the pesticide; the particular site or crop where it is to be used; the amount, frequency, and timing of its use; and storage and disposal practices.

EPA requires extensive scientific data on the potential health and environmental effects of a pesticide before granting a registration. The process EPA uses for evaluating the potential for health and ecological effects of a pesticide is called **risk assessment**. This includes evaluating the potential for harm to humans, wildlife, fish, and plants, including non-target organisms and endangered species. It also includes evaluating contamination of surface water or ground water from runoff, leaching, or spray drift.

As a condition of registration, EPA must review and approve the label. EPA then assigns an **EPA Registration Number** which is a unique product number for regular registrations, distributor registrations, Special Local Needs registrations, and Experimental Use Permits.

In order to mitigate the risk of harm to human health and the environment, EPA will impose a set of conditions, directions, and precautions that define who may use a pesticide, as well as where, how, how much, and how often it may be used. These mandatory requirements for registration are incorporated into pesticide product label statements. Pesticide product labels are legal documents. In other words, the label is the law.

IMPORTANT

This statement is found on all registered pesticide product labels in the United States:
"It is a violation of Federal law to use this product in a manner inconsistent with its labeling."

EPA Registration Review is required a minimum of every 15 years. EPA is legally authorized to initiate this process or other actions earlier, at any time in the product life cycle. EPA has the authority to suspend or cancel the registration of a pesticide if subsequent information shows that continued use would pose unreasonable risks. Pesticides (or particular pesticides uses) that no longer meet the safety standard of not posing unreasonable risk of harm to human health and the environment may be cancelled or reregistered only with strict limitations and changes in labeled uses.

1.2. Pesticides and Food Safety

For food and feed crops, EPA is required to establish maximum pesticide residue limits allowed on a crop at harvest called "tolerances" by commodity. Tolerances, or exemptions from the requirement of a tolerance, are published in the Code of Federal Regulations at 40 CFR 180.

The Food Quality Protection Act (FQPA) of 1996 required that all existing tolerances be re-evaluated by EPA so that pesticides used on food and feed would meet a legal safety standard of "a reasonable certainty of no harm" when used according to the pesticide label. Once registered, a Registration Review of a pesticide's registration and tolerances are conducted by EPA a minimum of every 15 years to ensure that a pesticide's FQPA safety standard is still being met.

Tolerances are legally enforceable by the United States Department of Agriculture and Food and Drug Administration. **Meeting established food safety standards requires strict adherence to the pesticide label**. ***It is illegal and unsafe when a grower exceeds the rate of application on the label, uses a product on a crop that is not on the label, or harvests a crop before the pre-harvest interval on the label.*** If the residue exceeds the set tolerance, the crop may not be marketed or sold. It is subject to condemnation and seizure by federal or state regulatory agencies. For example, EPA issued a Final Rule cancelling all tolerances for chlorpyrifos for all commodities effective February 2022; see section D 3.3.3 *Chlorpyrifos* for details.

2. Certification of Pesticide Applicators

EPA considers certain pesticides to have the potential to cause unreasonable adverse effects to the environment and injury to applicators or bystanders unless users are specially trained in handling and application. As a condition of registration, EPA may restrict use of a pesticide, (or certain of its' uses) solely to certified applicators, or someone under that applicator's direct supervision. A "**restricted use pesticide**" (RUP) is a pesticide that EPA requires may only be applied by or under the direct supervision of **trained and certified** users.

In 1972 under FIFRA, EPA required states to set up a program to train and certify applicators of RUPs to use them safely without endangering human health or the environment. Pesticide applicators become certified by demonstrating that they are competent to apply or supervise the use of RUPs, generally by examination. Certification requirements and processes may differ by state and may be more stringent than federal. **For example, some states require applicator certification to use ANY EPA-registered pesticide, not just restricted use** pesticides. New Jersey private and commercial applicators, including organic growers, in *addition to certification*, must possess a valid applicator license to make applications or supervise the use of ANY EPA-registered pesticide.

Certified users of pesticides are classified as either private or commercial applicators as follows:

Private Applicator. Any person who uses, or supervises the use of, pesticides for the purpose of raising some type of agricultural commodity. The application can be done on land owned or rented by the applicator or the applicator's employer. However, any applications on a "for-hire" basis for the purpose of raising an agricultural commodity are considered commercial applications. Examples of private applicators are dairy farmers, vegetable or fruit growers, greenhouse growers, and ranchers that apply pesticides only within their own confines.

Commercial Applicator. Any person who uses, or supervises the use of, pesticides on a "for-hire" basis; any person who applies pesticides for non-agricultural purposes; or any person who applies pesticides as a part of their job. This includes employees using pesticides in the course of their job working with any governmental agency such as a County mosquito control commission. Examples of commercial applicators in agriculture are those individuals who work for a commercial pesticide handling establishment that provide handler services to growers or nurseries during the growing season.

IMPORTANT REVISED FEDERAL EPA REGULATION STANDARDIZES PESTICIDE CERTIFICATION & TRAINING

In 2017, the Federal EPA finalized a rule at 40 CFR Part 171 that increases the national standards for pesticide applicator competency in core knowledge; establishes a training program for commercial noncertified applicators: requires increased standards of competency for applicators using fumigants for soil and non-soil pest control, and changes to applicator and pesticide dealer recordkeeping. *See https://www.epa.gov/pesticide-worker-safety/certification-standards-pesticide-applicators* for complete details of the Federal EPA revision to the rule.

All state pesticide regulatory agencies will now be required to implement these changes for both Private and Commercial Applicators, *if not already in place by current State pesticide regulation*s. Because these changes will require revision of state pesticide regulations in most cases, the dates of implementation will vary by individual state. For example, Delaware is looking to implement by 2024, while New Jersey by 2025.

Please contact your state's applicator certification agency or your state Extension Pesticide Safety Education Program for State-specific regulatory changes to certification and training.

When agricultural establishments hire commercial application services, they must first verify that the supervising applicator is certified as a commercial applicator in the State where the application is being made. Their certification *must include the corresponding category of use required by your State for the application being made* (for example, Agricultural Pest Control, Plant Agriculture Pest Control, Aerial Application).

3. The Pesticide Label

The correct, safe, and legal use of any pesticide is always found on the product label. Pesticide labels contain such important and pertinent information as the brand or trade name, the amount of active ingredient, directions for use, environmental hazards, what to do in the case of an accident, and storage and disposal directions.

Each product is required to have its EPA registration number and EPA establishment number as part of the container label. These numbers are valuable to pesticide applicators as unique identifiers in case of accidental poisoning; claims of misuse; faulty product (poor control or phytotoxicity, for example); or liability claims.

3.1. Labels and Labeling

A pesticide applicator is legally bound by the labeling found on and with the pesticide container in their possession. Labels are the written, printed, or graphic matter on, or attached to, the pesticide or device or any of its containers or wrappers. “Labeling” means the label and any technical bulletins, circulars, leaflets, or other printed or graphic material to which the label refers to, or which accompanies the product when distributed or sold. Advertising material not accompanying the product is not considered labeling.

Literature such as Safety Data Sheets legally become a part of the pesticide labeling, **but only <u>when accompanying</u> a pesticide (*i.e.*, during distribution and sale).** The SDS (formerly called a MSDS) is written or printed material concerning a hazardous chemical that is prepared by the manufacturer or the company importing the product describing the physical and chemical properties of the product according to specific guidelines.

Webpages cited in/on the label are legally considered labeling. This includes when a label has a Quick Response Code (QR Code) barcode that leads to consumer information. Another example is when a label requires the completion of EPA-approved training and provides its web link. A condition of legal use by the applicator of the pesticide product would be completion of the online training (*see example in section D 3.3.1 Soil Fumigants*).

“Web-distributed labeling” is a legally valid, enforceable labeling for a pesticide product that is accessible online. The product label provides a link that directs users to the website with the web-distributed labeling. The complete online label must be printed and in the possession of the applicator when using the product. Web-distributed labeling is **currently voluntary for pesticide manufacturers to adopt**, and not supported by the vast majority of pesticide manufacturers.

With the exception of “web-distributed labels” or specific links found directly on the product label, **pesticide labels downloaded from the web are NOT legal documents**. Sources of online labels include State regulatory agencies; EPA; and labeling services such as Kelly Solutions, CDMS, National Pesticide Information Retrieval System (NPIRS), Agrian, and others. Almost all provide disclaimers that they are only “specimens” of a label. Online labels may be helpful, but they should not be substituted for that distributed with and on the container itself. Product formulations and directions periodically change. Although a product container may appear the same, never assume that a replacement container has exactly the same contents and labeling as what you last purchased.

Labeling can include **Supplemental Labels** that are distributed with the product. These partial labels are EPA-approved new, not previously registered uses of the product. These new uses will typically be included in subsequent product labels. Supplemental labels must bear the product’s EPA registration number, and direct users to the product label for complete directions and precautions. Another example of a Supplemental Label is a “Section 24C Local Needs” label (Section 24C) where a State issues a Supplemental Label with an additional use of a federally registered pesticide product, or a new end use product to meet special local needs. Compliance with both the product label and supplemental labeling is required to use these products safely and effectively. **Important: Both the product label AND supplemental labeling must be in the possession of the user when using the product.**

3.2. Label Statements

FIFRA requires that each product label bears both hazard and precautionary statements for humans and domestic animals. Hazard statements describe the type of hazard that may occur, while precautionary statements will either direct or inform the user of actions to take to avoid the hazard or mitigate its effects. EPA's decision to register a product is based, in part, on the assumption that mandatory use directions, restrictions, and precautions of the pesticide label will be followed by the applicator. This section contains information on selected statements that will be found on a pesticide label.

3.2.1 Restricted Use Classification Statement

The "**Restricted Use Pesticide**" (RUP) classification, and the reason for RUP classification must appear at the very top of the label's front panel directly under the phrase "Directions for Use". EPA may assign a restricted use classification when it has determined that the pesticide product, or its use, has a high acute toxicity; has a history of accidents; may cause oncogenic effects (tumors), teratogenic effects (birth defects), fetotoxic effects (harm to a developing fetus), or reproductive effects (such as a lowered sperm count); can leach into ground water; or can harm wildlife.

As a condition of product registration, a pesticide (or certain uses of it), that are classified as restricted use, must bear the statement: "For retail sale to and use only by Certified Applicators or persons under their direct supervision and only for those uses covered by the Certified Applicator's certification".

The RUP statement must also include the reason for restricting use. ***The RUP statement for a particular pesticide product containing the active ingredient atrazine is depicted in the box directly below.*** The label signal word for this product is "Caution" and would not warrant RUP classification by acute toxicity. However, in this instance, EPA restricted use to certified applicators and those under their direct supervision due to ground and surface water concerns.

RESTRICTED USE PESTICIDE
(GROUND AND SURFACE WATER CONCERNS)
FOR RETAIL SALE TO AND USE ONLY BY CERTIFIED APPLICATORS OR PERSONS UNDER THEIR DIRECT SUPERVISION, AND ONLY FOR THOSE USES COVERED BY THE CERTIFIED APPLICATOR'S CERTIFICATION.
THIS PRODUCT IS A RESTRICTED-USE HERBICIDE DUE TO GROUND AND SURFACE WATER CONCERNS. USERS MUST READ AND FOLLOW ALL PRECAUTIONARY STATEMENTS AND INSTRUCTIONS FOR USE IN ORDER TO MINIMIZE POTENTIAL FOR ATRAZINE TO REACH GROUND AND SURFACE WATER.

On a case-by-case basis, some product-specific RUP statements may be more restrictive based on risk management decisions by EPA. Paraquat is a recent example; see section D 3.3.2 for details on its more restrictive RUP statement: "Restricted Use Pesticide Due to Acute Toxicity For Retail Sale To and Use By Certified Applicators Only – Not to Be Used by Uncertified Persons Working Under the Supervision of a Certified Applicator".

Also, some states may impose further restrictions on a RUP, such as limiting sale to certified applicators only. For example, only certified applicators possessing a valid New Jersey applicator license may purchase restricted use pesticides. At no time can either licensed pesticide operators or unlicensed handlers purchase RUPs in NJ. **Please contact your state's applicator certification agency or your state Extension Pesticide Safety Education Program for state-specific regulations.**

3.2.2 Signal Words

An important feature of pesticide labels is that they are required by law to carry certain "signal words" on the front panel of the label that indicate their **relative acute toxicity to humans**. The signal word on EPA pesticide products can be **DANGER**, **WARNING**, or **CAUTION**. Signal words help alert users to the **acute (short-term)** toxicity of the formulated pesticide product.

The signal words are typically determined by the results of the six acute toxicity studies performed with the product formulation: acute oral, acute dermal, acute inhalation, primary eye irritation, primary skin irritation, and sensitization. The acute toxicity studies measure systemic toxicity by route of exposure; while the primary eye and skin studies measure irritation or corrosion; and the dermal sensitization study evaluates the potential for allergic contact dermatitis. EPA signal words designated on a product label are based on the LD_{50} acute toxicity data of the pesticide product as formulated. Data is collected from small mammal population studies where a common measure of acute toxicity is the lethal dose (LD_{50}) or lethal concentration (LC_{50}) that causes death (resulting from a single or limited exposure) in 50 percent of the treated animals.

EPA categorizes acute toxicity of pesticides into four toxicity categories (I - IV) using LD_{50} data according to regulations at 40 CFR §156.62 and its draft revision in 1984. Chemicals are considered highly toxic when the LD_{50}/LC_{50} is small (Toxicity Category 1) and practically non-toxic (Toxicity Category IV) when the value is large.

- **EPA Toxicity Category I: DANGER POISON *(in red)***. Highly toxic, causing acute systemic illness if eaten, absorbed through the skin, or inhaled. The approximate lethal dose to kill the average person by ingestion is a taste to a teaspoon. The product labels of any products with "Danger-Poison" must have: 1) the skull and crossbones; 2) the word "POISON" prominently printed in red on a background of distinctly contrasting color; and 3) A statement of an antidote or a practical treatment in case of poisoning by the pesticide.

- **EPA Toxicity Category I: DANGER**. Highly toxic. through corrosivity causing irreversible damage to the skin or eyes. Poison should not be used for products Category I Toxicity when the determining effect is not systemic illness (by oral, respiratory, or skin absorption routes of exposure).
- **EPA Toxicity Category II: WARNING**. Moderately toxic if eaten, absorbed through the skin, inhaled; or it causes moderate eye or skin irritation. The approximate lethal dose to kill an average person through ingestion is a teaspoon to an ounce.
- **EPA Toxicity Category III: CAUTION**. Slightly toxic if eaten, absorbed through the skin, inhaled; or it causes slight eye or skin irritation. Ingestion of an ounce to more than a pint is the approximate amount needed to kill the average person.
- **EPA Toxicity Category IV: None Required (or CAUTION as optional)**. Lowest EPA toxicity category (IV) by all routes of exposure (oral, dermal, inhalation); and does produce the other effects of eye or skin irritation. They do not require a signal word. However, a manufacturer may voluntarily use the signal word "Caution" for Toxicity Category IV.

Table D-1. EPA Signal Words According to Toxicity Categories (I, II, III, IV) of Pesticide Products[1]

Study	Category I		Category II	Category III	Category IV
	 **Danger Poison** *(in red)*	**Danger**	**Warning**	**Caution**	**None or Caution**
Acute Oral	$LD_{50} \leq 50$ mg/kg	–	$LD_{50} > 50 - 500$ mg/kg	$LD_{50} > 500 - 5{,}000$ mg/kg	$LD_{50} > 5{,}000$ mg/kg
Acute Dermal	$LD_{50} \leq 200$ mg/kg	–	$LD_{50} > 200 - 2{,}000$ mg/kg	$LD_{50} > 2{,}000 - 5{,}000$ mg/kg	$LD_{50} > 5{,}000$ mg/kg
Acute Inhalation	$LC_{50} < 0.05$ mg/liter	–	$LC_{50} > 0.05 - 0.5$ mg/liter	$LC_{50} > 0.5$ thru 2 mg/liter	$LC_{50} > 2$ mg/liter
Primary Eye Irritation	–	Corrosive; irreversible destruction of ocular tissue; corneal involvement or irritation persisting more than 21 days	Corneal involvement or irritation clearing in 8-21 days.	Corneal involvement or irritation clearing in 7 days or less	Minimal effects clearing in less than 24 hours
Primary Skin Irritation	–	Corrosive (tissue destruction into the dermis and/or scarring)	Severe irritation at 72 hours (severe erythema or edema)	Moderate irritation at 72 hours (moderate erythema)	Mild or slight irritation (no irritation or slight erythema)
Dermal Sensitization	Positive			Negative	
	Product is a sensitizer or is positive for sensitization			Product is not a sensitizer or is negative for sensitization	

[1] Adapted from EPA Label Review Manual Chapter 7, rev March 2018.

Assignment of Signal Words

The signal word is determined by the most severe toxicity category assigned to the five acute toxicity studies (see Table D-1). Dermal sensitization is simply positive or negative and is not assigned a Toxicity Category. So, for example, if a pesticide product was assessed as Toxicity Category III for inhalation but as Toxicity Category II for oral, the Signal Word placed on the label would be WARNING corresponding to the more highly toxic Category II. A signal word is required for all registered pesticide products unless the pesticide product is classified as Toxicity Category IV for all routes of exposure and is negative for dermal sensitization.

Signal Words alert the applicator to the relative acute toxicity for short term exposure, during the application itself. It is important for applicators to understand that LD_{50}/LC_{50} data has limited use for comparing pesticides (other than acute toxicity). They do not reflect what dose may lead to other less serious, acute systemic effects, or to other, possibly equally serious contact effects or delayed systemic effects.

- LD_{50}/LC_{50} data does not reflect any effects from long-term exposure (*i.e.*, cancer, birth defects or reproductive toxicity) that may occur at levels below those that cause death.
- Also, they do not translate directly to humans because our body systems are slightly different from those of test animals (*e.g.*, rats, mice, etc.).
- Lastly, the LD_{50} and LC_{50} are measures of a single exposure, not the potential buildup of effects resulting from multiple exposures.

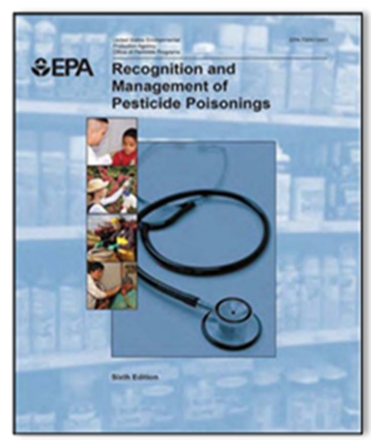
Most importantly, the results of the six acute toxicity studies determine the appropriate precautionary statements for the hazards to humans and domestic animals, personal protective equipment, and first aid statements. Hazards to Humans and Domestic Animals statements are required for products classified as toxicity categories I, II, or III, or positive for skin sensitization. Hazards to Humans and Domestic Animals statements may specify both mandatory actions and advisory information.

IMPORTANT

Hazard is a function of both toxicity as well as the amount and type of exposure.

The danger in handling pesticides does not depend *exclusively* on toxicity values. Relatively nontoxic pesticides can be hazardous if label instructions are not followed. Don't collapse the acute **HAZARD** that Signal Words signify with **RISK** of hazard! A compound may be highly toxic but presents little hazard to the applicator if the label precautions are followed carefully.

3.2.3 First Aid Statements



First Aid Statements of the pesticide label provide initial first steps to take when accidental exposure occurs and may inform physicians and emergency responders of appropriate medical procedures for victims of poisoning. Pesticide labels are required to have First Aid Statements if the product has systemic effects in EPA Toxicity Category I, II, or III, or skin or eye irritation effects in Category I or II. Some labels will have First Aid Statements for use dilutions specified by the label.

Using the information on the pesticide label First Aid Statements, be alert for the early symptoms of pesticide poisoning and contact effects in yourself and others. Recognizing symptoms early and providing an immediate first-aid response may save a life or prevent permanent injury.

The ***Recognition and Management of Pesticide Poisonings: 6th Edition*** manual gives healthcare providers a quick reference resource for the best toxicology and treatment information for patients with pesticide exposures. Downloadable in its entirety or by chapter at: *https://www.epa.gov/pesticide-worker-safety/recognition-and-management-pesticide-poisonings*. The fifth edition is available in Spanish. Free copies of the manual (EPA publication # 735K13001) are available from the National Service Center for Environmental Publications at: *https://www.epa.gov/nscep*.

Do not wait until you or someone else gets dangerously ill before calling a physician or going to a hospital. It is better to be too cautious than to act too late. **Any time after using pesticides, if you are having a medical emergency or require immediate medical attention, call 911 immediately.** Prompt action and treatment may save a life.

Seek medical attention immediately if you or any of your fellow workers have unusual or unexplained symptoms that develop within 24 hours of a pesticide exposure. If you have any of the following symptoms during or shortly after using pesticides: headache, blurred vision, pinpoint pupils, weakness, nausea, cramps, diarrhea, and discomfort in the chest, **call a physician and/or the National Poison Control Center hotline (1-800-222-1222). Anyone with a pesticide exposure or poisoning emergency can call the national toll-free Poison Control Center telephone number for help.** Personnel at the Center will give you first-aid information and direct you to local treatment centers if necessary.

Take the pesticide label with you, either a duplicate copy or the one attached to the container (or at a minimum, the EPA registration number of the product). To avoid contamination and exposure, do not carry pesticides in the passenger space of the vehicle.

If you are having a medical emergency after using pesticides, always call 911 immediately.

POISON Help® 1-800-222-1222

In Case of an Accident

- **Remove the person from exposure**
- **Get away from the treated or contaminated area immediately**
- **Remove contaminated clothing**
- **Wash with soap and clean water**
- **Call a physician and/or the National Poison Control Center (1-800-222-1222). Your call will be routed to your State Poison Control Center.**
- **Have the pesticide label with you!**
- **Be prepared to give the EPA registration number to the responding center/agency**

3.2.4 Other Label Statements

If risks of concern are identified in the risk assessment, EPA evaluates potential risk management measures. Precautionary statements that reduce risk will be included on the label, such as:

- reductions in application rates and changes to directions for use;
- extending the restricted entry interval;
- requiring engineering controls, such as use of closed systems for mixing and loading to reduce potential exposure to those who mix and load pesticides;
- safe handling procedures to avoid spills;
- not spraying the pesticide when a crop blooms to protect pollinators; or
- create buffers of unsprayed zones along water bodies to reduce exposure to surface water, etc.

In some cases, the use of a pesticide may only be acceptable if one or more risk mitigation measures are implemented. In other cases, pesticides will not be reregistered for certain use sites or for all uses because of unacceptable worker risk. When EPA determines that labeling cannot sufficiently mitigate the risk of pesticide harm, it may include special risk mitigation measures. See sections D 3.3.1 *Soil Fumigants* and D 3.3.2 *Paraquat Dichloride (Paraquat)* for recent label changes to allow continued registration.

3.3. Significant Labeling Changes

3.3.1 Soil Fumigants

EPA required specific safety measures to increase protections for handlers, re-entry workers, and bystanders from risk of exposure for use of the soil fumigants **chloropicrin, dazomet, metam sodium/potassium, dazomet, 1,3-dichloropropene, iodomethane, dimethyl disulfide, and methyl bromide**. As gases, fumigants move from the soil to the air at the application site and may move off site at concentrations that produce adverse health effects in people from hours to days after application. These health effects range from mild and reversible eye irritation to more severe and irreversible effects, depending on the fumigant and the level of exposure.

Revised safety measures were incorporated in the product labels. **Each of these fumigants** have been reclassified as restricted use pesticides due to acute toxicity and **can only be used by a certified applicator or persons under their direct supervision.**

IMPORTANT FEDERAL REGULATORY CHANGE FOR SOIL FUMIGATION

Based on revised federal pesticide applicator certification regulations, all state pesticide regulatory agencies will now be required to implement some method of separate **method-specific soil fumigation certification** for both Private and Commercial Applicators, *if not already in place by current State pesticide regulations*. Because these changes will require revision of state pesticide regulations in most cases, the dates of implementation will vary by individual state. For example, Delaware is looking to implement by 2024, while New Jersey by 2025. If you use commercial fumigators, be sure to verify their category license for your State.

Please contact your state's applicator certification agency or your state Extension Pesticide Safety Education Program for State-specific regulatory changes to certification and training.

Additionally, the labels of these pesticides were amended to require that **only trained handlers can assist with application and apply these soil fumigants**. The soil fumigants are one of the first groups of pesticides with product-specific training requirements to be specified on the pesticide label itself. This label-mandated **EPA-approved soil fumigant training** for certified applicators may be found at: *https://www.epa.gov/soil-fumigants/soil-fumigant-training-certified-applicators*. Training must be completed every 3 years.

Soil fumigant labels also require users to prepare a site-specific **fumigation management plan** (FMP) before the application begins. EPA has developed fumigant management plan templates listed by chemical that fulfill the elements required by the labels; see *https://www.epa.gov/soil-fumigants/fumigant-management-plan-templates-phase-2-files-listed-chemical*. Alternately, users may develop their own fumigant management plan or use one developed through an outside vendor to meet the label requirements rather than using these templates. Additionally, soil fumigant labels must also include language informing soil fumigant applicators that **some states and tribes require them to notify the state or tribe before making an application.** The label statement includes the URL *www.epa.gov/fumigantstatenotice*, linking to EPA's Web page on ***Complying with Required State and Tribal Notification before Soil Fumigations***. This page identifies the states and tribes that require applicators to make the notifications and provides contact information. Mid-Atlantic states currently listed that require applicators to notify their state's licensing agency prior to use of these fumigants are Maryland and West Virginia.

A national manual/certification study guide, the "Soil Fumigation Manual" produced by the National Association of State Departments of Agriculture Research Foundation is downloadable from. *https://www.epa.gov/system/files/documents/2023-11/soil-fumigation-manual-2012.pdf*.

3.3.2 Paraquat Dichloride (Paraquat)

Paraquat dichloride (also referred to as "paraquat") is highly toxic to humans. One small accidental sip can be fatal, and there is no antidote. Dermal or eye contact can also have serious lasting effects. A combination of public concern and EPA's evaluation of incident data prompted an in-depth statistical analysis of paraquat incidents ahead of the typical mitigation phase of Registration Review.

EPA's "Paraquat Dichloride Human Health Mitigation Decision" required changes in allowed uses of paraquat to mitigate risk to human health incidents involving paraquat. Risk mitigation measures that must be implemented to address accidental ingestion and worker exposure incidents were based on the high number and severity of human health incidents associated with the pesticide.

Sample revised RUP statement on paraquat product label with "acute toxicity" reason for RUP status.

In order for pesticide products containing paraquat to meet the FIFRA standard for registration, EPA determined the following risk mitigation measures were necessary for continued registration:

1. Use of paraquat is restricted to certified pesticide applicators only (*see RUP statement graphic above*).
2. Noncertified persons working under the supervision of a certified applicator are prohibited from using paraquat (including mixing, loading, applying the pesticide, and other pesticide-related activities).
3. Applicators are required to take an EPA-approved paraquat training program every 3 years in order to mix, load, apply, or handle paraquat.
4. Changes to the pesticide label and warning materials (*see cap seal to right*) to highlight the toxicity and risks associated with paraquat; and
5. New closed-system packaging designed to make it impossible to transfer or remove the pesticide except directly into the proper application equipment.

Paraquat Cap Sticker

All persons handling paraquat are expected to take the training every 3 years and retain documentation of successful completion. The pesticide label provides the link *www.usparaquattraining.com* to access the training; this redirects to the Extension Foundation Online Campus site where the EPA-approved paraquat training is hosted at *https://campus.extension.org/enrol/index.php*. The one-hour training is available in both English "How To Safely Use and Handle Paraquat-Containing Products" and Spanish "Cómo Utilizar y Manejar con Seguridad los Productos que Contienen Paraquat." After completion, a **training certificate is generated for applicators to keep in their records for three years.**

3.3.3 Chlorpyrifos

Chlorpyrifos is an organophosphate insecticide, first registered in 1965; labeled product names have included Lorsban, Dursban, and other trade names. It has been used for a **large variety of agricultural uses**, including **soybeans**, fruit and nut trees, **broccoli, cauliflower**, and **other row crops**, as well as non-food uses. Chlorpyrifos is a cholinesterase inhibitor, requiring medical monitoring (see section D 4.1. for requirements).

Currently, chlorpyrifos remains registered as it undergoes registration review, a program that re-evaluates all pesticides on a 15-year cycle. The chlorpyrifos registration review was scheduled to be completed in 2022.

As part of EPA's ongoing process of review of chlorpyrifos during its life cycle, the pesticide registrants voluntarily entered into an agreement in 2000 changing labeled uses of chlorpyrifos. All uses of chlorpyrifos tomatoes in the United States were discontinued in 2000. Most homeowner uses and all termiticide uses were eliminated, and uses of chlorpyrifos on specific fruit were restricted and tolerances lowered. Additional label changes in 2002 required buffer zones to protect water quality, fish, and wildlife; increased PPE; and reduction of application rates on a number of crops including corn. Label changes in 2012 included a significant lowering of the aerial pesticide application rates and "no-spray" buffer zones for ground, airblast and aerial application methods around public spaces. EPA issued its Third Revised Human Health Risk Assessment in 2020 incorporating all use restrictions.

IMPORTANT

Growers are directed to verify the current legal status of chlorpyrifos with your state pesticide regulatory agency or Cooperative Extension Pesticide Safety Education Program prior to considering use. As of publication date (12/22/2023), chlorpyrifos should not be used on any food or feed crop that will be marketed in the United States until revoked tolerances for the use of chlorpyrifos are reinstated by a Court mandate. If the residue exceeds the set tolerance, the crop may not be marketed or sold. It is subject to condemnation and seizure by federal or state regulatory agencies. The tolerance revocation does NOT impact application to non-bearing fruit/nut trees. *(see detailed narrative below)*

Since 2007, there have been a series of petitions to the Courts either requesting EPA ban the use of chlorpyrifos on food and feed products or requesting reinstatement of its use. In 2007, petitioners requested EPA cancel all uses of chlorpyrifos; it included a request for revocation of all pesticide tolerances (maximum residue levels in food) for chlorpyrifos. In 2015 EPA proposed a rule to revoke all chlorpyrifos tolerances because it could not make a safety finding for continued registration of chlorpyrifos under the Federal Food and Drug and Cosmetic Act based on *available* data.

However, in March 2017, EPA did a reversal and denied the 2007 petition concluding that "despite several years of study, the science addressing neurodevelopmental effects remains unresolved and further evaluation of the science during the remaining time for completion of registration review (*i.e.,* 2022) is warranted."

Environmental advocacy groups and several States challenged EPA's denial orders in the U.S. Court of Appeals for the Ninth Circuit. In April 2021, the Ninth Circuit issued its decision, finding that EPA's denial was arbitrary and capricious based on the record before the Court. The *Ninth* Court ruling directed EPA to grant the petition, issue a final rule revoking the tolerances or modifying the tolerances if EPA could determine the tolerances were safe, and to modify or cancel food-use registrations for chlorpyrifos under FIFRA.

EPA determined that the current aggregate exposures from use of chlorpyrifos do NOT meet the legally required safety standard that there is a reasonable certainty that no harm will result from such exposures. EPA complied with the Ninth Circuit's order directing EPA to issue a final rule in response to the 2007 petition with its **August 30, 2021 release of the "Final Tolerance Rule for Chlorpyrifos", which revoked all tolerances for chlorpyrifos published in the Code of Federal Regulations at 40 CFR 180 effective February 28, 2022.** The majority of registrants submitted cancellation requests and/or label amendments to reflect the tolerance revocation. This tolerance rule does NOT prohibit sale and distribution of registered pesticide products. However, sale and distribution of chlorpyrifos products *labeled for use on food crops* would be considered misbranded as long as the tolerances remain revoked; therefore, it would be a violation of FIFRA to sell and distribute those products.

HOWEVER, on November 3, 2023, the *Eighth* Circuit Court of Appeals issued a ruling that vacated EPA's tolerance revocations, and once the Court issues a mandate to EPA, the tolerances will immediately be reinstated. UNTIL THE EIGHTH COURT OF APPEALS ISSUES A MANDATE TO EPA, the tolerances remain revoked, and any applications of chlorpyrifos made to food will render any food so treated adulterated and unable to be distributed in interstate commerce.

In conformance with the Eighth Circuit's ruling and after issuance of the mandate, EPA intends to immediately issue a notice correcting the Code of Federal Regulations to reflect the court's reinstatement of chlorpyrifos tolerances. Based on EPA's December19, 2023 update, growers can *anticipate* that tolerances will be reestablished for 11 crops, *i.e*., alfalfa, apple, asparagus, cherry (tart), citrus, cotton, peach, soybean, strawberry, sugar beet, wheat (spring), and wheat (winter). Growers are advised of potential additional restrictions for geographic location, rate of application, farmworker and other vulnerable populations, and vulnerable species and their habitats that may be needed to address safety of the tolerances.

As of publication, the Eighth Court of Appeals has NOT issued its mandate, and the food tolerances for chlorpyrifos were checked and remain revoked; see *https://www.ecfr.gov/current/title-40/chapter-I/subchapter-E/part-180/subpart-C/section-180.342* (date accessed 12/22/2023). **Growers are directed to verify the current legal status of chlorpyrifos with your state pesticide regulatory agency or Cooperative Extension Pesticide Safety Education Program prior to considering use.**

4. Handling Pesticides

4.1. Prior to Pesticide Application

Use pesticides for only those crops specified on the label and use only those that have both state and federal registration. Using a pesticide for any other uses or in any other manner than specified on the label is against the law.

Verify, prior to application, that a commodity-specific tolerance or tolerance exemption exists for a particular pesticide prior to use on food or feed crops. For a list of pesticides that have tolerances or exemption from the requirements of an tolerance, see *https://www.epa.gov/pesticide-tolerances/how-search-tolerances-pesticide-ingredients-code-federal-regulations*). Contact your State Extension for assistance if in doubt.

D. Pesticide Safety

In advance of the application itself, applicators should **read and review the label carefully**, and prepare to be able to follow all directions and precautions specified by the label. Determine in advance the proper safety equipment, protective clothing, and measuring equipment you will need for the pesticide task that you will be performing. The protective equipment necessary may include socks, shoes, long pants, long-sleeve shirt, and a hat. Additional safety equipment may also be required by the label. Consult the Precautionary Statements of the pesticide label for the minimum Personal Protection Equipment (PPE) required by law. See sections D 5.2.1 *Body Protection for Early Entry Workers and Pesticide Handlers,* and D 5.2.2. *Respiratory Protection for Pesticide Handlers* for further direction on selection and use of the protective equipment according to the pesticide label.

Make sure that all application equipment that will be used has been **properly maintained and calibrated and is in good working order** prior to application.

Prior to application, be sure to **check the First Aid statements on the label**. Have any label-specified antidotes on hand in advance.

Your physician should be advised of the types of pesticides you use in your work. They may determine the need for medical monitoring for continued use; this includes certain uses of cholinesterase-inhibiting organophosphate and N-methyl carbamate pesticides (*see box below*). When a pesticide is a cholinesterase inhibitor, this is identified in the First Aid statements of the label.

When you will be using a pesticide that requires the use of a respirator, you will need to be medically evaluated and receive a medical clearance for your use of that respirator under its conditions of use. See section D 5.2.2 *Respiratory Protection for Pesticide Handlers* for details.

Prior to applying or otherwise handling pesticides, be sure to have a supply of clean water and liquid detergent available for drenching and washing in case of an accident. When the label requires eye protection, handler employers must provide at least one pint of water per handler in portable containers that are immediately available to each handler. Whenever a handler is mixing or loading a pesticide product whose labeling requires protective eyewear during handling (or is mixing or loading any pesticide using a closed system operating under pressure), the handler employer must provide at each mixing/loading site, at least one system that is capable of delivering gently running water at a rate of least 0.4 gallons per minute for at least 15 minutes; or at least six gallons of water in containers suitable for providing a gentle eye-flush for about 15 minutes.

Medical Monitoring Cholinesterase-Inhibiting Pesticides

*It is recommended that you advise your physician if: you will be using Class 1 and Class 2 organophosphates (OPs) and N-methyl carbamates; or simply OPs. Monitoring of blood cholinesterase level is recommended for those who will be using these pesticides for greater than a total of 30 hours in 30 consecutive days. **Before the start of the spray season**, each applicator should have a baseline blood cholinesterase level determination. The level of blood cholinesterase should be re-evaluated using the same lab during the spray season when 30 hours use within 30 days is reached or exceeded.

**The Migrant Clinicians Network website "Cholinesterase Testing Protocols for Healthcare Providers" outlines protocols, when medical removal from the job is necessary, and return to duty can be allowed.*

See https://www.migrantclinician.org/toolsource/resource/cholinesterase-che-testing-protocols-and-algorithm-healthcare-providers.html.

4.2. Pesticide Application and Record Keeping

Always have the label readily available when applying a pesticide. The label MUST be in your possession.

- Do **not** handle or apply pesticides if you have a headache or are not feeling well.
- **Never** smoke, eat or drink (or use cell phones) while handling pesticides.
- **Avoid** inhaling pesticide sprays, dust, and vapors. If the pesticide is dangerous to your respiratory system, the label will tell you to wear a respirator and specify which type (see section D 5.2.2. *Respiratory Protection for Pesticide Handlers*).
- Thoroughly wash exposed areas of yourself before eating, drinking, using tobacco products, using the bathroom, or using your cell phone. Wash your gloves with soap and water before you take them off. Then wash your hands and face.
- If hands, skin, or other body parts become contaminated or exposed, wash the area immediately with clean water and a liquid detergent. If clothing becomes contaminated, remove it immediately. If you splash a

concentrate of a pesticide labeled with a "Danger "or "Warning" signal word, take your contaminated clothing off immediately. Dispose of garments drenched with concentrates of any pesticides labeled with Danger or Warning signal words; do not wash these items.

- After each spraying or dusting, bathe and change your clothing; always begin the day with clean clothing. Wash contaminated clothing separately from other garments and run an extra rinse cycle afterwards.
- Always have someone with you or close by if you are using highly toxic pesticides (those with the signal word **DANGER** plus skull and crossbones)

APPLICATION DIRECTIONS

Always follow the pesticide label 'Directions for Use' regarding who may use, where, how, how much, and how often the pesticide may be used. Never use higher than the labeled rate of application. In addition to those mandatory statements, pesticide manufacturers also provide additional advisory information on the label on how to use a pesticide most effectively.

APPLICATION RECORDS (PRIVATE APPLICATORS ONLY)

Records document proper application. Records are one of the first things that regulators review when they have received a complaint. **Consider treating each record as documentation of a lawsuit going forth in court**.

Federal law prohibits US EPA from requiring PRIVATE APPLICATORS to keep pesticide application records. United States Department of Agriculture (USDA) regulations at 7CFR § 110.3 establish records, retention, and access to records of **restricted use pesticide applications.** In accordance with the 1990 Farm Bill, all private applicators are required by law to keep record(s) of their federally restricted use pesticide (RUP) applications for a period of 2 years.

The nine USDA-required elements of a pesticide application record that must be recorded within 14 days of each RUP application are as follows:

1. brand or product name.
2. EPA registration number.
3. total amount applied.
4. month, day, and year.
5. location of the application.
6. crop, commodity, stored product, or site.
7. size of area treated.
8. name of the certified applicator; and the
9. certification number of the certified applicator.

The location of the application may be recorded using any of the following designations:

(i) County, range, township, and section
(ii) An identification system utilizing maps and/or written descriptions which accurately identify location
(iii) An identification system established by a United States Department of Agriculture agency which utilizes maps and numbering system to identify field locations; or
(iv) The legal property description.

State recordkeeping requirements for Private Applicators may differ from these federal USDA requirements. Federal and State pesticide regulations typically prescribe required pesticide application information and record retention times but do not require a particular record format for pesticide applicators to keep.

State-Specific Pesticide Application Records

In addition to the USDA-required information above, *some* state pesticide regulations require that Private applicators maintain application records for both restricted and general use pesticides; or may have different retention times; and/or may require WPS information**. Always keep a record of all pesticides used (dates, locations, quantities, etc.) as required by your state regulations. See templates below for individual states (current to date accessed)**; these templates for agricultural users of pesticides are provided as a courtesy and are not regulatory documents. ***Several states have incorporated WPS-required application information in these templates, and these could be used by agricultural establishment owners (see box below).***

IMPORTANT

APPLICATION RECORDS (AGRICULTURAL ESTABLISHMENT OWNERS* ONLY)

EPA's 2015 Revised Worker Protection Standard requires owners of agricultural establishments to retain records of posted pesticide application information, and Safety Data Sheets (SDS) for a *minimum* of two years. For more details, see section D 5.1. State Worker Protection regulations may be more stringent and require additional information and longer retention times.

Delaware developed a "Pesticide Recordkeeping Form" which provides compliance guidance for the keeping of pesticide application records in accordance with 40 CFR PART 170, Worker Protection Standard, 7 CFR PART 110 Recordkeeping for Application of Federally Restricted Use Pesticides, and Section 14, Records, Commercial Applicators, Delaware Pesticide Rules & Regulations. The form is posted at: *https://agriculture.delaware.gov/wp-content/uploads/sites/108/2017/12/Pest_recordkeeping.pdf* (date accessed 11/27/2023).

An excerpt of **Maryland** pesticide recordkeeping regulations (15.05.01.12 Records) is located at: *https://mda.maryland.gov/Documents/Wkgp_Recordkeeping.pdf*. See also the University of Maryland "Pesticide Information Leaflet No. 14: Pesticide Record Keeping Requirements in Maryland" for more details and a template recordkeeping form provided by the Maryland Department of Agriculture at: *http://pesticide.umd.edu/uploads/1/3/5/6/13565116/pil14_recordkeeping_1991-2012.pdf* (date accessed 11/27/2023).

New Jersey regulations (NJAC 7:30-8.8 Records) require private applicators to maintain records of all applications of pesticides (both general and restricted use) for 3 years. All records should be recorded in writing as soon as possible, but no later than 24 hours after the application. These records must be made available to the New Jersey Department of Environmental Protection (NJDEP) and medical personnel (for emergencies) upon request. Rutgers Pesticide Safety Education Program's website provides templates designed for private applicators, and operations covered by the WPS to keep records of all their pesticide applications; see *https://pestmanagement.rutgers.edu/pat/record-forms-2/* (date accessed 11/27/2023). The NJDEP published a new pesticide WPS posting template that can also be used a pesticide application record; see *https://www.nj.gov/dep/enforcement/pcp/pcp-wps.htm* (date accessed 11/29/2023).

Pennsylvania pesticide regulations require recordkeeping by pest management consultants (7 § 128.24), pesticide applicator businesses (7 § 128.35), pesticide application technicians (7 § 128.53), and Private applicators (7 § 128.65); see these regulations in the Pennsylvania Department of Agriculture's Legal Library webpage at: *https://www.agriculture.pa.gov/Plants_Land_Water/PlantIndustry/health-safety/pesticide-programs/PesticideCART/Documents/007_0128.pdf* (date accessed 11/27/2023).

Pennsylvania's template **Private Applicator Pesticide Application Record** incorporates WPS-required application information; see *https://www.agriculture.pa.gov/Plants_Land_Water/PlantIndustry/health-safety/pesticide-programs/PesticideCART/Documents/Private%20Applicator%20Pesticide%20Application%20Record.pdf* (date accessed 11/30/2023).

Virginia requires that USDA records of restricted-use pesticide applications be kept for two years. Virginia Cooperative Extension and Virginia Department of Agriculture and Consumer Services prepared a template Private/Grower Pesticide Application Record that meets the USDA requirements plus additional WPS-required information; it is posted at the Virginia Tech Pesticide Programs website at: *https://vtpp.ento.vt.edu/content/dam/vtpp_ento_vt_edu/applicators/Sample%20Private%20Recordkeeping%20Form%20.pdf* (date accessed 11/27/2023).

West Virginia pesticide regulations at § 61-12A-9 outline state requirements for recordkeeping; see *https://agriculture.wv.gov/wp-content/uploads/2020/07/61-12A.pdf* (date accessed 11/27/2023). Private applicator records of restricted use pesticide applications must include at a minimum: the pesticide used, including registration number; formulation, dilution rate, and quantity of pesticide applied; date and place of application and the pest against which the pesticide was used.

For additional information on pesticide application recordkeeping for either applicators or agricultural establishments, contact your state pesticide regulatory agency or Cooperative Extension Pesticide Safety Education Program.

4.3. Pesticide Transport

When pesticides are transported, containers must be well secured to prevent breakage or spillage. If pesticide containers are glass, pad and secure them to prevent breakage. When containers are larger than 5 gallons, tightly brace them to a structural part of the vehicle to prevent accidental spills. Carry a supply of absorbent material to soak up or contain any liquid spills. Keep a shovel and/or broom and pan in the transport vehicle to help quickly contain any spills. Carry a working fire extinguisher (10 - B: C dry chemical, or carbon dioxide) immediately accessible on board as well.

While under transport, pesticides must be stored in a separate compartment from the driver such as the bed of a pick-up truck or a van equipped with a partition. All pesticide containers and equipment must be secured to the vehicle to prevent removal by unauthorized person(s) when the vehicle is unattended. The door or hatch of any service vehicle tank containing a pesticide must be equipped with a cover that will prevent spillage when the vehicle is moving. The above requirements would not apply if the vehicle were being used to hold and/or transport pesticides within the boundaries of a private applicator's property.

For additional information on pesticide transport, contact your state pesticide regulatory agency or Cooperative Extension Pesticide Safety Education Program.

4.4. Pesticide Storage

Improper storage of pesticides can lead to accidental poisonings, contamination of the environment, and deterioration of the chemicals themselves. Pesticides should always be stored in their original containers and kept tightly closed. **NEVER** transfer pesticides to food or beverage containers. Store pesticides in a cool, dry, well-ventilated area that is not accessible to children and others who do not know and understand their safe and proper use. For the protection of others, and especially in case of fire, the storage area should be posted as *Pesticide Storage* regardless of the use classification and kept securely locked.

Minimize the amount of products you need to store. Plan pesticide purchases so that supplies are used by the end of the growing season and will not have to be overwintered. Write the purchase or delivery date of the product on the label with indelible ink on the product container. Check and record expiration dates listed on the product label. EPA regulations require that pesticide manufacturers must place the statement "**Not for sale or use after [date].**" on product labels where the formulation changes in chemical composition significantly in a prominent position on the label. The product must meet all label claims up to the expiration time indicated on the label.

Always read the label. Most, if not all, pesticide labels will contain a general statement such as "do not contaminate water, food, or feed by storage, disposal, or cleaning of equipment." Special storage recommendations or restrictions will often be included. Moisture is a critical concern with dry pesticides, including granular materials and wettable powders, which have a strong affinity for water. When this is the case, the label may have the statement, "store in a dry place."

In New Jersey, any restricted use pesticide (or empty containers still contaminated with their residues) must be stored in a secure, locked enclosure while unattended. That enclosure must bear a warning that pesticides are stored there. If any pesticide must be stored in other than its original container (for example if the original container is leaking), that container must be labeled with the brand or trade name; EPA registration number; name and percentage of the active ingredient(s); the signal word; and precautionary statements for the pesticide. If the pesticide in the new container has been diluted, also write the dilution of the mixture. Keep an inventory of all pesticides held in storage and locate the inventory list in an accessible place away from the storage site, so it may be referred to in case of an emergency at the storage site.

Keep your local fire department informed of the location of all pesticide storage locations. Fighting a fire that includes smoke from burning pesticides can be extremely hazardous. A fire with smoke from burning pesticides may also endanger the people of the immediate area or community. The people of an area or community may have to be evacuated if the smoke from a pesticide fire drifts in their direction. In **New Jersey**, applicators are required to maintain a list of pesticides in storage or likely to be stored during the license year. Applicators must **send this inventory to their local fire department by May 1st each year**. It must also include a written description or depiction of the exact location of the pesticide storage area. For inventory and cover letter templates, see Rutgers Pesticide Safety Education Program's website at: *https://pestmanagement.rutgers.edu/pat/record-forms-2/*.

Inspect Product and Container Conditions

Inspect the condition of products and containers you have in storage routinely. During the registration of a pesticide, manufacturers are required to provide labels statements that describe where and how the pesticide is to be stored. In particular, maintain pesticides within the temperature range specified on the product label. Poor storage practices impact product efficacy and accelerates product deterioration.

General signs of product deterioration per formulation type are:

- EC - Evidence of separation of components, such as the formation of a sludge or sediment. Milky appearance does not occur when water is added.
- Oils - Milky appearance does not occur when water is added.
- WP, SP, WDG - Excessive lumping; powder does not suspend in water.
- D, G, WDG - Excessive lumping or caking

Cold Weather Storage:

Consult the "**Storage and Disposal**" statements listed on the label to determine whether a pesticide can freeze with no adverse effects. Some pesticide labels may indicate that if freezing occurs and crystals form, then the product may be reused if it is warmed up. Do not attempt to thaw frozen pesticide until after checking the pesticide container to make sure it is not ruptured or cracked from the expansion of the frozen liquid. To thaw a pesticide, place the container in warm storage, 50-80°F (10-27°C), and shake or roll the container every few hours to mix product or eliminate layering. If layering persists or if all crystals do not completely dissolve, do not use product. If in doubt, call the manufacturer for guidance.

Additional information can be obtained from manufacturers' websites or consult "Cold Weather Storage & Handling of Pesticides, January 2018" by the Montana State University Extension, available at (date accessed 11/27/2023): *https://store.msuextension.org/publications/AgandNaturalResources/MT201801AG.pdf*.

See section D 4.5. *Disposal of Pesticides* regarding disposal of deteriorated product.

4.5. Disposal of Pesticides

Pesticide waste may be hazardous. Improper disposal of excess pesticide, spray mixture, or rinsate is a violation of Federal Law. Do not contaminate water, food, or feed by storage or disposal. Pesticides (and their empty containers still containing residues) should not be disposed of in sanitary landfills or by incineration unless disposal sites and equipment are specially designed and licensed for this purpose by your state.

The federal Resource Conservation and Recovery Act (RCRA) governs the management and disposal of hazardous wastes **Agricultural producers (or their commercial applicator contractor) may dispose of excess pesticide or rinsate by applying to a labeled site on the farm according to the label directions** (*see box to right*).

However, if for whatever reason, that is not feasible, farmers are subject to the hazardous waste provisions of RCRA. For a detailed guide to RCRA requirements, please refer to EPA's "Managing Your Hazardous Waste: A Guide for Small Businesses" at *https://www.epa.gov/hwgenerators/ managing-your-hazardous-waste-guide-small-businesses* (date accessed 02/28/2023).

Always refer to the current pesticide label "Storage and Disposal" requirements because there may be product–specific requirements on the disposal of pesticides themselves or unrinsed containers or rinsate.

Pesticide labels now have specific directions on disposal for non-refillable and refillable containers. For non-refillable bags

FARMER EXCLUSION

The federal Resource Conservation and Recovery Act (RCRA) governs the management and disposal of hazardous wastes, including pesticides.

"…Although a farmer may be a generator of hazardous waste, waste pesticides disposed of on a farmer's own property in compliance with specified waste management requirements, including the disposal instructions on the pesticide label, are not subject to the generator requirements. This exclusion is intended to prevent the double regulation of farmers under both RCRA and the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)…"

(policy interpretation excerpted from ***RCRA Orientation Manual****. 2014. USEPA. https://www.epa.gov/sites/default/files/2015-07/ documents/rom.pdf)*

of granulars and powders, completely empty bag into application equipment by shaking and tapping sides and bottom to loosen clinging particles. If not emptied in this manner, the bag may be considered an acute hazardous waste and must be disposed of in accordance with local, state, and federal regulations.

After emptying a product container, triple rinse container (or equivalent) promptly. The **triple rinse-and-drain** procedure or the **pressure-rinse** procedure are recommended methods to prepare pesticide containers for recycling or (see section D 4.6. "*Disposal of Pesticide Containers*").

State-Specific Pesticide Disposal Programs

The **Delaware Department of Agriculture** (DDA) sponsors the Environmental Sweep Program (ESP), a new initiative that offers to all three counties easy and environmentally responsible disposal of unwanted, outdated or cancelled pesticides for free to qualifying individuals and businesses. Farmers, commercial applicators, nurseries, green houses, golf courses and pest control businesses can qualify for the free on-site removal of up to 500 pounds or 50 gallons of pesticides through this program. For convenience and safety, pesticides will be picked up directly from your site by a waste disposal contractor. For more information see *https://agriculture.delaware.gov/pesticide-management/environmental-sweep-program/*. Please contact Jimmy Hughes at (302) 698.4569 or Chris Wade at (302) 698.4570.

The **Maryland Department of Agriculture** (MDA) sponsors a **free pesticide disposal program for service for all current or retired farmers and producers**, including orchardists, nurserymen, greenhouse operators, and Xmas tree growers; see *https://mda.maryland.gov/plants-pests/Pages/Pesticide-Disposal-Program.aspx*. MDA provides that although there is currently (November 2023) no funding for the program, registrants will be put on a wait list for when funding becomes available. For growers seeking to participate in the MDA program, they must complete and return to MDA a ***Disposal Program Registration Form*** obtained from MDA or from the participating county office of the Maryland Cooperative Extension Service (MCES).

New Jersey has no state-sponsored waste pesticide disposal program. All RCRA requirements for disposal must be followed by those farmers that qualify as Small Quantity Generators (SQG) and Large Quantity Generators (LQG), or those Very Small Quantity Generators (VQSG) that have liquid hazardous waste. The requirements for hazardous waste generators are specifically found at N.J.A.C. 7:26G-6 et seq., which references 40 CFR Part 262 of the Federal regulations (with some exceptions and/or changes). Please refer to the New Jersey Department of Environmental Protection (NJDEP) **Compliance Assistance Packet for Hazardous Waste Generators** at *https://www.nj.gov/dep/enforcement/docs/-compliance-assistance-packet-2020-v20-3.pdf* (date accessed 02/28/2023). For regulatory assistance related to hazardous waste disposal in New Jersey, please contact the NJDEP Bureau of Hazardous Waste Compliance & Enforcement at your closest regional office listed below:

- **Northern Regional Office:** Phone: (973) 656-4470
  Serving Bergen, Essex, Hudson, Hunterdon, Morris, Passaic, Somerset, Sussex & Warren Counties,
- **Central Regional Office:** Phone: (609) 943-3019
  Serving Mercer, Middlesex, Monmouth, Ocean & Union Counties,
- **Southern Regional Office**: Phone: (856) 614-3658
  Serving Atlantic, Camden, Cape May, Cumberland, Gloucester, Salem & Burlington Counties.

The **Pennsylvania Department of Agriculture** CHEMSWEEP provides Pennsylvania farmers and other licensed pesticide applicators with a means to dispose of canceled, suspended, or unwanted pesticide products. Through CHEMSWEEP, applicators can legally dispose of unwanted pesticides, generally at little or no cost, covering the cost of the first 2,000 pounds per participant. Only pesticide products that are or have been registered for sale or use in the Commonwealth will be accepted in this program. CHEMSWEEP operates in a selected number of counties each year. Licensed farmers, professional pesticide applicators and pesticide businesses in the counties selected for that year are eligible to participate.

- **For 2024**, CHEMSWEEP will be conducted in Armstrong, Blair, Cambria, Chester, Clarion, Delaware, Forest, Indiana, Lackawanna, Lancaster, Lebanon, Luzerne, Snyder, Somerset, Union, Venango, Wyoming counties. Registration forms are online and due by March 31, 2024; *see third bullet below*.
- **For 2025**, CHEMSWEEP will be conducted in Bedford, Berks, Bradford, Butler, Columbia, Cumberland, Fulton, Lawrence, McKean, Montour, Northumberland, Schuylkill, Sullivan, York, and Warren counties.

- **For more details**, see *https://www.agriculture.pa.gov/Plants_Land_Water/PlantIndustry/health-safety/ environmental-programs/Pages/CHEMSWEEP%20Waste%20Pesticide%20Disposal%20Program.aspx*.

Virginia's Pesticide Collection Program assists agricultural producers, licensed pesticide dealers, pest control firms, golf courses and homeowners with the proper disposal of unwanted and outdated pesticides. The program is an effort by the Virginia Department of Agriculture and Consumer Services (VDACS), with participation from Virginia Cooperative Extension and the Division of Consolidated Laboratory Services. Scheduled events are held at predetermined sites. Participants bring pesticide material to the collection event. Pre-registration is required; see *https://www.vdacs.virginia.gov/pesticide-collection.shtml* online for form and details. The program is available at no cost to eligible participants.

The **West Virginia Department of Agriculture** (WVDA) sponsors free disposal of waste pesticide. In order to be considered, individuals complete the WVDA "APPLICATION FOR WASTE PESTICIDE DISPOSAL" located at *https://agriculture.wv.gov/wp-content/uploads/2020/07/Application-for-Waste-Pesticide-Disposal.pdf*. Pickup is arranged depending upon the volume. For more information on the West Virginia Waste Pesticide Disposal Program, contact Program Manager Devin Johnston; 1900 Kanawha Blvd East Charleston, WV 25305-0190; Office Phone: 304-558-2209; email: *djohnston@wvda.us*.

4.6 Disposal of Pesticide Containers

Disposal options for empty pesticide containers may be limited by local regulations and ordinances (and recycling program availability). Crushed/punctured containers may be accepted by sanitary landfills or landfills that accept industrial waste; check with landfill operators prior to taking empty containers for disposal.

Always refer to the current pesticide label "Storage and Disposal" requirements. EPA's pesticide container regulations [40 CFR 156] establish standards for pesticide containers and repackaging. They also now provide standards for label instructions to ensure the safe use, reuse, disposal, and adequate cleaning of the containers. **Cleaning the container before final disposal is the responsibility of the person disposing of the container. Applicators must follow the label instructions for cleaning and handling empty containers prior to disposal.**

Container handling statements will also be found in the **Storage & Disposal Statements** of the pesticide label state whether: 1) is it refillable or non-refillable; 2) can the container be reused, recycled, or reconditioned; 3) how to dispose of the container if recycling or reconditioning are not an option; and 4) how to clean the container if cleaning is required.

For non-refillable bags of granulars and powders, completely empty bag into application equipment by shaking and tapping sides and bottom to loosen clinging particles. If not emptied in this manner, the bag may be considered an acute hazardous waste and must be disposed of in accordance with local, state, and federal regulations. Other similar dry pesticides that have not been combined with liquids include dusts, wettable powders, dry flowables, water-soluble powders, granules, and dry baits.

After emptying a non-refillable or refillable product container containing a dilutable pesticide, triple rinse container (or equivalent*) promptly (see below)*. **Empty the rinsate into application equipment or a mix tank or store rinsate for later use or disposal according to label directions** (see section D 4.5 *Disposal of Pesticides*). Rinsate may be disposed of when applied to a labeled site in accordance with the pesticide label.

To prepare pesticide containers for recycling or reconditioning, either the **triple rinse-and-drain** procedure or the **pressure-rinse** procedure are acceptable methods. Unless the applicator rinses in the field (preferred method), cleaning should be done on a mixing and loading pad, or other containment structure that ensures collection of rinse water. Thoroughly clean both the interior and exterior of container. NO residues are acceptable.

Acceptable methods to prepare non-refillable containers that contained dilutable pesticides for recycling and/or disposal are **triple rinsing-and-draining** or **pressure-rinsing, as follows:**

<u>Triple Rinse-and-Drain Method</u> (for refillable containers larger than 5 gallons):
To empty a pesticide container for disposal, drain the container into application equipment or mix tank by holding container in a vertical position for 30 seconds. Add a solvent, capable of removing the pesticide, to the pesticide container, so that it is approximately one-fourth full. Only use solvents as specified on the label, such as water.

Agitate the container thoroughly, and then drain the liquid (rinsate) into the application equipment or mix tank by holding the pesticide container in a vertical position for 30 seconds. Repeat two more times. Empty the rinsate into application equipment or a mix tank, or store rinsate for later use or disposal.

Pressure Rinse Method:
An optional method to rinse small pesticide containers is to use a special rinsing device on the end of a standard water hose. The rinsing device has a sharp probe (called a "stinger") to puncture the container and several orifices to provide multiple spray jets of water. After the container has been drained into the sprayer tank (container is upside down), jab the pointed pressure rinser through the bottom of the inverted container. Rinse for at least 30 seconds. The spray jets of water rinse the inside of the container and the pesticide residue is washed down into the sprayer tank for proper use. Thirty seconds of rinse time is equivalent to triple rinsing. An added benefit is the container is rendered unusable.

When either of these methods is used, a farmer can consider the container 'empty' legally; but it cannot be reused for other purposes. If a container cannot be cleaned, contact the pesticide manufacturer for disposal guidance. If the container has visible residue not removable via normal cleaning, then it is outside the scope of most recycling programs. Contact the product manufacturer for disposal guidance. Pesticide manufacturers, formulators, producers, and registrants can provide you with valuable information about their pesticide products. See the National Pesticide Information Center's online directory of pesticide manufacturers, formulators, producers, and registrants at *http://npic.orst.edu/ingred/manuf.html* for information on your pesticide product.

State-Specific Pesticide Container Recycling Programs

Recycle!

The status of services provided by several Mid-Atlantic states for the recycling of pesticide containers that have been rendered empty by either triple or pressure rinsing is provided below. Delaware, Maryland, and West Virginia have all indefinitely paused their pesticide container recycling programs due to Contractor issues (inconsistencies with reliability and rejection/acceptance of containers). Information about state-specific pesticide container recycling for referral for 2024 through 2025 follows.

The **Delaware Department of Agriculture (DDA) Pesticide Section** last provided an empty pesticide container recycling program in 2021 in cooperation with the Ag Container Recycling Council (ACRC). It directs pesticide applicators seeking recycling of empty pesticide containers to contact the current vendor, Ag Plastic Solutions (Justin Geisinger, 717-658-9660), to arrange pickups and discuss individual recycling needs. DDA has postponed the Container Recycling Program for 2023 and hopes to re-instate the program in the future. **For annual updates on the status of the DDA empty pesticide container recycling program**, check *https://agriculture.delaware.gov/pesticide-management/calendar/*.

The **Maryland Department of Agriculture (MDA)** Pesticide Container Recycling Program has collected more than a million pounds of plastic in its empty pesticide container collection program for 30 years. The Agricultural Recycling Container Council (ACRC) provides a contractor to pick up and/or grind the collected plastic free of charge. MDA has postponed the Container Recycling Program for 2023 and hopes to re-instate the program in 2024. **For further information please contact the Pesticide Regulation Section** at 410-841-5710 or via email at *pest.reg@maryland.gov*.

The **New Jersey Department of Agriculture (NJDA)** promotes the New Jersey Agricultural Recycling Programs. Pesticide container disposal is offered to agricultural, professional, and commercial pesticide applicators who hold a NJDEP pesticide license as well as state, county, and municipal government agencies. One core credit will be given to pesticide license holders who follow required processing steps and bring their license with them at time of collection. The program **accepts non-refillable, high-density polyethylene #2 (HDPE) containers that are no larger than 55 gallons and that have been triple rinsed**. For more details on recycling requirements, scheduling, and locations, see the NJDA webpage at *https://www.nj.gov/agriculture/divisions/anr/nrc/recycling. html*. Year-round collection sites are located at the Rutgers Fruit and Ornamental Research Extension Center at Cream Ridge in Monmouth County and Allied Recycling in Mt. Holly in Burlington County. Contact the NJDA Recycling Program Manager at (609) 913-6490 for additional information on New Jersey's various agricultural recycling programs.

The **Pennsylvania Department of Agriculture** Plastic Pesticide Plastic Container Recycling Program provides licensed pesticide applicators a means to dispose of triple-rinsed #2 HDPE plastic containers that are free of all pesticide residue inside and outside. An online map search for recycling locations statewide an online map search for recycling locations statewide with contact information at *https://padeptag.maps.arcgis.com/apps/webappviewer/index.html?id=1f206187d68d413a8214afa8a565d6f7*. For additional assistance with the recycling program, please call 717-705-5858.

The **Virginia Department of Agriculture and Consumer Services (VDACS)** Plastic Pesticide Container Recycling Program is a free service that assists with the disposal of *properly rinsed* plastic pesticide containers. The program is available to any pesticide applicator or dealer in Virginia. Many agricultural pesticide dealers, private producers of agricultural commodities, and commercial applicators such as golf courses, aerial applicators, and management companies participate by simply storing their empty, properly rinsed containers for annual or biannual collection. For a collection site near you, visit: *vdacs.virginia.gov/pesticides/r-localities.shtml.* Onsite pickups are available for locations with at least 500 properly rinsed plastic pesticide containers. Contact VDACS' Office of Pesticide Services Program Coordinator at 804.371.6561 or email *marlene.larios@vdacs.virginia.gov*.

Always refer to the label's "Storage and Disposal" requirements. For additional information on the disposal of pesticides themselves or *unrinsed* containers or rinsate, call your State pesticide regulatory agency.

4.7 Pesticide Spills

Keep a supply of an absorbent agent on hand to contain liquid spills in the area that you store pesticides, as well as transport pesticide products. Industrial sorbents rated by sorption capacity and type of liquid are commercially available for absorbing the liquids in a cleanup. Use label-prescribed PPE including chemical resistant gloves to clean up spills. Barrier laminate gloves have a broad range of chemical resistance and are a good choice to keep in a spill kit. Rubber gloves might break down depending on the pesticide. Let it soak a couple of hours to absorb the spilled pesticide from the floor. This procedure is also recommended for cleaning truck beds that are contaminated.

Specific information concerning pesticide cleanup can be obtained by calling the manufacturer directly or consulting the product Safety Data Sheet (SDS). **EPA encourages, but does not require, registrants to include a company telephone number or toll-free hotline number for emergency information in the first aid section.**

Reporting of Pesticide Spills

Follow your state spill reporting protocol.
Be prepared to report:

1. Date and time
2. Name/address/phone of the pesticide applicator
3. Name /address/phone of the applicator or dealer business if any
4. Name/phone of the property owner or operator
5. Location of the incident
6. Name and EPA registration number of the pesticide(s)
7. Estimated amount and dilution rate of pesticide(s) involved
8. Corrective action(s) taken

For Delaware, Maryland, Pennsylvania, Virginia, and West Virginia, pesticide spills may be reported using the 8 elements listed above to the US EPA Region 3 Office (1-800-438-2474). **These states may have additional reporting requirements; see below for contacts. Check with your state pesticide agency to verify if there are additional regulatory requirements.**

New Jersey licensed dealers, dealer businesses, commercial pesticide operators, applicators, or applicator businesses, shall ***immediately*** **notify the NJDEP at 1-877-927-6337** of **any 'reportable' pesticide spills** occurring under their direct supervision and/or direct observation. The report should include the 8 elements listed above.

New Jersey **"reportable spills" of pesticides include:** 1) Outside a structure – only if more than 1 pound active ingredient; 2) Inside a structure – only if more than 1 pound active of dry pesticides; or 1 gallon of liquid (pesticide and/or diluent); and 3) Indoor spill of termiticide – only if more than 50 in² organochlorine termiticide contamination at one injection point; or greater than 1 yd² aggregate contaminated by organochlorine termiticide on/at interior wall base; and/or when heating duct/system is contaminated.

Within ten days of the spill, a written report must be submitted to the NJDEP Pesticide Control Program, PO Box 411, Trenton, NJ 08625-0411 outlining the eight elements listed above. You may download a template "Spill Report Card" from the Rutgers NJAES PSEP website at *https://pestmanagement.rutgers.edu/pat/record-forms-2/*.

In **Pennsylvania**, any oil or petroleum product, chemical or waste that is released in any unauthorized manner constitutes a spill. The Emergency Planning and Community Right to Know Act establishes procedures for emergency planning preparedness and reporting of specific quantities of stored and spilled hazardous chemicals, including pesticides. This act is administered by the U.S. EPA and the Pennsylvania Emergency Management Agency. All spills and releases should be reported the PA Department of Environmental Protection (DEP) by calling the statewide toll-free number, 1-800-541-2050. If the Waters of the Commonwealth is threatened, the DEP must be notified *immediately*. Contact one of the seven Pennsylvania Department of Agriculture (PDA) Regional Office if the chemical is a pesticide or other agricultural chemical; for phone numbers, go to: *https://extension.psu.edu/navigating-the-paplants-website*.

Virginia pesticide regulations (2VAC5-685-170) require reporting to the Virginia Dept. of Agriculture & Consumer Services (VDACS) when there is a threat to any person, to public health or safety, or to the environment as a result of the use or presence of any pesticide. Report to VDACS is required within 48 hours by calling (804) 371-6560. A written report is required within 10 days to: VDACS-OPS Field Operations Office of Pesticide Services; PO Box 1163; Richmond, VA 23218. Report the 8 elements plus: the name (or description if unnamed) and location of nearby bodies of water nearby that could be contaminated.

If the accident or incident involves a spill, the applicator should **contact VDACS/OPS for help in determining whether the release is governed under SARA Title III (the Community Right-to Know Law). Reporting under SARA Title III is determined by the chemical hazard and the volume of the released chemical. If so, the applicator must also notify the: National Response Center at 1-800-424-8802**. In the event of an emergency release which would impact other individuals or other property, notify the: Virginia Department of Emergency Services (DES) at 1-800-468-8892.

IMPORTANT

In the event of a **fire, explosion, or other release** that could threaten human health **outside the facility,**

OR,

if you know that the **spill has reached surface water:**

Call the **National Response Center** at its **24-hour number:**

(1-800-424-8802)

5. Reducing Risks to Handlers and Workers

5.1. EPA's Worker Protection Standard

EPA first implemented the Federal Worker Protection Standard – CFR Title 40, Part 170 regulations in 1994 to provide specific safety requirements for both **pesticide handlers** and general **agricultural workers**. EPA revised the 1992 **Agricultural Worker Protection Standard (WPS) regulation** on November 2, 2015, to increase protection from pesticide exposure for the nation's two million agricultural workers and their families. **State regulations may differ, and when more stringent take precedence over federal regulations.**

"**Handlers**" are those persons who are employed by an agricultural establishment or commercial pesticide application company who mix, load, or apply pesticides; who handle opened pesticide containers; who act as flaggers; who clean, maintain, or repair application equipment; who assist with the application of a pesticide; who enter a treated greenhouse to operate ventilation equipment; who adjust or remove coverings or check air levels; who enter an outdoor area that has been fumigated to adjust or remove soil coverings; who perform tasks as a crop advisor; or who dispose of pesticides or their containers. The Revised WPS requires that handlers, except for immediate family, be **at least 18 years old**. New Jersey labor laws are more stringent, and minors under 18 years old cannot be employed as applicators of pesticides or be permitted in any area where pesticides are applied.

"Agricultural Workers" are those persons who are employed by the agricultural establishment to perform tasks such as harvesting, weeding, or watering, relating to the production of agricultural plants on a farm, forest, nursery, or greenhouse.

The WPS regulations are applicable to any agricultural establishment that employs either pesticide handlers or agricultural workers where **<u>any EPA-registered pesticides</u>** are used in the production of agricultural commodity(ies). The WPS also applies to custom pesticide applicators and labor contractors supplying employees or independent crop consultants who are hired by these establishments.

Only "WPS-labeled" pesticides may be used in the production of an agricultural commodity. These pesticides are identified by a box on the product label with the title "**AGRICULTURAL USE REQUIREMENTS**". The first paragraph within the box **invokes by reference a requirement for compliance with all of the WPS regulations**. Specifically, the paragraph reads: "Use this product **only in accordance with labeling and with the Worker Protection Standard 40 CFR part 170**. The Standard contains requirements for the protection of agricultural workers on farms, forests, nurseries, and greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification, and emergency assistance. It also contains specific instructions and exceptions pertaining to statements on the label about personal protective equipment (PPE) and restricted-entry interval. The requirements in this box only apply to uses of this product that are covered under the Worker Protection Standard…"

> **AGRICULTURAL USE REQUIREMENTS**
>
> Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR part 170. Refer to supplemental labeling under "Agricultural Use Requirements" in the Directions for Use section for information about this standard.

This section provides a brief overview of some of these regulations. Compliance resources for regulation specifics and other information are provided at the end of this section. The WPS reduces risks of occupational illness and injury from exposure to pesticides in three ways:

- **Inform** workers and handlers about potential exposures to pesticides.
- **Protect** worker, handlers, and others from exposure to pesticide(s); and
- **Mitigate** any pesticide exposures that workers or handlers receive.

INFORM

To ensure that employees are informed about exposure to pesticides, employers must provide certain information to their farmworkers. This includes providing **annual pesticide safety training** to both pesticide handlers and agricultural workers. Grace period for worker training is eliminated. Workers must be trained before they work in an area where a pesticide has been used or a restricted-entry interval has been in effect in the past 30 days.

Training content under the 2015 Revised WPS has expanded and is freely available (*see "Compliance Assistance" at the end of this section for free training resources, including videos*). Worker training topics have been expanded to 23 items, and handler training has been expanded to 36 items. Resources developed for the training of workers and handlers per the requirements of the 1992 Worker Protection Standard (as amended) can no longer be used, effective December 2018. Training of employees using the old materials does NOT have the new content required under the 2015 Revised WPS and would be invalid. Do not use training materials unless they are approved for use with the 2015 Revised Worker Protection Standard.

IMPORTANT

Make sure to replace your old 1992 WPS training videos or booklets with 2015 Revised WPS training materials!

Trainers must be either: certified applicators; designated as a qualified trainer by EPA or their state pesticide regulatory agency; or have completed an EPA-approved "Train the Trainer" course. Approved trainers must use EPA-approved training materials. Employers are required by **federal regulations to retain records of WPS training for two years**. **State WPS training recordkeeping regulations may be more stringent**; the 2020 Revised NJDEP Worker Protection regulations require that worker and handler training records be maintained on file by BOTH ag employers and trainers on file for three years; *see* *http://www.nj.gov/dep/enforcement/pcp/pcp-wps.htm* for forms and retention times and responsible parties.

Other requirements for providing information include **displaying WPS-required pesticide safety information** at a central location (and certain decontamination sites). Safety information may be displayed in any format, including a poster that meets the requirements (*see the PERC WPS safety information poster at: http://pesticideresources.org/wps/cp.html)*.

Agricultural employers must also provide workers and handlers access to both Safety Data Sheet (**SDS**) and **pesticide application information** for applications at the establishment. An SDS is required to have specific information set forth by the OSHA Hazard Communication Standard, but they are not reviewed or approved by government officials like pesticide labels.

EPA Revised WPS requires that the following pesticide application information be displayed be in a centrally located area:
1. Pesticide product name, EPA registration #, and active ingredients(s):
2. Crop or site treated, & location and description of treated area.:
3. Date(s), times application started and ended; and
4. Duration of REI.

EPA requires that employers maintain SDS and pesticide application information **on file for two years** and provide access/copies of records to workers, handlers, treating medical personnel, or a "designated representative". **State regulations for display and retention of pesticide application information may differ; where more stringent, they take legal precedence over federal requirements.**

New Jersey has additional display requirements for agricultural employers including posting a map of the farm for designation of treated areas. NJDEP column headings for posted pesticide application information include: 1) Crop; 2) Pesticide name; 3) Safe Reentry Time; 4) Application Date; 5) Application start and finish times; and 6) Application Location. This application information must be displayed either before workers enter treated fields or prior to workers entering fields at the beginning of the next workday, whichever occurs first. Once posted, this information must remain posted for 30 days following the date for safe reentry.

PROTECT

Employers are required to ensure that employees will be protected from exposure to pesticides. Employers must take measures so that applications do not expose unprotected workers during applications. The Revised WPS has requirements for restricting access around application equipment in a defined area called the "**Application Exclusion Zone**" surrounding applications in progress. Employers must also provide personal protective equipment (PPE) to handlers, *and early entry workers* per the pesticide label (see section D 5.2).

Employers must notify early-entry workers of application specifics, tasks to be performed, conditions of the early-entry exception, and hazard information from the pesticide label.

All WPS-labeled pesticide products are required to have a prescribed REI. These range from 4 to 48 hours or longer. Check your pesticide's label for the reentry time in effect. Some pesticides have one REI, such as 12 hours, for all crops and uses. Other products have different REIs depending on the crop or method of application. When two (or more) pesticides are applied at the same time, and have different REIs, you must follow the longer interval.

To protect farmworkers, employers are required to **post warning signs** (*see left*) around treated areas when the **product applied outdoors has an REI greater than 48 hours**; and when the **product applied indoors has an REI greater than 4 hours**. When a product applied outdoors has an REI of 48 hours or less; or a product applied indoors has an REI of 4 hours or less, the employer may choose either to post the treated area or give oral notification, unless the labeling requires both types of notification.

However, there are situations where the WPS allows workers to enter treated areas before the end of an REI to do non-hand labor tasks and is limited to a maximum of one hour per day. Early entry cannot be made until four full hours have passed since the completion of the application. The Revised WPS requires that "early-entry workers", except for immediate family, be at least 18 years old. Note: New Jersey regulations require that both handlers and early entry workers be at least 18 years old. Early-entry workers must be given label-prescribed PPE for early entry prior to entry if they will contact treated surfaces.

MITIGATE

To mitigate or lessen the impact of pesticide exposures that employees do receive, employers must provide decontamination sites and emergency assistance. Employers must provide supplies for emergency eye flush at all pesticide mixing and loading sites when handlers use products that require eye protection. Decontamination sites must contain a supply of water, soap, and towels for both routine washing and emergency decontamination. Employers must provide emergency assistance which includes transportation to medical care facilities in the event of a pesticide-related injury and providing information about the pesticide(s) involved to the medical staff.

Immediate Family Exemptions: The Revised WPS has expanded the definition of immediate family to include spouse, parents, stepparents, foster parents, father-in-law, mother-in-law, children, stepchildren, foster children, sons-in-law, daughters-in-law, grandparents, grandchildren, brothers, sisters, brothers-in-law, sisters-in-law, aunts, uncles, nieces, nephews, and first cousins.

Owners of agricultural establishments and their immediate family members are exempt from most WPS requirements.

If only immediate family members are employed by the agricultural establishment, owners are exempt from providing themselves and their family members:

- pesticide safety training and information
- providing, cleaning, and maintaining PPE
- information at a central location
- decontamination facilities
- emergency assistance requirements
- notifications of pesticide applications; and
- handler monitoring.

Note: EPA's WPS does NOT exempt owners of agricultural establishments from providing themselves or their family members WPS-required respiratory protections, *i.e*., *the Revised WPS requires that when a WPS-covered pesticide label requires a handler to wear a respirator, the handler's employer must provide them with a medical evaluation, fit test, and respirator training*. (see section D 5.2.2. *Respiratory Protection for Pesticide Handlers* for details).

Federal Compliance Assistance EPA provides resources to agricultural employers and handler employers to assist with compliance with the Revised WPS in conjunction with the **Pesticide Educational Resources Collaborative (PERC).**

Key resources developed and posted at the PERC website (*http//pesticideresources.org)* are:

- "Quick Reference Guide to the Worker Protection Standard (WPS) as Revised in 2015"; see *http://pesticideresources.org/wps/hosted/quickrefguide.pdf*. This one-page double-sided chart outlines requirements with direct hyperlinks to the text of the regulation for each item being cited in the chart.
- "How to Comply With the 2015 Revised Worker Protection Standard For Agricultural Pesticides/Cómo cumplir con la Norma de protección del trabajador revisada de 2015 para pesticidas agrícolas Lo que los propietarios y empleadores deben saber"; see *http://pesticideresources.org/wps/htc/index.html*. The purpose of this online guide is to help users of agricultural pesticides comply with the requirements of the revised federal Worker Protection Standard.
- Frequently Asked Questions (FAQs) on EPA's Revised Worker Protection Standard for Agricultural Pesticides (WPS) 40 CFR Part 170 (PDF). 4/14/2016. EPA. See *https://www.epa.gov/sites/production/ files/2016-04/documents/wps-faq.pdf.* The Revised WPS requires that specific pesticide safety information with newly expanded content be accessible to workers at any time during normal work hours. EPA does not require a specific format. PERC has produced an updated "WPS Safety Poster" for "Central Posting" areas and certain decontamination sites. These may be downloaded in English, Spanish, Russian, Ilocano, Tagalog, Karen, Haitian-Creole, and Vietnamese from *http://pesticideresources.org/wps/cp.html,* or purchased from the National Pesticide Safety Education Center's online store at *https://npsecstore.com/collections/posters*.

PERC will use email distribution lists to keep interested parties informed about new publications. PERC has developed lists for several target groups, including "Agricultural Employers and Handler Employers" to distribute notices relevant to agricultural employers and commercial pesticide handler employers, as defined by the WPS. See *http://pesticideresources.org//lists.html* to enroll in the email list(s) of your choice.

PERC is collaborating with the National Pesticide Safety Education Center (NPSEC) as its distributor for printed resources and posters. You can purchase printed copies of PERC's resources, including laminated WPS Safety Posters, at the NPSEC Store at *https://npsecstore.com/*.

Please refer to your State pesticide regulatory agency for state-specific regulations and policy on the Revised WPS. In cases where state rules are more stringent than federal, the state rules will take primacy. Some state PSEP Programs, such as Rutgers New Jersey PSEP, will be providing WPS outreach to agricultural producers at conferences, meetings, the Rutgers NJAES Plant and Pest Advisory Commercial Agriculture blog, and its Worker Protection webpages at *https://pestmanagement.rutgers.edu/worker-protection/*.

Final Revised New Jersey Pesticide Regulations (NJAC 7:30) were amended April 6, 2020.
*See NJDEP website at https://www.nj.gov/dep/enforcement/pcp/pcp-regs.htm***.**

The revisions to N.J.A.C. 7:30 Subchapter 12 incorporate new federal Worker Protection Standard requirements not previously addressed by New Jersey regulations. Additionally, the revisions addressed conflicts between the State and federal rules. In some instances, New Jersey's Agricultural Worker Protection regulations are more stringent than EPA's 2015 Revised WPS regulations. For specific questions or concerns about NJDEP's implementation of the revised WPS, please contact the NJDEP Worker Protection Unit by email at *pcp@dep.nj.gov*.

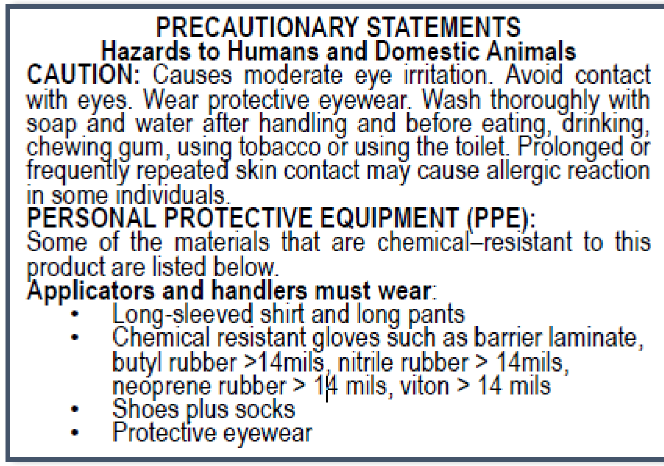
5.2. Personal Protective Equipment (PPE) for Pesticides

Personal Protective Equipment (PPE) refers to apparel and devices worn to protect your body from contact with hazardous materials, including pesticides or pesticide residues. PPE includes such items as coveralls or protective suits, aprons, gloves, footwear, headgear, eyewear, and respirators. *More details follow in subsequent sections about Body Protection for Early Entry Workers and Pesticide Handlers (section D 5.2.1) and Respiratory Protection for Pesticide Handlers (section D 5.2.2).*

Wearing PPE can greatly reduce the potential for dermal, eye, oral, and inhalation exposure; and thereby significantly reduce the chances of pesticide poisoning or injury. Employers have a responsibility to make available any necessary or appropriate safety equipment required by the pesticide label to employees who use, apply, transport, or otherwise handle pesticides. It has to be clean and in good working order. Under EPA's Worker Protection Standard, **employers of handlers of pesticides used in the production of agricultural plants are legally required to provide and train users in the use of label-required PPE.**

Selection of PPE

The **pesticide label** lists the minimum PPE that a person must wear to be **adequately protective while performing any handling or early-entry activities.** Wearing any less than this is **illegal** and **dangerous**. Applicator PPE requirements are listed in the "Precautionary Statements" section of the pesticide label (*see example to right*). Look for additional specific PPE requirements in the "Agricultural Use Requirements" box on the label. This might include, for example, PPE for early-entry workers.



PRECAUTIONARY STATEMENTS
Hazards to Humans and Domestic Animals
CAUTION: Causes moderate eye irritation. Avoid contact with eyes. Wear protective eyewear. Wash thoroughly with soap and water after handling and before eating, drinking, chewing gum, using tobacco or using the toilet. Prolonged or frequently repeated skin contact may cause allergic reaction in some individuals.
PERSONAL PROTECTIVE EQUIPMENT (PPE):
Some of the materials that are chemical–resistant to this product are listed below.
Applicators and handlers must wear:
- Long-sleeved shirt and long pants
- Chemical resistant gloves such as barrier laminate, butyl rubber >14mils, nitrile rubber > 14mils, neoprene rubber > 14 mils, viton > 14 mils
- Shoes plus socks
- Protective eyewear

PPE label requirements vary, depending upon the toxicity, formulation, dilution, and route of exposure of the pesticide product and activity. For example, a single label may have one set of PPE requirements for applicators and a different set for agricultural early-entry workers going into areas during the restricted-entry interval. Even very low hazard pesticides require a long-sleeved shirt, long pants, shoes, and socks.

For pesticides that are hazardous when inhaled, the pesticide label "Precautionary Statements" will include the type of respiratory protection (respirator type including filters or chemical cartridges, if needed) required to minimize your exposure to an acceptable level (See section D.5.2.2 *Respiratory Protection for Pesticide Handlers*).

5.2.1 Body Protection for Early Entry Workers and Pesticide Handlers

Different types of clothing, protective coveralls or suits, aprons, hats, boots, and gloves are not equally protective against all pesticides and under all conditions. To be protective, they must:

- Keep pesticides **away from your body** (head, face, neck, trunk, arms, legs, and feet) throughout the pesticide handling activity.
- Be **resistant** to punctures and tears during normal use.
- Be **comfortable** enough without restricting your movement so you will wear it.

To protect your skin, your normal work clothing must cover most of your body. Depending upon the product's toxicity and use, other PPE (such as coveralls or chemical resistant suits, aprons, hats, boots, and gloves) may also be required. Protective clothing, gloves, and boots must provide a barrier to pesticide for the duration of the task.

In some instances, the pesticide label requires that you wear gloves and other PPE that is "chemical resistant." Generally speaking, this is required when you need protection from highly toxic (label signal word: "Danger") or moderately toxic (signal word "Warning") pesticides. When a pesticide label lists chemical-resistant PPE, it means that you need a barrier to that pesticide for the duration of the task.

PPE materials ("barriers") perform differently when exposed to different pesticides. Some **degrade** the PPE material; it essentially starts to break down. In some instances, degradation of protective fabric is easy for applicators to recognize. PPE may swell, discolor, shrink, soften, become brittle, or change texture. So, be alert for these signs and replace compromised clothing immediately to minimize your exposure to pesticides.

Some PPE materials restrict pesticide entry for a long time, while others allow the pesticide to pass through quickly. Pesticides can move through by the **process of permeation until the chemical actually "breaks through**" to the inside. If a PPE garment material is not very chemical resistant to a particular pesticide, passage to the inside can occur very quickly, in just minutes. Once "breakthrough" takes place your bare skin is directly exposed to the pesticide.

Permeation into a PPE material may begin as soon as it gets on the surface. Once a pesticide is absorbed on the surface of PPE, it continues to move into and through the PPE, molecule by molecule. In these cases, the pesticide is difficult to detect or decontaminate. And pesticide residues that contact PPE are likely to continue to permeate through the material. So, washing gloves and other PPE does not necessarily make them safe for reuse. Things that can affect the extent of permeation are contact time, concentration, temperature, and the physical state of the product itself. **When selected correctly, protective clothing reduces the risk of dermal exposure but does not eliminate it.**

Work Clothing: Your work clothes provide a basic barrier to minimize pesticide contact with your skin. Always wear - at a minimum - a long-sleeved shirt, long pants, closed-toed shoes, and socks whenever you handle pesticides or work around pesticide residues. Select work clothes made of tightly woven fabrics to reduce pesticide penetration. Make sure they are free of holes and tears. Fasten the shirt collar completely to protect the lower part of your neck.

Do not use these work clothes for anything other than handling pesticides. Store and launder fabric work clothing separately from all other clothing after each day's use.

Coveralls: Some pesticide labels require coveralls (a second layer of clothing) over work clothes. A coverall can be made of woven (like cotton or twill) or nonwoven fabrics. It should be sturdy enough for laundering and repeated use. According to regulations, coveralls must be loose-fitting, one- or two-piece garments that cover the entire body except head, hands, and feet.

In rare instances, a pesticide label may require wearing a chemical-resistant coverall or suit. Using one that is disposable reduces decontamination time and lowers the risk of contaminating yourself, your application equipment, and your vehicle. Most importantly, wearing coveralls lessens the chance that you will take pesticides home. Handle disposable coveralls carefully so as to not contaminate other people.

Apron for Mixing: Some pesticide labels require you to wear a chemical-resistant apron when mixing or loading a pesticide, or when cleaning application equipment. Select aprons that cover the front of your body from the middle of the chest to the knees.

Gloves: Pesticide handlers get by far the most exposure from pesticides on their hands and forearms. Research has shown that workers mixing pesticides received 85 percent of the total exposure to the hands and 13 percent to their forearms. The same study showed that wearing chemical-resistant gloves reduced exposure by 99 percent (Source: The Farm Family Exposure Study, John Acquavella). Protective gloves are essential to dermal protection. Wear the type of chemical-resistant glove specified by the product labeling. For gloves, labels will often specify materials that are highly chemical resistant for that product. Older pesticide labels may add another statement that you can consult an EPA chemical resistance category chart for more options. In these cases, the glove type that provides highest protection is listed. Use only those listed.

There are many types of gloves on the market including nitrile, butyl, natural rubber, polyethylene, neoprene, and barrier laminates. Each has different chemical resistance properties. Each type of glove has to be considered on a case-by-case basis. Read the label carefully to make sure you have the correct protective glove material. Explain to your supplier which glove types you need.

When the pesticide label specifies waterproof or chemical-resistant gloves, do not use those constructed with any kind of absorbent material, lining, or flocking. This includes leather or cloth. These all absorb pesticide and trap it closely against your bare skin, greatly increasing skin absorption.

Some pesticide labels specify both the glove material and its thickness. As a general rule, the thicker the glove (of the same material under identical conditions), the longer the breakthrough time. A pesticide label's specification of glove type is generally based upon a thickness of 14 mils, except for polyethylene and barrier laminate gloves. Use the 14 mils thickness as a rule of thumb when selecting glove materials that appear on the pesticide label.

Glove durability is another important consideration. Select a glove that is protective, does not tear or puncture easily, and protects you for the duration of the task. A glove that is rated highly chemical-resistant, but tears or punctures easily, will likely not protect you for the duration of the task. Discard the gloves if there is any sign of wear or if the gloves leak.

Also choose a glove size that fits you comfortably. Gloves that fit well give you increased dexterity for equipment maintenance or calibration. Gloves that are too tight stretch the material and pesticide can directly penetrate through enlarged pore spaces. And too tight gloves restrict movement of your fingers and can cause hand fatigue. Gloves that are too large can get caught in equipment. If a glove is too loose, pesticides can run down the inside and be directly absorbed by your skin.

Select gloves designed to give you extra protection when needed for the job, such as elbow length gloves when mixing and loading. Do not use a glove beyond the breakthrough time provided by the PPE manufacturer. Lastly, gloves should be disposed of frequently because absorbed pesticides will continue to permeate through the material.

When using reusable gloves rinse them at each break and wash them thoroughly at the end of the workday. Make sure your gloves are in top condition. Replace your gloves immediately if they get cut, torn, or damaged. Throw out any gloves showing wear. Check glove integrity before each use. Rinse and slash all gloves before discarding them.

Footwear: If the product labeling specifies "chemical-resistant footwear", EPA regulations prescribe use of any chemical- resistant shoes; boots; or shoe coverings worn over shoes or boots. Do not wear leather boots or canvas shoes in these cases. Leather and canvas absorb pesticides and cannot be decontaminated.

Regulations allow you to substitute leather for chemical-resistant boots only when the chemical-resistant footwear required by the pesticide label is not durable enough for use in rough terrain. Consult manufacturers or suppliers of footwear for guidance in selecting chemical resistant footwear that has the durability you need. Do not use these boots for other purposes.

Headgear: When a pesticide product label specifies 'chemical-resistant headgear', you may use either a chemical-resistant hat with a wide brim that goes all around your head, or a chemical-resistant hood. Chemical-resistant hoods attached to jackets or coveralls protect your neck and back from pesticides sprays that would otherwise run down your back. When handling pesticides, do not use headgear made of any absorbent material such as cotton, leather, or straw. These absorb pesticides and cannot be decontaminated.

Eye Protection: Eyes readily absorb pesticides. When a label simply says to "wear protective eyewear", you may use any of the following: goggles; face shield; safety glasses with shields at front, brow, and temple; or a full-face respirator. Use common sense and select eyewear that protects you for the task at hand. Eyewear made of impact-resistant material, such as polycarbonate, can protect you from flying objects, such as granular pesticides. However, safety glasses will not protect your eyes from pesticide splashes.

Labels may be more specific and require that a particular type of eyewear be worn. For example, goggles may be specified when there is a concern about protecting your eyes from liquids or particulates for that application or use. Goggles that have covered air baffles reduce lens fogging while keeping liquids out.

Under the agricultural Worker Protection Standard, if the label requires eye protection, then the handler must have immediate access to eyewash of 1 pint of water at all times.

Maintenance and Disposal of PPE

All PPE should either be disposable, OR easy to clean and sturdy enough for repeated use. Gloves, non-woven (including coated non-woven) coveralls and hoods, such as Tyvek®, usually are designed to be disposed of after use. Most are intended to be worn for only one workday. For example, you might use disposable gloves, shoe covers, and an apron while pouring pesticide into a hopper or tank, cleaning or adjusting a nozzle, or making minor equipment adjustments. If using "reusable" PPE, pay close attention and be ready to change and dispose of them whenever the inside surface is contaminated. And be sure to clean all reusable PPE items between uses, even if worn for only a brief period of exposure.

Pesticide residues that remain on PPE are likely to continue to permeate through the material once contaminated. Even if you do not see any signs of wear, replace reusable chemical-resistant items regularly - the ability of a chemical-resistant material to resist the pesticide decreases each time an item is worn.

In addition, PPE worn several times between launderings may build up pesticide residues. The residues can reach a level that can harm you, even if you are handling pesticides that are not highly toxic. So, disposable PPE is a preferred option to reusable PPE. They are low-cost, and their use minimizes clean-up and spread of contamination. **Rinse and slash used/unusable PPE prior to disposal.**

5.2.2 Respiratory Protection for Pesticide Handlers

Occupational users of pesticides can be exposed to toxic gases and vapors, particulates, or both. Various pesticide formulations, environments, and application methods require different types of respiratory protection devices (respirators).

EPA requires that pesticide manufacturers determine and specify respiratory protection according to the anticipated hazards and risk of inhalation. Manufacturers provide requirements for respiratory protection on the pesticide label that are product- and task-specific. **It would potentially be life-threatening to assume that all products with the same active ingredient have the same respiratory protection requirements. Read and follow each individual product's label for respirator requirements since pesticides may have different formulations and use directions.**

The pesticide label states whether you must use a respirator and, if so, which type. Atmosphere-supplying respirators provide clean, breathable air from an uncontaminated source, while air-purifying respirators remove contaminants from the air that you breathe. Both may be configured with either tight- or loose-fitting face pieces. When a tight-fitting respirator is used, fit testing is required to select the correct size, model, and manufacturer. Occupational users of pesticides must understand the capabilities and limitations of each respirator they will use.

The pesticide label specifies use of **"NIOSH-approved" respirators**. The NIOSH-approval certificate that accompanies the respirator indicates the approved configuration, protection, and cautions and limitations of the respirator. For example, air purifying respirators do not supply oxygen, and must not be used in an environment containing less than 19.5% oxygen.

When air-purifying respirators are required, the label will specify the type of particulate filter and/or chemical cartridge or canister. For example, non-powered particulate filters differ according to their oil resistance. When a pesticide contains oil or an oil-like substance, an N-series (not oil proof) cannot be used; and the pesticide label will specify R-series (oil-resistant) or P-series (oil-proof) filters. Powered air purifying respirators only have a single type of particulate filter, HE. EPA regulations [40 CFR 170.507(d)] require replacement of particulate filters when damaged, torn, soiled, or it becomes uncomfortable for the wearer to breathe. Additionally, particulate filters should be replaced according to respirator manufacturer recommendations or pesticide labeling (whichever is more frequent).

Always use the type of purifying element required by the pesticide label. The most typical chemical cartridge or canister specified by the label for pesticide use is an organic vapor (OV) cartridge or canister. They contain activated carbon that absorbs organic vapor gas or vapor molecules from the air being drawn in through the container. A chemical cartridge/canister is effective until the sorbent bed is filled and the gas or vapor "breaks through." Breakthrough is the penetration of a gas or vapor through a chemical air-purifying element to inside the wearer's mask. Any taste, smell, or irritation is a warning that breakthrough of the pesticide through the sorbent may have occurred, and that you should exit the area. Respirator manufacturers recommend that OV cartridges/canisters should not be used beyond one day. Change cartridges/canisters earlier if contaminant odor, taste, or irritation is detected inside the face piece.

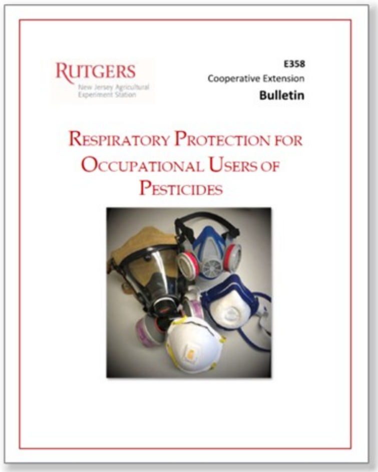
The Revised WPS requires that when a WPS-covered pesticide label requires a handler to wear a respirator, the handler's employer must provide them with a medical evaluation, fit test, and respirator training.

Prior to use of respirators, users must be **medically evaluated** to determine that they can safely use the respirator under the conditions of use. When use of a respirator is required by the pesticide label, both commercial applicator and agricultural employers must provide pesticide handlers a medical evaluation per OSHA 29 CFR 1910.134(e) to determine their ability to safely use the respirator specified.

Annual respirator training is required. Employers of occupational users of pesticides must provide effective respirator training per OSHA 29 CFR 1910.134(k) to those employees required to wear respiratory protection by the product label. Respirator users must know how to properly inspect, recognize danger signals during use and what to do; don and doff (put on and remove). After use, proper care, maintenance, and storage of their respirator can prolong the life of the respirator.

D. Pesticide Safety

Contact your Cooperative Extension Pesticide Safety Education Program for assistance in selecting the correct respirator and any component parts from the pesticide label. **Call your state's Extension office to refer you to the Pesticide Safety Education Program Coordinator or Program if you have any questions about pesticide safety equipment.**



Consult **Rutgers Bulletin E0358 "Respiratory Protection for Occupational Users of Pesticides"** for detailed guidance on the different types of respirators; their limitations, use, care, maintenance, and storage; as well as requirements for the medical evaluation, fit testing, and training of respirator users. It outlines regulatory requirements of EPA and OSHA that apply to commercial users and agricultural operations that use pesticides.

The publication may be downloaded at: *https://njaes.rutgers.edu/pubs/publication.php?pid=E358*. Hardcopies are available at the NPSEC online store at: *https://npsecstore.com/collections/respiratory-guides*.

6. Protection of the Environment

Generally speaking, to protect the environment from pesticide exposure:

- **Avoid off-target drift** by proper selection of application methods, droplet size, nozzle types, and tank mix partners.
- **Avoid using excess quantities of pesticides**. Calibrate your sprayer to make sure the output is within the label rate.
- **Always read the pesticide label** prior to selection of a pesticide and check for environmental concerns and restrictions. The "Environmental Hazard" section of the label addresses concerns for surface water and groundwater contamination, non-targets, and endangered species protection requirements.

6.1 Minimize Off-Target Drift

Agricultural chemicals applied through spraying have the potential to drift away from the intended target areas. **Drift is defined as "the movement of spray particles and vapors off-target causing less effective control and possible entry to susceptible wildlife vegetation and people."** Spray drift has the potential to cause injury or damage to plants, animals, environment, or property, and can affect human health.

- **Particle drift** is the movement of spray particles during or soon after the spray application. 'Particle' means the active ingredient of a pesticide as a liquid (spray droplet), granule, pellet, dust, fumigant, etc. The four factors which impact particle drift are: 1) wind speed; 2) boom height; 3) distance from susceptible vegetation; and 4) spray particle size.
- **Vapor drift** is associated with the volatilization of a pesticide spray into a gas or fume. Off-target drift increases with pesticides with higher vapor pressures, and with higher ambient air temperatures. For pesticides that are quite volatile and pose harm when the vapor moves off target, the pesticide label may state a cut-off temperature for application, or the label may require soil incorporation after application.

Surveys indicate that approximately 65% of the drift complaints involved application procedures in violation of the label (Sumner 1997). ALWAYS READ AND FOLLOW THE PESTICIDE LABEL.

Related to spray particle size, the larger the droplet size the greater the deposition rate or the less drift. **Pesticide labels will have mandatory drift requirements, as well as manufacturer's advisory statements for best management practices to control drift**. This may include application methods, droplet size, nozzle types, and tank mix partners.

Always assess weather conditions before and DURING application. Use a wind gauge and **avoid spraying in winds above 10 mph**. Drift potential is lowest at wind speeds between 3 and 10 mph blowing in a direction away from sensitive non-targets. **"Dead calm" (0 to 3 mph winds) are NEVER recommended** because temperature inversions can cause long distance drift. Maintain boom heights as low as possible within manufacturer guidelines; the shorter the distance a droplet has to travel, the less chance for drift.

Generally speaking, to minimize off-target drift:

- Select low or nonvolatile pesticides.
- Choose days with better weather. Avoid spraying when windy, high temperature without low humidity, or inversion conditions. Spray when soil is coolest and relative humidity is highest.
- Use lowest spray pressure and largest droplets that provide sufficient coverage and control.
- Do not use nozzles or nozzle configurations that produce small droplets; consider use of "low drift" nozzles.
- Adjust boom height as low as is recommended by manufacturer or is practical.
- Adjust equipment to keep spray on target.
- Use lower travel speeds.
- Use drift control additives when permitted by the pesticide label.

Sample Drift Mitigation Label Language:

Controlling Droplet Size. *The most effective way to reduce drift potential is to apply the largest droplets that provide sufficient coverage and control.*
Volume. *Use high flow rate nozzles to apply the highest practical spray volume. Nozzles with higher rated flows produce larger droplets.*
Pressure. *DO NOT exceed the nozzle manufacturer's recommended pressures. For many nozzle types, lower pressure produces larger droplets. When higher flow rates are needed, use higher flow rate nozzles instead of increasing pressure.*

6.2 Protect Surface and Ground Water

Pesticides can be transported from the atmosphere to streams and ground water with rainfall or by the deposition of particles from off-target drift. Streams are particularly vulnerable to pesticide contamination because surface water runoff from agricultural and urban areas flows directly into streams as both dissolved and particle-associated (sediment) pesticides. The timing of pesticide application relative to precipitation occurrence and intensity controls, for the most part, transport to streams and surface water, and ultimately groundwater.

Pesticides are transported to ground water mostly by recharge, resulting from rainfall or irrigation within agricultural and urban areas where they are used. Other locally important sources include transport down leaky well casings and contaminated streams that lose water to ground water. Alternately, ground water can be a major portion of streamflow during low-flow periods and if contaminated, could be a source of pesticides to some streams.

Factors That Affect Movement of Water and Contaminants

The depth of aquifers, in conjunction with soil types, influences how much surface water reaches the aquifer. Their depth also affects how quickly water and contaminants reach an aquifer. Thus, shallow water tables tend to be more vulnerable to contamination than deeper ones. This tendency, however, depends on the soil type. Soils with high clay or organic matter content may hold water longer and retard its movement to the aquifer. Conversely, sandy soils allow water to move downward at a fast rate. High levels of clay and/or organic content in soils also provide a large surface area for binding contaminants that can slow their movement into groundwater. Soil texture also influences downward water movement. Finer textured soils have fewer spaces between particles than coarser ones, thus decreasing movement of water and contaminants.

Pesticide Characteristics

The characteristics of an individual pesticide affect whether it remains adsorbed to surface soil or sediment; is dissolved and transported in surface runoff; or is leached to groundwater. The most important characteristics are solubility in water, adsorption to soils, and persistence in the environment.

Pesticides that are highly soluble in water have a higher potential for contaminating groundwater than those which are less soluble. The water solubility of a chemical indicates how much chemical will dissolve in water and is measured in parts per million (ppm). Those chemicals with a water solubility greater than 30 ppm may create problems. A chemical's ability to adhere to soil particles plays an important role. Chemicals with a high affinity for soil adsorption are less likely to reach the aquifer. Adsorption is also affected by the amount of organic matter in the soil. Soils with high organic matter content are less vulnerable than those with low organic matter content.

Finally, how persistent a chemical is in the environment may affect its ability to reach groundwater. Persistence is measured by the time it takes *half* of a given pesticide to degrade (*half-life*). Half-life is a measure of how quickly a chemical breaks down in soil (soil half-life) or water (hydrolysis half-life). US Geological Survey National Water-Quality assessment (NAWQA) data from agricultural areas across the Nation indicate that pesticides with greater persistence in soil are more likely to be detected in shallow ground water than compounds that are less persistent (1999). The longer a chemical remains in water or soil without breaking down, the more likely it is to leach through the soil. Pesticides are less likely to leach when their hydrolysis half-life is less than six months, and their soil half-life is less than three weeks.

Transformations or degradation of pesticides proceed at widely varying rates, depending on the structure of the compound and environmental conditions. Half-lives vary widely from hours to decades. Generally, persistent pesticides or degradates (what they degrade into) may accumulate in soils, sediment, or biota; or be transported for long distances. In some cases, such as several of the historically used organochlorine pesticides (*e.g*., DDT), both long-distance transport and accumulation have been observed.

How to Prevent Contamination of Your Ground Water

Apply pesticides only when needed:
The use of extraneous pesticides can increase the threat of contamination. Check your irrigation practices as well. Do not irrigate immediately after a pesticide application, unless required by a pesticide's label. The increased water content in the soil might speed up the movement of a pesticide into ground water.

Examine the chemical properties of the pesticides that you use:
If you are using materials which persist for long periods of time, are very water soluble, or are not tightly held by the soil, then you may be contaminating your groundwater. You may wish to select another material that has a shorter persistence, lower water solubility or higher potential for soil adsorption.

To compare product leachability, refer to the OSU Extension Pesticide Properties Database at: *http://npic.orst.edu/ingred/ppdmove.htm* (date accessed 11/30/2023). This database provides a qualitative Pesticide Movement Rating (*i.e*., low, moderate, high) for each pesticide listed, as well as individual values or ranges for soil half-life (days), water solubility (mg/l), and the Sorption Coefficient (soil Koc).

Determine your local soil and geologic circumstances:
If you are in an area with a shallow water table or your soil is low in organic matter or sandy in nature, you have a greater risk of contaminating your groundwater. In these cases, choose a pesticide that has a low water solubility and is not persistent (has a short half-life).

Evaluate your management practices:
They may be the most important factor in determining your risk of contaminating your groundwater. If you use the same materials year after year, or many times a season, you can increase the potential for contamination due to the amount of pesticide in your soil.

The timing of pesticide applications has an effect on groundwater contamination:
If you make applications during periods of high rainfall or heavy irrigation, it is more likely that contamination may occur. Also, the water table in the spring may be higher than at other times. Early season applications, therefore, may pose a greater chance for groundwater contamination. Finally, the method of application may have an effect on ground water contamination. Direct injection, incorporation, and chemigation all increase the chance of contamination. If you use these techniques, be sure to follow the procedures listed on the material's label.

The location of your wells can be important:
The ground surrounding the wellhead should be sloping away from the well to divert surface runoff. If your sprayer loading area or pesticide storage building is too close to your well, the risk of contamination may be greater. **Wells used for drinking water or other purposes should be at least 50 feet away** from pesticide storage buildings and

loading areas. In the event of an accident, this distance should prevent contamination. This minimum distance should also be followed for field irrigation wells. If they are too close to application areas, contamination might occur.

Check the condition of all wells in the vicinity of sprayer loading areas, pesticide storage areas, or field applications:
The National Ground Water Association recommends routine annual maintenance checks to ensure the proper operation of the well and prolong its years of service, as well as monitor the water quality. Periodically check the well cover or well cap on top of the casing (well) to ensure it is in good repair and securely attached. Its seal should keep out insects and rodents. Cracks in a well casing provide a direct point of entry for pesticide-contaminated water in the soil around the well. Always replace cracked casings before the growing season.

Incorporate an anti-backflow device in any system used for chemigation or to fill your sprayer with water:
In the event of a pump shutoff or other failure, if any backflow into the water system occurs, these devices will prevent pesticides from entering your well. **New Jersey pesticide regulations at 7:30-10.2** require that "whenever any water is being added to any pesticide handling, storage, or application equipment via a hose, pump, or other equipment, the hose, pump, or other equipment is fitted with an effective valve or device to prevent backflow of pesticides or liquids containing pesticides into water supply systems, streams, lakes, other sources of water or other areas". The NJDEP has provided Rutgers with a policy interpretation that an "air gap" between the water source and pesticide which is sufficient to prevent backflow is acceptable to the Department.

The care and maintenance of your equipment is also an important consideration:
If your equipment does not function properly, you may be applying more than is needed and increasing the chance of groundwater contamination.

- Prior to the season, inspect all of the working parts of your sprayer or chemigation system. Check the pump to see if it is working properly.
- For both sprayers and chemigation systems, check the water lines for clogs and leaks. For sprayers, check the nozzles for wear and clogs. Clogged, leaking, or worn lines and nozzles can cause pesticides to be delivered excessively or in unwanted areas.
- Be sure to calibrate your equipment. Uncalibrated equipment can cause over delivery as well. Calibrate your equipment at the beginning of the season, periodically during the remainder of the season, and any time you make changes or adjustment to the equipment.

6.3. Protect Non-Target Organisms

Based upon the results of required ecological risk assessment or incident reports, the Environmental Hazards statements on the pesticide label for foliar application to agricultural crops must include use precautions and/or restrictions for **all identified non-target** birds, mammals, fish, aquatic invertebrates, and bees.

6.3.1 Protection of Pollinators

Pollinators are vulnerable to many chemicals used to control insects, pathogens, and weeds. Insecticides applied at bloom can be toxic to pollinators, including honeybees and wild bees. This would include **foliar applications to alfalfa, peas, or beans if the crop or weeds in treatment area are in bloom; or to corn during pollen shed.** In addition, **systemic seed treatments may result in residues in nectar and pollen.** However, residues tend to be much lower from seed treatments compared to foliar treatments.

ALWAYS READ AND FOLLOW THE PESTICIDE LABEL

If a pesticide is used outdoors as a foliar application, and is toxic to pollinating insects, a "bee hazard" warning has generally been required to be included in the **Environmental Hazards** of the pesticide label.
Generally speaking, pesticide applicators must take measures that will minimize the risk of pollinators contacting a

"bee-toxic" pesticide. **"Bee-toxic" pesticides** are those pesticides that have information on the label indicating that the pesticide is highly or moderately toxic to bees, and precautionary statements for the protection of pollinators on the product labeling (*see box to the right*).

Example Label Precautionary Statement for Bee Toxic Pesticides

"…This product is highly toxic to bees and other pollinating insects exposed to direct treatment or residues on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds if bees or other pollinating insects are visiting the treatment area…."

Whenever insecticides are applied, select those that give effective control but pose the least danger to bees (see **Chapter F Insect Control tables** in this guide). Regardless, **do not apply any insecticides during bloom, *unless they are completely non-toxic to bees*, and avoid applications of all pesticides during active foraging by pollinators in the crop, or adjacent flowering crops and weeds.** Do not apply or allow drift of bee-toxic pesticides until all flowering of crop, cover crops, or weeds is complete/petal fall, unless you take necessary precautions to minimize exposure to foraging bees or and their hives. Precautions may include making applications after sunset when the temperature has dropped below 55˚F and notifying beekeepers in advance.

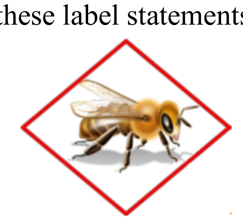
Notification of beekeepers allows them to move, cover, or otherwise be protected prior to spraying. This protects a valuable agricultural resource and avoids conflicts and possible lawsuits. Some states, such as New Jersey, have mandatory beekeeper notification regulations. Many Mid-Atlantic states have State Pollinator Protection Plans (MP3) that may include recommendations for written agreements between beekeepers and agricultural operations. For more details on this and how applicators can register for the FieldWatch® online mapping of managed bees, see next section ***State-Specific Pollinator Protection*. See also Section A 12 *Pollination* in this guide for information on pollinators.**

Bees will forage on all flowers found within the farm. Do not apply bee-toxic pesticides when bees are foraging in cover crops or weeds. Managing row middles by removing wild flowering plants (such as dandelion and clover) will reduce bee mortality. This can be helped by maintaining pure turf aisles and using a mix of 2,4-D and clopyralid (Stinger, Spur, and other generics).

Many fungicides are known to interact antagonistically with insecticides, which can lead to higher toxicity to bees. Recent data show that combinations of DMI FRAC group 3 (DMI fungicides including: Indar, Rally, Orbit, Bumper, Quash, Procure and Vintage) and neonicotinoid insecticides (IRAC code 4 including: Assail, Actara, Admire Pro, Belay, Calypso, Scorpion, Venom, including combinations and generics) cause increased bee mortality. Furthermore, DMI fungicide applications are not recommended during bloom for resistance management. Other recent research continues to show that certain combinations of fungicides mixed with insecticides increases the toxicity of those insecticides to both adult and larval forms of honeybees and some wild bees. In some cases, the fungicides themselves or in combination with other fungicides have shown negative impacts on pollinators. **Avoid fungicide application on flowering crops when bees are present.**

Product-Specific Pollinator Protection – Neonicotinoid Pesticides

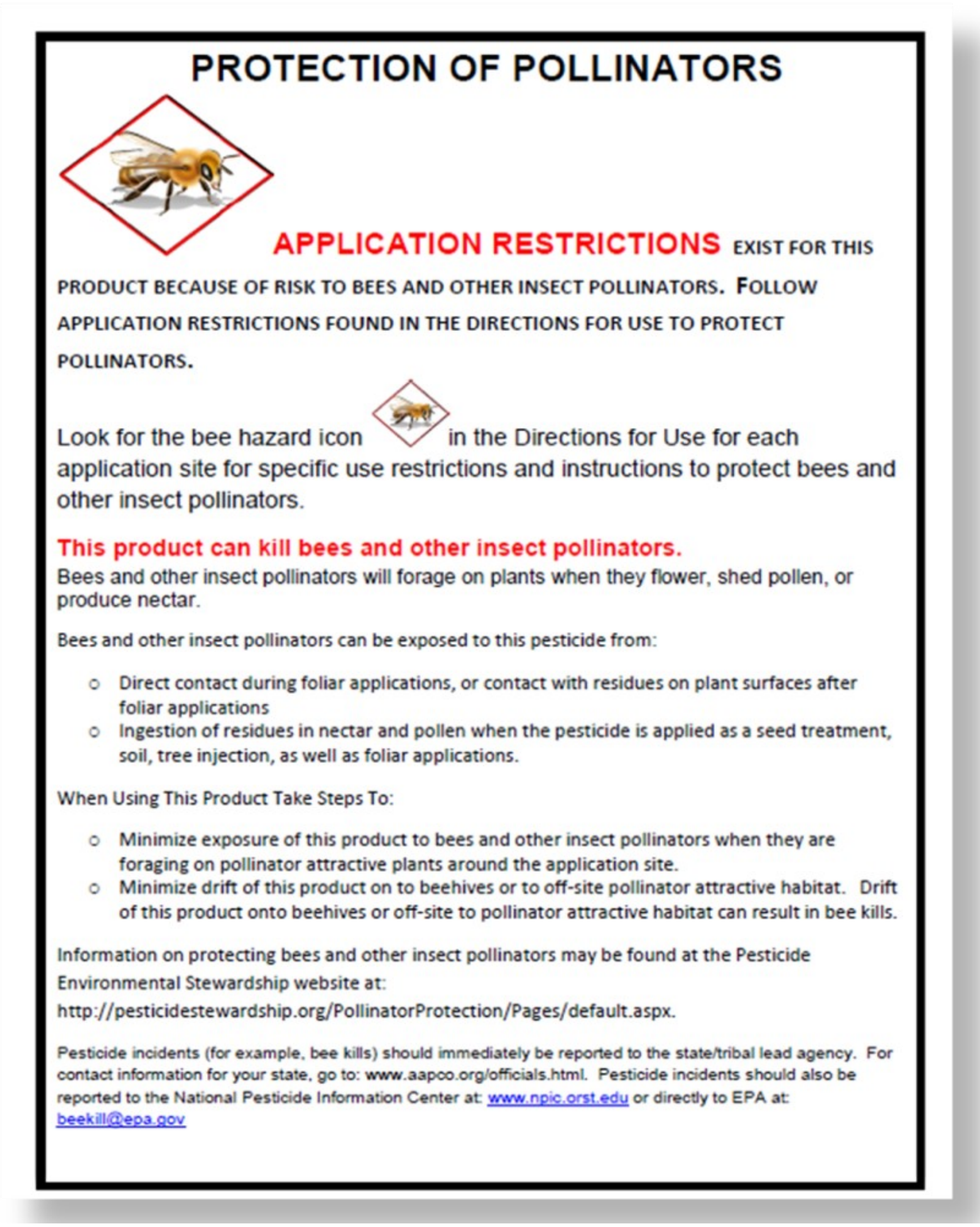
In some cases, EPA may require **product-specific labeling** to protect non-targets, such as pollinators. Due to concerns regarding pollinator health, in 2014, EPA required that all manufacturers of pesticide products containing active ingredients from the **neonicotinoid group of insecticides** (*i.e.*, clothianidin, dinotefuran, imidacloprid and thiamethoxam) relabel these products with an ***advisory*** **"pollinator protection box"** (Figure 1.1) and ***mandatory*** **"Directions for Use"** (Figure 1.2). Both of these label statements are marked with the following "bee icon":



Neonicotinoid Pesticide Labels:
EPA Pollinator Protection

__Mandatory Product-Specific__ pollinator protection language is __required__ in **the "Directions for Use"** of the product label **for __all__ __neonicotinoid__ products**. Each of these statements are also flagged with the "bee icon". See Figure 1.2 for an excerpt of the current (February 2023) pollinator protection label language contained in the "Directions for Use" for these neonicotinoids. Notice specific use precautions for 1) contracted pollination services; 2) food crops and commercially grown ornamentals attractive to pollinators, without contracted pollination services; and 3) non-agricultural products. All of this information could be applied to the use of any "bee-toxic" pesticide.

Figure 1.1 EPA Pesticide Label Pollinator Protection Box for Neonicotinoid Pesticides
Sample pollinator protection box with "bee icons" and ***__advisory__*** language to alert the applicator that there are additional application restrictions for pollinator protection to follow on the label.



PROTECTION OF POLLINATORS

APPLICATION RESTRICTIONS EXIST FOR THIS PRODUCT BECAUSE OF RISK TO BEES AND OTHER INSECT POLLINATORS. FOLLOW APPLICATION RESTRICTIONS FOUND IN THE DIRECTIONS FOR USE TO PROTECT POLLINATORS.

Look for the bee hazard icon in the Directions for Use for each application site for specific use restrictions and instructions to protect bees and other insect pollinators.

This product can kill bees and other insect pollinators.
Bees and other insect pollinators will forage on plants when they flower, shed pollen, or produce nectar.

Bees and other insect pollinators can be exposed to this pesticide from:

- Direct contact during foliar applications, or contact with residues on plant surfaces after foliar applications
- Ingestion of residues in nectar and pollen when the pesticide is applied as a seed treatment, soil, tree injection, as well as foliar applications.

When Using This Product Take Steps To:

- Minimize exposure of this product to bees and other insect pollinators when they are foraging on pollinator attractive plants around the application site.
- Minimize drift of this product on to beehives or to off-site pollinator attractive habitat. Drift of this product onto beehives or off-site to pollinator attractive habitat can result in bee kills.

Information on protecting bees and other insect pollinators may be found at the Pesticide Environmental Stewardship website at: http://pesticidestewardship.org/PollinatorProtection/Pages/default.aspx.

Pesticide incidents (for example, bee kills) should immediately be reported to the state/tribal lead agency. For contact information for your state, go to: www.aapco.org/officials.html. Pesticide incidents should also be reported to the National Pesticide Information Center at: www.npic.orst.edu or directly to EPA at: beekill@epa.gov

Figure 1.2 EPA Pesticide Label Excerpt of "Directions for Use" for Neonicotinoid Pesticides
An example of ***mandatory*** label language now found on the neonicotinoids.

DIRECTIONS FOR USE

1. FOR CROPS UNDER CONTRACTED POLLINATION SERVICES

Do not apply this product while bees are foraging. Do not apply this product until flowering is complete and all petals have fallen unless the following condition has been met.

If an application must be made when managed bees are at the treatment site, the beekeeper providing the pollination services must be notified no less than 48-hours prior to the time of the planned application so that the bees can be removed, covered or otherwise protected prior to spraying.

2. FOR FOOD CROPS AND COMMERCIALLY GROWN ORNAMENTALS NOT UNDER CONTRACT FOR POLLINATION SERVICES BUT ARE ATTRACTIVE TO POLLINATORS

Do not apply this product while bees are foraging. Do not apply this product until flowering is complete and all petals have fallen unless one of the following conditions is met:

- **The application is made to the target site after sunset**
- **The application is made to the target site when temperatures are below 55"F**
- The application is made in accordance with a government-initiated public health response
- **The application is made in accordance with an active state-administered apiary registry program where beekeepers are notified no less than 48-hours prior to the time of the planned application so that the bees can be removed, covered or otherwise protected prior to spraying**
- **The application is made due to an imminent threat of significant crop loss, and a documented determination consistent with an IPM plan or predetermined economic threshold is met. Every effort should be made to notify beekeepers no less than 48-hours prior to the time of the planned application so that the bees can be removed, covered or otherwise protected prior to spraying.**

3. FOR NON-AGRICULTURAL PRODUCTS

Do not apply [insert name of product] while bees are foraging. Do not apply [insert name of product] to plants that are flowering. Only apply after all flower petals have fallen off.

State-Specific Pollinator Protection

Some states have completed or are in the process of implementing State Managed Pollinator Protection Programs (MP3s). MP3s are typically voluntary. Consult your State Apiarist (see section A12. Pollination**, Table A-6. State Apiarist Contact Information**) or the Department of Agriculture for your State requirements.

Delaware published its **State Pollinator Protection Plan** in September 2016 at *https://agriculture.delaware.gov/wp-content/uploads/sites/108/2017/12/DelawarePollinatorPlan2016.pdf*. Senate Bill 264 was proposed in 2022 to amend the Delaware Pesticide Code to classify neonicotinoid pesticides for outdoor use as restricted use and ban the retail sale of neonicotinoid pesticides to the public for outdoor applications; the Bill was tabled in Committee.

The **Maryland** Department of Agriculture has released its **Maryland Pollinator Protection Plan** in 2017; see *http://mda.maryland.gov/plants-pests/Pages/pollinator_protection_plan.aspx*. Maryland's **Pollinator Protection Act of 2016** limits the use and sale of neonicotinoid pesticides within the state. Neonicotinoid pesticides were defined as pesticides with active ingredients including: Imidacloprid, Nithiazine, Acetamiprid, Clothianidin, Dinotefuran, Thiacloprid, and Thiamethoxam. This law went into effect on January 1, 2018; see. *https://mda.maryland.gov/plants-pests/Documents/PollinatorProtectionActFactSheet.pdf*. The Pollinator Protection Act **prohibits the use of neonicotinoid pesticides outdoors by home by gardeners**. **Only farmers and certified pesticide applicators (or people working under their supervision) can apply neonicotinoid pesticides outdoors.** So, while neonicotinoid products may appear on store shelves in Maryland, they cannot be applied outdoors by gardeners.

New Jersey does not have a Pollinator Protection Plan. However, the **New Jersey Department of Environmental Protection (NJDEP)** does have **Beekeeper Notification Regulations** at NJAC 7:30-9.11. Beekeepers that have hives overwintering in New Jersey are allowed to voluntarily register their bee yards with the NJDEP. A list of registered beekeepers is provided on the NJDEP's Beekeeper Notification webpage at *https://www.nj.gov/dep/enforcement/pcp/bpo-bee.htm.* Pesticide applicators are required to notify each of those beekeepers (that have registered) within a 3-mile radius of a planned application at least 24 hours prior to the application of any pesticide labeled as toxic to bees. Once notified, it is the responsibility of the beekeeper to take action to protect their hives.

Beekeeper notification is mandatory for growers using "bee-toxic" pesticides within three miles of the target site at least 24 hours prior to the date of application on crops listed under NJAC 7:30-9.11(i), either within the dates stated below or when in the flowering stage (*i.e.*, both). "Flowering stage" specifically means when plants bear any portion of a blossom as part of the blooming process associated with pollen and nectar production. New Jersey agricultural applications are exempt from the notification requirements, unless specifically listed as follows:

- Apples, pears, strawberries, peaches, and blueberries: April 15th to May 15th
- Holly: June 1st to June 30th
- Cranberries: June 15th to August 15th
- Vine Crops (Cucurbits): June 1st to August 31st
- Sweet corn (during flowering stage)
- Fields where flowering weeds are present

Important

EPA neonicotinoid pesticide "Directions for Use" have a more stringent (protective) beekeeper notification requirement of 48 hours versus the New Jersey 24-hour notification; the **more stringent 48-hour notice must be given to beekeepers per the pesticide labeling for the use of neonicotinoids in New Jersey.**

Notification must include intended date and approximate time of application; location of the application, brand name and active ingredients of the pesticide to be applied; and the name and license number of the pesticide applicator. Notification to the apiarist can be made in person, by phone, by fax, by email, or regular or certified mail (as long as it is received 24 hours before the application). The detailed regulations are located at: *https://www.nj.gov/dep/enforcement/pcp/regulations/Subchapter%209%20Changes%20in%20Red%202020.pdf*.

New Jersey P.L. 2021, c.386 amends the New Jersey Pesticide Control Act to make the neonicotinoid class of pesticides "restricted use" (meaning any person using these pesticides must have a valid New Jersey pesticide applicator license). **This amendment further prohibits any use of neonicotinoids except agricultural use**. The intent of this law is to reduce pollinator exposure to these pesticides, and the practical affect is to prohibit use of these pesticides in home gardens and landscapes, golf courses and other non-agricultural settings. **The law provides a specific deadline that beginning October 31, 2023, no sale of neonicotinoid pesticide can occur unless to a licensed applicator and for use only on agricultural plants.** Specific narrow exemptions are given for uses such as domestic pet and indoor applications, structural pest control, invasive pest emergencies, and use within a structural "band treatment" around a structure that does not involve application to plants.

The **Pennsylvania** Pollinator Protection Plan (P4) is a living document that information on the status of pollinators in Pennsylvania, and also provides recommendations for best practices and resources to support and expand pollinator populations; see *https://ento.psu.edu/pollinators/pollin-spotlight-items/the-pennsylvania-pollinator-protection-plan-p4*.

D. Pesticide Safety

The **Virginia** Department of Agriculture and Consumer Services has a State Pollinator Protection Plan at *https://www.vdacs.virginia.gov/plant-industry-services-pollinator-protection-plan.shtml* which includes best management practices for beekeepers, agricultural producers, agricultural commercial applicators, structural pest management and the horticultural industry. This plan to mitigate the risk of pesticides to managed pollinators was published in May 2017.

West Virginia Pollinator Protection Plan was published March 2016; see *https://agriculture.wv.gov/wp-content/uploads/2020/07/WV-Managed-Pollinator-MP3-Final-Draft.pdf*.

FieldWatch®
Communication. Cooperation. Collaboration.

Mid-Atlantic State Departments of Agriculture (Delaware, Maryland, New Jersey, Pennsylvania, Virginia, and West Virginia) have partnered with FieldWatch® to help protect honeybees and other specialty crops. *https://fieldwatch.com/*.

FieldWatch® is a non-profit company whose mission is to develop and provide free mapping tools intended to enhance communications that promote awareness and environmental stewardship activities between crop growers, beekeepers, seed companies and pesticide applicators**. FieldWatch® allows beekeepers and specialty crop producers to map out where their hives or crops are located with an easy-to-use mapping tool**. Beekeepers have the option to set their locations to "private", allowing only registered users access to their information.

Apiarists register and map hive locations via *BeeCheck®* and commercial specialty crop growers map those crops via *DriftWatch®* so that pesticide applicators can review *FieldCheck®* for locations mapped by growers and beekeepers before spraying to improve decision making. FieldCheck® also provides contact information to support communication between applicators and beekeepers. The partnership will help beekeepers, producers and applicators better communicate as part of ongoing stewardship activities.

Applicators are encouraged to register in FieldCheck® at *https://driftwatch.org/signup#applicator*. With registration, FieldWatch® will notify any registered applicators using either an online or mobile portal when new beehives or fields are added. FieldWatch® encourages all users who find value in the tools they provide to consider joining as dues-paying members. By registering, producers and beekeepers can record their sites and purchase signs, and applicators can receive email notifications about newly added sites in their defined areas. However, growers, beekeepers, seed companies and applicators can access our registries and free mapping tools, without becoming dues-paying members.

FieldWatch® is a national crop and apiary registry that is voluntary and free. As such, *be aware that all registered users of the FieldWatch® platform, including DriftWatch®, BeeCheck®, CropCheck®, FieldCheck®, and the SeedFieldCheck pilot program are bound by its following disclaimer posted at https://mkvf33.p3cdn1.secureserver.net/wp-content/uploads/2020/05/FieldWatch-Site-Disclaimer-03.25.20-.pdf*.

Pesticide Bee Incident Reporting

Immediately report pesticide incidents (*e.g*., bee kills) to your State pesticide regulatory agency. Pesticide incidents should also be reported to the National Pesticide Information Center at: *www.npic.orst.edu* or directly to EPA at: *beekill@epa.gov*.

Information on protecting bees and other insect pollinators may be found at the Pesticide Environmental Stewardship website at:
***https://pesticidestewardship.org/pollinator-protection/*.**

Information about toxicity of organic pesticides to bees can be found at:
***http://www.xerces.org/publications/guidelines/organic-pesticides*.**

6.3.2 Protection of Endangered Species

EPA's Endangered Species Protection Program is designed to determine whether pesticide use may affect any threatened or endangered species or cause harmful modification of designated critical habitat under the Endangered Species Act. This includes protections for the 1,300 different species in the United States that are listed as endangered or threatened. EPA's goal is to protect threatened and endangered species and their habitats, without placing unnecessary burden on agriculture and pesticide users. Pesticide limitations are developed to ensure safe use of pesticides in order to meet this goal and will be communicated to applicators on the pesticide label. **EPA may require changes to a pesticide's registration, label, or use instructions to protect endangered or threatened species**.

When <u>those changes are needed only in specific regions</u>, rather than nationwide, EPA may implement the changes through geographically specific ***<u>Endangered Species Protection Bulletins</u>*.** The goal of Bulletins is to protect listed species and/or their critical habitat in specific locations and, *in some cases, during certain times of the year*.

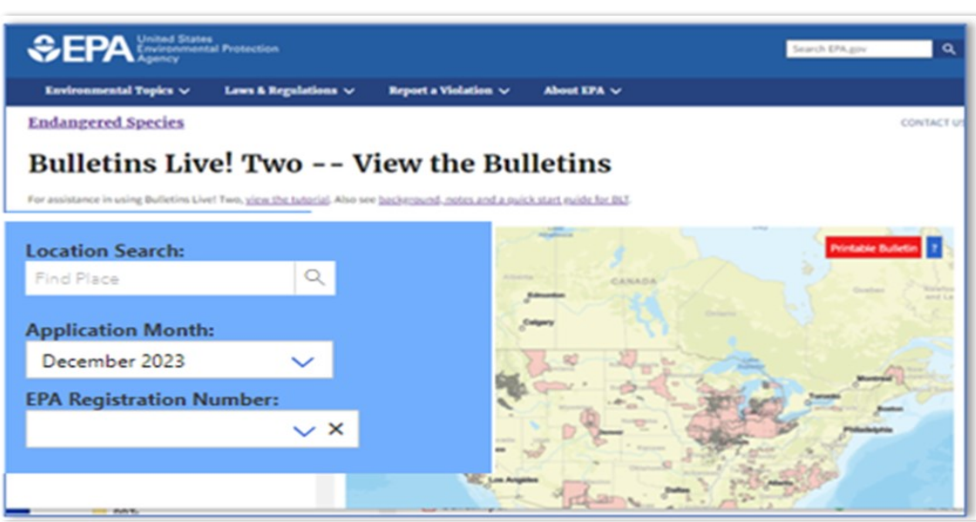
If a geographically specific "pesticide use limitation" is necessary to protect a listed species or its designated critical habitat, the Environmental Hazards section of the pesticide label will direct the pesticide user to *an Endangered Species Protection Bulletin* (*see example label right*). The label directs the applicator to obtain a Bulletin for the area they are applying that product by either consulting *<u>http://www.epa.gov/espp</u>* or *<u>https://www.epa.gov/endangered-species/bulletins-live-two-view-bulletins</u>*; or by calling 1-844-447-3813.

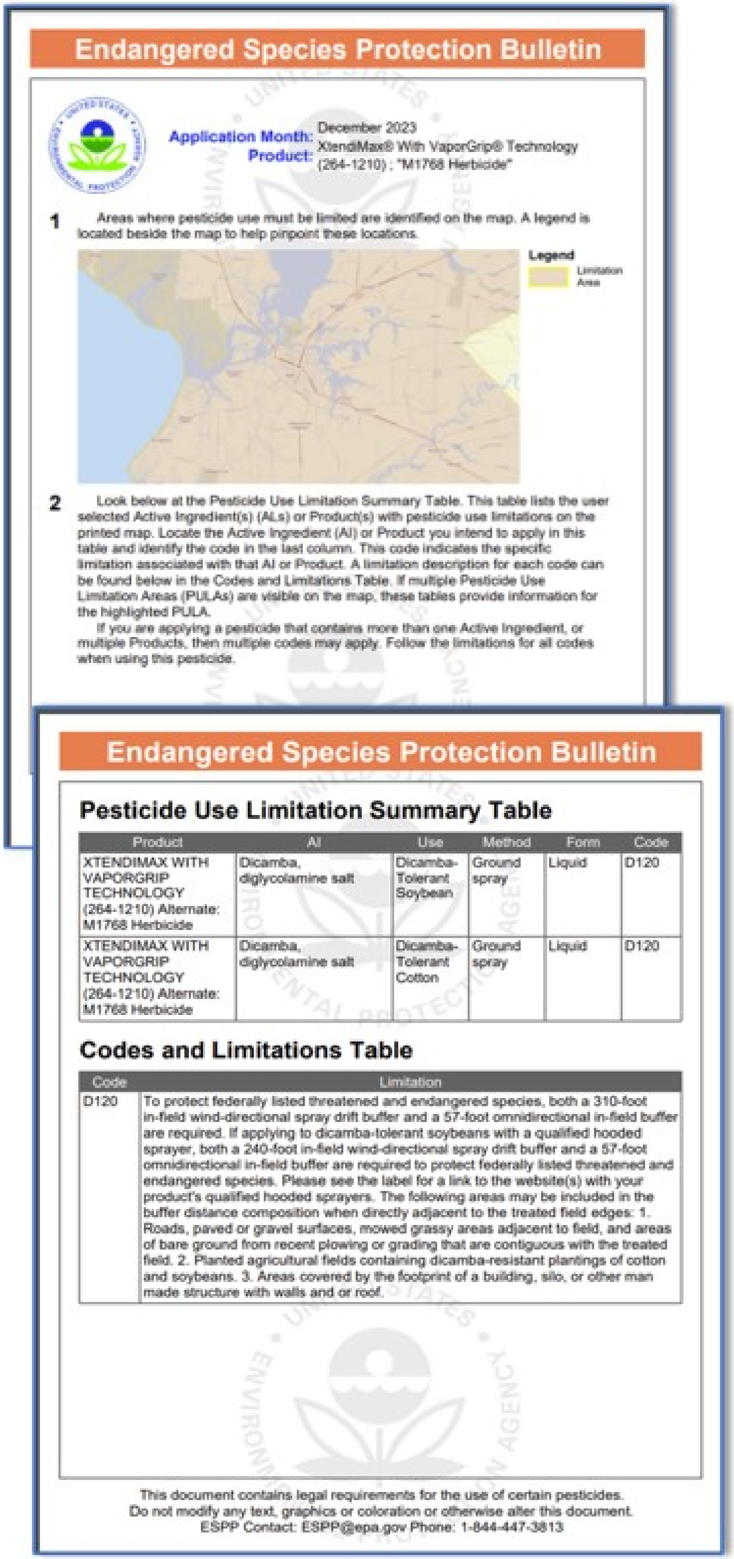
Of the two options, applicators will obtain instantaneous results by going directly online to the weblink provided on the pesticide product label. **"Bulletins Live! Two" (BLT) is EPA's current *online* endangered species bulletins system.** It is accessible through your computer or using your cell phone browser. The webpage (*see below*) opens to a map of the United States for applicators to enter in the blue box the exact location and month they are planning to make an application of that particular product.

PROTECTING ENDANGERED SPECIES / PESTICIDE USE LIMITATION AREAS

The use of any pesticide in a manner that may kill or otherwise harm an endangered species or adversely modify their habitat is a violation of federal law. Use of this product in a manner inconsistent with its labeling may pose a hazard to endangered or threatened species. When using this product, you must follow the measures contained in the Endangered Species Protection Bulletin for the area in which you are applying the product. To obtain Bulletins, no more than six months before using this product, consult *<u>https://www.epa.gov/endangered-species/bulletins-live-two-view-bulletins</u>* or call 1-844-447-3813. You must use the Bulletin valid for the month in which you will apply the product.

It is a Federal offense to use any pesticide in a manner that results in the death of an endangered species.





Endangered Species Protection Bulletin

Application Month: December 2023
Product: XtendiMax® With VaporGrip® Technology (264-1210) ; "M1768 Herbicide"

1 Areas where pesticide use must be limited are identified on the map. A legend is located beside the map to help pinpoint these locations.

2 Look below at the Pesticide Use Limitation Summary Table. This table lists the user selected Active Ingredient(s) (ALs) or Product(s) with pesticide use limitations on the printed map. Locate the Active Ingredient (AI) or Product you intend to apply in this table and identify the code in the last column. This code indicates the specific limitation associated with that AI or Product. A limitation description for each code can be found below in the Codes and Limitations Table. If multiple Pesticide Use Limitation Areas (PULAs) are visible on the map, these tables provide information for the highlighted PULA.

If you are applying a pesticide that contains more than one Active Ingredient, or multiple Products, then multiple codes may apply. Follow the limitations for all codes when using this pesticide.

Endangered Species Protection Bulletin

Pesticide Use Limitation Summary Table

Product	AI	Use	Method	Form	Code
XTENDIMAX WITH VAPORGRIP TECHNOLOGY (264-1210) Alternate: M1768 Herbicide	Dicamba, diglycolamine salt	Dicamba-Tolerant Soybean	Ground spray	Liquid	D120
XTENDIMAX WITH VAPORGRIP TECHNOLOGY (264-1210) Alternate: M1768 Herbicide	Dicamba, diglycolamine salt	Dicamba-Tolerant Cotton	Ground spray	Liquid	D120

Codes and Limitations Table

Code	Limitation
D120	To protect federally listed threatened and endangered species, both a 310-foot in-field wind-directional spray drift buffer and a 57-foot omnidirectional in-field buffer are required. If applying to dicamba-tolerant soybeans with a qualified hooded sprayer, both a 240-foot in-field wind-directional spray drift buffer and a 57-foot omnidirectional in-field buffer are required to protect federally listed threatened and endangered species. Please see the label for a link to the website(s) with your product's qualified hooded sprayers. The following areas may be included in the buffer distance composition when directly adjacent to the treated field edges: 1. Roads, paved or gravel surfaces, mowed grassy areas adjacent to field, and areas of bare ground from recent plowing or grading that are contiguous with the treated field. 2. Planted agricultural fields containing dicamba-resistant plantings of cotton and soybeans. 3. Areas covered by the footprint of a building, silo, or other man made structure with walls and or roof.

This document contains legal requirements for the use of certain pesticides.
Do not modify any text, graphics or coloration or otherwise alter this document.
ESPP Contact: ESPP@epa.gov Phone: 1-844-447-3813

Always follow the labeling instructions. If directed by the product label to check for Bulletins for your application site and month, these Bulletins contain enforceable "**pesticide use limitations**" that are necessary to ensure a pesticide's use will not harm a species listed as threatened or endangered (listed) under the Endangered Species Act or their designated critical habitat.

When you log onto the site, you will be able to generate a Bulletin specific to the location of where you intend to make an application, the pesticide product you plan to use, and by application month (*see left for sample **two-page Bulletin** generated for Salem County, New Jersey for December 2023 for pesticide product containing active ingredient dicamba with the EPA Registration Number 264-1210*).

The PDF from the Bulletins Live! Two (BLT) application provides you with the specific **"pesticide use limitation" or PULA** information for your application site and month.

Specifically, each Bulletin will have a "**Pesticide Use Limitation Summary Table**" *(see bottom left for the **second page of the sample Bulletin cited above**)*. The Table lists product name, active ingredient, method of application, and physical form of the pesticide use queried. **The last column in the table contains a code for the pesticide use limitation that will be required for any application of the product on the date and location queried in BLT.**

Underneath the Pesticide Use Limitation Summary Table is a "**Codes and Limitations Table**" which is a key that lists each PULA Code with a corresponding detailed explanation of the pesticide use limitations that must be followed by the applicator to protect the threatened and endangered species at that location in the month queried. Please **consult Cooperative Extension Specialists and Agents for technical assistance** in understanding and implementing any and all pesticide use limitations that are listed in the Endangered Species Protection Bulletin.

Remember, when users are directed to check the Bulletins website on a pesticide label, Bulletins are enforceable mitigations under FIFRA.

EPA currently provides that if you would like to save the Bulletin, for your own records, you can. **Check with your State pesticide regulatory agency for any state-specific recordkeeping requirements of Bulletins** for pesticide applications with Endangered Species Precautionary Statements directing the applicator to consult Bulletins Live! Two. If your application location changes or the application timing is to occur later than the intended application month that you originally checked, make sure to check BLT again and generate a new Bulletin.

Resources to get started with Bulletins Live! Two:

- **Bulletins Quick Start Guide:** *https://www.epa.gov/endangered-species/endangered-species-protection-bulletins#quick*
- **BLT Tutorial (February 2022):** *https://www.epa.gov/system/files/documents/2022-02/blt-tutorial-updated-feb2022.pdf.*
- **Bulletins Live! Two Webinar (November 2023):** *https://www.epa.gov/endangered-species/materials-november-2023-bulletins-live-two-webinar*

Please refer to your State pesticide regulatory agency for state-specific regulations and policy on the pesticide use limitations for protection of endangered species. In cases where state rules are more stringent than federal, the state rules will take primacy.

IMPORTANT
THE LABEL IS THE LAW!

1. When users are directed on a pesticide label to check for Endangered Species Protection Bulletins, ***Bulletins Live! Two*** provides Bulletins that are enforceable mitigations under FIFRA.
2. **Not following the limitation on your Bulletin is a misuse of the pesticide and enforceable under FIFRA**.
3. If this **misuse results in "take" of listed species, the action is also enforceable under the Endangered Species Act** by the US Fish and Wildlife Service and National Marines Fisheries Service.

7. Mid-Atlantic Region Pesticide Program Contacts

Delaware

- **Delaware Department of Agriculture; Pesticides Management Section**
  https://agriculture.delaware.gov/pesticide-management/
  Christopher Wade, Pesticides Administrator
  302-698-4570; christopher.wade@state.de.us
  Amanda Strouse, Pesticide Certification & Training Specialist (Agricultural Specialist)
  302-698-4575; ***amanda.strouse@delaware.gov***

- **University of Delaware**
  https://www.udel.edu/academics/colleges/canr/cooperative-extension/sustainable-production/psep/
  John Emerson, Pesticide Safety Education Program Coordinator for Delaware
  859-621-0500; *jremer@udel.edu*

Maryland

- **Maryland Department of Agriculture Pesticide Regulation Section**
  https://mda.maryland.gov/plants-pests/pages/pesticide_regulation.aspx
  Alexander T Lehmann, PhD, Entomologist Advanced, Certification and Training Coordinator
  (410)-841-5710; *Alexander.Lehmann1@maryland.gov*

- **University of Maryland**
  http://pesticide.umd.edu/pesticide-safety-education.html
  Niranjana Krishman, PhD, Pesticide Safety Education Program Coordinator for Maryland
  (301) 405-3928; *nkrish@umd.edu*

D. Pesticide Safety

New Jersey

- **New Jersey Department of Environmental Protection**
  Division of Compliance Operations and Coordination Bureau of Licensing and Registrations
  https://www.nj.gov/dep/enforcement/pcp/bpo.htm
  Michael McConville, Chief
  609-984-6507; *Mike.McConville@dep.nj.gov*

- **Rutgers University New Jersey Agricultural Experiment Station**
  https://pestmanagement.rutgers.edu/rutgers-pesticide-safety-education-program/
  Patrica D. Hastings, Extension Pesticide Safety Education Program Coordinator for New Jersey
  (848) 932-0176; *hastings@njaes.rutgers.edu*

Pennsylvania

- **Pennsylvania Dept. of Agriculture, Bureau of Plant Industry**
  https://www.agriculture.pa.gov/Plants_Land_Water/PlantIndustry/health-safety/pesticide-programs/PesticideCART/Pages/default.aspx
  Jessica L. Lenker, Chief
  717-772-5212; *jeslenker@pa.gov*
  Matthew Kohan, Pesticide Certification and Education Specialist
  717-772-5217; *mattkohan@pa.gov*

- **Penn State University Pesticide Education Program**
  https://extension.psu.edu/about-the-pesticide-education-program
  Jon M. Johnson, Director Pesticide Education Program
  (814) 863-0263; *jmj5@psu.edu*

Virginia

- **Virginia Department of Agriculture and Consumer Services**
  https://www.vdacs.virginia.gov/pesticides.shtml
  Liza Fleeson-Trossbach, Program Manager
  804.371.6559; *Liza.Fleeson@vdacs.virginia.gov*

- **Virginia Tech Pesticide Program**
  https://vtpp.ento.vt.edu/
  Daniel L. Frank PhD, Director of Pesticide Programs
  (540) 231-6543; *dlfrank@vt.edu*

West Virginia

- **West Virginia Dept. of Agriculture**
  https://agriculture.wv.gov/divisions/regulatory-and-environmental-affairs-2/pesticides/
  Jennifer Shivley, Certification Supervisor
  304-558-2209; *jshivley@wvda.us*

- **West Virginia University Extension Service**
  https://extension.wvu.edu/agriculture/farm-management/pesticide-education
  Carlos Quesada, Pesticide Safety Education Program Coordinator for West Virginia
  (304) 293-9464; *Carlos.Quesada@mail.wvu.edu*

E. Pest Management

1. How to Improve Pest Management

1.1. Recommendations for More Effective Pest Control

Failure to control a weed, insect, or disease is often blamed on the pesticide when frequently the cause is one of the following: 1. Delaying applications 2. Making applications with insufficient gallonage or with clogged or poorly arranged nozzles, and 3. Selecting the wrong pesticide.
For more effective pest control check the following recommendations:

1. Field Inspection
Frequent scouting (at least twice per week) to determine pest populations will help determine the proper timing of the pesticide applications.

2. Integrated Pest Management (IPM)
Guidelines and information about current pest activity in vegetables are published by Cooperative Extension in weekly IPM newsletters and reports. These publications provide accurate information for the timing of pesticide applications and suggestions for more effective control. To receive these newsletters and reports, contact your state Extension IPM specialist or Extension agent, *e.g.*, *http://plant-pest-advisory.rutgers.edu/*.

Use this up-to-date information to decide whether pesticide applications or other management actions are needed. Action thresholds for insects are generally expressed as a count of a given life stage or as a damage level based on a recommended sampling procedure. They are intended to reflect the population size that will cause economic damage and warrant the cost of treatment. Thresholds are listed for a number of crops and pests in chapter F. **Control decisions are also based on the following: a)** economic action threshold level - when the cost of control equals or exceeds potential crop losses attributed to real or potential damage, **b)** field history, **c)** growth stage and vigor of crop, **d)** life stage of the pest, **e)** parasite and predator populations, **f)** pest populations, **g)** resistance to chemicals, **h)** time of the year, **i)** variety, and **j)** weather conditions

To employ an IPM program successfully, basic practices need to be followed. Whether participating in an IPM program, hiring a private consultant, or performing the work yourself, the grower should: **a)** examine fields frequently to determine pest populations and buildup, **b)** apply a control measure only when the economic action threshold level has been reached, and **c)** choose a pesticide that is least harmful to bees, parasites, and predators.

3. Resistance Management
Resistance to pesticides can develop because pests may have natural resistance or develop resistance due to a specific pesticide through the intensive (or overuse) of that pesticide. In general terms, once resistance develops the pesticide will only kill the susceptible population, leaving only the resistant population to reproduce. Consult the following sections for more information on how to reduce the risk of developing resistance: E 2.5 for herbicides, E 3.2 for insecticides, and E 4.1 for fungicides.

4. Pest Control: Insect and Weed Population Sampling Techniques and Disease Monitoring
Insect Population Sampling Techniques:
a) Shake cloth (ground cloth): Use a standard 3x3 ft shake cloth to assess insect populations. Randomly choose a site without disturbing the plants and carefully unroll the cloth between two rows. Bend the plants over the cloth one row at a time and beat the plants vigorously. Plants are pushed back to their original position and gently shaken to dislodge insects held on stems, leaves, and branches. Count only insects that have landed on the cloth. The number of sampling sites per field will vary with the crop. **b) Sweep net:** Use a standard 15-inch diameter sweep net to assess insect populations. While walking along one row, swing the net from side to side with a pendulum-like motion. The net should be rotated 180 degrees after each sweep and swung through the foliage in the opposite direction. Each pass of the net is counted as one sweep. The number of sweeps per field will vary with the crop. **c) Visual observation:** Examine plants or plant parts (leaves, stems, flowers) for direct counts of insect stages (eggs, larvae, adults), or for the presence of expected injuries. Counts can be taken on individual plants or a prescribed length of row depending on the crop. Quick moving insects are usually counted before less mobile ones.

Weed Population Sampling Techniques:

a) Weed identification: Weed identification is critical for determining a plant's life cycle, emergence patterns, and growth; and in turn, are key for developing a successful weed control program. There are excellent on-line weed guides as well as weed identification books. **b) Growth stage determination:** The ability of weeds to compete with the crop is related to weed and crop size. Weed control by herbicides or mechanical methods is also dependent on weed size. Weed control decisions must be carried out before the crop is affected and before the weed is too large to be controlled. **c) Weed population:** Weed competition for light, water, nutrients, and space is dependent on population and is usually expressed as weeds per foot of row or weeds per square meter. Control measures are needed when the weed population exceeds the maximum tolerable population of that species. Problematic weeds and species prone to developing resistance should be controlled before they produce viable seeds.

Disease Monitoring:

a) Fields should be scouted on a regular basis for disease symptoms. b) For many foliar diseases, effective fungicide applications must begin prior to the arrival of the pathogen and be repeated every 7 to 10 days and according to label instructions and weather conditions. Treatment for soil-borne diseases should be done immediately at seeding or transplanting and later in the production season if necessary. If environmental conditions are favorable for disease development, delaying a fungicide application may result in a lack of control. c) Predictive disease forecasting systems are available online and timely disease alerts are often published in online Extension publications.

5. Weather Conditions

Consider weather conditions before applying a pesticide. Spray only when the wind velocity is less than 10 mph. Dust only when it is perfectly calm. Do not spray plants that are showing signs of moisture stress. Certain pesticides, including biological insecticides and some herbicides, are less ineffective in cool weather. Others do not perform well or may cause crop injury when hot or humid conditions occur. If possible, make applications when good weather conditions prevail.

Rainfall or overhead irrigation can wash pesticide deposits from foliage. Wait at least 48 hours after insecticide or systemic fungicide application and allow contact fungicides to dry on the leaf surface before irrigating. More frequent fungicide applications may be needed during and after periods of heavy rainfall. Provide a minimum rain/irrigation-free period of 1 to 4 hours after most postemergence herbicide applications.

Refer to individual product labels for all application precautions or restrictions.

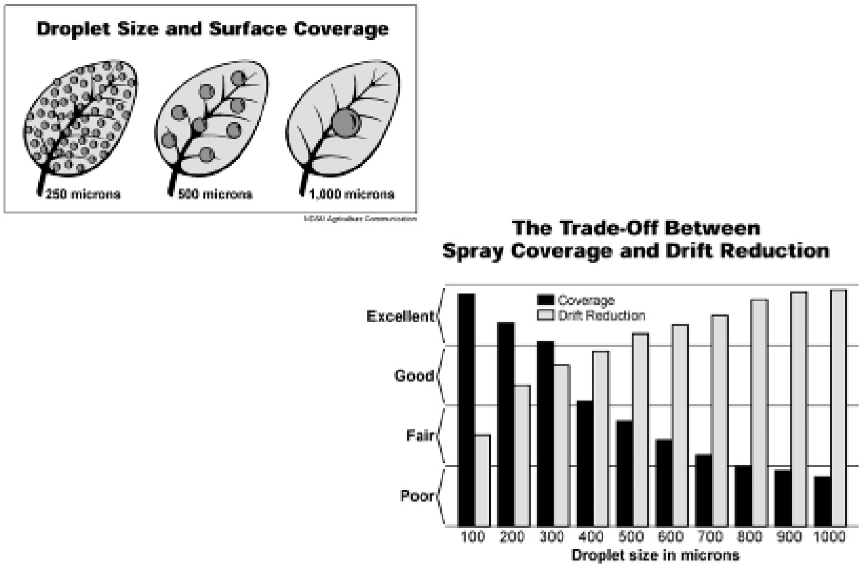
6. Pesticide Coverage of Plants

Non-systemic pesticides require more thorough spray droplet coverage than systemic pesticides which move through the plant's vascular system. Several insects (*e.g.*, aphids, mites) and diseases also require thorough spray coverage to obtain adequate control. Better pesticide performance can be accomplished by using adequate spray pressure and appropriately designed nozzles and nozzle arrangements with directed sprays to the surface as well as the underside of leaves.

High gallonage, air assisted sprayers and smaller droplets enhance spray coverage of many fungicides and insecticides (Fig. E-1). The volume of water required for adequate spray coverage increases as plants grow and leaf surface area increases; a minimum of 60 gal/A is recommended on vegetable crops for effective pest control with smaller droplets. As a rule of thumb: spray volumes in excess of 100 gal/A would be considered high-volume applications and spray pressures above 60 psi up to 400 psi would be considered high-pressure applications. **Refer to pesticide labels for specific application instructions. Note that pesticide drift increases with smaller spray droplets** (Fig. E-1). More information is available *at: http://sustainable-farming.rutgers.edu/companion-handouts-for-the-backpack-sprayer-videos/.*

Use one sprayer for herbicides and a different sprayer for fungicides and insecticides. Herbicide sprays should be applied at 15-25 gal/A of spray solution using low pressure (30-45 psi), and a nozzle designed to deliver the appropriate size droplet. Never apply herbicides with a high-pressure sprayer suitable for insecticide or fungicide application because excessive **drift** can result in damage to crops and non-target plants in adjacent areas. On crops that are difficult to wet (*e.g.*, asparagus, cole crops, onions, peppers, and spinach), disease control can be improved with the addition of a spray adjuvant. **However, do not add oil concentrates, surfactants, spreader-stickers, or any other additive unless specified on the label, or the risk of crop injury may be increased.**

Fig. E-1. Droplet Size and Surface Coverage, and Trade-off Between Spray Coverage and Drift Reduction (North Dakota State University).



7. Pesticide Selection

Know the pests to be controlled and choose the recommended pesticide and rate of application (**check the label**). If in doubt, consult your Extension agent. For pests that are extremely difficult to control or for whom resistance is a risk, it is important to alternate labeled pesticides with different modes of action (MoA). In this guide, recommended insecticides are listed with their Insecticide Resistance Action Committee (IRAC) group number, herbicides by their Herbicide Resistance Action Committee (HRAC) group number, and fungicides by their Fungicide Resistance Action Committee (FRAC) code. For example, insecticides are placed in IRAC groups based on common MoA and alternating between insecticides in different IRAC groups is a way of ensuring that different MoA are used on a specific pest. For more assistance, contact your Extension agent.

Caution: Proper application of systemic insecticides is extremely important. Sprays should be directed according to the instructions on the label (which, in general, indicate away from the seed) or crop injury may occur.

Be sure to properly identify disease(s).

8. Pesticide Compatibility

To determine if two pesticides are compatible, use the following "jar test" before tank mixing pesticides or pesticides and fluid fertilizers:

a. Add 1.0 pt of water or fertilizer solution to a clean qt jar, add pesticides in the same proportion as used in the field.

b. To a second clean qt jar, add 1.0 pt of water or fertilizer solution, and add ½ tsp of an adjuvant (such as Compex, Sponto 168D, Uni-Mix, or Unite) to keep the mixture emulsified. After that, add the pesticides to the water-adjuvant or fertilizer solution-adjuvant mixture in the same proportion as used in the field.

c. Close both jars tightly and mix thoroughly by inverting 10 times. Inspect the mixtures immediately and after standing for 30 minutes: If a uniform mix cannot be made, the mixture should not be used. If the mix in either jar remains uniform for 30 minutes, the combination can be used. If the mixture with adjuvant stays mixed and the mixture without adjuvant does not, use the adjuvant in the spray tank. If either mixture separates but readily remixes, constant agitation is required. If non-dispersible oil, sludge, or clumps of solids form, do not use the mixture. **Note**. **For compatibility testing, the pesticide can be added directly or premixed in water first. In actual tank mixing for field application, unless label directions specify otherwise, add pesticides to the water in the tank in this order**: **1)** add, wettable granules or powders; **2)** then add flowables, emulsifiable concentrates, water solubles, and companion surfactants. If tank mixed adjuvants are used, these should be added first to the fluid carrier in the tank. Thoroughly mix each product before adding the next product.

9. Calibration of Application Equipment

Periodic calibrations of sprayers, dusters, and granule distributors are necessary to ensure accurate delivery rates of pesticides per acre. Calibrations are made by measuring the total gal/A of water applied in the case of sprayers, and the total lb/A of dust or granules in the case of dust and granule distributors. The application of too little spray or dust per acre results in inadequate distribution of toxicant over plant surfaces, usually poor control, and the need for additional applications. Application of too much spray or dust per acre is hazardous for the applicator, is frequently injurious to plants (phytotoxic), and could lead to excessive residues if applied close to harvest.

10. Selection of Sprayer Nozzle Tips

The selection of proper sprayer tips for use with various pesticides is very important. Flat fan-spray tips are designed for preemergence and postemergence application of herbicides. These nozzles produce a tapered-edge spray pattern that overlaps for uniform coverage when properly mounted on a boom. Standard flat fan-spray tips are designed to operate at low pressures (30-60 psi) to produce small- to medium-sized droplets that do not have excessive drift. Some flat fan tips (SP) are designed to operate at even lower pressures (15-40 psi) and are generally used for preemergence herbicide applications. Flat fan nozzle tips are available in brass, plastic, ceramic, stainless steel, and hardened stainless steel. Brass nozzles are inexpensive and are satisfactory for spraying liquid pesticide formulations. Brass nozzles are least durable and hardened stainless steel nozzles are most durable and are recommended for wettable powder formulations which are more abrasive than liquid formulations. When using any wettable powder, it is essential to calibrate the sprayer frequently because, as a nozzle wears, the volume of spray material delivered through the nozzle increases.

Flood-type nozzle tips are used for various solutions (*e.g.*, complete fertilizer, liquid N) and sometimes for spraying herbicides onto the soil surface prior to incorporation. They are less suited for spraying postemergence herbicides or for applying fungicides or insecticides to plant foliage. Coverage is often less uniform and complete when flood-type nozzles are used, compared with the coverage obtained with other types of nozzles. Results with postemergence herbicides applied with flood-type nozzles may be satisfactory if certain steps are taken to improve target coverage. Space flood-type nozzles a maximum of 20” apart, rather than the standard 40”. This will result in an overlapping spray pattern. Spray at the maximum pressure recommended for the nozzle. These techniques will improve target coverage with flood-type nozzles and result in satisfactory weed control in most cases.

Full and hollow-cone nozzles deliver circular spray patterns and are used for application of insecticides or fungicides to crops where thorough coverage of the leaf surfaces is extremely important and where spray drift will not cause a problem (see step 6). They are used when higher water volumes and spray pressures are recommended. With cone nozzles, the disk size and the number of holes in the whirl plate affect the output rate. Various combinations of disks and whirl plates can be used to achieve the desired spray coverage.

11. Pesticides and pH

Unsatisfactory results of pesticide applications may be caused by poor application, a bad batch of chemical, pest resistance, and weather conditions. Another possible reason may be the incorrect pH of the mixing water. **Check the pH of the water with a pH meter or ask your Extension agent to test a sample.**

Some materials carry a label cautioning the user against mixing the pesticide with alkaline materials, because the pesticide (in particular organophosphate insecticides) undergoes a chemical reaction known as "alkaline hydrolysis" when mixed with alkaline water (*i.e.*, water with a pH greater than 7). The more alkaline the water, the faster the breakdown rate. In addition to lime sulfur, several other materials provide alkaline conditions, *e.g.*, caustic soda, caustic potash, soda ash, magnesia or dolomitic limestone, and liquid ammonia. **Water sources in agricultural areas can vary in pH from below 3 to greater than 10.**

Many manufacturers provide information on the rate at which their products hydrolyze or break down in water solutions. This rate is expressed as "**half-life**," which is the time it takes for 50% hydrolysis or breakdown to occur. Examples of pesticides that are sensitive to hydrolysis in alkaline water solutions include Counter, Malathion, Dimethoate, Imidan, Lannate, Sevin, and Thimet.

Correction of the alkaline pH: Nutrient buffer sprays are one method; some brand names include: Buffer-X (Kalo Lab), LI-700 Buffer (Hopkins), Mix-Aid (Agway), Nutrient Buffer Sprays (Ortho), Sorba Spray (Leffingwell), Spray-Aide (Miller), and Unite (Hopkins). **Note:** Sprays containing fixed copper fungicides (*e.g.*, Bordeaux mixture, copper oxide, basic copper sulfate, copper hydroxide) should **not** be acidified.

1.2. Calibrating Field Sprayers

Width of Boom The width of boom must be expressed in feet. The boom coverage is equal to the number of nozzles multiplied by the space between two nozzles.

Ground Speed Careful control of ground speed is very important for accurate spray application. Select a gear and throttle setting to maintain constant speed. A speed of 2-3 miles per hour (mph) is desirable. From a "running start," mark off the beginning and end of a 30-second run. The distance traveled (in feet) in this 30-second period divided by 44 will equal the speed in mph. Measure ground speed under field conditions.

Table E-1. Ground Speed Conversion

Tractor speed (mph)	Distance (feet) traveled per minute	Travel time per 500 feet (minutes and seconds)	Tractor speed (mph)	Distance (feet) traveled per minute	Travel time per 500 feet (minutes and seconds)
1.0	88	5 min. and 41 sec	4.5	396	1 min and 16 sec
1.5	132	3 min and 47 sec	5.0	440	1 min and 8 sec
2.0	176	2 min and 50 sec	6.0	528	56 seconds
2.5	220	2 min and 16 sec	7.0	616	49 seconds
3.0	264	1 min and 53 sec	8.0	704	43 seconds
3.5	308	1 min and 37 sec	9.0	792	38 seconds
4.0	352	1 min and 25 sec	10.0	880	34 seconds

Calculating Gallons per Minute Run the sprayer at a certain pressure and catch the discharge from each nozzle for a known length of time. Collect all the discharge and measure the total volume. Divide this volume by the time in minutes to determine discharge in gallons per minute (GPM). Catching the discharge from each nozzle checks the performance of the individual nozzle. When it is not convenient to catch the discharge from each nozzle, a trough may be used to catch the total discharge. Formula For Calculating Sprayer Gallons Per Acre (GPA):

GPA= 5940 x GPM [per nozzle] / MPH x Width [nozzle spacing in inches]

Before Calibrating

1. Thoroughly clean all nozzles, screens, etc., to ensure proper operation.
2. Check to be sure that all nozzles are the same, are made by one manufacturer, and have the same part number.
3. Check the spray patterns of all nozzles for uniformity. Check the volume of delivery by placing similar containers under each nozzle. All containers should fill at the same rate. Replace nozzles that do not have uniform patterns or do not fill containers at the same rate.
4. Select an operating speed. Note the tachometer reading or mark the throttle setting. When spraying, be sure to use the same speed as used for calibrating.
5. Select an operating pressure. Adjust pressure to desired psi while pump is operating at normal speed and water is actually flowing through the nozzles. This pressure should be the same during calibration and field spraying.

Calibration (Jar Method)

Either a special calibration jar or a homemade one can be used. If you buy one, carefully follow the manufacturer's instructions. Take accurate speed and pressure readings and jar measurements; check several times. Keep in mind that you are collecting less than a quart of liquid to measure an application rate of several gallons per acre for many acres. Any 1-quart or larger container, such as a jar or measuring cup, if calibrated in fluid ounces, can easily be used in the following manner:

1. Measure a course on the same type of surface (*e.g.*, sod, plowed) and same type of terrain (*e.g.*, hilly, level) as that to be sprayed, according to nozzle spacing as follows:

Nozzle spacing (in)	16	20	24	28	32	36	40
Course length (ft)	255	204	170	146	127	113	102

2. Time the seconds it takes the sprayer to cover the measured distance at the desired speed. Average several runs.
3. With the sprayer standing still, operate at selected pressure and pump speed. Catch the water from several nozzles for the number of seconds measured in step 2.
4. Determine the average output per nozzle in fluid ounces. The ounces per nozzle equal the gallons per acre applied by one nozzle per spacing.

Calibration (Boom or Airblast Sprayer)

1. Fill the sprayer with water.
2. Spray a measured area (width of area covered x distance traveled) at constant speed and pressure selected from manufacturer's information.
3. Measure the amount of water necessary to refill tank (gallons used).
4. Multiply gallons used by 43,560 square feet (sq ft) per acre (A) and divide by the number of square feet in area sprayed. This gives gallons per acre (gal/A).
5. Add correct amount of spray material to tank to give the recommended rate per acre.

Example

Assume: 10 gal of water used to spray an area 660 ft long and 20 ft wide,
Tank size-100 gal, Spray material-2 lb formulated product/A

Calculation: (Gal used x 43,560 sq ft/A) / (area sprayed)
= (10 gal x 43,560 sq ft/A) / (660 ft x 20 ft)
= (435,600 gal x sq ft)/A / 1,320 sq ft
= 33 gal/A (all other units cancel out)
Tank capacity 100 gal / 33 gal/A = 3.03 A/tank

1.3. Calibrating Granular Applicators

Sales of granular fertilizer, herbicides, and insecticides for application through granular application equipment have been on the increase. Much of the available equipment was not designed for precision application of granular materials; therefore, extra care must be taken to get the results desired. How well the material is applied is no accident. It will take a conscientious operator, effort, knowledge of equipment, and calibration.

The first step to good application is to be sure the equipment is prepared for operation. Be sure all controls are free and work properly. Check and lubricate moving parts as necessary, remove corrosion, and tighten loose nuts and bolts. Application rates of granular application equipment are affected by several factors: gate openings or settings, ground speed of the applicator, shape and size of granular material, and evenness of the soil surface.

Calibration for Broadcast Applicators (Gravity-Drop or Spinner Applicators)

1. From the label, determine the application rate.
2. From the operators' manual, set dial or feed gate to apply desired rate.
3. On a level surface, fill the hopper to a given level and mark this level.
4. Measure test area-length of run will depend on size of equipment. It need not be one long run but can be multiple runs at shorter distances.
5. Apply material to measured area, operating at the speed applicator will travel during application.
6. Weigh amount of material required to refill hopper to the marked level.
7. Determine application rate:

Area covered (A) = number of runs x length of run (ft) x width of application (ft) **/** 43,560 sq ft/A

Application rate (lb/A) = amount applied (lb to refill hopper) **/** area covered (A)

Note. Width of application is width of the spreader for drop or gravity spreaders. For spinner applicators, it is the working width (distance between runs). Check operator's manual for recommendations, generally one-half to three-fourths of overall width spread.

Example:

Assume: Rate: 50 lb/A. Test run: 200 ft. Number of runs: 4. Application width: 12 ft. Lbs to refill hopper: 11.5 lb.

Area covered: (4 runs x 200 ft x 12 ft) / 43,560 sq ft/A = 9,600 runs x sq ft / 43,560 sq ft/A = 0.22 A

Application rate: 11.5 lb / 0.22 A = 52.27 lb/A

8. If the application rate is not correct, adjust feed gate opening and recheck.

Calibration for Band Applicators

1. From the label, determine application rate.
2. From the operator's manual, determine applicator setting and adjust accordingly.
3. Fill hopper half full.
4. Operate applicator until all units are feeding.
5. Stop applicator; remove feed tubes at hopper.
6. Attach paper or plastic bag over hopper openings.
7. Operate applicator over measured distance at the speed equipment will be operated.
8. Weigh and record amount delivered from each hopper.
   (Be sure all hoppers and all tubes deliver the same amount.)
9. Calculate application rate:
   Area covered in bands (A) = Number of bands x length of run (ft) x band width (ft) / 43,560 sq ft
10. If not correct, readjust and recheck.

Calibration for Changing from Broadcast to Band Application

[Band width (ft) / row spacing (ft)] x broadcast rate (lb/A) = Amount needed (lb/A)

1.4. Pesticide Drift and Misapplication

Serious problems can occur when an unintended pesticide drifts onto your plants or is directly applied due to misapplication or sprayer contamination. Misapplied herbicides, in particular, can result in significant injury to a vegetable crop for which the herbicide is not labeled. For all pesticides that are misapplied or that drift onto unintended crops, you must decide on whether the crop can be sold. To legally sell the produce, there has to be an established tolerance for the particular pesticide(s). Even though a pesticide is not sold for the particular crop, a tolerance may exist. Tolerance is an acceptable level of pesticide allowed based on EPA regulations. If the concentration of the pesticide in your vegetable is above the established tolerance or if there is no tolerance, you have a tainted crop that is illegal to sell. Pesticide residue levels can only be determined by laboratory analysis, contact your state department of agriculture or state extension specialists for an appropriate laboratory. To check for tolerances, go to: *https://www.epa.gov/pesticide-tolerances*.

Tolerance is not the only factor that should be considered in deciding whether or not to sell or consume produce. The U.S. EPA tolerance levels are the best scientific information available, but if your customers have heard of the drift problem, even if residues are below tolerances, selling affected produce may damage your farm's reputation.

Samples for residue analysis must be collected correctly and in a timely manner for it to be useful in the decision-making process. If the harvested part is present, collect that tissue. If fruit are not present, collect samples of recently formed leaves and shoot tips; translocated pesticides will concentrate in those tissues. Ask that fruit samples be collected later to help you in deciding whether or not to sell or consume the fruit. Make sure that samples are collected from the crop plants showing injury and as close as possible to the site of pesticide application.

What will pesticide residue concentrations tell you? Sometimes they may not tell you much. The critical question is: "Are the pesticides absent from the parts you wish to harvest and eat, or are the pesticide concentrations within the tolerances set by the EPA?" But undetectable residues may be due to poor sampling procedure, so care must be taken to ensure the samples were taken from the correct part of the plant, in a timely fashion, and handled properly. Be conservative in how you interpret the residue information.

The scientific literature suggests that acute poisoning effects in humans caused by pesticide residues in vegetables due to drift are very unlikely. Questions about the possible chronic effects (including cancer) from multiple exposures from repeated incidents of pesticide drift along with many other routes of exposure remain the subject of research.

Herbicide drift or herbicides misapplied to a vegetable crop for which the herbicide is not labeled can result in significant visible injury. But misapplication of any pesticide has the same issues.

1.5. Soil Fumigation

In fields that are infested with soil borne plant pathogens, plant parasitic nematodes, or significant weed populations, soil fumigation can help reduce pest populations. Soil fumigants must be applied properly and a dissipation period between fumigant application and planting of the crop is necessary to prevent plant injury. **Labels should be read carefully before deciding whether to use a soil fumigant.**

Nearly all soil fumigants have been re-registered since 2009 resulting in substantial label changes (see also section D.3.3.1 Soil Fumigants). **Labels now include mandatory stipulations on fumigant application including soil tillage, soil temperature, and soil moisture. Labels have specific requirements for plant-back periods that must be adhered to for crop safety. There are also new personal protective equipment mandates as well as site monitoring and management requirements**. Consult your Extension professional for advice regarding your specific needs and assistance with label interpretation. More information on Nematode Control can be found in the following section.

One of the following multipurpose soil fumigants should be used to provide weed, disease, and/or nematode control. Rates are broadcast rates in product/acre:

- allyl isothiocyanate + chloropicrin (Dominus 67:33), 20 gal/A
- allyl isothiocyanate (Dominus), 10-40 gal/A
- chloropicrin, 25-34 gal/A
- dichloropropene + chloropicrin (Pic-Clor 60) (if available), 20-30 gal/A
- dichloropropene + chloropicrin (Pic-Clor 80), 17-34 gal/A
- dichloropropene + chloropicrin (Telone C-17), 11-17 gal/A
- dichloropropene + chloropicrin (Telone C-35), 13-20.5 gal/A
- metam-potassium (K-PAM HL), 30-60 gal/A
- metam-sodium (Vapam HL), 37.5-75 gal/A
- dichloropropene + chloropicrin (Inline), non-perforated plastic 13-30.8 gal/A, perforated 13-84 gal/A (drip-applied)

For nematode control only:

- dichloropropene (Telone II), 9-12 gal/A,
- dichloropropene (Telone EC), 9-18 gal/A (drip-applied)

To determine if it is safe to plant into fumigated soil, collect a soil sample from the treated field (do not go below the treated depth). Place the sample in a glass jar with a screw top lid. Firmly press numerous seeds of a small-seeded vegetable crop (*e.g.*, lettuce or radish) on top of the soil and tighten the lid securely. Repeat the process in another jar with non-fumigated soil to serve as a check. Observe the jars within 1-2 days. If seeds have germinated, it is safe to plant in the field. If seeds have not germinated in the fumigated sample and have germinated in the non-treated sample, then the field is not safe to plant. Rework the field and repeat the process in a few days.

1.6. Nematode Control

Some 100 species of plant-feeding nematodes can seriously damage various crops. Before starting any nematode management procedure, determine what nematodes are present in the soil to find out if action is warranted. If nematode damage is suspected, both soils and roots should be examined to determine if and to what extent nematodes may be involved. Follow the procedures below for proper collection and handling of samples to enable an accurate diagnosis at a Nematode Diagnostic Laboratory.

Soil and Root Samples for Nematode Detection

1. Collecting and Handling

Only a single, composite sample should be collected in each field. If the field is larger than 2 acres, divide the field into 2-acre blocks and collect a composite sample from each block. Label each bag accordingly. This will provide a more accurate assessment of the nematode population and enable more targeted management.

Collect soil and roots from the edges of the affected area(s) in the field. Take a mixture of roots and soil from at least 10 scattered sites, or preferably, under 10 scattered plants in the affected area. Do not take samples from areas where plants are dead. Dig up plants with a shovel and take a small handful of soil and roots from each or use a soil sampling tube (3/4-inch diameter). Combine the individual samples in a bucket to make a composite sample of at least one quart of soil. Mix the soil in the bucket, then place one pint of the mixed soil in a plastic freezer bag and seal it to prevent drying of the soil. Protect bagged samples from high temperatures and freezing which can kill the nematodes.

Take soil samples while the crop is still growing so that areas that are suspected of being affected by nematodes can be identified and sampled, because these areas may be missed in random sampling. In general, samples can be collected from June through November. However, to plan your cropping sequence, it is best to take these survey samples after harvest in the fall *before* any fall tillage and *before* cold weather arrives. This timing is recommended (and especially important for growers who need to monitor root knot nematode populations) because nematode populations are generally highest in the fall. The chance of detecting damaging levels of plant pathogenic nematodes is greatest at that time. The *worst* time to sample to detect root knot nematodes is in late spring just before planting.

Survey samples should be taken at a depth of 8-10 inches, and several inches from the base of the plants, between plants in the row. Do not take samples if the soil is wet. The moisture level should be less than field capacity and there should not be any free water in the plastic bag after adding the sample. Use a soil sampling tube and take 20 to 25 cores per sample in a random pattern in the field. Mix soil cores in a plastic bucket and immediately place a pint of soil in a plastic bag or a nematode soil sample kit purchased from a Nematode Diagnostic Laboratory.

2. Submitting Samples to a Nematode Diagnostic Laboratory

Samples should be sent to the laboratory as soon as possible after collection. If there is any delay, refrigerate samples until shipment. Provide some insulation around the sample(s) during shipment, such as several layers of newspaper, a padded envelope or Styrofoam peanuts. Mark the samples: "For Nematode Analysis" and include the following information **with each sample** (check with the laboratory to see if any additional information is required):

1. Name and address of the grower and of the person submitting the sample
2. Date collected
3. Name of the present crop, the crop to be planted, and history of the affected area
4. Plant and field symptoms

Attach the paper with this information to the **outside** of the bag of soil. Forward the samples to your Extension agent, or directly to the diagnostic laboratory. There is usually a fee for nematode analyses.

Nematode Management Strategies

Plant-parasitic nematodes are difficult to control after they have become established. The best strategy is to use preventive measures, including nematicides, soil fumigants, and/or cultural practices.

1. Chemical Management of Nematodes

Fumigants

Soil fumigation can effectively control plant-feeding nematodes. See section E 1.5. Soil Fumigation above for specific fumigants, rates, and application techniques.

Non-fumigant nematicides

Several non-fumigant nematicides are currently available for selected vegetable commodities. These nematicides are listed in the sections dealing with the vegetables on which they are labeled. Some non-fumigant nematicides are not labeled in all states within the Mid-Atlantic region, so consult the label carefully before applying a chemical. These nematicides do not volatilize in the soil as do fumigants. Consequently, these chemicals are effective over a wider range of soil temperature and moisture than are fumigants.

Chemicals registered for use on selected vegetables include:
Contact nematicides: Counter (20CR), Mocap (10G and 6EC), Nimitz (4EC), Velum.
Both contact and systemic nematicide: Vydate L.
Consult the label before applying any of these chemicals.

Factors Affecting the Efficacy of Nematicides

As with any pesticide, the two factors that determine efficacy are **concentration** and **exposure time**. If toxic nematicide concentrations do not come in contact with nematodes for a sufficient period of time, nematode control will be poor. Many factors can reduce the concentration of nematicide available in the soil and/or effectively shorten the time that nematodes are exposed. Good site preparation is extremely important. The soil should be thoroughly tilled several weeks before application to break up clods and encourage decomposition of plant residues. Nematicides can adsorb to organic matter and thus reduce the amount of compound free in the soil. Soil clods can interfere with nematicide distribution and reduce efficacy.

Fumigant nematicides such as Telone or Vapam volatilize and move through the soil as a gas. The movement of a fumigant through the soil is strongly affected by factors such as temperature, moisture, and soil texture. Fumigants tend to move upwards through the soil and will dissipate quickly unless the surface is sealed after treatment. Follow the label to ensure that you are applying the correct dose for your conditions.

Most non-fumigant nematicides such as Vydate are organophosphate or carbamate pesticides, which are potent cholinesterase inhibitors. Nimitz and Velum Prime are in different chemical classes than those mentioned above and kill nematodes via unknown modes of action. All of these compounds are extremely water-soluble, and their redistribution in the soil depends on water movement. Excessive rain or irrigation creates a risk of diluting the nematicide below the level needed to be effective. However, too little water may prevent the nematicide from being distributed effectively in the root zone. Nimitz has an additional concern of being phytotoxic to plants under cold stress; under those conditions, plants grow much slower than those not treated with Nimitz. During warmer periods of the growing season, Nimitz application results in little phytotoxicity to crops.

Organophosphate and carbamate nematicides act relatively slowly. Although high concentrations are lethal, the lower concentrations in soil generally kill by behavior modification. The affected nematodes typically are unable to move, find a host, feed, or find a mate. Eventually they die. If exposure to the nematicide is too short or at a too low concentration, however, these behavioral modifications can be reversed, and the treatment is not effective. Both Nimitz and Velum Prime kill nematodes within the recommended dose ranges.

2. Non-chemical Management of Nematodes

Prevention of spread

Plant-feeding nematodes move only short distances under their own power, *i.e.*, a few inches to a few feet. Nematodes are commonly spread by the movement of infested soil and/or infected plants by human activity. Sanitation and good cultural practices are the best preventive measures against nematodes. Obtain nematode-free transplants from reputable sources. Wash soil from machinery and tools before using them at another location. Nematodes may also be spread by wind, water, soil erosion, and animals.

Crop rotation

Rotation of crops is an effective and widely used cultural practice to reduce nematode populations in the soil. To be most effective, crops that are poor hosts or nonhosts of the target nematodes should be included in the rotation sequence.

Cover crops

Some plants commonly used as cover crops are naturally suppressive to certain nematode species, but no single crop is effective against all nematodes. The cover crop plant may be a nonhost and, therefore, the nematodes starve, their population being reduced as with fallow. Nematodes invade the roots of certain other cover crop plants, but they fail to reproduce. Yet, other “antagonistic” plant species exude chemicals from their roots that are toxic to nematodes, such as marigold and asparagus.

Green manures and soil amendments

In general, the incorporation of large amounts of organic matter into the soil reduces populations of plant-feeding nematodes. The decomposition products of some plants kill nematodes. These include butyric acid released during the decomposition of ryegrass and timothy, and isothiocyanates released during the decomposition of rapeseed and other plants in the genus Brassica. Maximum benefit of these “natural” nematicides is obtained when the plant material is incorporated into the soil as green manure. It is important to consult with a diagnostic lab or extension agent to make sure the treatment is appropriate for the nematode being controlled, as green manure treatments are not equally effective against all plant- parasitic nematodes. For example, rapeseed is effective against dagger nematodes but not lesion nematodes. Also keep in mind that varieties of the same green manure crop can differ in the amount of toxic chemical components in their cell walls and therefore differ in the amount of toxic byproducts released during decomposition.

For dagger nematode control, two years of rapeseed green manure is desirable, but it may be possible to realize the same benefit by growing two crops of rapeseed within one year. The following timetable is suggested for producing two rotations of rapeseed within one year:

- Prepare seedbed and plant rapeseed by late April or early May (plant only recommended winter rapeseed varieties).
- Turn under green rapeseed by early September. Prepare seedbed and plant second crop by mid-September.
- The second crop should be turned under in late spring after soil temperatures reach 45°F or higher.
- Ideal conditions for incorporating the cover crop are similar to those required for obtaining the maximum benefit from fumigation (*i.e.*, the soil should be above 45°F and moist).
- Alternatively, planting dates may be reversed so that the first planting is in the fall followed by a second crop planted in the spring. This would end the rotation cycle in fall of the following year.

Some rapeseed varieties are more effective at suppressing nematode populations than others, and some varieties will not over-winter (*i.e.*, spring types) or they bloom too early in summer to be useful. The winter varieties 'Dwarf Essex' and 'Humus' work well for both spring and fall planting dates. If planted in the spring, these varieties grow vigorously to crowd out weeds and do not go to seed.

Tips:

- Rapeseed requires a firm, smooth seedbed that is free of weeds, heavy residue, and large clods.
- Seed may be drilled or broadcast. Seed at a depth of 3/8 inch and avoid planting too deep! If seed is broadcast, a cultipacker may be used to cover seed.
- A seeding rate of 7–8 lb/A works well.
- Rapeseed is sensitive to broadleaf herbicide carryover.
- Fall-planted rapeseed should have 8–10 true leaves and a 5-6-inch tap root with a 3/8-inch diameter root neck before the ground freezes.
- Sulfur is necessary for rapeseed to produce nematicidal compounds. Some soils may be deficient in sulfur. A soil test for sulfur may be beneficial.

Keep in mind that some biofumigant crops like rapeseed and sorghum-sudangrass are hosts for nematodes and it is not until incorporated into the soil as green manure that they will suppress nematode populations.

Plant nutrition and general care of the plant

The harmful effects of nematodes on plants can be reduced by providing plants with adequate nutrition, moisture, and protection from stress.

Fallow. Fallow is the practice of keeping land free of vegetation for weeks or months by frequent tilling or applying herbicides. In the absence of a host, nematodes gradually die out; however, eggs of some nematodes may survive for years in the soil. Because fallow may be destructive to soil and the land is out of production during that time, extended periods of fallow are not recommended.

Integrated management practices. Each of the practices mentioned above reduces the soil population of plant-feeding nematodes to varying degrees. Each practice has limitations and the degree of nematode control achieved depends on environmental factors, as well as the particular nematode and crop being considered.

Maximum benefit is realized when several of these practices are employed in an integrated crop management program. Because the host range of different nematode varies, the selection of cover crops, rotation crops, and green manures will be determined by the kinds of nematodes present. No single practice is a "cure-all" for all nematode problems.

2. Weed Control

Effective weed control requires a program that emphasizes prevention and combines crop rotation with mechanical and chemical control methods.

2.1. Postharvest Perennial Weed Control

Weed seed populations in the soil should be kept to a minimum by preventing weeds from producing seed in and around vegetable fields. Destroy all weeds immediately after a crop is harvested. Consider control measures after harvest, but before the first frost, for the following weeds:

1. To suppress or control bitter nightshade, Canada thistle, field bindweed, hemp dogbane, horsenettle, or pokeweed, use a tank mix of 1 qt dicamba plus 1 qt 2,4-D amine. Apply in late summer or early fall to healthy weed foliage for maximum effectiveness (Note. Delay seeding of winter cover crop 3 weeks for each pint per acre of dicamba used). See herbicide labels for optimum treatment time for each weed.
2. To suppress brambles, horseradish (volunteer), horsenettle, milkweed, poison ivy, or sow thistle, tank mix 1.5 lb acid equivalent glyphosate, using one of many labeled glyphosate products, plus 1 pt dicamba (see note above). Use 1 to 2 qt surfactant per 100 gal of spray mixture. Apply in late summer or early fall to healthy weed foliage for maximum effectiveness. See herbicide labels for optimum treatment time for each weed.
3. To control bermudagrass, johnsongrass or quackgrass, apply 0.75 to 1.1 lb acid equivalent glyphosate, using one of many labeled glyphosate products. Delay tillage for 7 to 10 days after application. Apply in late summer or early fall to healthy weed foliage for maximum effectiveness.
4. To control bermudagrass johnsongrass, or quackgrass in crop, apply the maximum labeled rate of Poast, Fusilade, or clethodim (Select, Select Max) early in the season. Repeat applications may be needed for the highest level of control.
5. To control yellow nutsedge foliage and suppress nutlet formation, spray with a labeled glyphosate product after flowers (seed heads) appear, but before foliage dies. Use 1.5 lb acid equivalent glyphosate. Expect only partial control of yellow nutsedge the first year after initiating the program. Plant a crop the following spring with registered herbicides recommended for yellow nutsedge control (see Table E-3). Effective yellow nutsedge control can be achieved by repeating the application for several consecutive years.

2.2. Herbicide Mode of Action: Reducing the Risk of Herbicide Resistance Development

Reducing the risk for developing herbicide-resistant weed populations requires incorporating a number of guidelines in managing your fields. These guidelines include:

1. Spray only when necessary
2. Use alternative methods of control whenever possible such as mechanical cultivation or using cover crops, delayed planting (row crops), mowing (forage crops), and using weed-free crop seeds
3. Rotate crops and their accompanying herbicides' mode of action (HRAC Group Number, see note below)
4. Limit the number of applications of herbicide(s) with the same mode of action in a growing season
5. Use mixtures or sequential herbicide treatments with different modes of action that will control the weeds of concern
6. Scout fields after herbicide application to detect weed escapes or shifts
7. Clean equipment before leaving fields infested with or suspected to have resistant weeds

Note: Classification of Herbicides

A classification of herbicides based on mode of action, was developed to better understand and plan for resistance management. Rotating herbicides with differing modes of action is important for minimizing the risk of developing herbicide-resistant weeds. The system was first developed by the Weed Science Society of America (WSSA) (See: E. James Retzinger and Carol Mallory-Smith. 1997. Classification of Herbicides by Site of Action for Weed Resistance Management Strategies. Weed Technology volume 11, pages 384 to 393).

Table E-2. Important Herbicide Groups for Commercial Vegetables

In the table below, important herbicide groups for vegetable crops grown in the Mid-Atlantic region are listed with their modes of action. Note that more than one herbicide family may have the same mode of action.

Trade Name	Active Ingredient	HRAC Group	Herbicide Class	Mode of Action
2,4-D	2-4-D	4	Plant growth regulators	IAA-like
Accent Q	nicosulfuron	2	Amino acid biosynthesis	ALS (acetolactate synthase)
Aim	carfentrazone	14	Cell membrane disrupters	PPO (oxidase)
Armezon	topramezone	27	Pigment inhibitors	HPPD (4-hydroxyphenyl-pyruvatedioxygenase)
Assure II	quizalofop	1	Fatty acid (Lipid) biosynthesis inhibitors	ACCase (acetyl coA carboxylase)
Atrazine	atrazine	5	Photosynthesis inhibitors (mobile 1)	Photosystem II
Basagran	bentazon	6	Photosynthesis inhibitors (non-mobile)	Photosystem II
Beyond Xtra	imazamox	2	Amino acid biosynthesis	ALS (acetolactate synthase)
Cadet	fluthiacet	14	Cell membrane disrupters	PPO (protoporphyringogen oxidase)
Callisto	mesotrione	27	Pigment inhibitors	HPPD (4-hydroxyphenyl-pyruvatedioxygenase)
Caparol	prometryn	5	Photosynthesis inhibitors (mobile 1)	Photosystem II
Chateau	flumioxazin	14	Cell membrane disrupters	PPO (protoporphyringogen oxidase)
Clarity	dicamba	4	Plant growth regulators	IAA-like
Command	clomazone	13	Pigment inhibitors	Diterpenes (carotenoid biosynthesis)
Curbit	ethalfluralin	3	Seedling growth inhibitors (Root)	Microtubule inhibitors
Dacthal	DCPA	3	Seedling growth inhibitors (Root)	Microtubule inhibitors
Devrinol	napropamide	15	Seedling growth inhibitors (Shoot)	Mitosis inhibitor
Dimetric	metribuzin	5	Photosynthesis inhibitors (mobile 1)	Photosystem II
Dual Magnum	s-metolachlor	15	Seedling growth inhibitors (Shoot)	Mitosis inhibitor
Eptam	EPTC	8	Seedling growth inhibitors (Shoot)	Lipid synthesis inhibitors
Fusilade	fluazifop	1	Fatty acid (Lipid) biosynthesis inhibitors	ALS (acetolactate synthase)
Glory	metribuzin	5	Photosynthesis inhibitors (mobile 1)	Photosystem II
Glyphosate	glyphosate	9	Amino acid biosynthesis	EPSPS-enzyme
Goal	oxyfluorfen	14	Cell membrane disrupters	PPO (protoporphyringogen oxidase)
Goal Tender	oxyfluorfen	14	Cell membrane disrupters	PPO (protoporphyringogen oxidase)
Gramoxone	paraquat	22	Cell membrane disrupters	Photosystem I
Harness	acetochlor	15	Seedling growth inhibitors (Shoot)	Mitosis inhibitor
Impact	topramezone	27	Pigment inhibitors	HPPD (4-hydroxyphenyl-pyruvatedioxygenase)
Karmex	diuron	7	Photosynthesis inhibitors (mobile 2)	Photosystem II
Kerb	pronamide	3	Seedling growth inhibitors (Shoot)	Mitosis inhibitor
Laudis	tembotrione	27	Pigment inhibitors	HPPD (4-hydroxyphenyl-pyruvatedioxygenase)
League	imazosulfuron	2	Amino acid biosynthesis	ALS (acetolactate synthase)
Liberty	glufosinate	10	Phosphorylated amino acid (N metabolism disrupter)	Glutamine synthetase
Linex	linuron	7	Photosynthesis inhibitors (mobile 2)	Photosystem II
Lorox	linuron	7	Photosynthesis inhibitors (mobile 2)	Photosystem II
Maestro	bromoxynil	6	Photosynthesis inhibitors (non-mobile)	Photosystem II
Matrix	rimsulfuron	2	Amino acid biosynthesis	ALS (acetolactate synthase)
Metribuzin	metribuzin	5	Photosynthesis inhibitors (mobile 1)	Photosystem II
Optogen	bicyclopyrone	27	Pigment inhibitors	HPPD (4-hydroxyphenyl-pyruvatedioxygenase)
Outlook	dimethenamid	15	Seedling growth inhibitors (Shoot)	Mitosis inhibitor
Permit	halosulfuron	2	Amino acid biosynthesis	ALS (acetolactate synthase)

Table E-2. Important Herbicide Groups for Commercial Vegetables - continued next page

E.2. Weed Control

Table E-2. Important Herbicide Groups for Commercial Vegetables - continued

Trade Name	Active Ingredient	HRAC Group	Herbicide Class	Mode of Action
Poast	sethoxydim	1	Fatty acid (Lipid) biosynthesis inhibitors	ALS (acetolactate synthase)
Prefar	bensulide	8	Seedling growth inhibitors (Shoot)	Lipid synthesis inhibitors
Prowl	pendimethalin	3	Seedling growth inhibitors (Root)	Microtubule inhibitors
Prowl H2O	pendimethalin	3	Seedling growth inhibitors (Root)	Microtubule inhibitors
Pursuit	imazethapyr	2	Amino acid biosynthesis	ALS (acetolactate synthase)
Raptor	imazamox	2	Amino acid biosynthesis	ALS (acetolactate synthase)
Reflex	fomesafen	14	Cell membrane disrupters	PPO (protoporphyringogen oxidase)
Reglone	diquat	22	Cell membrane disrupters	Photosystem I
Rely 280	glufosinate	10	Phosphorylated amino acid (N metabolism disrupter)	Glutamine synthetase
Ro-Neet	cycloate	8	Seedling growth inhibitors (Shoot)	Lipid synthesis inhibitors
Roundup	glyphosate	9	Amino acid biosynthesis	EPSPS-enzyme
Sandea	halosulfuron	2	Amino acid biosynthesis	ALS (acetolactate synthase)
Select	clethodim	1	Fatty acid (Lipid) biosynthesis inhibitors	ALS (acetolactate synthase)
Shadow	clethodim	1	Fatty acid (Lipid) biosynthesis inhibitors	ALS (acetolactate synthase)
Sharpen	saflufenacil	14	Cell membrane disrupters	PPO (protoporphyringogen oxidase)
Shieldex	tolpyralate	27	Pigment inhibitors	HPPD (4-hydroxyphenyl-pyruvatedioxygenase)
Sinbar	terbacil	5	Photosynthesis inhibitors (mobile 1)	Photosystem II
Solicam	norflurazon	12	Pigment inhibitors	PDS (carotenoid biosynthesis)
Spin-Aid	phenmedipham	5	Photosynthesis inhibitors (mobile 1)	Photosystem II
Sonalan	ethalfluralin	3	Seedling growth inhibitors (Root)	Microtubule inhibitors
Spur	clopyralid	4	Plant growth regulators	IAA-like
Starane Ultra	fluroxypyr	4	Plant growth regulators	IAA-like
Stinger	clopyralid	4	Plant growth regulators	IAA-like
Surpass	acetochlor	15	Seedling growth inhibitors (Shoot)	Mitosis inhibitor
Targa	quizalofop	1	Fatty acid (Lipid) biosynthesis inhibitors	ALS (acetolactate synthase)
Thistrol	MCPB	4	Plant growth regulators	IAA-like
Treflan	trifluralin	3	Seedling growth inhibitors (Root)	Microtubule inhibitors
TriCor	metribuzin	5	Photosynthesis inhibitors (mobile 1)	Photosystem II
Valor	flumioxazin	14	Cell membrane disrupters	PPO (protoporphyringogen oxidase)
Weedar 64	2-4-D	4	Plant growth regulators	IAA-like
Zeus	sulfentrazone	14	Cell membrane disrupters	PPO (protoporphyringogen oxidase)
Zidua	pyroxasulfone	15	Seedling shoot inhibitor	Mitosis inhibitor

2.3. Herbicide Effectiveness on Common Weeds in Vegetables

Notes:

1. Herbicide performance depends on herbicide selection, herbicide rate, weed pressure, weather, soil type, and other factors.
2. The ratings in Table E-3 indicate **ONLY relative effectiveness** in tests conducted by the University of Delaware, University of Maryland, University of Pennsylvania, Rutgers, The State University of New Jersey, and Virginia Polytechnic Institute and State University. **Actual performance may be better or worse than indicated in this table.**
3. **The Herbicide Resistance Action Committee (HRAC) group number** indicates the chemical structure and mode of action of the herbicide.
4. **For field management guidelines aimed at reducing the risk for developing herbicide-resistant weed populations see section E 2.2. Herbicide Mode of Action: Reducing the Risk of Herbicide Resistance Development.**

Table E-3. Herbicide Effectiveness on Common Weeds in Vegetables

Abbreviations: G=good, F=fair, P=poor, N=no control, - =insufficient data.

Herbicide	HRAC Mode of Action Number	Barnyardgrass	Crabgrass, Large	Fall Panicum	Foxtail sp.	Goosegrass	Johnsongrass (Seedlings)	Yellow Nutsedge	Carpetweed	Cocklebur, Common	Galinsoga, Hairy	Jimsonweed	Lambsquarters, Common	Morningglory sp.	Shepherdspurse	Pigweed sp.	Purslane, Common	Ragweed, Common	Smartweed, Pennsylvania	Nightshade, Eastern Black	Velvetleaf
SOIL-APPLIED HERBICIDES (PREPLANT INCORPORATED OR PREEMERGENCE)																					
Acetochlor products	**15**	G	F/G	G	G	G	G	F	F	N	-	N	P/F	N	-	F/G	-	P	P	G	P
Atrazine	**5**	F	P/F	P	F	-	P	P/F	G	F/G	G	G	G	G	G	G	G	G	G	G	F
Callisto	**27**	N	F	N	P	N	N	P	-	P/F	G	F	G	F	G	F/G	-	P	-	P	-
Caparol	**5**	F	P/F	P	F	P/F	-	N	G	P	G	P/F	G	P	F	F/G	G	F	F	F	P
Chateau	**14**	P	P	P	P	P	P	P	G	F	G	-	G	F	G	G	G	F	G	G	-
Command	**13**	G	G	G	G	G	G	N	N	N/F	F	G	G	P	F	N/P	G	P/F	G	-	G
Curbit / Sonalan	**3**	F	G	G	-	G	-	N	G	N	N	N	P/F	P	-	F	F/G	N	P	P	P
Dacthal	**3**	F/G	G	F/G	G	F/G	-	N	P	N	N	P	G	N	P	F/G	G	N	N	N	N
Devrinol	**15**	G	G	G	G	G	G	N/P	G	N	F/P	N	F/G	N	-	F/G	G	P/F	P	N	N
Dual Magnum	**15**	G	G	G	G	G	G	F/G[1]	F	N	G	N	P	N	-	G	F/G	N	P	G	P
Eptam	**8**	G	G	G	G	G	G	G	G	P	N	P	F	F	-	G	G	P	P	F/G	F/G
Goal/GoalTender	**14**	P	P	P	P	P	P	P[2]	G[2]	-	G[2]	-	F	-	G	G	G	F	G[2]	G[2]	F[2]
Karmex	**7**	G	F/G	G	G	F/G	N	N	G	-	G	G	G	G	G	G	G	G	G	G	G
Kerb	**3**	G	G	G	G	G	-	N	G	N	P	N	G	-	-	G	G	P	-	-	P
Lorox/Linex	**7**	F	P/F	P	F	P/F	-	N	G	P	G	P/F	G	P	F	G	G	F	G	G	P

*Table E-3. **Herbicide Effectiveness on Common Weeds in Vegetables** - continued next page*

Table E-3. Herbicide Effectiveness on Common Weeds in Vegetables - continued

Herbicide	**HRAC Mode of Action Number**	**Barnyardgrass**	**Crabgrass, Large**	**Fall Panicum**	**Foxtail sp.**	**Goosegrass**	**Johnsongrass (Seedlings)**	**Yellow Nutsedge**	**Carpetweed**	**Cocklebur, Common**	**Galinsoga, Hairy**	**Jimsonweed**	**Lambsquarters, Common**	**Morningglory sp.**	**Shepherdspurse**	**Pigweed sp.**	**Purslane, Common**	**Ragweed, Common**	**Smartweed, Pennsylvania**	**Nightshade, Eastern Black**	**Velvetleaf**
SOIL-APPLIED HERBICIDES (PREPLANT INCORPORATED OR PREEMERGENCE) – *continued*																					
Matrix/Solida	**2**	G	F	F	G	-	-	F	-	-	F	-	F	P/F	-	G	G	F	F	P/F	P
Metribuzin	**5**	F	F	F	F	F	-	N	G	F	G	F/G	G	F/P	-	F/G	F	G	G	P	G
Micro-Tech	**15**	G	F/G	G	G	G	G	F	G	N	G	P	P/F	N	G	G	G	N	P	G	P
Outlook	**15**	G	G	G	G	G	P	P/F	-	N	G	N	P	N	-	F/G	G	N	P	F	N
Prefar	**8**	G	G	G	G	F/G	G	N	N	N	N	N	F/G	N	P/F	F	F	N	N	N	N
Prowl/Prowl H2O	**3**	G	G	G	G	-	G	N	G	N	N	N	F/G	P	N	F/G	F/G	N	F	P	G
Pursuit	**2**	P/F	P/F	P/F	P/F	-	N	G	F	-	F	G	F	F	G	G	P	G	F	G	G
Reflex[3]	**14**	P	P	P	P	P	P	N	G	N	G	F/G	P	P	G	E	E	G	P	G	P
Ro-Neet	**8**	G	G	G	G	G	-	N/P	G	N	N	N	F	-	G	G	G	N	-	-	F
Sandea	**2**	N	N	N	N	N	N	F	P	G	G	G	F	F	-	G	F	G	F	N	G
Sinbar	**5**	F	F	-	F	F	-	P	G	-	G	G	G	G	G	P	G	G	G	G	G
Solicam	**12**	G	G	G	G	-	F	F	-	-	-	F	F	P	-	G	G	G	-	-	F
Spartan Charge	**14+14**	P	P	P	P	P	P	P	-	-	-	-	P	P	-	F/G	-	N	P	-	-
Strategy[4]	**3+13**	G	G	G	G	G	G	N	G	N/F	F	G	G	P	F	F	G	F	G	P	G
Treflan	**3**	G	G	G	G	G	G	N	G	N	N	N	F/G	P/F	N	F	G	N	P/F	P	N
Zeus	**14**	P	P/F	P	P	P/F	P	P/F	G	P	-	G	F/G	F/G	F/G	-	G	G	P/F	F	F/G
Zidua	**15**	G	G	G	G	G	P	P	-	N	P	P	F	N	-	G	G	P	P	F/G	P
POSTEMERGENCE																					
2,4-D	**4**	N	N	N	N	N	N	P	G	F/G	P	F	F/G	G	G	G	G	G	F	G	G
Accent Q	**2**	G	P/F	G	G	P	G	P	-	P	-	F	P	F	G	G	P/F	P	F/G	N	P
Aim/Cadet	**14**	N	N	N	N	N	N	N	G	P	-	P	G	F	-	G	-	F	-	G	G
Assure II /Targa	**1**	G	G	G	G	G	G	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Atrazine	**5**	F	F	F	F	F	-	G	-	F	G	G	G	G	G	G	G	G	G	G	F/G
Basagran	**6**	N	N	N	N	N	N	F	N	G	F	G	F	P	-	F	F/G	G	G	P	G
Callisto	**27**	N	F	P	P	P	P	F	-	F/G	G	G	G	F	F/G	G	-	P	-	F/G	G
Caparol	**5**	F	P/F	P	F	P/F	-	N	G	P	G	P/F	G	P	F	F/G	G	F	G	G	P

Table E-3. ***Herbicide Effectiveness on Common Weeds in Vegetables*** *- continued next page*

Table E-3. Herbicide Effectiveness on Common Weeds in Vegetables - continued

Herbicide	HRAC Mode of Action Number	Barnyardgrass	Crabgrass, Large	Fall Panicum	Foxtail sp.	Goosegrass	Johnsongrass (Seedlings)	Yellow Nutsedge	Carpetweed	Cocklebur, Common	Galinsoga, Hairy	Jimsonweed	Lambsquarters, Common	Morningglory sp.	Shepherdspurse	Pigweed sp.	Purslane, Common	Ragweed, Common	Smartweed, Pennsylvania	Nightshade, Eastern Black	Velvetleaf
POSTEMERGENCE – *continued*																					
Clarity/dicamba	4	N	N	N	N	N	N	P	G	G	G	G	G	G	G	G	G	G	G	G	G
Fusilade DX	1	G	F/G	G	G	G	G	N	N	N	N	N	N	N	N	N	N	N	N	N	N
glyphosate products	9	G	G	G	G	G	G	F	G	G	G	G	G	F	G	G	G	F	G	G	G
Goal Tender	14	P	P	P	P	P	P	P	G	P	G	F	G	F	G	G	G	F	G	G	F
Gramoxone[5]	22	F/G	F/G	F/G	G	F/G	-	G	G	G	G	G	F/G	F/G	-	G	F/G	G	P	-	-
Impact/Armezon	27	G	G	F/G	G	F	F	-	-	F/G	-	G	G	F	-	G	-	G	G	G	G
Laudis	27	G	F/G	P	G	F	G	-	-	F/G	-	G	G	F	-	G	-	F	-	-	-
Liberty	10	F/G	F	F/G	F/G	P	F/G	P	G	G/E	G/E	G/E	F/G	G/E	G/E	G	F	G/E	F	G	G
Lorox	7	P	P	P	P	P	P	P	G	P/F	F/G	P/F	G	-	G	G	G	G	G	P/F	G
Maestro/Buctril	6	P	P	P	P	P	P	P	G	G	G	G	G	G	G	G	F	F	G	G	F
Matrix/Solida	2	G	P/F	F/G	G	P	-	F	-	F/G	-	F	F	F	G	G	F/G	P	P/F	P	F
Metribuzin	5	P	P	P	P	P	-	P	G	-	G	G	G	P	G	G	G	G	F	P	P/F
Poast	1	G	G	G	G	G	G	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Pursuit	2	F/G	F/G	F/G	F/G	P	F/G	-	G	F	G	F	G	F	P/F	G	G	P/F	-	-	G
Raptor	2	P	P	P	P	P	P	P	-	F/G	G	-	F	F	G	G	P/F	P/F	G	G	G
Reflex[3]	14	P	P	P	P	P	P	P	G	F	G	G	P	F/G	G	G	-	F	P	F	P
Sandea	2	N	N	N	N	N	N	G	P	G	G	G	N	F	-	G	P	G	F	N	G
Select	1	G	G	G	G	P	G	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Shieldex	27	P/F	F/G	N	F/G	P/F	P	P	-	F/G	-	G	G	F	-	G	-	F	P/F	P	G
Sinate	10+27	G	G	F/G	G	F	F	P	G	G/E	G/E	G/E	G	G/E	G/E	G	F	G/E	G	G	G
Sinbar	5	F	F	-	F	F	-	P	G	G	G	G	G	G	G	P	G	G	G	G	G
Spin-Aid	5	P	P	P	P	P	P	P	-	P	G	G	F	G	G	P/F	G	F/G	-	-	N
Starane Ultra	4	N	N	N	N	N	N	N	N	G	-	-	F/G	-	F	G	G	-	F	G	G
Stinger/Spur	4	N	N	N	N	N	N	N	N	G	G	P	P	N	N	N	N	G	P	P	P

[1] Control improved with a preplant incorporated treatment, [2] Control of this species based on preemergence application; control from preplant incorporated treatment slightly reduced.
[3] Reflex ratings based on 1.25 pt/A. Lower rates will result in reduced levels of weed control. [4] Strategy is a repackaged mixture of Command and Curbit. [5] Gramoxone: nonselective herbicide that needs to be applied with shielded application equipment to prevent spray from contacting the crop.

2.4. Weed Species Prone to Resistance and of Concern in the Mid-Atlantic Region

Herbicide resistant weeds are common in the Mid-Atlantic region. A number of common herbicide groups are no longer effective on many weed species. Also, there are some species that have evolved resistance to multiple herbicides which further complicates herbicide selection.

Table E-4 shows weed species that have been confirmed to be resistant to herbicides mode(s) of action in the Mid-Atlantic region ("xx") and weed species ("oo") for which resistance problems have not been identified in our region. Herbicide control for weed species marked "oo" must be monitored; adjustments in herbicide regimes may be necessary if resistance to these herbicides is observed.

Table E-4. Weed Species Prone to Resistance and of Concern in the Mid-Atlantic Region

	HRAC Mode of Action Number															
	1	2	3	4	5	6	7	8	9	10	11	13	14	15	22	27
Broadleaf Species																
Amaranth, palmer		xx	oo	oo	oo				xx	oo			oo	oo		oo
Chickweed, common		xx		oo	oo											
Horseweed/marestail		xx			oo		oo		xx						xx	
Lambsquarters, common		oo			xx	xx			oo							
Pigweed, redroot/smooth		xx			xx	oo	oo		oo				oo			
Ragweed, common		xx			oo		oo		xx	oo			xx			
Ragweed, giant		oo							oo							
Waterhemp		xx		oo	oo				xx							oo
Grass Species																
Barnyardgrass	oo	oo	oo	oo	xx		oo	oo	oo			oo		oo		
Foxtail, giant	oo	xx			xx											
Goosegrass	oo	oo	oo		oo				oo				xx		oo	
Johnsongrass	xx	xx	oo						oo							
Ryegrass, Italian	xx	xx					oo		xx	oo	oo			oo	oo	
Shattercane		xx														

xx Species confirmed to be resistant to a particular site of action in the Mid-Atlantic United States
oo Species confirmed to be resistant to a particular site of action worldwide (resistance not yet identified in the Mid-Atlantic region)

2.5. Crop Rotation Planting Restrictions

Table E-5. Crop Rotation Planting Restrictions: Months After Herbicide Application Until Planting New Crop

This table summarizes the crop rotation planting restrictions after certain herbicide applications have been made. **For example**, if Devrinol was applied to tomatoes, planting sweet corn must be delayed for 12 months after the Devrinol application. **Consult the label** for a different time interval if two or more herbicides were applied in the same season. The label may also mention additional restrictions due to rainfall, soil, pH, geographical region, variety, or application rate. **This table is not a substitute for the label!**

Trade Name	Alfalfa	Cabbage	Clover	Cotton	Cucumber	Field Corn	Grain Sorghum	Lima Bean	Muskmelon	Onion	Peanut	Peas	Pepper	Pumpkin	Snap Bean	Soybean	Spring Oat	Squash	Sweet Corn	Tobacco	Tomato	Watermelon	White Potato	Winter Barley	Winter Rye	Winter Wheat
2,4-D[1]	3	3	3	1	3	0.25-1	1	3	3	3	1	3	3	3	3	0.25-1[1]	1	3	1	3	3	3	1	1	1	1
Accent/ Accent Q	10[1]	10[2]	10	10	10[2]	NR	10-18[1]	10-18[1]	10[2]	10[2]	10[2]	10	10[2]	10[2]	10	0.5	8	10[2]	10	10[2]	10[2]	10[2]	10[1]	4	4	4
Acuron	18	18	18	10	18	NR	10	18	18	18	10	18	18	18	18	10	4	18	NR	18	18	18	10	4	4	4
Acuron Flexi[23]	10	18	18	10	18	NR	10	18	18	18	10	18	18	18	18	10	4	18	NR	18	18	18	10	4	4	4
Acuron GT	10	18	18	10	18	NR	10	18	18	18	10	18	18	18	18	10	4.5	18	NR	18	18	18	10	4.5	4.5	4.5
Afforia (2.5 oz)	4[24]	4[24]	4[24]	1	4[24]	0.5[24]	1	4[24]	4[24]	4[24]	1.5	3	4[24]	4[25]	3	NR[24]	4[24]	4[24]	3	1.5	4[24]	4[24]	4[24]	3	3	1[24]
Aim	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Antares Complete	12	18B	18B	12-18[1]	18B	4-10[1]	12-18[1]	18B	18B	18B	12	18B	18B	18B	18B	NR	18B	18B	18B	18	4[9]	18B	12	4.5	18B	4.5
Anthem Flex (5.46 oz)	10	18	18	4	18	NR	10[25]	11	18	18	4	11	18	18	11	NR	11[25]	18	NR	18	9	18	NR	11[25]	11[25]	4[25]
Anthem Maxx (4.87 oz)	10	18	18	4	18	NR	10[25]	11	18	18	4	11	18	18	11	NR	11[25]	18	NR	18	9	18	1	11[25]	11[25]	4[25]
Armezon/ Impact (0.75 oz)	9	18	18	9	18	NR	9	9	18	18	9	9	18	18	9	9	3	18	NR	18	18	18	9	3	3	3
Armezon PRO (16–20 fl oz/A)	9	18	18	9	18	NR	9	9[3]	18	18	9	9[3]	18	18	9[3]	9	4	18	NR	18	18	18	9	4	4	4
Assure II	4	4	4	NR	4	4	4	4	4	4	4	NR	4	4	NR	NR	4	4	4	4	4	4	4	4	4	4
Atrazine	SY	SY	SY	SY	SY	NR	NR	SY	SY	SY	NY	SY	SY	SY	SY	NY	SY	SY	NR	SY	SY	SY	SY	NY	NY	NY
Authority Edge	12	18[9]	18	12[1]	18	4	10-18[1]	9	18	18	4	9	18	18	9	NR[1]	12-18[1]	18	12	18	18	18	4	11-18[1]	11-18[1]	4-10[1]
AuthorityElite/ BroadAxe XC	12	2[9]	12B	18[4]	12B	10	10	12B	12B	12	4	12B	12B	12B	12B	NR	12	12B	18	10	4	12B	4	4.5	4.5	4.5
Authority First/Sonic	12	30B	30B	12-18[1]	30B	10-18[1]	12	12	30B	30B	12	9	30B	30B	12	NR	12	30B	10-18[1]	30[1]	30B	30B	18	12	12	4

Trade Name	Alfalfa	Cabbage	Clover	Cotton	Cucumber	Field Corn	Grain Sorghum	Lima Bean	Muskmelon	Onion	Peanut	Peas	Pepper	Pumpkin	Snap Bean	Soybean	Spring Oat	Squash	Sweet Corn	Tobacco	Tomato	Watermelon	White Potato	Winter Barley	Winter Rye	Winter Wheat
Authority MTZ	12	18	18	18[4]	18	10	12	18	18	18	12	18	18	18	18	NR	18	18	18	12	NR[9]	18	12	4	4	4
Authority Supreme	12	18[9]	18	12–18[1]	18	4	10[1]	9	18	18	4	9	18	18	9	NR[1]	12[1]	18	10	18	18	18	4	11[1]	11[1]	4[1]
Authority XL	12-18[1]	18	18	18	18	10-18[1]	10-18[1]	36	36	36	18	36	36	18	36	NR	12-18[1]	36	18	10-18[1]	12-18[1,9]	18	36	4	4	4
Autumn Super[1]	18 B	18B	18B	10	18	1	18B	18B	18B	18B	18B	18B	18B	18B	18B	2	18B	18B	9	18B	18B	18B	18B	9	18B	3
Axial Bold, Axial Star, Axial XL	3	1	3	3	3	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3	3	3	1	NR	3	NR
Axiom	12	12B	12	8	12B	NR	12	12B	12B	18	12B	12B	12B	12B	12B	NR	12	12B	12B	12B	12B	12B	1	12	12	0.23-4
Balance Flexx[1]	10[1]	18	18	10[1]	18	NR	6	18	18	18	11	18	18	18	18	6	18	18	6	12	18	18	6	6	4	4
Basagran	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Basis	10[6]	18	10[6]	1[6]	10	NR	10[6]	18	18	18	18	10	18	18	10	10[6]	9	18	10	18	1	18	NR	3	3	3
Basis Blend[6]	10[6]	18	10[6]	1[6]	10	NR	10[6]	18	18	18	1.5	10	18	18	10	10[6]	9	18	10	1.5	1	18	1	3	3	3
Beyond	3	9	18	9	9	8.5[8]	9	NR	9	9	9	NR	9	9	NR	NR	9	9	8.5	9	9	9	9	9	4	3[8]
Bicep products	SY	SY	SY	NY	SY	NR	NR[10]	SY	SY	SY	NY	SY	SY	SY	SY	NY	SY	SY	NY	SY	SY	SY	SY	NY	NY	NY
Boundary	4.5	12	12	12	12	4	12	12	12	18	12	8	12	12	12	NR	12	12	4	12	12	12	NR	4.5	12	4.5
Buctril/ Maestro	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Cadet	AH	AH	AH	AH	AH	NR	AH	AH	AH	AH	AH	AH	AH	AH	AH	NR	AH	AH	NR	AH	AH	AH	AH	AH	AH	AH
Calibra	10	18	18	10	18	NR	NR	18	18	18	10	18	18	18	18	10	18	18	NR	10	18	18	10	4.5	4.5	4.5
Callisto	10	18	18	10	18	NR	NR	18	18	18	10	10[1]	18	18	10[1]	10	NR	18	NR	10	18	18	10	4	4	4
Callisto Xtra	NY	18	18	NY	18	NR	NR	18	18	18	NY	18	18	18	18	NY	18	18	NR	NY	18	18	NY	NY	18	NY
Canopy[1]	10	18	12	10	18	10	12	30	30	30	18	12	30	18	12	NR	30	30	18	10[9]	10[9]	18	30	4	4	4
Canopy Blend	10	18	18	18	18	10[26]	18	30	30	30	18	12	30	18	18	NR	4	30	18	18[9]	10[9]	18	30	4	30	4
Canopy EX	10	18	12	10	18	10[1]	10[1]	30	30	18[1]	8	12	30	18	12	0.25[1]	4	30	18	10[9]	10[9]	18	18[1]	4	4	4
Caparol	12	5	12	5	12	5	12	12	12	8	12	5	12	12	12	12	12	12	5	12	12	12	12	12	12	12

Trade Name	Alfalfa	Cabbage	Clover	Cotton	Cucumber	Field Corn	Grain Sorghum	Lima Bean	Muskmelon	Onion	Peanut	Peas	Pepper	Pumpkin	Snap Bean	Soybean	Spring Oat	Squash	Sweet Corn	Tobacco	Tomato	Watermelon	White Potato	Winter Barley	Winter Rye	Winter Wheat
Capreno[1]	10-18	18	18	10	18	NR	10	18	18	18	11	18	18	18	18	10	10	18	10	12	18	18	18	10	18	4
Chaparral	SY B	SY B	SY B	SY B	SY B	NY	NY	SY B	SY B	SY B	SY B	SY B	SY B	SY B	SY B	SY B	NY	SY B	SY B	SY B	SY B	SY B	SY B	NY	NY	NY
Chateau (up to 3 oz)[11]	5[11]	12B	5[11]	2[11]	12B	0.5-1	1[1]	12B	12B	12B	NR	4	12B	12B	4	NR	5[11]	12B	4	2	12B	12B	5[11]	4	4	2
Cimarron Max/ metsulfuron[1]	12[1]	NY B	12[1]	NY B	NY B	NY B	NY B	NY B	NY B	NY B	NY B	NY B	NY B	NY B	NY B	NY B	10	NY B	NY B	NY B	NY B	NY B	NY B	10	NY B	1
Cimarron Plus	4	B	4-12[1]	B	B	12[1]	B	B	B	B	B	B	B	B	B	12[1]	10	B	B	B	B	B	B	10	NY B	1
Clarity	4	4	4	0.75 -1.5[5]	4	NR	NR	4	4	4	4	4	4	4	4	0.5-1[5]	0.5-1.5[5]	4	4	4	4	4	4	0.5-1.5[5]	0.5-1.5[5]	0.5-1.5[5]
Classic[1]	12	18	12	9	18	9	9	30	30	30	15	9	30	18	9	NR	3	30	18	10[9]	10[9]	18	30	3	3	3
Cobra	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Command/ Up-Stage	12	9	12	NR[12]	9	9	9	12	9	12	9	NR[1]	NR	NR[1]	9	NR	12	NR[1]	9	NR	9[9]	9	9	12	12	12
Corvus	17	17B	17B	10	17B	NR	17B[1]	17B	17B	17B	11[1]	17B	17B	17B	17	9	17	17B	9	12[1]	17B	17B	17	9	4	4
Crossbow[30]	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
Curbit	AH	AH	AH	AH	NR	AH	AH	AH	NR	AH	NR	AH	AH	NR	AH	NR	AH	NR	AH	AH	AH	NR	AH	AH	AH	AH
Curtail	10.5 -18[1]	10.5 -18[1]	10.5 B	10.5 B	10.5 B	1	10.5 -18[1]	10.5 B	10.5 B	10.5 -18[1]	10.5 B	18	10.5 B	10.5 B	10.5 B	10.5 -18[1]	1	10.5 B	10.5 -18[1]	10.5 B	10.5 B	10.5 B	18	1	10.5 B	1
Dacthal	8	AH	8	8	8	8	8	8	AH	AH	8	8	AH	8	8	8	8	8	8	8	AH	NR	AH	8	8	8
Degree Xtra	SY	SY	SY	NY	SY	NR	NR[10]	SY	SY	SY	SY	SY	SY	SY	SY	NY	SY	SY	NR	NY	SY	SY	SY	SY	SY	AH
Devrinol	12	NR	12	12	12	12	12	12	12	12	12	12	NR	12	12	12	6	12	12	NR	NR	12	12	6	6	6
DiFlexx	4	4	4	2	4	NR	2	4	4	4	4	4	4	4	4	2[1]	2	4	4	4	4	4	4	2	4	2
DiFlexx Duo	10	18B	18B	10	18	NR	10	18B	18	8/18[27]	11	10	18B	18	10	8	4	18	4	12	10	18	10	4	4	4
Distinct[1]	1	4	4	1	4	0.25	1	4	4	4	4	4	4	4	4	1	1	4	4	4	4	4	4	1	1	1
Dual products	4	2[1]	9	NR	12	NR	NR[10]	NR	12	2[1]	NR	NR	2	2[1]	NR	NR	4.5	12	NR	NY	2[1]	12	NR	4.5	4.5	4.5
DuraCor	24B	24B	24B	24B	24B	12	24B	24B	24B	24B	24B	24B	24B	24B	24B	24B	12	24B	12	24B	24B	24B	24B	12	12	12

E.2. Weed Control

Trade Name	Alfalfa	Cabbage	Clover	Cotton	Cucumber	Field Corn	Grain Sorghum	Lima Bean	Muskmelon	Onion	Peanut	Peas	Pepper	Pumpkin	Snap Bean	Soybean	Spring Oat	Squash	Sweet Corn	Tobacco	Tomato	Watermelon	White Potato	Winter Barley	Winter Rye	Winter Wheat
Elevore	9	15B	9	1	15B	0.1-0.5[1]	0.5	15B	15B	15B	9	9	15B	15B	15B	0.5	0.5	15B	15B	15B	15B	15B	24B	0.5	0.5	0.5
Enlist Duo	NI	NS	NS	1[32]	NS	0.23-0.5[32]	NS	NS	NS	NS	NS	NS	NS	NS	NS	1[32]	NS	NS	0.2-0.5	NS	NS	NS	NS	NS	NS	NI
Envive	10	18	12	10	18	10	12	30	30	30	8	12	30	18	12	NR	10	30	18	10[9]	12[9]	18	30	4	4	4
Eptam	NR	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	NR	AH	AH	AH	AH	AH	AH	AH	NR	AH	AH	AH
Evik	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	3	11	11	11	11	11	10	3	3	3
Expert	SY	SY	SY	NY	SY	NR	NR[10]	SY	SY	SY	NY	SY	SY	SY	SY	NY	SY	SY	NY	SY	SY	SY	SY	NY	NY	NY
Extreme	4	18	4	18	18	8.5[8]	18	NR	18	40B	NR	NR	18[9]/ 40B	40B	2	NR	18	40B	18	9.5	18[9]/ 40B	18	26	4	4	3
Facet L	24B	10	24B	10	10	10	NR	10	10	10	10	24B	24B	10	10	10	10	10	10	24B	24B	10	24B	10	10	NR
Fierce/ Fierce EZ	10	18	18	1-2[1]	18	0.25 -1[1]	18	11	18	18	4	11	18	18	11	NR	11-12[1]	18	18	12	18	18	4	11-12[1]	11-12[1]	1-2[1]
Fierce XLT[1]	18	18-30	18	18-30	18-30	10-18	18	18-30	18-30	18-30	18-30	18-30	18-30	18-30	18-30	NR	18-30	18-30	18-30	18[9]	18[9]	18-30	18-30	18	18	4
Finesse Cereal and Fallow (0.4 oz)	B	B	B	18	B	18	4-18[1]	B	B	B	B	B	B	B	B	18[14]	10	B	B	B	B	B	10	10-16[1]	0-4[1]	0-4[1]
FirstRate	9	18	18	9	18	9	9	9	18	18	9	9	18	18	9	NR	9	18	18	18[15]	18	18	18	12	18	4
Flexstar/ Flexstar GT	18	18	18	NR	12	10	18	4	12	18	10	4	10[9]/ 12	10	NR	NR	18	12	10	18	10[9]/ 12	10	NR	4	4	4
FulTime/ Keystone	15	SY	SY	NY	SY	NR	NY	SY	SY	SY	SY	15	SY	SY	SY	NY	15	SY	NR	15	SY	SY	15	15	15	4
Fusilade/ Fusion	2	2	2	NR	2	2	2	2	2	NR	NR	1	1	1	1	NR	2	2	2	2	2	2	2	2	2	2
Glyphosate products	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	1	NR	NR	NR	NR	NR	NR
Goal/ GoalTender	2	3	2	0.25	3	10	10	1-2	2-3[1]	6[1]	2	2	3[9]	3	2	0.25	10	3	10	2	1[9]	2[1]	2	10	10	10
Gramoxone/ paraquat	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
GrazonNext HL	24B	24B	24B	24B	24B	12	24B	24B	24B	24B	24B	24B	24B	24B	24B	24B	12	24B	12	24B	24B	24B	24B	12	12	12
Grazon P+D	B	B	B	B	B	B	8	B	B	B	B	B	B	B	B	B	8	B	B	B	B	B	B	2	2	2
Halex GT	10	18	18	10	18	NR	NR[10]	18	18	18	10	10[1]	18	18	10[1]	10	4.5	18	NR	10	18	18	10	4.5	4.5	4.5

Trade Name	Alfalfa	Cabbage	Clover	Cotton	Cucumber	Field Corn	Grain Sorghum	Lima Bean	Muskmelon	Onion	Peanut	Peas	Pepper	Pumpkin	Snap Bean	Soybean	Spring Oat	Squash	Sweet Corn	Tobacco	Tomato	Watermelon	White Potato	Winter Barley	Winter Rye	Winter Wheat
Harmony Extra SG	1.5	1.5	1.5	0.5	1.5	0.5	0.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	0.25	1.5	1.5	1.5	1.5	1.5	1.5	1.5	NR	1.5	NR
Harmony SG	1.5	1.5	1.5	0.25	1.5	NR	NR	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	NR	NR	1.5	1.5	1.5	1.5	1.5	1.5	NR	1.5	NR
Harness	9	SY	9	NS	SY	NR	NR [10]	SY	SY	SY	NY	NS	SY	SY	NS	NS	NS	SY	NR	NS	SY	SY	NS	NS	NS	4
Harness Max	10	18	18	10	18	NR	NR [10]	18	18	18	18	18	18	18	18	10	NY	18	18	18	18	18	18	NY	NY	4
Harness Xtra	SY	SY	SY	NS	SY	NR	NS	SY	SY	SY	SY	SY	SY	SY	SY	NS	SY	SY	NR	SY	SY	SY	SY	SY	SY	SY
Hornet WDG	10.5 [1]	26B	26B	18	26B	NR	12	10.5 [1]	26B	26B	18	18[16]	26B	26B	18[16]	10.5	4	26B	18[16]	18	26B	26B	18	4	4	4
Huskie	4[1]	1	1	1	1	4	0.25	1	1	9[1]	1	9	1	1	9	4	1	1	1	1	1	1	9	0.25	1	0.25
Impact Core	9	18	18	10	18	NR	9	18	18	18	10	18	18	18	18	10	9	18	NR	18	18	18	10	9	9	4
Instigate	18	18	18	10	18	NR	10	18	18	18	10	10[1]	18	18	10[1]	10	9	18	10	10	18	18	10	4	4	4
Karmex	24	24	24	NR	24	NY	NY	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Kerb[1]	NR	3-6	NR	3-5	3-6	12	12	3	3-6	3-6	12	3-4	3-6	3-6	3-4	3-4	12	3-6	12	12	3-6	3-6	3	12	12	12
Keystone NXT	SY	18	SY	NY	18	NR	NY	SY	18	18	SY	SY	18	18	18	NY	SY	18	NR	SY	18	18	SY	15	15	4
Kyro	10.5	18	18	12	18	NR	10.5	18	18	18	18	18	18	18	18	10.5	10.5	18	NR	18	18	18	18	10.5	10.5	4
Laudis	10	18	18	10	18	NR	10	18	18	8[1]	11	10	18	18	10	8	4	18	NR	12	10	18	10	4	4	4
LeadOff (1.5 oz)	10	18	10[1]	1	10	NR	10	18	18	18	1.5	10	18	18	10	1[1]	9	18	10	1.5	1	18	1	3	3	3
Lexar/ Lexar EZ	18	18	18	NY	18	NR	NR [10]	18	18	18	NY	18	18	18	18	NY	NY	18	NR	18	18	18	18	NY	NY	NY
Liberty	6	2.3	6	NR	6	NR	6	6	6	2.3	6	6	6	6	6	NR	2.3	6	NR	6	6	6	2.3	2.3	2.3	2.3
Lightning	9.5	40B	40B	9.5[1]	40B	8.5[8]	18	9.5	40B	40B	9.5	9.5	40B	40B	9.5	9	18	40B	18	9.5	40B	40B	26	18	4	4
Lorox/ Linex	4	4	4	4	4	NR[1]	NR[1]	4	4	4	4	4	4	4	4	NR[1]	4	4	4	4	4	4	NR[1]	12	4	4
Lumax/ Lumax EZ	18	18	18	NY	18	NR	NR [10]	18	18	18	NY	18	18	18	18	NY	NY	18	NR	18	18	18	18	4.5	4.5	4.5
Marvel	18	18	18	NR	18	10	18	18	18	18	10	10	4[9]	18	NR	NR	4	18	18	18	4[9]	18	NR	4	4	4

E.2. Weed Control

Trade Name	Alfalfa	Cabbage	Clover	Cotton	Cucumber	Field Corn	Grain Sorghum	Lima Bean	Muskmelon	Onion	Peanut	Peas	Pepper	Pumpkin	Snap Bean	Soybean	Spring Oat	Squash	Sweet Corn	Tobacco	Tomato	Watermelon	White Potato	Winter Barley	Winter Rye	Winter Wheat
Matrix	4	12	18	10	10	NR	18	10	18	10	18	8	12	12	10	4	9	18	10	18	NR	12	NR	12	12	4
Maverick	18	18	18	18	18	NR	18	18	18	18	18	18	18	18	18	10.5	18	18	NR	18	18	18	18	18	18	4-6
Metribuzin products	4	18	18	18	18	4	18	18	18	18	18	8	18	18	18	4	18	18	4	18	4	18	12	4[1]	18	4[1]
Milestone	24B	24B	24B	24B	24B	12	24B	24B	24B	24B	24B	24B	24B	24B	24B	24B	12	24B	24B	24B	24B	24B	24B	12	12	12
Optill[1]	4	40B	4	18	18	8.5[8]	18	4	40B	40B	4	4	18	40B	4	0-1	18	40B	18	9.5	18	40B	26	9.5	4-18	4[8]
Osprey	10	10	10	3	10	3	3	10	10	10	3	3	10	10	10	3	10	10	10	10	10	10	10	1	10	0.25
Outlook[1]	4-6	6-9	6-9	4	6-9	NR	NR[10]	6-9	6-9	6-9	NR	4	6-9	6-9	6-9	NR	4	6-9	NR	6-9	6-9	6-9	6-9	4	4	4
Outrider	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	NR
Overdrive	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
PastureGard HL	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	4	NI	NI	NI	NI	NI	NI	4	NI	4
Peak (0.25 oz)[1]	22	22	22	10	22	1[8]	1	22	22	22	10	10	22	22	10	10	NR	22	10	10	22	22	22	NR	NR	NR
Permit	9	15	9	4	2	1[8]	2	NI	9	18	6	9	10	9	2	9[1]	2	9	3	36	2	9	9	2	2	2
Permit Plus	9	15	9	4	2	1	2	NI	9	18	6	9	10	9	2	9[1,14]	2	9	3	36	2[9]	9	9	2	2	2
Perpetuo	10	18	18	2-4	18	NR	6-8[1]	11	18	18	2-4[1]	9-11[1]	18	18	11	NR	18	18	8	18	18	18	4	18	18	1-4
Poast	NR	NR	NR	NR	NR	1	1	NR	NR	NR	NR	NR	NR	NR	NR	NR	30	NR	1[7]	NR	NR	NR	NR	1	1	1
PowerFlex HL	9	12	12	3[1]	12	9	3	12	12	12	9	9	12	12	12	3[1]	9	12	9	12	12	12	9	9	12	1
Prefar[1]	4	NR	4	4	NR	4	4	4	NR	NR	4	4	NR	NR	4	4	4	NR	4	4	NR	NR	4	4	4	4
Prefix	18	18	18	1	12	10	18	4	12	18	4	4	10[9]	10	NR	NR	4.5	12	10	18	10[9]	10	1	4.5	4.5	4.5
Princep 4L	SY	SY	SY	NY	SY	NR	NY	SY	SY	SY	NY	SY	SY	SY	SY	NY[17]	SY	SY	NY	SY	SY	SY	SY	NY	NY	NY
Prowl H2O	6[1]	NY	NY	NR	NY	NR[18]	NY	NR	NR	NY	NR	NR	NR[1]	NY	NR	NR	NY	NR	NR[18]	NR[1]	NR[1]	NR	NR[1]	4[1]	NY	4[1]
Pursuit[1]	4	40B	4	18[19]	40B	8.5[8]	18	NR	40B	40B	NR	NR	18[9]	40B	2	NR	18	40B	18	9.5	40B[9]	40B	26[1]	9.5[1]	4	4

Trade Name	Alfalfa	Cabbage	Clover	Cotton	Cucumber	Field Corn	Grain Sorghum	Lima Bean	Muskmelon	Onion	Peanut	Peas	Pepper	Pumpkin	Snap Bean	Soybean	Spring Oat	Squash	Sweet Corn	Tobacco	Tomato	Watermelon	White Potato	Winter Barley	Winter Rye	Winter Wheat
Python	4	26B	9	9[1]	26B	NR	12	4	26B	26B	4	4	26B	26B	4[1]	NR	4	26B	18[1]	9	26B	26B	12	4	4	4
Raptor	3	9	18	9	9	8.5[8]	9	NR	9	9	9	NR	9	9	NR	NR	9	9	8.5	9	9	9	9[1]	9[1]	4	3
Realm Q	10	18	18[1]	10	18	NR	10	18	18	18	10	10[1]	18	18	10[1]	10	9	18	10	10	18	18	10	4	4	4
Reflex	18	18	18	NR	12	10	18	4	12	18	4	4	10[9]	10	NR	NR	4	12	10	18	10[9]	10	NR	4	4	4
RemedyUltra[30]	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
Resicore/ Resicore XL	10.5[28]	18	18	12	18	NR[28]	10.5[28]	18	18	18	18	18	18	18	18	10.5[28]	10.5[28]	18	10.5	18	18	18	18	10.5[28]	10.5[28]	4
Resolve SG (1 oz)	10	18	10[1]	1	10	NR	10	18	18	18	18	10	18	18	10	10[14]	9	18	10	18	1	18	NR	9	18	3
Resolve Q (1.25 oz)	10	18	10[1]	1	10	NR	10	18	18	18	1.5	10	18	18	10	2[1]	9	18	10	1.5	1	18	NR	3	3	3
Resource	1	1	1	1	1	NR	1	1	1	1	1	1	1	1	1	NR	1	1	1	1	1	1	1	1	1	1
Reviton (2 oz)	5	5	5	0.5	5	NR	5	5	5	5	5	5	5	5	5	0.25	5	5	5	5	5	5	5	5	5	NR
Revulin Q	10[1]	18	18	10	18	NR	10[1]	18	18	18	18	18	18	18	18	10	8	18	10[20]	18	18	18	10[1]	4	4	4
Ro-Neet	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH
Sandea	9	15	9	4	2	1[8]	2	36	9	18	6	9	10	9	2	9[1]	2	9	3	36	2	9	9	2	2	2
Scepter[1]	18	18	18	18	18	9.5[13]	11	11	18	18	11	18	18	18	11	NR	11	18	18	9.5	18	18	18	11	18	3
Select/ Select Max	NR	NR	NR	NR	NR	0.2	1	NR	NR	NR	NR	NR	NR	NR	NR	NR	1	NR	1	1	NR	NR	NR	1	1	1
Sentrallas	4	4	4	4	4	NR	NR	4	4	4	4	4	4	4	4	4[1]	NR	4	4	4	4	4	4	NR	4	NR
Sequence	4	NY	9	NR	NI	NR	NR	NR	NI	NI	NI	NR	NY	NI	NR	NR	4.5	NI	NI	NY	6[1]	NI	NY	4.5	4.5	4.5
Sharpen (1 oz)[1]	4	4	4	1.5	4	NR	NR	4	4	4	4	NR	4	4	4	0-1	NR	4	0.5	4	4	4	4	NR	NR	NR
Shieldex	9	9	12	9	9	NR	9	9	9	12	9	9	12	9	9	9	3	9	NR	12	9	9	9	3	3	3
Sinate	9	18	18	9	18	NR	9	18	18	18	9	9-18[1]	18	18	9-18[1]	9	3	18	NR	18	18	18	9	3	3	3
Sinbar	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24

Trade Name	Alfalfa	Cabbage	Clover	Cotton	Cucumber	Field Corn	Grain Sorghum	Lima Bean	Muskmelon	Onion	Peanut	Peas	Pepper	Pumpkin	Snap Bean	Soybean	Spring Oat	Squash	Sweet Corn	Tobacco	Tomato	Watermelon	White Potato	Winter Barley	Winter Rye	Winter Wheat
Solicam	16	24B	24B	1-16[1]	24B	24B	24B	24B	24B	24B	1-16[1]	24B	24B	24B	24B	1.5-16[1]	24B	24B	24B	24B	24B	24B	24B	24B	24B	24B
Sonalan	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	NR	AH	AH	AH	AH	NR	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH
Spartan	12	NR	12B	18	12B	10	10[1]	NR	12B	12B	12B	12B	12B	12B	12B	NR	12	12B	18	NR	NR[9]	12B	12B	4	4	4
Spartan Charge	12	NR[9]	12B	12-18[1]	12B	NR	10[1]	12B[1]	12B	12B	NR	12B	12B	12B	12B	NR	12	12B	12	NR	NR[9]	12B	NR[1]	4	4	4
Spin-Aid	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	4	AH	AH	AH	AH	AH	AH	4	4	4
Spirit	18	10	18	10	18	18	10	18	18	18	18	10	18	18	10	10	3	18	8	10	10	18	10	3	3	3
Spur	12-18	NR	10.5B	10.5-18B	10.5-18B	NR	12	10.5B	10.5-18B	12	10.5B	18B	10.5B	10.5-18B	10.5B	12-18	NR	10.5B	NR	10.5B	10.5B	10.5-18	10-18B	NR	10.5B	NR
Starane Ultra	4	4	4	4	4	NR	NR	4	4	4	4	4	4	4	4	4[31]	NR	4	NR	4	4	4	4	NR	NR	NR
Status	1[5]	4	4	1[5]	4	0.25	1[5]	4	4	4	4	4	4	4	4	1[5]	1[5]	4	4	4	4	4	4	1[5]	1[5]	1[5]
Steadfast Q	10[1]	18	10[1]	10	10-18	NR	10-18	10-18	10-18	10-18	10-18	10	10-18	10-18	10	0.5	4	10-18	10[20]	10-18	10-18	10-18	10[1]	4	4	4
Stinger	10.5	NR	18	18B	18B	NR	10.5	18B	18B	10.5	18B	18B	18B	18B	18B	10.5[1]	NR	18B	NR	18B	18B	18B	18B	NR	NR	NR
Storen	10	18	18	10	18	NR	10	18	18	18	10	18	18	18	18	10	11	18	NR	18	18	18	10	11	11	4.5
Storm	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	NR	3.3	3.3	3.3	3.3	NR	1.3	3.3	3.3	3.3	3.3	3.3	3.3	1.3	1.3	1.3
Stout	10[1]	18	10[1]	10	18	NR	10	18	18	18	18	10	18	18	10	0.5	8	18	10[20]	18	18	18	10[1]	4	4	4
SureStart II/ TripleFLEX	NY[1]	26B	NY[1]	26B	26B	NR	12	26B	26B	26B	26B	NY	26B	26B	26B	NY[1]	NY	26B	18[1]	18	26B	26B	18	NY	NY	4
Surpass NXT	9	NI	9	NY	NI	NR	NR[10]	NY	NI	NI	NI	NY	NI	NI	NY	NY	NY	NI	NR	NY	NY	NI	NY	NY	NY	4
Surveil	10	30B	30B	9	30B	9	9	9	30B	30B	9	9	30B	30B	9	NR	9	30B	18	10[21]	30B	30B	18	30B	30B	3
Synchrony XP[1]	12	18	12	9	18	9	9	30	30	30	15	9	30	18	9	NR	3	30	18	9[9]	9[9]	18	30	3	3	3
Targa	4	4	4	NR	4	4	4	4	4	4	4	NR	4	4	NR	NR	4	4	4	4	4	4	4	NR	4	NR
Tavium	6	6	9	1.4[1]	12	NR	6	6	12	6	6	6	6	6	6	1[1]	4.5	12	NR	NY	6	12	6	4.5	4.5	4.5
Treflan	NR	NR	5	NR	5	12-14[33]	12-14[33]	NR	5	5	NR	NR	NR[9]	5	NR	NR	12-14[33]	5	12-14[33]	5	NR	5	NR	NR	NR	NR

Trade Name	Alfalfa	Cabbage	Clover	Cotton	Cucumber	Field Corn	Grain Sorghum	Lima Bean	Muskmelon	Onion	Peanut	Peas	Pepper	Pumpkin	Snap Bean	Soybean	Spring Oat	Squash	Sweet Corn	Tobacco	Tomato	Watermelon	White Potato	Winter Barley	Winter Rye	Winter Wheat
Trivence	10	18	18	18	18	10[1]	18	30	30	30	18	12	30	18	30	NR	18	30	18	18[9]	12[9]	18	30	4	30	4
TriVolt	17	17	17	10	17	NR	17	17	17	17	12	17	17	17	17	9	17	17	9	17	17	17	17	12	12	4
Ultra Blazer	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	NR	3.3	3.3	3.3	3.3	NR	1.3	3.3	3.3	3.3	3.3	3.3	3.3	1.3	1.3	1.3
Valor SX/Valor EZ (up to 3 oz)	5[11]	6-12B	5[11]	2[11]	6-12B	0.5-1[1]	1	6-12B	6-12B	6-12B	NR	4	6-12B	6-12B	4	NR	5[11]	12	4	2[11]	6-12B	6-12B	5[11]	4	4	2[11]
Valor XLT[22]	12-18	18-30	12	10-18	18-30	10-18	10-18	18-30	18-30	18-30	18-30	12	18-30	18-30	12	NR	18-30	18-30	18-30	10-18[9]	12-18[9]	18-30	18	4	4	4
Varisto	3	9	18	9	18	8.5[29]	9	NR	9	9	9	NR	9	9	NR	NR	9	9	8.5	9	9	9	9[29]	9[29]	4	3[29]
Verdict	7	7	7	6	7	NR	NR	7	7	7	7	4	7	7	7	NR	4	7	4	7	7	7	7	4	4	4
Vida	1	1 day	1	NR	1 day	NR	1 day	1 day	1 day	1 day	1	1 day	1 day	1 day	1 day	NR	1 day	1 day	1	1	1 day	1 day	NR	1 day	1 day	NR
Warrant	9	NI	9	NR	NI	NR	NR[10]	NY	NI	NI	NR	SY	NI	NI	NY	NR	NY	NI	NY	NY	NI	NI	NY	NY	NY	4
Warrant Ultra	18	NI	18	1	NI	10	18	NY	NI	NI	10	10	NI	NI	NY	NR	NY	NI	12	NI	NI	NI	NI	NY	NY	4
XtendiMax[1]	4	4	4	1[1]	4	NR	0.5[1]	4	4	4	4	4	4	4	4	1	1	4	4	4	4	4	4	1	1	1
Yukon	9	15	9	4	9	1[8]	2	NI	9	18	6	9	10	9	2	9[1]	2	9	3	NI	2[9]	9	9	2	2	2
Zeus XC	12	NR[9]	12B	18	12B	10	10[1]	NR	12B	12B	4	NR	12B	12B	12B	NR	12	12B	18	NR	12B[9]	12B	12B	4	4	4
Zidua/ZiduaSC (3 oz or 5 fl oz)[1]	10	18	18	4	18	NR	10	11	18	18	4	11[1]	18	18	11	NR	11	18	NR	18	18	18	4	11[1]	11[1]	4[1]
Zone Defense	12	4[34]	4[34]	18	12	10	10	4[34]	4[34]	12	NR	4[34]	12	12	12	NR	12	12	18	1	4[9,34]	4[34]	4[34]	4	4	4

Abbreviations

AH = after harvest

B = bioassay of soil recommended before planting

NI = no information

NR = no restrictions

NS = next season

NY = next year

SY = second year following application

The information listed in this rotation restriction table is our interpretation of label statements. Consult the label if two or more of these materials are applied during the same season. Herbicide labels are constantly changing; therefore, this list is not a substitute for the most recent herbicide label.

Table E-5 Footnotes

[1]Read the label for additional restrictions due to application rate, timing, geographical region, rainfall, soil pH, tillage, variety, or supplemental labeling.

[2]18 months with a soil pH > 6.5. At rates greater than 2.1 oz/A, a rotation interval of 30 months and a successful field bioassay are required.

[3]Rotation interval for lima bean is 18 months if Armezon PRO is applied at greater than 20 fl oz/A. Rotation interval for pea and snap bean is extended to 18 months if Armezon PRO is applied at greater than 25 fl oz/A.

[4]Cotton may be planted after 12 months where Authority Elite/BroadAxe was applied at rates less than 36 oz/A, Authority MTZ DF at rates less than 17 oz/A, or Authority First/Sonic at rates less than 5 oz/A and the following conditions are met: medium and fine soils, pH < 7.2, and rainfall or irrigation must exceed 15 inches after herbicide application and prior to planting cotton.

[5]Following application of Clarity and a minimum of 1 inch of rainfall or overhead irrigation, a waiting interval of 21 days is required per 8 fl oz/A applied prior to planting cotton, 30 days per pint restriction for soybean, and 20 days per pint restriction for small grains. If less than 1 inch or rainfall or irrigation is received after application and Status is applied at greater than 5 oz/A, the rotation interval is 4 months.

[6]If Basis rate is 0.33 to 0.5 oz/A or Basis Blend rate is 1.25 oz/A, alfalfa, sorghum, pea = 18 months; soybean, snap bean = 10 months; STS soybean = 1 month; spring oat = 9 months; if Basis rate is greater than 0.5 oz/A or Basis Blend rate is 2.5oz/A, cotton = 10 months and 18 months if greater than and less than 15 inches of rainfall or irrigation occur after application and prior to planting, respectively; STS soybean = 4 months; if Basis rate is 0.33 oz/A or Basis Blend rate is 0.825, soybean = 0.5 month.

[7]NR for Poast Protected corn hybrids.

[8]NR for IMI (IR/IT) or Clearfield (CL) varieties.

[9]Transplanted.

[10]Use safener with seed.

[11]Cotton may be planted no-till or strip-till after 14 or 21 days when applied at 1 oz/A or 1.5 to 2 oz/A, respectively. For winter wheat, at rates up to 2 oz/A, the rotation interval is 7 days for no-till or minimum-till wheat and 30 days for conventional-till wheat. At least 1 inch of rainfall/irrigation must occur between application and cotton, field corn, grain sorghum, tobacco, or wheat planting, or crop injury may occur. For alfalfa, clover, potato, and spring oats the rotation interval is 5 months if the soil is tilled prior to planting or 10 months if no tillage is preformed prior to planting. At lower rates of Valor/Rowel/Chateau, rotation interval for many crops is reduced. Chateau may be applied to potato following hilling at a rate of 1.5oz/A. Consult labels for more specific information.

[12]Command may be applied preemergence to cotton only if Di-Syston or Thimet insecticides are applied in furrow with the seed at planting.

[13]Corn hybrids that are classified as IMI-corn or as tolerant (IT) or resistant (IR) may be planted in the spring of the year following regardless of rainfall or time interval from chemical treatment to corn planting. Rotation interval varies by tillage type and use rate. Consult the label for specific rotation intervals.

[14]Rotation interval is shorter for STS soybean.

[15]Transplanted tobacco = 10 months if ≤ 0.3 oz/A.

[16]If Hornet WDG rate is < 4 oz/A, snap beans, peas, and some varieties of sweet corn = 10.5 months.

[17]If no more than 2 lb ai applied the previous year.

[18]Regardless of tillage, be sure to plant corn at least 1.5 inches deep and completely cover with soil.

[19]Cotton may be planted 9.5 months following Pursuit if all of the following criteria are met: Pursuit is applied to peanuts only; soil texture is sandy loam or loamy sand only; and greater than 16 inches of rainfall/irrigation is received following application of Pursuit through October of the application year.

[20]The rotation interval for the sweet corn varieties 'Merit', 'Carnival', and 'Sweet Success' is 15 months.

[21]Transplanted tobacco may be planted 10 months after application of 2.1 oz/A of Surveil. Tobacco in seeded nurseries may be planted 18 months after application of 2.1 oz/A of Surveil and following a successful field bioassay. At rates greater than 2.1 oz/A, a rotation interval of 30 months and a successful field bioassay are required.

[22]Rotation intervals based on soil pH less than 7.0. In Pennsylvania, rotation interval for clover, lima bean, muskmelon, onion, pepper, spring oat, squash, and white potato is 18, 30, 30, 30, 30, 30, 30, and 30 months, respectively. Consult seed corn agronomist regarding inbred sensitivity to Valor XLT/Rowel FX prior to planting inbred seed corn lines.

[23]If applied after June 1, rotating to crops other than corn (all types) may result in crop injury.

[24]For Bolt or non-Bolt soybean and minimum- or no-till field corn, if Afforia is used on coarse textured soils, such as sands and loamy sands, or on high-pH soils (>7.9), extend time to planting by 7 additional days. For minimum- or no-till wheat in the states of DE, MD, NJ, or VA, Afforia may be applied at a minimum 7 days before planting. Do not us on Durum wheat and do not irrigate between emergence and spike. Wheat must be planted at least 1 inch deep. Do not graze until wheat has reached 5 inches in height. For conventional-till field corn, grain sorghum, cotton, and wheat, at least 1 inch of rainfall/irrigation must occur between application and planting, or crop injury may occur. For alfalfa, cabbage, clover, cucumber, lima bean, muskmelon, onion, pepper,

pumpkin, spring oat, squash, sweet corn, tobacco, tomato, watermelon, and white potato, the rotation interval is 4 months if the soil is tilled prior to planting. If no tillage is performed prior to planting these crops, the rotation interval is extended to 8 months.

[25]Rotation interval for spring oat, or winter barley at 5.7 oz/A or greater rates is extended to 18 months. For winter wheat, at 5.7 oz/A or greater rates, the rotation interval is extended to 6 months.

[26]Seed corn inbred lines vary in sensitivity to herbicides; therefore, users should seek advice from seed corn agronomist regarding inbred sensitivity to Canopy Blend prior to planting inbred seed corn.

[27]For onion, the rotation interval for irrigated and nonirrigated is 8 and 18 months, respectively.

[28]For corn, if the original corn crop is lost, do not make a second application. Injury may occur to soybean planted the year following application on soils having a calcareous subsurface layer if products containing atrazine were used at rates greater than 0.75 lb/ai atrazine per acre in tank mixtures and/or sequentially with Resicore. If Resicore is applied after June 1, rotating to crops other than corn or grain sorghum the next spring may result in crop injury.

[29]NR for Clearfield corn (field and seed). For wheat, planting non-Clearfield cultivars in areas receiving less than 10 inches of precipitation from time of application up until wheat planting may result in wheat injury. Injury potential increases if less than normal precipitation occurs in the 2 months just after Varisto application. For barley, the rotation interval at pH > 6.2 and > 18 inches of rainfall/irrigation, pH < 6.2 and < 18 inches of rainfall/irrigation and with moldboard plowing, and pH < 6.2 and < 18 inches rainfall/irrigation and without moldboard plowing is 9, 9, and 18 months, respectively. For potato, the rotation interval at pH > 6.2 and > 18 inches of rainfall/irrigation and pH < 6.2 and < 18 inches of rainfall/irrigation is 9 and 18 months, respectively.

[30]Rotation information is unknown for this product. Contact manufacturer for recommendations.

[31]In Delaware and Virginia, a Special Local Needs Label 24(c) has approved a 3-month plant-back restriction for soybean after an application to winter wheat.

[32]NR for Enlist varieties.

[33]In areas receiving 20 inches of rainfall or irrigation; 12 months after a spring application or 14 months after a fall application of Treflan 4L or 4EC. Labelled for these crops or after crop plants have emerged.

[34]Rotation is 8 months in no-till.

2.6. Prepackaged Herbicide Mixtures

Table E-6. Prepackaged Herbicide Mixtures

Prepackaged herbicide mixtures and the components of the mixtures available for various vegetable crops.

Trade Name	Components (ai/gal or lb)	HRAC Mode of Action Number	If You Apply (per acre)	You Have Applied (ai per acre)	Equivalent to a Tank Mixture of These Products (per acre)
Acuron 3.44SC	2.14 lb s-metolachlor	15	2.5 qt	1.34 lb s-metolachlor	1.4 pt Dual II Magnum 7.64E
	0.24 lb mesotrione	27		0.15 lb mesotrione	4.8 fl oz Callisto 4SC
	0.06 lb bicyclopyrone	27		0.038 lb bicyclopyrone	0.038 lb bicyclopyrone
	1 lb atrazine	5		0.625 lb atrazine	0.625 qt Atrazine 4L
Acuron Flexi 3.26SC	2.86 lb s-metolachlor	15	2 qt	1.43 lb s-metolachlor	1.5 pt Dual II Magnum 7.64E
	0.32 lb mesotrione	27		0.16 lb mesotrione	5.12 fl oz Callisto 4SC
	0.08 lb bicyclopyrone	27		0.04 lb bicyclopyrone	0.04 lb bicyclopyrone
Anthem Flex 4SE	3.733 lb pyroxasulfone	15	4.0 fl oz	0.117 lb pyroxasulfone	3.5 fl oz Zidua 4.17SC
	0.267 lb carfentrazone	14		0.008 lb carfentrazone	0.54 fl oz Aim 2EC
Armezon PRO 5.35 EC	0.1 lb topramezone	27	24 fl oz	0.017 lb topramezone	0.76 fl oz Armezon 2.8SC
	5.25 lb dimethenamid	15		0.84 lb dimethenamid	18 fl oz Outlook 6E
Authority Elite 7SE	0.7 lb sulfentrazone	14	25 fl oz	0.13 lb sulfentrazone	4.2 fl oz Zeus 4L OR 5.3 fl oz Spartan Charge 3.5EC
	6.3 lb s-metolachlor	15		1.23 lb s-metolachlor	1.29 pt Dual Magnum 7.62E
Authority MTZ 45DF	0.18 lb aulfentrazone	14	8 oz	0.13 lb metribuzin	2.8 oz metribuzin 75DF
	0.27 lb metribuzin	5		0.09 lb sulfentrazone	3.3 fl oz Spartan Charge 3.5EC
Bicep II Magnum 5.5L	2.4 lb s-metolachlor	15	2.1 qt	1.26 lb s-metolachlor	1.33 pt Dual II Magnum 7.64E
	3.1 lb atrazine	5		1.63 lb atrazine	1.63 qt Atrazine 4L
Boundary 6.5L	1.25 lb metribuzin	5	2 pt	1.24 lb S-metolachlor	1.3 pt Dual Magnum 7.26EC
	5.25 S-metochlor	15		0.314 lb metribuzin	10 fl oz metribuzin 4L
BroadAxe XC 7SE	0.7 lb sulfentrazone	14	25 fl oz	0.13 lb sulfentrazone	4.2 fl oz Zeus 4L OR 5.3 fl oz Spartan Charge 3.5EC
	6.3 lb s-metolachlor	15		1.23 lb s-metolachlor	1.29 pt Dual Magnum 7.62E
Calibra 3.1ZC	0.28 lb mesotrione	27	2.4 qt	0.168 lb mesotrione	5.36 fl oz Callisto 4SC
	2.82 lb S-metolachlor	15		1.67 lb S-metolachlor	1.7 pt Dual II Magnum 7.64 EC
Coyote 3.67SC	0.33 lb mesotrione	27	2 qt	0.168 lb mesotrione	5.36 fl oz Callisto 4SC
	3.34 lb S-metolachlor	15		1.67 lb S-metolachlor	1.75 pt Dual II Magnum 7.64 EC
Degree Xtra 4.04ME	2.7 lb acetochlor	15	3 qt	2.03 lb acetochlor	4.3 pt Degree 3.8ME
	1.34 lb atrazine	5		1 lb atrazine	1 qt Atrazine 4L
Empyros 3.82E	0.1 lb tolpyralate	27	1.4 qt	0.035 lb tolpyralate	1.3 fl oz Shieldex 3.3SC
	3.72 lb S-metolachlor	15		1.3 lb S-metolachlor	1.3 pt Dual II Magnum 7.64 EC

Table E-6. Prepackaged Herbicide Mixtures - continued next page

Table E-6. Prepackaged Herbicide Mixtures - continued

Trade Name	Components (ai/gal or lb)	HRAC Mode of Action Number	If You Apply (per acre)	You Have Applied (ai per acre)	Equivalent to a Tank Mixture of These Products (per acre)
Harness Xtra 5.6L	0.74 lb dimethenamid	15	2.5 qt	1.94 lb acetochlor	2.21 pt Harness 7E
	1.44 lb atrazine	5		1.56 lb atrazine	1.56 qt Atrazine 4L
Keystone NXT 5.6SE	3.1 lb acetochlor	15	2.5 qt	1.94 lb acetochlor	2.22 pt Surpass NXT 7E
	2.5 lb atrazine	5		1.57 lb atrazine	3.15 pt Atrazine 4L
Lexar EZ 3.7SC	1.74 lb s-metolachlor	15	3 qt	1.3 lb s-metolachlor	1.36 pt Dual II Magnum 7.64E
	0.224 lb mesotrione	27		0.168 lb mesotrione	5.36 oz Callisto 4SC
	1.74 lb atrazine	5		1.3 lb atrazine	1.3 qt Atrazine 4L
Lumax EZ 3.6SC	2.49 lb s-metolachlor	15	2.7 qt	1.67 lb s-metolachlor	1.75 pt Dual II Magnum 7.64E
	0.249 lb mesotrione	27		0.168 lb mesotrione	5.36 oz Callisto 4SC
	0.935 lb atrazine	5		0.625 lb atrazine	0.625 qt Atrazine 4L
Moccasin MTZ 52DF	3.35 lb S-metolachlor	15	3 pt	1.25 lb S-metolachlor	1.3 pt Dual Magnum 7.26EC
	1.116 lb metribuzin	5		0.419 lb metribuzin	13.4 fl oz metribuzin 4L
Preview 2.1 3.35SC	2.23 lb metribuzin	15	10 fl oz	0.17 lb metribuzin	5.4 fl oz metribuzin 4L
	1.12 lb sulfentrazone	5		0.09 lb sulfentrazone	3.3 fl oz Spartan Charge 3.5EC
Restraint 6.5EC	0.094 lb tolpyralate	27	30 fl oz	0.02 lb tolpyralate	0.85 fl oz Shieldex 3.3SC
	6.404 lb acetochlor	15		1.5 lb acetochlor	1.7 pt Harness 7E
Revulin Q 51.2WDG	0.144 lb nicosulfuron	2	4 oz	0.036 lb nicosulfuron	1.1 oz Accent Q WG
	0.368 lb mesotrione	27		0.094 lb mesotrione	3 fl oz Callisto 4SC
Sinate 2.57SL	2.47 lb glufosinate	10	28 fl oz	0.54 lb glufosinate	30 fl oz Liberty 2.34L
	0.1 lb topramezone	27		0.022 lb topramezone	1 fl oz Impact 2.8SC
Spartan Charge 3.5EC	3.15 lb sulfentrazone	14	3.5 fl oz	0.09 lb sulfentrazone	2.8 fl oz Zeus 4L
	0.35 lb carfentrazone	14		0.01 lb carfentrazone	0.6 fl oz Aim 2EC
Storen 3.2ZC	0.31 lb mesotrione	27	2.1 qt/A	0.163 lb mesotrione	5.2 fl oz Callisto 4SC
	0.075 lb bicyclopyrone	27		0.039 lb bicyclopyrone	0.039 lb bicyclopyrone
	0.15 lb pyroxasulfone	15		0.08 lb pyroxasulfone	2.5 fl oz Zidua 4.17SC
	2.69 lb S-metolachlor	15		1.41 lb S-metolachlor	1.47 pt Dual II Magnum 7.64E
Strategy 2.1SC	1.6 lb ethalfluralin	3	3 pt	0.61 lb ethalfluralin	26 fl oz Curbit 3EC
	0.5 lb clomazone	13		0.19 lb clomazone	8 fl oz Command 3ME
Varisto 4.187SL	4 lb bentazon	6	21 fl oz	0.65 lb bentazon	21 fl oz Basagran 4L
	0.187 imazamox	2		0.03 lb imzamox	4 fl oz Raptor 1L
Verdict 5.57EC	5 lb dimethenamid	15	13 fl oz	0.5 lb dimethenamid	11 fl oz Outlook 6EC
	0.57 lb saflufenacil	14		0.058 lb saflufenacil	2.6 fl oz Sharpen 2.85L

3. Insect Control

3.1. Soil Pests - Detection and Control

Cutworms

Several cutworm species can damage vegetables. Cutworm larvae (caterpillars) chew leaves, sever stalks and stems, and also may chew tubers, roots, spears, or fruit, rendering them unmarketable. Most cutworm larvae are night feeders and hide during the day, *e.g.*, under sod clumps, stones, or decaying vegetation. During periods of drought, low-lying areas in fields are more subject to cutworm damage than other areas, presumably because of more desirable conditions.

For cutworm adults (moths), weedy or minimum-tillage fields are especially attractive overwintering and egg-laying sitess. Moths also lay eggs on transplants in greenhouses that are lighted at night. Eggs and larvae may be transferred with transplants to the field.

Control. Where cutworms are suspected, a broadcast spray of a pyrethroid insecticide on no-till crop residue or broadcast incorporation of an insecticide treatment into the soil may be necessary just before planting (see individual crops for labeled insecticides). For organic producers, Seduce bait (OMRI listed) is labeled for cutworm control. **Always consult the label for rates and restrictions.**

Even if a broadcast treatment is used, fields should be scouted for cutworm damage within a week of planting or plant emergence. If cutworms are actively cutting plants, a post-planting contact treatment may be necessary. The following procedures may help improve control when a contact insecticide treatment is used:

1. Direct sprays at the base of the plants where cutworms are actively feeding.
2. Increase the amount of water used to at least 30 gal/A, especially in dry weather.
3. Spray between midnight and 5 a.m. when cutworms are most active.
4. Cultivate after insecticide application to improve contact with cutworms, especially in dry weather.

Garden Centipedes (Symphylans)

Garden centipedes are arthropods that are related to insects. They feed on germinating seed and fibrous roots of many crops and non-crop plants, including practically all vegetable species, and on decaying plant material. They are often associated with moist, fine textured heavier soils and typically establish in spots or field edges. Crops planted into those areas are often damaged because the symphylans are continuously grazing on the fibrous roots. Spinach acts as a very good host for this pest. Rotation does not appear to be an effective control.

Detection. The first symptom is an area or patch of poorly developing plants, similar to other root problems. Check the soil in these areas so that treatment can be made before planting the next crop, as there is no practical post-planting control. A common practice is to flag off the spot and treat that area with soil insecticides in the following fall or spring. Soil solarization **has not been** effective control. Symphylans can probably be transported in soil on field equipment. Dig up the soil and look for small, slender (smaller than 0.25 inch) white centipede-like animals that move quickly and try to avoid light. Another sampling method is to drop soil into a bucket of water. Symphylans will float to the top. Symphylans have beaded antennae and 12 pairs of legs on 14 body segments. Do not confuse symphylans with true centipedes (that eat other arthropods and are considered beneficial). Centipedes are not white and have large mandibles. Note: Dry or cold (under 45°F/7°C) soil will reveal few, if any, symphylans.

When to treat. For spring soil samples, control is generally warranted if there are more than 2 symphylans per shovelful on average. For September or October soil samples, on average 4 or 5 per shovelful warrants treatment before the next crop. Insecticides are generally applied before spring planting; fumigant treatments are usually made in the fall. Effectiveness of soil-applied insecticides decreases if soil temperatures are below 55°F (13°C).

Maggots

Three species of maggots (seedcorn maggot, cabbage maggot, and onion maggot) attack either the seed or roots of vegetables during the growing season. The biology is similar for these species, although the timing and the crops they feed on are often different. The adult of the maggot (a fly) fluctuates in abundance in different areas in different years. Since it is impossible to determine when and where maggots will attack and since nothing can be done once the injury is noted, preventive controls are good insurance before planting if you have previously had maggot problems. Overwintering fly emergence can be predicted using degree day models, but subsequent generations are less predictable.

Seed Maggots: A seed attacked by seed maggots usually fails to sprout or, if it does, the seedling is weak or sickly. Newly transplanted plants are also susceptible to maggots that tunnel up through the stem causing the plant to wilt. Injury is most severe in wet, cold springs and on land rich in organic matter or with recent organic matter incorporation or tillage.

Control. Control may be achieved using commercially applied seed treatments containing either clothianidin (Poncho 600), imidacloprid (Gaucho 600), or thiamethoxam (Cruiser 5FS, or Farmore DI-400). The level of control will depend on soil type, soil moisture, crop, weather conditions, and other factors. Refer to each specific crop section of this manual for the listing of labeled seed treatments. **Do NOT use treated seed for food or feed.**

Root Maggots: Plant roots become riddled with maggot tunnels, and underground fleshy parts soon decay or are infected with secondary pathogens. Above ground, plants appear off-color, wilt, and seldom reach full growth. Transplant water treatments, in-furrow treatments, preplant broadcast, and postplant treatments may be recommended depending on the crop. Refer to insecticide labels for labeled materials.

Nematodes

See section E 1.6. Nematode Control.

Slugs

Slugs are closely related to snails. All slugs require damp or humid surroundings for development and will avoid the drying effects of sun and wind. During the day, slugs seek shelter under protective debris and mulch. This is why weed control is a useful deterrent to any slug problem. Slugs are particularly problematic in no-till or minimal till farming systems. Look for slime trails in the morning. Shelter traps, such as square foot shingle or cardboard segments can be used to detect slugs. Slugs have rasping mouthparts and will leave holes in fruit and shredded looking holes in leaves. Their feeding can destroy seedlings.

Control. Metaldehyde (*e.g.*, Deadline M-Ps Mini-Pellets) is an effective slug-control chemical, and numerous commercial preparations are available at farm supply centers. Iron phosphate containing products are also labeled for slug control on a number of crops (*e.g*., Sluggo [OMRI listed], Ferroxx AQ, and IronFist). Residue management, soil disturbance, and dry conditions can aid with reducing slug activity.

Read the label for crops and use rates, as not all products are labeled for all crops!

White Grubs

White grubs are the larvae of scarab beetles (such as Japanese beetle) and can be soil pests in most vegetable crops. Serious problems may occur in potatoes, sweet potatoes, beans, corn, spinach, and strawberries. Grubs feed on the roots and underground parts of the plant from one to several inches below the soil surface. The plants may yellow and wilt, which causes a patchy growth in fields where plants are dead or dying. If injured plants are pulled up, the roots will show feeding damage, and usually the C-shaped, white grub can be found in the soil. Beetles lay eggs in the soil during the summer. As the soil cools in the fall, grubs move deeper into the soil and return to the surface the following spring. Depending on the insect, grubs may take 1-3 years to become adults and may cause problems year after year. **Control**. Grub damage is usually associated with grassy or weedy fields. Clean fields may help prevent serious grub damage. Problems may occur with crops planted in fields that were previously sod.

Wireworms

Wireworms are the larval stage of click beetles. Some species can remain in the soil as larvae for multiple years. They injure vegetable crops by killing seeds or seedlings and tunneling and scarring tubers, roots, bulbs, and low-growing vegetable fruit in contact with soil.

Detection. Injury to young plants or tubers frequently is sufficient evidence to warrant future control measures. Since there is no effective post-planting rescue treatment, the following methods are useful to detect the presence of wireworms before planting:

Method 1: A technique using baits has been developed for evaluating wireworm potential before planting. The bait stations should be established 2-3 weeks before the anticipated planting date. Fields where small grain or grasses have been grown the preceding 2 or 3 years are the best candidates for bait stations. Since wireworm infestations are often localized within a field, it will be necessary to place the bait stations randomly throughout the field. One bait station per acre is desirable. Place 2 bait stations at the highest elevation in a field, 2 on a slope, and 2 in the lowest area. Follow this procedure for baiting:

1. Mix 1 cup of untreated wheat or rolled oats and 1 cup of untreated shelled corn at each station
2. Bury the bait about 2” deep (if buried too deeply the grain will rot). Cover the ground over each bait station with

an 18” square of black plastic. The plastic collects solar heat and speeds germination of the corn and wheat, enticing overwintering wireworms to respond.
3. Mark each station with a flag or stake.
4. Dig up the bait stations after 10-14 days and count the number of wireworms. For best results wait until the germinating grain has emerged before digging. Look for slender, reddish-brown insects that are ¼-1” long.

Method 2: Be sure the soil temperature at the 6-inch depth ranges between 45-85°F (7-29°C) and that soil moisture is equivalent to that desired for planting.
1. Collect soil samples from 20 scattered sites per acre. Each sample should be about 12” deep and 6” in diameter. Sample sites should be near plant crowns.
2. Sift soil and count wireworms.

Control. If you find an average of 1 wireworm per bait station (Method 1) or if you find 5 or more wireworms in 20 soil samples (Method 2), a labeled soil insecticide should be used. Wireworm infestations tend to concentrate in some locations. Hence several wireworms may be found in one bait station and none in others. It may be possible to limit treatment to areas of the field with the largest concentration. **See individual crops for labeled insecticides.**

When to apply. Insecticides can be applied either in the spring or fall when the soil temperature at the 6-inch depth is at least 50°F (10°C) and soil moisture is equivalent to that desired for planting. Frequently, insecticide is applied immediately before planting. Consider fall treatment if an early spring planting is planned.

Using Degree Days to Predict Development Stages of Pests

Calculating degree days is a powerful predictive tool for managing several orchard pests and can be used to predict the occurrence of several vegetable pests. Predicting development stages of pests (or predicting plant phenological stages) depends on setting a start date called a ‘biofix date’ and a base temperature which differs among pests. Degree days can be calculated by taking the average temperature $(T_{high} + T_{low})/2$ and subtracting the base temperature. Negative values are counted as ‘0.’ Several Mid-Atlantic states feed data to the Northeast Weather Association (NEWA, *https://newa.cornell.edu*). NEWA has degree day tools that simplify calculation. Examples of pests for which degree day models are useful include **seedcorn maggot** (360, 1080, and 1,800 DD, base 40F), **cabbage maggot** (450, 1260, and 2170 DD, base 40F), **onion maggot** (735, 1750, and 2975 DD, base 40), **squash vine borer** (1,000 DD, base 50), and **Allium leafminer** (250 DD, base 38.3F). Models for these pests use a start date of January 1. A good overview of degree days can be found at *https://ag.umass.edu/landscape/fact-sheets/growing-degree-days-for-management-of-insect-pests-in-landscape*. Each of these pests also have an upper temperature cutoff afterwhich no more degree days accumulate. Consult your local Cooperative Extension Service for assistance with calculating and verifying degree days in your area.

3.2. Insecticide Mode of Action: Reducing the Risk of Insecticide Resistance Development

Resistance to insecticides develops because intensive pesticide use kills the susceptible individuals in a population, leaving only the surviving resistant ones to reproduce. Adopting the practices outlined below will help reduce the development of pest resistance.

a. Crop rotation to a nonhost crop reduces the need for pesticide treatment and, thus, reduces the ratio of resistant to susceptible individuals in the breeding population.
b. Spot treatment is an important practice. Early season insects are often concentrated in areas near their overwintering sites. Spot treating these areas, rather than the entire field, will reduce the resistance problem at a reduced cost.
c. Control efforts should be concentrated on the early stages of development, which are often easier to kill.
d. Do not overspray. Attempts to destroy every pest in the field by multiple applications or by using rates higher than labeled rates often eliminate the susceptible but not the resistant pests. **The way pesticides are used affects the development of resistance.** Insecticides within a specific chemical group usually share a common target site within the pest, and thus share a common Mode of Action (MoA). Resistance often develops based on genetic modification of this target site. When this happens, the compound usually loses its pesticidal activity. Because all insecticides within the chemical grouping share a common MoA, there is a high risk that this resistance will automatically confer cross-resistance to all the compounds in that group. The MoA classification provides a guide to the selection of insecticides for an insecticide resistance management strategy. The MoA

classification was developed and is endorsed by the Insecticide Resistance Action Committee (IRAC) to ensure growers can effectively alternate insecticides with different modes of action. More information can be found at: http://www.irac-online.org/documents/moa-classification/?ext=pdf. In Table E-7 below, insecticides are listed with their MoA classification (IRAC Group). **In crop specific sections, insecticides are organized by mode of action only, not by efficacy or recommendation.**

3.3. Insect Pest and Mite Control for Greenhouse Production

Adequate ventilation is critical for greenhouse pesticide use. Follow the re-entry intervals (REI) listed on the labels for worker safety. Always read and fully understand the label before applying any pesticide.

Applications of insecticides in **high tunnels** may be considered equivalent to a greenhouse (see Table E-7), depending on the state's definition of "high tunnel". Check with your state's pesticide regulatory agency for an interpretation concerning use of pesticides in high tunnels.

Yellow and blue sticky traps are effective at catching winged aphids, leafminers, thrips, whiteflies, fungus gnats and shore flies. Traps can be hung vertically just above the plant canopy or just above the growing medium surface or near doors and side vents, or other areas where insects may enter or exit the greenhouse. It is suggested that at least 1 trap be used per 1,000 sq ft.

Table E-7. Insecticides and Miticides Labeled for Use on Greenhouse Vegetables

Pesticides are listed in alphabetical order by Active Ingredient. The IRAC number refers to the Mode of Action, see section E 3.2. "Insecticide Mode of Action: Reducing the Risk of Insecticide Resistance Development"

IRAC Group	**Active Ingredient** Product Name(s)	**Target Pests**	**Labeled Crops**	**PHI (d)**	**REI (h)**	**Comments**
6	**abamectin** Agri-Mek SC	spider mites, russet mites, leafminers, pinworms	tomatoes only (not for transplants)	1	12	Use a minimum of 20 gal/A
20B	**acequinocyl** Kanemite 15SC, Shuttle O	two spotted spider mites, broad mites	fruiting vegetables	1	12	Use at least 100-gal water/A 2 applications per year No surfactant or adjuvant use
4A	**acetamiprid** TriStar 30SG	aphids, leaf-hoppers, mealy-bugs, caterpillars, plant bugs, whiteflies, fungus gnat larvae, thrips, beetles, leafminers	leafy vegetables, fruiting vegetables, cole crops, cucurbits, onions and bulb vegetables, strawberries (non-bearing)	7	12	**For vegetables grown as transplants only, except for peppers and strawberry.** Treat small area to test for phytotoxicity first.
18b	**azadirachtin** Azatin XL, Azatrol EC, Neemix, Ornazin, Azahar, Aza-Direct	immature stages of whiteflies, aphids, and other listed insects; fungus gnat larvae (as soil drench)	most vegetables including fruiting vegetables and cucurbits, herbs, spices, and others	0	4 or 12 check label	Botanical insect growth regulator (some products OMRI listed). Can be applied via chemigation. Spray water pH should be between 5.5 and 6.5. REI 12 for Neemix and Ornazin
11	***Bacillus thuringiensis*** var ***aizawai*** XenTari, Agree	armyworms, beet armyworm, cabbage looper, tomato fruitworm	most vegetables including fruiting vegetables and cucurbits, herbs, spices, and others	0	4	Lepidopteran larvae only - most effective against early instars.
11	***Bacillus thuringiensis*** var ***israelensis*** Gnatrol	fungus gnats (larvae only)	all vegetables	0	4	Drench. Repeat applications may be needed.
11A	***Bacillus thuringiensis*** var ***kurstaki*** Dipel, Javelin, Deliver, Biobit	armyworms, beet armyworm, cabbage looper, tomato fruitworm,	most vegetables including fruiting vegetables and cucurbits, herbs, spices, and others	0	4	Lepidopteran larvae only - most effective against early instars.

Table E-7. Insecticides and Miticides Labeled for Use on Greenhouse Vegetables – continued next page

Table E-7. Insecticides and Miticides Labeled for Use on Greenhouse Vegetables - continued

IRAC Group	Active Ingredient Product Name(s)	Target Pests	Labeled Crops	PHI (d)	REI (h)	Comments
n/a	***Beauveria bassiana*** strain GHA Mycotrol O (OMRI listed) BotaniGard ES, BotaniGard WP	aphids, thrips, whiteflies, certain other pests	all vegetables, herbs, spices, and others	0	4	Slow acting, fungus infects insects. Repeat applications at 5-10-day intervals may be needed. Note storage and other restrictions. **Do not use BotaniGard ES on tomatoes**.
25	**bifenazate** Floramite SC	spider mites, clover mites	tomatoes	3	12	No more than 2 applications per crop per season for tomatoes that are greater than 1" in diameter at maturity. Maintain spray water pH 5.5-6.5. **Do not use an adjuvant**.
16	**buprofezin** Talus 40SC	leafhoppers, mealybugs, whiteflies	tomatoes	1	12	Insect growth regulator for immature stages only. Maximum 2 applications per season at least 5 d apart. Will reduce egg viability.
13	**chlorfenapyr** Pylon	caterpillars, spider mites (*Tetranychus* spp.), broad mites, western flower, and melon thrips	fruiting vegetables	0	12	**Do not** use on tomato varieties with mature fruit less than 1 inch in diameter. No more than 3 applications per crop.
28	**cyantraniliprole** Exirel	thrips, whitefly	tomatoes, eggplant, peppers, cucumbers	1 (0 for cucumber)	12	For whitefly add effective adjuvant. Only suppresses thrips
28 + 6	**cyantraniliprole + abamectin** Minecto Pro	leafminer, spider mites, tomato russet mite, tomato psyllid, whitefly, pinworm	tomatoes	1	12	Tomatoes only. Foliar feeding thrips suppression only. Thorough coverage is essential to obtain best results.
17	**cyromazine** Citation	leafminers, fungus gnats, shore flies	only for vegetable transplant production grown for consumers	7	12	**Do not** apply within 7 d of shipping to market. No more than 6 applications per crop
4A	**dinotefuran** Safari 20 SG	aphids, leafminers, mealybugs, whiteflies	cucurbits, fruiting vegetables, head and stem brassicas, leafy vegetables	1 or 7	12	One application/crop. For vegetable transplants only. May be applied via a chemigation system. PHI 7 for leafy vegetables, PHI 1 for all other.
10B	**etoxazole** TetraSan 5WDG	spider mites	tomatoes only	1	12	**Do not** make more than 2 applications per season. **Do not** use with an adjuvant.
21A	**fenpyroximate** Akari	two spotted spider mites, tomato russet mites (suppresses whiteflies)	cucumbers, tomatoes, peppers	7	12	One application per growing season. **Do not** use adjuvants.
29	**flonicamid** Beleaf 50 SG	aphids, plant bugs, GH whitefly	cucumbers	0	12	Allow a minimum of 7-days between applications. Whitefly suppression only
4D	**flupyradifurone** Altus 1.67 SL	aphids, whiteflies, chili thrips, squash bug, psyllids, leaf hoppers	cucumbers, lettuce, tomatoes, peppers, many vegetable transplants	1-all but Pepper-3	4	**Do not make more than 1 (one) application to transplants per season**
10A	**hexythiazox** Onager miticide 1EC	two spotted spider mites, European red mites	tomatoes	1	12	**Do not** make more than 1 (one) application per year
4A	**imidacloprid** Marathon	aphids, fungus gnat larvae, leafhoppers, whiteflies	cole crops, collards, kale, kohlrabi, lettuce, mustard greens, pepper, tomato, eggplant.	-	12	**Use on vegetable plants intended for resale only**. May be applied via a chemigation system.

Table E-7. Insecticides and Miticides Labeled for Use on Greenhouse Vegetables – continued next page

Table E-7. Insecticides and Miticides Labeled for Use on Greenhouse Vegetables - continued

IRAC Group	Active Ingredient Product Name(s)	Target Pests	Labeled Crops	PHI (d)	REI (h)	Comments
4A	**imidacloprid** Admire PRO	aphids, whiteflies	tomato and cucumber only in production greenhouses.	0	12	**Only** for plants growing in field soil, potting media, or mixes. **Do not** apply to plants growing hydroponically or in rock wool, perlite or other soil-less mix. May be applied as drench or chemigation system. Label notes possible repellent effect on bumble bees and some beneficials (*Orius* sp.)
n/a	**iron phosphate** Sluggo-AG, Escar-Go	slugs and snails	all vegetables	0	0	OMRI listed. Bait; scatter around plants or perimeter of plantings.
1B	**malathion** Gowan Malathion 8F	Japanese beetles, thrips, onion maggots	succulent beans, cucumbers, eggplant, lettuce, green & bulb onions, sweet corn, tomatoes (crops vary depending on label)	1 to 7	12	See the label for specific crops. May be applied through a chemigation system.
n/a	**paraffinic oils** Sunspray Ultra-fine SuffOil-X	aphids, two spotted spider mites, leafminers, thrips, whitefly	tomato, pepper, lettuce, cucurbits, radish, squash, herbs, spices	1	4	**Do not** exceed 4 applications a growing season. Allow 2 w between applications.
n/a	**potassium salts of fatty acids** insecticidal soap M-Pede	aphids; leafminer; spider, broad and russet mites; thrips; whiteflies; plant bugs; leafhopper; powdery mildew (cucumber only)	many vegetables (see label for specifics), herbs, spices	0	12	Works well on whiteflies, mites, and aphids if coverage is good but has no residual control. Note label cautions about application frequency, water quality and tank mixing. OMRI listed
3a	**pyrethrins** Pyrenone Crop Spray, Pyronyl Crop Spray, PyGanic, Pyrethrum PT	all	all vegetables, herbs, spices	0	12	Pyrenone and Pyronyl include PBO synergist; PyGanic is OMRI listed.
21	**pyridaben** Sanmite	two spotted spider mite, whiteflies, leafhoppers, European red mite, some aphid species, broad mite	tomatoes (PHI 2) and cucumbers (PHI 1)	1 or 2	12	Only 2 applications per crop per year. Allow 30 days between sequential applications.
7c	**pyriproxyfen** Distance	whiteflies, aphids, fungus gnats, shoreflies	fruiting vegetables (except non-bell peppers)	1	12	Insect growth regulator. **Do not** use on tomato varieties with mature fruit less than 1 inch in diameter. Spray, sprench or drench.
n/a	**rosemary oil + peppermint oil** Ecotec	aphids, beetles, mites, thrips, plant bugs, others	many vegetables, herbs, spices	0	0	OMRI listed. Can be applied in drip for soil pests.
23	**spirotetramat** Kontos	aphids, leafhoppers, mealybugs, psyllids, spider mites, spittlebugs, whiteflies	vegetable transplants only (see label for list)	-	24	Apply as drench or via an irrigation system to plants in containers. Not for use in vegetable production.
4a	**thiamethoxam** Flagship 25WG	whiteflies, leafhoppers, Colorado potato beetle, stinkbugs	fruiting vegetables and cucurbits	-	12	**ONLY** use for vegetable transplants intended for resale

3.4. Insect Pest and Mite Control for Chemigation

Table E-8. Insecticides with Labels for Chemigation
Note: Read and understand all chemigation instructions on the label before use on any crop!

Overhead and Sprinkler Systems		Drip/Trickle Systems
abamectin (Agri-Mek **onion only**)	**lambda-cyhalothrin** (Warrior II)	**azadirachtin** (Aza-Direct or OLF)
acetamiprid (Assail 30SG)	**lambda-cyhalothrin + chlorantraniliprole** (**potato only**) (Voliam Xpress)	**chlorantraniliprole** (Coragen, Vantacor)
afidopyropen (Versys and Sefina)	**lambda-cyhalothrin + thiamethoxam** (Endigo ZC)	**clothianidin** (Belay)
azadirachtin (Aza-Direct or OLF)	**malathion** (Malathion 8 Aquamul)	**cyantraniliprole** (Verimark)
Bacillus thuringiensis (DiPel, XenTari)	**methomyl (green/bulb onions, potatoes only**) (Lannate LV)	**diazinon** (Diazinon)
beta-cyfluthrin (Baythroid XL)	**novaluron (potatoes only)** (Rimon)	**dimethoate** (Dimate)
bifenthrin (Capture or OLF)	**permethrin** (Pounce or OLF)	**dinotefuran** (Venom)
bifenthrin + imidacloprid (Brigadier)	**propargite (sweet corn, potatoes only)** (Comite)	**flupyradifurone** (Sivanto Prime)
carbaryl (Sevin or OLF)	**pymetrozine (potato only)** (Fulfill)	**imidacloprid** (Admire PRO or OLF)
chlorantraniliprole (Coragen, Vantacor)	**pyrifluquinazon** (PQZ)	**malathion** (Malathion 8 Aquamul)
clothianidin (Belay)	**pyrethrins** (PyGanic)	**oxamyl** (Vydate)
cryolite (Kryocide)	**spinetoram** (Radiant)	**rosemary oil + peppermint oil** (Ecotec)
cyclaniliprole (Harvanta)	**spinosad** (Entrust, SpinTor)	**thiamethoxam** (Platinum)
cyfluthrin (Tombstone or OLF)	**spinosad + gamma-cyhalothrin** (**corn only**) (Consero)	**thiamethoxam + chlorantraniliprole** (Durivo)
diazinon (Diazinon)	**spiromesifen** (Oberon)	
dimethoate (Dimate or OLF)	**spirotetramat** (Movento)	
dinotefuran (Venom)	**sulfoxaflor** (Transform WG)	
esfenvalerate (Asana)	**thiamethoxam** (Platinum, **potato only**) (Actara 25WDG)	
flonicamid (Beleaf)	**thiamethoxam + chlorantraniliprole** (**potato only**) (Voliam Flexi)	
flupyradifurone (Sivanto Prime)	**thiamethoxam + lambda-cyhalothrin** (Endigo ZC)	
gamma-cyhalothrin (Proaxis)	**tolfenpyrad** (Torac)	
imidacloprid (Admire PRO or OLF)	**zeta-cypermethrin** (Mustang Maxx)	
imidacloprid + beta-cyfluthrin (Leverage 360)	**zeta-cypermethrin + bifenthrin** (Hero)	
indoxacarb (Avaunt, Avaunt eVo)		

3.5. Other Labeled Formulations for Insecticides

Table E-9. Other Labeled Formulations for Insecticides

In addition to insecticide brands listed in this guide, other labeled formulations may be used. Read labels prior to use! Labeled crops, use rates, and use patterns may differ among other labeled formulations and may also differ from the products listed in this guide.

MoA group[1]	Active Ingredient	Brand listed in this guide	Other Labeled Formulations
1A	carbaryl	Sevin XLR Plus	Sevin 4F, Carbaryl 4L, Sevin SL
1A	methomyl	Lannate LV	Nudrin, Lanveer LV
1B	diazinon	Diazinon AG500	Diazinon AG600
1B	acephate	Orthene 97	Acephate 97WDG
1B	dimethoate	Dimethoate 400EC	Dimethoate 400, Dimethoate 4EC, Dimethoate LV-4
1B	malathion	Malathion 57EC	Fyfanon 57EC, Malathion 5, Malathion 8F, Malathion Aquamul
1B + 3A	acephate + bifenthrin		Acenthrin
3A	bifenthrin	Brigade, Capture	Battalion, Bifen, Bidash, Bifenture, Bifender, Empower[2], Fanfare, GCS Bifenthrin 2EC, Lancer 2EC, Nirvana RTU, Reveal, Ruckus LFR, Sniper, Sniper LFR, Tundra, XPedient Plus
3A	beta-cyfluthrin	Baythroid XL	Sultrus
3A	esfenvalerate	Asana XL	S-FenvaloStar
3A	lambda-cyhalothrin	Warrior II	Cavalry II, Crusader, Firestone, Grizzly Too, Kendo, L-C, Lambda Cyhalotrhin, Lambda 1EC, Lambda T, Lamcap, Lambda Star, Lambda Cy, Lamcap II, Lunge, Paradigm, Province II, Ravage, Serpent, Silencer, Willowood Lambda-Cy 1EC
3A	permethrin	Permethrin 3.2EC	Ambush, Arctic, Permethrin, PermaStar AG, Permethrin 3.2AG
3A	zeta-cypermethrin	Mustang Maxx	Cortes Maxx
3A + 4A	bifenthrin + acetamiprid	Savoy EC	Punisher
3A + 4A	lambda-cyhalothrin + imidacloprid		Kilter
3A + 4A	bifenthrin + imidacloprid	Brigadier	Skyraider, Swagger, Tempest
4A	imidacloprid	Admire Pro	Acronyx, Advise, Alias, Imidashot, Lada, Macho, Malice, Mantra, Montana, Nuprid 4F Max, Nuprid 4.6 F Pro, Pasada, Prey, Provoke, Sherpa, Willowood Imidacloprid, Widow, Wrangler
4A	acetamiprid	Assail	Anarchy, ArVida, Intruder Max, Quasar, Tristar, Azomar
4A	dinotefuran	Scorpion, Venom	Certador
6	abamectin	Agri-Mek	Abacus V, Abacus V6, Abamex, Abba Ultra, Averland FC, Enterik, Reaper, Willowood Abamectin 0.75SC
7C	pyriproxyfen	Knack	Cusack
9B	pymetrozine	Fulfill	Seville, Achiever
10B	etoxazole	Zeal	Zara SC, Stifle SC, Suremite SC, Inntervene SC
11A	*Bacillus thuringiensis aizawai*	Xentari	Agree, Jackpot
11A	*Bacillus thuringiensis kurstaki*	Dipel	Biobit, Bt Now, Leprotec
17	cyromazine	TriGard 75WP	Trignata WSP
18	methoxyfenozide	Intrepid	GCS Methoxy 2F, Inspirato 2F, Insurgent, Invertid, Troubador, Turnstyle, Vexer, Zylo
20D	bifenazate	Acramite	Banter SC, Bifenamite 4SC, 50 WDG, Bizate 4SC, 50 WDG, Enervate, Vigilant 4SC
22	indoxacarb	Avaunt, Avaunt eVo	Armont 30DG, Comber,
23	spiromesifen	Oberon 2SC	Sepoy
28	chlorantraniliprole	Coragen, Vantacor	Shenzi 400SC

[1]Mode of Action, see section 3.2

4. Disease Control

4.1. Fungicide Mode of Action: Reducing the Risk of Fungicide Resistance Development

Pathogens may develop resistance to fungicides with the intensive use of high-risk fungicides. High-risk fungicides may only kill susceptible individuals within a given pathogen population, while allowing resistant individuals to continue to reproduce and cause more plant disease. Use the practices outlined below to help reduce the chances for fungicide resistance development.

a. Long and proper crop rotations with non-host crops will help break disease cycles and decrease the need for or overuse of specific fungicides. This is especially important for controlling soil-borne pathogens.

b. Do NOT apply a fungicide at a higher or lower than recommended labeled rate.

c. Fungicides are organized according to Fungicide Resistance Action Codes (FRAC codes), based on chemical structure (see Table E-10) and Mode of Action (MoA). Fungicides within a given FRAC code control pathogens in a similar manner and share the same risk for fungicide resistance development. Table E-12 lists commonly used fungicides and their FRAC codes.

d. Some fungicides are referred to as **high-risk fungicides because of their very specific MoA's and high risk for resistance development**, for example, the DMI's (FRAC code 3) and the QoI's (FRAC code 11). Fungicides in high-risk FRAC codes (**in bold in Table E-10 and in crop sections in chapter F**) should be rotated with fungicides in other FRAC codes and tank-mixed with broad spectrum, protectant fungicides to delay or reduce the potential for resistance development. All high-risk fungicides have seasonal application restrictions which should be followed precisely.

e. Rotate as many fungicides from different FRAC codes as possible during the production season.

f. If you feel control with a high-risk fungicide is no longer effective, stop using it and switch to fungicides with a different MoA (*i.e.*, fungicides in other FRAC codes).

Table E-10. FRAC Codes and Corresponding Chemical Groups for Commonly Used Fungicides

FRAC Code*	Chemical Group	FRAC Code*	Chemical Group
P01	Salicylic Acid Pathway	12	phenylpyrroles
P05	Extract of *Reynoutria sachalinensis*	**13**	aryloxyquinoline
P07	phosphonates; fosetyl-Al	14	aromatic hydrocarbons
M01	inorganic copper	17	hydroxylanilide
M02	inorganic sulfur	21	quinone outside inhibitor (QiI)
M03	dithiocarbamate	22	benzamides (toluamides)
M04	phthalimide	27	cyanoacetamideoxime
M05	chloronitrile	28	carbamates
1	benzimidazole	29	dinitroanilines
2	dicarboximide	39	quinazoline
3	triazole	40	carboxylic acid amides
4	phenylamide	43	benzamides (acylpicolides) quinazoline
7	carboxamide	45	triazolo-pyrimidylamine carboxylic acid amides
9	anilino-pyridines	49	piperidinyl-thiazole-isoxazolines
11	quinone inside inhibitor (QoI)	50	benzophenone triazolo-pyrimidylamine

*** FRAC Code listed in bold for commonly used fungicides in FRAC codes with a high risk for resistance development**

4.2. How Biofungicides Work

Used with permission – Angela Madeiras and M. Bess Dicklow (Authors), University of Massachusetts, Amherst

Biofungicides are formulations of living organisms that are used to control the activity of plant pathogenic fungi and bacteria. The concept of biofungicides is based upon observations of natural processes where beneficial microorganisms, usually isolated from soil, hinder the activity of plant pathogens. Biocontrol microorganisms are free-living fungi, bacteria, or actinomycetes that are active in root, soil, and foliar environments. These microorganisms produce a wide range of antibiotic substances, parasitize other fungi, compete with other fungi, and induce localized or systemic resistance in plants. The use of composts and suppressive growing medium, which both contain living microorganisms, to mitigate disease is another example of this disease management option.

- **Rhizosphere Competence** - The most successful of the strains of biocontrol microorganisms exhibit rhizosphere competence, the ability to colonize and grow in association with plant roots. They can colonize entire root surfaces for several months. Here they effectively compete with plant pathogens for nutrients, infection sites, and space. Competition for glucose in the soil is involved in disease suppression. Biofungicide organisms also metabolize seed and root exudates that normally stimulate pathogen germination or zoospore attraction.
- **Parasitism** - Parasitism, the ability of species to attack and consume plant pathogens, has been well studied. Mycoparasitism of biocontrol microorganisms includes directed growth, contact and binding, coiling of hyphae around the host fungus, penetration, and degradation. Production of cell wall degrading enzymes is almost always part of the process.
- **Antibiosis** - Antibiosis occurs when one microorganism produces molecules that directly affect other organisms negatively by toxicity or growth inhibition. These compounds are called antibiotics and are commonly produced by a wide range of soil dwelling microorganisms in the course of their growth. A familiar antibiotic, streptomycin, is produced by *Streptomyces* species which are classified as actinomycetes or filamentous bacteria.
- **Inducing Metabolic Changes** - An important mechanism of biocontrol microorganisms is the ability to induce metabolic changes in plants that increase their resistance to a wide range of plant pathogenic fungi and bacteria. Systemic Acquired Resistance (SAR) improves the plant response to pathogen attack by priming the production of plant defense compounds. This capacity to induce resistance to a wide range of diseases in a variety of plants appears to be widespread. Enhanced resistance is systemic because disease resistance occurs at sites distance from the location of the biocontrol microorganisms.
- **Plant Growth Promotion** - A final way in which these organisms act is through plant growth promotion. Beneficial root-colonizing microorganisms promote plant growth and productivity. Many resistance-inducing fungi and bacteria promote both root and shoot growth in the absence of plant pathogens. When applied to growing media or as a seed treatment, some biofungicides can increase root development and improve drought resistance in some plants. Improvements in plant growth result from effects on soil microflora and direct effects on the plant. Biofungicides can also improve nutrient uptake (copper, phosphorous, iron, and manganese).

In the greenhouse industry, biofungicides are applied preventively to growth media or as a seed treatment for root and crown disease control and can be as effective as chemical fungicides. Biofungicides used for foliar disease management must be applied preventatively. Biofungicides are generally safer for growers, can be more persistent, and are sometimes less expensive than conventional fungicides.

The most effective uses of biofungicides are as a preventive treatment in growing media or as a seed treatment. They should be mixed into the growing media prior to planting or applied as a drench immediately after transplanting, making sure that the entire soil volume is treated. For foliar applications, the biofungicides must be in place before pathogen infection as their action is purely protective. They must be reapplied frequently both to protect new growth and to ensure that effective populations of the microorganisms are present. Because biofungicides consist of living organisms, they may have different storage, shelf life, and handling requirements than conventional fungicides. Most biofungicides have short reentry intervals (0-4 hours).

4.3. Disease Control in Seeds, Plant Growing Mix and Plant Beds

Seed Treatment

Seed treatment is essential to control seed-borne diseases in many transplanted crops. Failure to treat seed properly could lead to diseases in the plant bed that will reduce plant stands, or that are carried into the field at transplanting. Crop failure could result. Seed treatment is especially important for asparagus, broccoli, Brussels sprouts, cabbage, cauliflower, collards, eggplant, kale, kohlrabi, peppers, radish, and tomato.

Heat treatment of seeds is a non-chemical alternative to conventional chlorine treatments with the additional benefit of killing pathogens that may be found within the seed coat (*e.g.*, bacterial canker organism of tomatoes). Seed heat-treatment follows a strict time and temperature protocol and is best done with thermostatically controlled water baths. Two baths are required: one for pre-heating and a second for the effective pathogen killing temperature. The initial pre-heat treatment is 10 minutes at 100ºF (38ºC). The effective temperature treatment and time in the second bath differ between crops; protocols for several important crops are listed in Table E-11.

Immediately after removal from the second bath, seeds should be rinsed with cool water to stop the heating process and dried on screen or paper. Seeds may be re-dusted with fungicide if desired. Pelleted seed is not recommended for heat treatment. Heat treat only seed that will be used during the current season. See crop sections for specific seed treatment recommendations.

Table E-11. Effective Seed Treatment Temperature Protocols (2nd Bath) for Pathogen Eradication

Crop	Water Temperature		Minutes
	°F	°C	
Brussels sprouts, eggplant, spinach, cabbage, tomato	122	50	25
Broccoli, cauliflower, carrot, collard, kale, kohlrabi, rutabaga, turnip	122	50	20
Mustard, cress, radish	122	50	15
Pepper	125	51	30
Lettuce, celery, celeriac	118	48	30

Disease Control in Plant Growing Mix

For the best control of all soil-borne diseases, use the plant-growing mix described in Table R-4 or R-5. If this is not possible, use soil steaming or fumigation as described below.

Disease Control in Plant Beds

Preplant: soil steaming is the only practice that ensures complete sterilization of soil. A temperature of 180°F (82°C) must be maintained throughout the entire mass of soil for a period of 30 minutes. **Soil fumigation** is also used to control disease. The following materials are suitable for small lots of soil:

- chloropicrin and metam-sodium (Vapam HL), see label for rates and instructions.

For larger areas, such as plant beds or seed beds, the following materials are suitable (see label for rates and instructions):

- chloropicrin
- metam-sodium (Vapam HL)
- Potassium N-methyldithiocarbamate (K-Pam HL)

Consul the Fumigation section in this chapter (section E 1.5.) for additional recommendations.

Note: The use of soil fumigants has become severely limited because of new restrictions. Check with your local county agricultural agent.

Pre-and post-seeding treatments in transplant and greenhouse production: See crop sections for seed treatment options and Table E-13. below for a list of selected fungicides for use in greenhouse production.

Nematode Control

See section E 1.6. Nematode Control.

4.4. Fungicides Registered for Vegetables

See Table E-12 "Commonly Used Fungicides Registered for Vegetables" on the following pages

Note:

- **Table E-12 is not all inclusive; crop sections in chapter F Commodity Recommendations may include additional recommendations.**
- **Crop sections in chapter F should be consulted to ensure efficacy on specific pathogens.**
- **Guidelines for preventing fungicide resistance development can be found in section E 4.1. "Fungicide Mode of Action: Reducing the Risk of Fungicide Resistance Development."**

Table E-12. Commonly Used Fungicides Registered for Vegetables

X=fungicide is registered for the crop. The number next to X=PHI (days to harvest); if no number is present PHI=0 days (See also Table E-13. Selected Fungicides Labeled for Greenhouse Use).

Fungicides	**Actigard** (acibenzolar-S-methyl)	**Aliette** (fosetyl A1)	**Aproach** (picoxystrobin)	**Aprovia Top** (difenoconazole + benzovindiflupyr)	**Ariston** (chlorothalonil + cymoxanil)	**azoxystrobin**	**Cabrio** (pyraclostrobin)	**Cannonball** (fludioxonil)	**Catamaran** (chlorothalonil + phosphite)	**chlorothalonil**[a]	**Curzate** (cymoxanil)	**Dexter Max** (azoxystrobin + mancozeb)	**Elatus** (azoxystrobin + benzovindiflupyr)
FRAC Code(s) / **Crop**	P01	33	11	3+ 7	M05 + 27	11	11	12	M05+ P07	M05	27	11 + M03	11+ 7
Asparagus		X110				X100				X190		X180	
Beans, Snap			X14	X14		X		X7		X7			
Beans, Lima			X14	X14		X		X7		X14			
Beets						X	X						
Broccoli	X7	X3				X	X			X7			
Carrots						X	X			X			
Celery		X3				X	X	X		X7			
Chinese Cabbage	X7	X3				X	X			X7			
Cole Crops	X7	X3				X	X			X7			
Cucumbers	X	X		X	X3	X1	X			X	X3		
Eggplants				X		X	X			X3			
Garlic	X7					X	X7	X7		X7			
Greens, Mustard	X7	X3				X	X						
Greens, Turnip	X7					X							
Horseradish						X	X			X14			
Leeks						X	X7	X7		X14			
Lettuce	X7	X3				X	X	X			X3		
Muskmelons	X	X		X	X3	X1	X	X14		X	X3		
Okra				X		X				X3			
Onions, Dry	X7	X7				X	X7	X7		X14			
Onions, Green		X7				X	X7	X7		X14			
Parsley		X				X	X	X					
Parsnips						X	X			X10			
Peas				X14		X							
Peppers	X14			X		X	X			X3			
Potatoes						X14				X7	X14		X14
Pumpkin/Winter Squash	X	X		X	X3	X1	X			X	X3		
Radish						X	X						
Spinach	X7	X3				X	X	X			X1		
Squash, Summer	X	X		X	X3	X1	X			X	X3		
Strawberries	X	X				X	X						
Sweet Corn			X7			X7				X14		X7	
Sweet Potatoes				X14		X							
Tomatoes	X14	X14		X		X	X		X0/4	X	X3		
Watermelon	X	X		X	X3	X1	X	X14		X	X3		

Superscripts: a=seed treatment or soil use only, b=Ultra Flourish is not labeled on these crops, c=Sulfur rates above 4 lb/A applied during high temperatures may cause crop injury, d=Only in DE, PA, MD, and VA, e=See label for PHI.

Table E-12. - continued next page.

Table E-12. Commonly Used Fungicides Registered for Vegetables - *continued*

X=fungicide is registered for the crop. The number next to X=PHI (days to harvest); if no number is present PHI=0 days (See also Table E-13. Selected Fungicides Labeled for Greenhouse Use).

Fungicides	**Elumin** (ethaboxam)	**Endura** (boscalid)	**Fixed copper**[a]	**Flint Extra** (trifloxystrobin)	**Fontelis** (penthiopyrad)	**Forum** (dimethomorph)	**Gatten** (flutianil)	**Gavel** (zoxamide + mancozeb)	**Gem** (trifloxystrobin)	**Headline** (pyraclostrobin)	**Headline AMP** (pyraclostrobin+metconazole)	**Inspire Super** (difenoconazole + cyprodonil)	**iprodione**
FRAC Code(s) / **Crop**	22	7	M01	11	7	40	U13	22 + M03	11	11	11 + 3	3+ 9	2
Asparagus													
Beans, Snap		X7	X		X					X7			X[e]
Beans, Lima		X7	X		X	X7				X7			X[e]
Beets			X	X7	X				X7				
Broccoli		X	X		X	X7						X7	X
Carrots		X	X		X				X7				X
Celery		X	X		X3	X7			X7				
Chinese Cabbage		X	X		X	X7						X7	
Cole Crops		X14	X		X	X7						X7	
Cucumbers	X2	X	X		X1	X5	X	X5				X7	
Eggplants		X	X		X	X5			X3			X	
Garlic		X7	X		X3	X5		X7				X7	X
Greens, Mustard		X14	X		X	X7						X7	
Greens, Turnip			X		X	X7						X7	
Horseradish		X			X				X7				
Leeks		X7	X		X3	X5						X7	
Lettuce		X14	X		X3	X7							X14
Muskmelons	X2	X	X		X1	X5	X	X5				X7	
Okra			X		X								
Onions, Dry		X7	X		X3	X5		X7				X7	X7
Onions, Green		X7	X		X3	X5		X7				X14	
Parsley		X14	X		X3	X7							
Parsnips				X7					X7				
Peas		X21	X		X					X7			
Peppers		X	X		X	X5			X3			X	
Potatoes		X10	X	X7		X5		X14[d]	X7	X3			X14
Pumpkin/Winter Squash	X2	X	X		X1	X5		X5				X7	
Radish					X								
Spinach			X		X3	X7							
Squash, Summer	X2	X	X		X1	X5	X	X5				X7	
Strawberries			X	X	X								X[e]
Sweet Corn			X							X7	X7		
Sweet Potatoes	X2	X10								X3			
Tomatoes		X	X		X	X5		X5	X3			X	
Watermelon	X2	X	X		X1	X5		X5				X7	

Superscripts: a=seed treatment or soil use only, b=Ultra Flourish is not labeled on these crops, c=Sulfur rates above 4 lb/A applied during high temperatures may cause crop injury, d=Only in DE, PA, MD, and VA, e=See label for PHI.

Table E-12. - continued next page.

Table E-12. Commonly Used Fungicides Registered for Vegetables - *continued*

X=fungicide is registered for the crop. The number next to X=PHI (days to harvest); if no number is present PHI=0 days (See also Table E-13. Selected Fungicides Labeled for Greenhouse Use).

Fungicides	**Luna Experience** (fluopyram + tebuconazole)	**Luna Sensation** (fluopyram + trifloxystrobin)	**Luna Tranquility** (fluopyram + pyrimethanil)	**Magister** (fenazaquin)	**mancozeb**	**ManKocide** (mancozeb + copper hydroxide)	**Merivon** (fluxapyroxad + pyraclostrobin)	**metalaxyl**	**Miravis Neo** (propiconazole + pydiflumetofen + azoxystrobin)	**Miravis Prime** (pydiflumetofen + fludioxonil)	**Omega** (fluazinam)	**Orondis Gold** (oxathiapiprolin + mefenoxam)	**Orondis Opti** (oxathiapiprolin + chlorothalonil)	**Orondis Ultra** (oxathiapiprolin + mandipropamid)
FRAC Code(s) / **Crop**	7 + 3	7 + 11	7 + 9	39	M03	M03+ M01	7 + 11	4	3+ 7 + 11	7 + 12	29	49 + 4	49 + M05	49 + 40
Asparagus					X180			X				X[e]		
Beans, Snap								X			X14			
Beans, Lima								X	X14		X30			
Beets			X7				X7	X		X7				
Broccoli								X			X50			
Carrots		X7					X7	X		X7	X7			
Celery							X1	X		X7				
Chinese Cabbage								X			X20			
Cole Crops								X			X20		X[e]	X[e]
Cucumbers	X7			X3	X5		X	X		X1			X[e]	X[e]
Eggplants								X		X0	X30	X[e]		
Garlic					X7		X7	X			X7			X[e]
Greens, Mustard										X7	X20			X[e]
Greens, Turnip										X7	X20			X[e]
Horseradish							X7	X		X7				
Leeks	X7		X7				X7	X					X[e]	
Lettuce							X1	X		X0	X30	X[e]		X
Muskmelons	X7	X		X3	X5		X	X		X1	X30		X[e]	X
Okra											X30			
Onions, Dry			X7		X7	X5	X7	X			X7		X[e]	
Onions, Green			X7			X5	X7	X					X[e]	
Parsley							X1	X		X7		X[e]		
Parsnips		X7	X7				X7	X						
Peas								X						
Peppers								X			X30	X[e]		
Potatoes			X7		X14[d]			X			X14		X[e]	X
Pumpkin/Winter Squash	X7			X3			X	X		X1		X[e]	X[e]	X
Radish			X7				X7	X						
Spinach							X1	X		X		X[e]		
Squash, Summer	X7			X3	X5		X	X		X1		X[e]	X[e]	X
Strawberries		X	X7				X			X0		X[e]		
Sweet Corn					X7				X14					
Sweet Potatoes								X						
Tomatoes					X5	X5		X					X[e]	X
Watermelon	X7	X		X3	X5		X	X		X1	X30		X[e]	X

Superscripts: a=seed treatment or soil use only, b=Ultra Flourish is not labeled on these crops, c=Sulfur rates above 4 lb/A applied during high temperatures may cause crop injury, d=Only in DE, PA, MD, and VA, e=See label for PHI.

Table E-12. - continued next page

Table E-12. Commonly Used Fungicides Registered for Vegetables - *continued*

X=fungicide is registered for the crop. The number next to X=PHI (days to harvest); if no number is present PHI=0 days (See also Table E-13. Selected Fungicides Labeled for Greenhouse Use).

Fungicides	**phosphonates**[a]	**Polyram** (metiram)	**Presidio** (fluopicolide)	**Previcur Flex** (propamocarb)	**Priaxor** (fluxapyroxad + pyraclostrobin)	**Pristine** (pyraclostrobin + boscalid)	**Procure** (triflumizole)	**Proline** (prothioconazole)	**propiconazole**	**Quadris Opti** (azoxystrobin + chlorothalonil)	**Quadris Top** (difenoconazole + azoxystrobin)	**Quash** (metconazole)	**Quilt Xcel** (propiconazole + azoxystrobin)
FRAC Code(s) / **Crop**	P07	M03	43	28	7 + 11	11 + 7	3	3	3	11 + M05	3 + 11	3	3 + 11
Asparagus													
Beans, Snap	X				X7				X7				X7
Beans, Lima	X				X7				X7	X14			X7
Beets			X7						X14				
Broccoli	X		X2		X3		X1				X1		
Carrots			X7			X			X14	X	X7		X14
Celery	X		X2			X			X14	X7			X14
Chinese Cabbage	X		X2		X3		X1				X1		
Cole Crops	X		X2		X3		X1				X1		
Cucumbers	X		X2	X2		X	X	X7		X1	X1		
Eggplants	X		X2		X						X		
Garlic	X					X7			X14	X7	X7		X14
Greens, Mustard	X		X2		X3		X1				X1		
Greens, Turnip	X				X3		X1				X1		
Horseradish			X7										
Leeks	X					X7			X14	X14	X7		X
Lettuce	X		X2	X2			X						
Muskmelons	X		X2	X2		X	X	X7		X1	X1		
Okra													
Onions, Dry	X					X7			X14	X7	X7		X14
Onions, Green	X					X7			X14	X14	X7		X
Parsley	X		X2				X		X14				
Parsnips			X7										
Peas	X				X7			X7					
Peppers	X		X2	X5	X						X		
Potatoes	X	X14		X14	X7					X14	X14	X1	
Pumpkin/Winter Squash	X		X2	X2		X	X	X7		X1	X1		
Radish			X7										
Spinach	X		X2										
Squash, Summer	X		X2	X2		X	X	X7		X1	X1		
Strawberries						X	X1		X		X		X
Sweet Corn					X7				X14				X14
Sweet Potatoes			X7								X14	X1	
Tomatoes	X		X2	X5	X					X	X		
Watermelon	X		X2	X2		X	X	X7		X1	X1		

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Table E-12. - continued next page.

Table E-12. Commonly Used Fungicides Registered for Vegetables - *continued*

X=fungicide is registered for the crop. The number next to X=PHI (days to harvest); if no number is present PHI=0 days (See also Table E-13. Selected Fungicides Labeled for Greenhouse Use).

Fungicides	**Quintec** (quinoxyfen)	**Rally** (myclobutanil)	**Ranman** (cyazofamid)	**Reason** (fenamidone)	**Revus** (mandipropamid)	**Revus Top** (mandipropamid + difenoconazole)	**Rhyme (flutriafol)**	**Ridomil Gold, Ultra Flourish** (mefenoxam)	**Ridomil Gold Bravo** (mefenoxam + chlorothalonil)	**Ridomil Gold Copper** (mefenoxam + copper)	**Ridomil Gold MZ** (mefenoxam + mancozeb)	**Scala** (pyrimethanil)	**Stratego** (propiconazole + trifloxystrobin)
FRAC Code(s) / **Crop**	13	3	21	11	40	3 + 40	3	4	4+ M05	4+ M01	4+ M03	9	3 + 11
Asparagus		X180						X					
Beans, Snap		X	X	X3	X1			X[b]		X7			
Beans, Lima			X	X3				X[b]		X3			
Beets				X14				X					
Broccoli			X	X2	X1			X[b]	X7				
Carrots			X14	X14				X[b]	X7	X7			
Celery				X2	X1		X7	X					
Chinese Cabbage			X	X2	X1			X[b]	X7				
Cole Crops			X	X2	X1			X	X7				
Cucumbers		X	X	X14	X		X	X	X	X5	X5		
Eggplants	X3	X	X	X14	X			X					
Garlic				X7	X7			X[a]	X7	X10	X7	X7	
Greens, Mustard			X	X2	X1			X[b]					
Greens, Turnip			X	X2	X1			X[b]					
Horseradish				X14				X[a]					
Leeks				X7	X7			X	X14	X10	X7	X7	
Lettuce	X1	X3	X	X2	X1		X7	X[a]					
Muskmelons	X3	X	X	X14	X		X	X	X	X5	X5		
Okra		X	X	X14	X								
Onions, Dry				X7	X7			X	X7	X10	X7	X7	
Onions, Green				X7	X7			X	X14	X7		X7	
Parsley			X	X2	X1		X7	X					
Parsnips				X14				X					
Peas								X[b]					
Peppers	X3	X	X	X14	X			X		X7			
Potatoes			X7	X14		X14		X	X14	X14	X14	X7	
Pumpkin/Winter Squash	X3	X	X	X14	X		X	X	X	X5			
Radish				X14				X		X7			
Spinach			X	X2	X1			X		X3			
Squash, Summer		X	X	X14	X		X	X	X	X5	X5		
Strawberries	X1	X						X				X1	
Sweet Corn													X14
Sweet Potatoes			X7	X14				X				X7	
Tomatoes	X3	X	X	X14		X1		X	X5	X14	X5	X1	
Watermelon	X3	X	X	X14	X		X	X	X	X5	X5		

Superscripts: a=seed treatment or soil use only, b=Ultra Flourish is not labeled on these crops, c=Sulfur rates above 4 lb/A applied during high temperatures may cause crop injury, d=Only in DE, PA, MD, and VA, e=See label for PHI.

Table E-12. - continued next page.

Table E-12. Commonly Used Fungicides Registered for Vegetables - *continued*

X=fungicide is registered for the crop. The number next to X=PHI (days to harvest); if no number is present PHI=0 days (See also Table E-13. Selected Fungicides Labeled for Greenhouse Use).

Fungicides	**Sulfur** [c,e]	**Switch** (cyprodinil + fludioxonil)	**Tanos** (famoxadone + cymoxanil)	**tebuconazole**	**Terraclor** (PCNB)	**thiophanate-methyl**	**Tilt (propiconazole)**	**Top Guard EQ (flutriafol + azoxystrobin)**	**Torino** (cyflufenamid)	**Uniform** (mefenoxam + azoxystrobin) [e]	**Vivando** (metrafenone)	**Zampro** (ametoctradin + dimethomorph)	**Zing!** (zoxamide + chlorothalonil)
FRAC Code(s) / **Crop**	M02	9 + 12	11 + 27	3	14	1	3	3 + 11	U06	4 + 11	50	45+ 40	22+ M05
Asparagus	X			X180									
Beans, Snap	X	X7		X14	X14	X14				X			
Beans, Lima	X	X7		X14	X14	X14				X			
Beets	X	X7		X7			X14			X			
Broccoli	X	X7		X7	X							X	
Carrots	X	X7											
Celery	X	X				X7				X		X	
Chinese Cabbage		X7		X7	X					X		X	
Cole Crops	X	X7		X7	X					X		X	
Cucumbers	X	X1	X3	X7		X1		X1	X	X	X	X	X
Eggplants	X	X		X7							X	X4	
Garlic	X	X7	X3	X7	X	X[a]				X		X	X7
Greens, Mustard	X	X7		X7						X		X	
Greens, Turnip	X	X7		X7									
Horseradish	X	X7											
Leeks		X7	X3	X7						X		X	
Lettuce	X	X	X1							X		X	
Muskmelons	X	X1	X3	X7		X1		X1	X	X	X	X	X
Okra	X	X		X3							X		
Onions, Dry	X	X7	X3	X7		X[a]				X		X	X7
Onions, Green	X	X7	X3	X7		X[a]				X		X	
Parsley		X7	X1					X7		X		X	
Parsnips	X	X7											
Peas	X									X			
Peppers	X	X	X3	X7	X			X			X	X4	
Potatoes	X	X7	X			X21						X4	X7
Pumpkin/Winter Squash	X	X1	X3	X7		X1			X	X	X	X	X
Radish	X	X7					X14			X			
Spinach	X	X	X1							X		X	
Squash, Summer	X	X1	X3	X7		X1			X	X	X	X	X
Strawberries	X	X				X1	X		X				
Sweet Corn				X7									
Sweet Potatoes	X	X7			X					X			
Tomatoes	X	X	X3	X7	X			X			X	X4	X5
Watermelon		X1	X3	X7		X1		X1	X	X	X	X	X

Superscripts: a=seed treatment or soil use only, b=Ultra Flourish is not labeled on these crops, c=Sulfur rates above 4 lb/A applied during high temperatures may cause crop injury, d=Only in DE, PA, MD, and VA, e=See label for PHI.

4.5. Disease Control for Greenhouse Production

Table E-13. Selected Fungicides Labeled for Greenhouse Use

Fungicides are listed in alphabetical order within FRAC code.
BM 02 = Biological; M0x = Protectant Fungicide; P0x = Plant Defense Inducer; NC = not classified by FRAC; # = FRAC code(s)
Note: Some states define pesticide applications in high tunnels as greenhouse applications, others define them as field applications. Check with your extension educator or state department of agriculture for correct application. If any information in this table is inconsistent with the label, follow the label.

Fungicide	Active Ingredient(s)	FRAC Code	OMRI Listed	Target Diseases/Pathogens	Labeled Crops	Comments
Actinovate (Novozymes BioAg, Inc.)	*Streptomyces lydicus*	BM 02	**Yes**	Damping off and root rot, pathogens *Pythium*, *Rhizoctonia*, *Phytophthora*, *Verticillium,* and foliar diseases including Downy and Powdery Mildew and *Alternaria* and *Botrytis*	Greenhouse vegetables and herb crops	May be applied to soil or foliage through mist systems or sprayer.
Bio-Tam (SePRO)	*Trichoderma asperellum* + *Trichoderma gamsii*	BM 02	**Yes**	Damping off and root rot, pathogens *Pythium*, *Rhizoctonia*, *Phytophthora*, and *Verticillium*	For cole crops, cucurbits, fruiting vegetables and leafy vegetables, onions, and herbs	See label for specific rates.
Cease, Serenade ASO, Subtilex NG	*Bacillus subtilis* (various) - see labels	BM 02	**Yes**	For suppression of soilborne and foliar diseases including damping off, Root Rot and Early Blight	Many vegetables including fruiting and leafy vegetables, cucurbits, cole crops and herbs	May be used in hydroponic and soilless production systems. Most effective when used preventatively.
Contans (Sipcam Agro)	*Coniothyrium minitans*	BM 02	**Yes**	*Sclerotinia sclerotiorum*, *S. minor*	Many vegetables including leafy vegetables, brassicas, legumes, fruiting vegetables and bulb vegetables. <u>Do not</u> use on tomato.	Contains a beneficial fungus. Do not allow to stand overnight following mixture. Acts as a preventative.
Howler (AgBiome Innovations)	*Pseudomonas chlororaphis* strain AFS009	BM 02	**Yes**	For suppression of *Rhizoctonia*, *Pythium*, *Fusarium*, *Phytophthora*, *Sclerotinia*, *Colletotrichum* and *Botrytis*	Cucurbits fruiting vegetables, herbs, leafy vegetables, cole crops	May be used in hydroponic and soilless production systems. Most effective when used preventatively.
Lifegard WG (Certis USA)	*Bacillus mycoides* isolate J	BM 02	**Yes**	Downy Mildew, Powdery Mildew, Leaf Spots	Brassica head and stem vegetables, cucurbits, fruiting vegetables	Transplants can be treated in the greenhouse prior to transplanting.
RootShield, RootShield + (Bioworks, Inc.)	*Trichoderma harzianum*	BM 02	**Yes**	*Pythium*, *Rhizoctonia*, and *Fusarium*. When applied as a foliar spray, suppresses *Botrytis* and Powdery Mildew.	Greenhouse vegetables	Contains a beneficial fungus. Avoid applications of fungicides at least one week before or after application. Acts as a preventative. Will not cure diseased plants.
SoilGard 12G (Certis USA)	*Trichoderma virens* GL-21 (formerly known as *Gliocladium virens*)	BM 02	**Yes**	Damping off and root rot caused by *Pythium* and *Rhizoctonia*	Food crop plants in greenhouse	Has preventative activity only, will not cure already diseased plants. Allow treated soil to incubate for one day prior to planting for best results. Do not use other soil fungicides at time of incorporation.

Table E-13. Selected Fungicides Labeled for Greenhouse Use - continued next page

Table E-13. Selected Fungicides Labeled for Greenhouse Use - continued

Fungicide	Active Ingredient(s)	FRAC Code	OMRI Listed	Target Diseases/Pathogens	Labeled Crops	Comments
Sonata (Bayer Crop Science LP)	*Bacillus pumilus*	BM 02	**No**	Early Blight, Late Blight, Downy Mildew, Powdery Mildew	Many vegetables including brassicas, cucurbits, bulb, fruiting, and leafy vegetables and root and tuber crops	Preventative biological fungicide. Can be used in organic production.
Stargus, Double Nickel	*Bacillus amyloliquefaciens* (various) - see labels	BM 02	**Yes**	Bacterial Blight, Bacterial Spot, Late Blight, Grey Mold, Downy Mildew, and other diseases	Cucurbits, tomatoes, peppers, leafy vegetables, and other greenhouse-grown vegetables	Can be used as a soil drench for soilborne diseases or as a foliar spray. Apply prior to disease infection.
Badge SC, Badge X2 (Gowan)	copper hydroxide + copper oxychloride	M01	**No**	Leaf Spots, Bacterial Leaf Spot, and others	Tomato, pepper, eggplant, and cucumber	See label for rates, restrictions, and application timing. Phytotoxicity may occur.
Camelot O, Cueva	copper octanoate	M01	**Yes**	Leaf Spots, Bacterial Leaf Spot, and others	Cucurbits, tomatoes, peppers, and others	See labels for specific rates and usage instructions. Phytotoxicity may occur.
Cuprofix Ultra 40 Disperss (United Phosphorus, Inc.)	basic copper sulfate	M01	**No**	Many diseases including Angular Leaf Spot, Downy Mildew, *Alternaria* blight, *Anthracnose*, Bacterial Blight, etc.	Vegetables including cucumbers, eggplant, peppers, tomatoes, and others	Crops grown in the greenhouse may be more sensitive to copper injury so end user should determine plant sensitivity.
Kocide 2000-O, Kocide 3000-O, Nu-Cop 50DF, Champ WG, ChampION++	copper hydroxide	M01	**Yes**	Leaf Spots, *Anthracnose* and Bacterial Spots, and others	See labels for specific crops	See labels for specific usage instructions. Phytotoxicity may occur.
Magna-Bon CS 2005 (Magna-Bon II, LLC)	copper sulfur pentahydrate	M01	**Yes**	Many diseases including Angular Leaf Spot, Downy Mildew. *Alternaria* blight, *Anthracnose*, Bacterial Blight, etc.	Vegetables including cucurbits, eggplant, peppers, tomatoes and others	Crops grown in the greenhouse may be more sensitive to copper injury so end user should determine plant sensitivity.
Nordox (Brandt Consolidated)	cuprous oxide	M01	**No**	Bacterial Spot and Speck, *Alternaria* leaf spot, *Anthracnose*, Early and Late Blight, etc.	Eggplant, pepper, and tomato	See label for specific usage instructions.
Microthiol Disperss (United Phosphorus, Inc.)	sulfur (S)	M02	**Yes**	Powdery Mildew	Crucifers, cucurbits, peppers and tomatoes	Crops grown in greenhouses may be more sensitive to S injury, so the lowest label rate should be tried initially. Do not use within two weeks of an oil spray treatment.
Dithane M45 (Corteva Agriscience US)	mancozeb	M03	**No**	Seed treatment for damping-off, Seedling Blight, Seed Rots	Tomato	Broad-spectrum protectant fungicide.
Actigard (Syngenta Crop Protection)	acibenzolar-s-methyl	P01	**No**	Angular Leaf Spot, Bacterial Fruit Blotch, Bacterial Leaf Spot, Downy Mildew, Powdery Mildew, Scab	Summer squash production only	See label for rates, restrictions, and application timing. Phytotoxicity may occur.
Regalia, Regalia CG (Marrone Bio Innovations)	*Reynoutria sachalinensis*	P05	**Yes**	Many diseases including Powdery Mildew	Cucurbits, bulb vegetables, fruiting vegetables and others	See label for crops, application methods

Table E-13. Selected Fungicides Labeled for Greenhouse Use - continued next page

Table E-13. Selected Fungicides Labeled for Greenhouse Use - continued

Fungicide	Active Ingredient(s)	FRAC Code	OMRI Listed	Target Diseases/Pathogens	Labeled Crops	Comments
K-Phite (Plant Food Systems) **Prophyt** (Helena Chemical Co.)	phosphorous acids - mono and di-potassium salts	P07	**No**	Root Rots, damping off, Downy Mildew	Cucurbit, fruiting vegetable, and leafy vegetable crops	See label for preplant seedling tray application instructions.
DeBug Tres, Debug Turbo (Agro Logistic Systems, Inc.)	azadirachtin + neem oil	NC	**Yes**	Nematodes. *Sclerotinia sclerotiorum* and *S. rolfsii* diseases	Cucurbits, fruiting vegetables and others (see label)	See labels for specific rates and usage instructions.
Majestene Bionematicide (Marrone Bio Innovations)	*Burkholderia* spp.	NC	**Yes**	Root-Knot, Lesion, Sting, Stunt, Ring and other nematodes	Brassica, bulb, cucurbit, fruiting and leafy vegetables	Take soil samples prior to planting to assess nematode populations.
Milstop SP (BioWorks, Inc.), **Kaligreen** (OAT Agrio Co.), **Carb-O-Nator** (Certis USA)	potassium bicarbonate	NC	**Yes**	Powdery Mildew and others	Many vegetables including cabbage, cucumber, eggplant, broccoli, cauliflower, lettuce, peppers, tomatoes, and squash	Works by contact. Potassium bicarbonate disrupts the potassium ion balance in the fungus cell, causing the cell walls to collapse.
M-Pede (Gowan Company)	potassium salts of fatty acids	NC	**Yes**	Powdery Mildew	Cucurbits, fruiting, leafy, root and tuber vegetables and others	Contact fungicide. See label for details.
Oxidate 2.0, Oxidate 5.0 (Bio-Safe Systems LLC)	hydrogen dioxide, peroxyacetic acid	NC	**Yes**	*Anthracnose*, Downy Mildew, Powdery Mildew, *Pythium* Root Rot, and other diseases	Many vegetables including cole crops, cucurbit, leafy vegetables, peppers, and tomatoes	Strong oxidizing agent. Contact, oxidizing sanitizer.
Surround WP (Tessenderlo Kerley, Inc.)	kaolin	NC	**Yes**	Powdery Mildew	Cucurbit and other vegetables	Product forms a white clay film on leaves and fruit. Reduces sunburn and heat stress.
Ultra-Pure Oil (BASF Corp)	mineral oil	NC	**No**	Powdery Mildew, insect pests (see label)	Cucurbits, melons, squash, tomatoes, oriental vegetables, and others	Application should be made when disease is first noticed. See label for information on plant safety. Use lower label rates in the greenhouse.
3336 WP (Cleary Chemicals, LLC)	thiophanate-methyl	1	**No**	*Anthracnose*, Gray Mold, *Sclerotinia*, Gummy Stem Blight, Powdery Mildew, and others	Dry and succulent beans, and cucurbits for transplant.	Caution: Some populations of the pathogens that cause gummy stem blight, grey mold and powdery mildew, are resistant to thiophanate-methyl.
Procure 480SC (UPL NA Inc)	triflumizole	3	**No**	Powdery Mildew, *Alternaria* Leaf Spot	Butterhead lettuce only	See label for specific instructions.
Terraguard (Arysta Lifescience North America, LLC)	triflumizole	3	**No**	Powdery Mildew	Greenhouse tomato and cucumber production, including transplants	See label for specific instructions.
Fontelis (Corteva Agriscience US)	penthiopyrad	7	**No**	Many diseases, including Gummy Stem Blight, *Sclerotinia* Stem Rot, Leaf Spots, Powdery Mildew and *Anthracnose*	Tomatoes, eggplant, peppers, and edible peel cucurbits	See label for specific usage instructions.

Table E-13. Selected Fungicides Labeled for Greenhouse Use - continued next page

Table E-13. Selected Fungicides Labeled for Greenhouse Use - continued

Fungicide	Active Ingredient(s)	FRAC Code	OMRI Listed	Target Diseases/Pathogens	Labeled Crops	Comments
Scala SC (Bayer CropScience)	pyrimethanil	9	**No**	Early Blight and Gray Mold, *Botrytis*	Tomatoes and greenhouse grown cucumber	Use in well-ventilated houses only and ventilate two hours after application.
Heritage, Quadris, A-frame, Dynasty, Satori and others	azoxystrobin	11	**No**	*Rhizoctonia*, Leaf Spots and others	Brassica, cucurbit, fruiting vegetables and others	Vegetable and herb plants grown for transplanting
Reason (Bayer/Gowan)	fenamidone	11	**No**	Basil Downy Mildew	Basil only	See label for specific instructions.
Emblem, Spirato GHN (Nufarm Americas, Inc.)	fludioxonil	12	**No**	*Alternaria* Leaf Blight, *Cercospora* Leaf Spot, Gummy Stem Blight, Powdery Mildew, Early Blight, Gray Mold, *Septoria* Leaf Spot, and *Sclerotinia* Rot	Brassica (cole) crops, cucurbits, tomatoes and other fruiting vegetables, leafy greens	Good coverage is essential for disease control. Use good resistance management practices (see label for crop use and rates.
Terraclor 400 (Amvac Chemical Corp.)	pentachloro-nitrobenzene (PCNB)	14	**No**	Root and Stem Rot, damping off (*Rhizoctonia solani*, *Pellicularia filamentosa*)	Vegetable bedding plants. Limited to container-grown broccoli, Brussels sprouts, cabbage, cauliflower, peppers, and tomatoes.	Apply as a soil drench in nursery and greenhouse to seedlings grown in containers prior to transplanting. See label for additional information.
Decree (Arysta LifeScience)	fenhexamid	17	**No**	*Botrytis*	Tomatoes, cucumber, pepper, lettuce, and eggplant	Protectant fungicide with some plant back restrictions. See label for details.
Affirm WDG (Nufarm Americas, Inc.)	polyoxin D zinc salt	19	**No**	Powdery Mildew, Leaf Spots, *Botrytis*	For cucurbits, fruiting vegetables, herbs, and strawberry transplant production only	NOT for field use or production of edible commodities
Ranman (FMC Corp.)	cyazofamid	21	**No**	*Pythium* damping-off, Basil Downy Mildew	Tomato greenhouse transplant production and basil	Drench transplant tray with fungicide at planting or up until one week before transplant. See label for additional details.
Segway O (OHP Inc.)	cyazofamid	21	**No**	Basil Downy Mildew, *Pythium,* damping-off, *Phytophthora capsica, Phytophthora* Blight	Greenhouse herbs, tomato, and pepper production	See label for specific instructions.
Agri-Mycin 50 (Nufarm Americas, Inc.)	streptomycin sulfate	25	**No**	Bacterial Leaf Spot, Bacterial Speck	Tomatoes and peppers grown for transplant only	Repeated applications can result in resistant bacteria. Do not apply through any irrigation system.
Previcur Flex (Bayer CropScience)	propamocarb hydrochloride	28	**No**	*Pythium* Root Rot and damping off	Tomatoes, leaf lettuce, cucurbits, and peppers	See label for specific instructions.
Micora (Syngenta Crop Protection, LLC)	mandipropamid	40	**No**	Downy Mildews, Blue Mold, Late Blight, and suppression of *Phytophthora* blight	Some vegetables and basil grown for transplant and retail sale to customers	Registered for closed greenhouses with permanent flooring on transplants for re-sale to consumers.
Revus (Syngenta Crop Protection)	mandipropamid	40	**No**	Late Blight only	Tomato production only	See label for rates, restrictions, and application timing.

Table E-13. Selected Fungicides Labeled for Greenhouse Use - continued next page

Table E-13. Selected Fungicides Labeled for Greenhouse Use - continued

Fungicide	Active Ingredient(s)	FRAC Code	OMRI Listed	Target Diseases/Pathogens	Labeled Crops	Comments
Inspire Super (Syngenta Crop Protection	difenoconazole + cyprodinil	3 + 9	**No**	*Alternaria* Leaf Spot, *Anthracnose*, *Cercospora* Leaf Spot, Gummy Stem Blight, Powdery Mildew	Cucumber production only	See label for rates and application timing.
Luna Tranquility (Bayer CropScience)	fluopyram + pyrimethanil	7 + 9	**No**	Early Blight, Gray Leaf Spot, Gray Mold, *Alternaria*, Powdery Mildew	Tomato and strawberry only	See label for rates, restrictions, and application timing.
Mural (Syngenta Crop Protection LLC)	benzovindiflupyr + azoxystrobin	7 + 11	**No**	Powdery Mildew, Leaf Mold, Leaf Spots and others.	Tomatoes, cucurbits	Vegetable plants for re-sale to consumers. Do not make more than two applications per crop.
Pageant Intrinsic (BASF Corp)	boscalid + pyraclostrobin	7 + 11	**No**	Gray Mold	Transplant and greenhouse-grown tomatoes, cucurbits, and leafy greens	Pageant Intrinsic is also labeled for greenhouse use on transplants grown for the home consumer market
Orondis Ultra (Syngenta Crop Protection LLC)	oxathiapiprolin + mandipropamid	49 + 40	**No**	Late Blight and Buckeye Rot	Tomato production only	See label for rates, restrictions, and application timing.

F. Commodity Recommendations

Pesticide Use Disclaimer

THE LABEL IS THE LAW

A pesticide applicator is legally bound by the labeling found on and with the pesticide container in their possession. Before using a pesticide, check and always follow the labeling distributed with the product at the point of sale for legally enforceable rates and use restrictions and precautions. Although labels are available on the Internet from electronic label services such as Proagrica's CDMS (*https://www.cdms.net/*), Greenbook (*https://www.greenbook.net*), or Agworld DBX powered by Agrian (*https://www.agrian.com/labelcenter/results.cfm)* the information contained in these electronic labels may not be identical to the labeling distributed with the product. **Please be advised that these electronic label services provide use disclaimers, and in some cases legally binding *User Agreements* assigning ALL liability to user of service. (**See section D 3.1. Labels and Labeling for more detail.)

Guide to the Recommended Pesticide Tables in the Following Crop Sections:

1. Pesticides are listed by **group number or code based on chemical structure and mechanism of action**, as classified by the Herbicide Resistance Action Committee (**HRAC**, *https://hracglobal.com*) for herbicides, the Insecticide Resistance Action Committee (**IRAC**, *https://irac-online.org*) for insecticides, and the Fungicide Resistance Action Committee (**FRAC,** *https://www.frac.info/*) for fungicides. **In this guide, if the group number or code is in bold font, there are resistance concerns for the product.**

2. Restricted use pesticides are marked with a * in the Tables. These products may only be used by certified and/or licensed pesticide applicators, and when stated on the label, those making applications under their direct supervision. Some labels may restrict use solely to certified and/or licensed applicators. (See section D 3.2.1 Restricted Use Classification Statement for more detail).

3. In addition to the pesticide products listed in the Commodity Recommendations below, other formulations or brands with the same active ingredient(s) may be commercially available. ALWAYS CHECK THE LABELING ON THE PRODUCT CONTAINER ITSELF:
a) to ensure a pesticide is labeled for the same intended use,
b) to ensure the pesticide is labeled for the desired crop,
c) for differences in application rates and % active ingredient(s), and
d) additional restrictions.

4. All pesticide recommendations contained in this document are prescribed for spray applications to a **broadcast area of 1 acre** (43,560 square feet). **Adjust the rate accordingly for banded applications** (See section E 1.3. Calibrating Granular Applicators) **or for chemigation** (check labels for amounts per 1,000 feet).

5. Check the physical product label for and do not exceed the maximum amount of pesticide *per application* and the maximum number of applications *per year*.

6. Bee Toxicity Rating (Bee TR): N=nontoxic; L=minimum impact on bees; M=moderately toxic, can be used if dosage, timing, and method of application are correct, but should NOT be applied directly to the crop if bees are present; H=highly toxic, severe losses expected, -- = data not available.

7. In accordance with the USDA National Organic Program, the Organic Materials Research Institute (OMRI) maintains a directory of all products that OMRI has determined are allowed for use in organic production, processing, and handling. These products are catalogued online in the **OMRI Products List** (see *https://www.omri.org/omri-lists*).

Asparagus

Recommended Varieties[1]

Atlas* (RT, FT, CBT, HT)	Millennium* (RT, FT)
Eclipse* (RT, FT)	Purple Passion (RT, FT)
Grande* (RT, FT, HT)	Walker Deluxe* (RT, FT)
Jersey Knight* (RT, FT)	

[1]**Listed alphabetically**. *Indicates hybrid variety. RT = Rust Tolerant; FT = Fusarium Tolerant. CBT = Cercospora Blight Tolerant; HT = Heat Tolerant

Recommended Nutrients Based on Soil Tests

Before using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and Chapter B Soil and Nutrient Management. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede the recommendations found below.

Asparagus[1,2]		**Soil Phosphorus Level**				**Soil Potassium Level**				
		Low	**Med**	**High (Opt)**	**Very High**	**Low**	**Med**	**High (Opt)**	**Very High**	
	N (lb/A)	**P_2O_5 (lb/A)**				**K_2O (lb/A)**				**Nutrient Timing and Method**
Growing Crowns	50	200	100	50	0[3]	200	100	50	0[3]	Total nutrient recommended
	50	200	100	50	0[3]	200	100	50	0[3]	Broadcast and disk-in
New Plantings Crowns and Transplants	75-100	200	100	50	0[3]	200	100	50	0[3]	Total nutrient recommended
	50	200	100	50	0[3]	200	100	50	0[3]	Broadcast and disk-in
	25-50	0	0	0	0	0	0	0	0	Sidedress 4 weeks after planting
Cutting Beds to Maintain	75-100	200	150	100	0[3]	300	225	150	0[3]	Total nutrient recommended
	50	200	150	100	0[3]	150	100	75	0[3]	Apply before cutting season
	25-50	0	0	0	0	150	125	75	0	Sidedress after end of cutting season

[1]Apply 1-2 lb/A of boron (B) every 3 yr on most soils; see also Table B-7. in Chapter B Soil and Nutrient Management.
[2]Apply 25-30 lb/A of sulfur (S) for most soils.
[3]In VA, crop replacement values of 50 lb/A of P_2O_5 and 75 lb/A of K_2O are recommended on soils testing Very High.

Purity of Seed Lots

The varieties listed in the table above are all male hybrids. Male asparagus hybrid varieties are preferred over standard hybrids and open-pollinated populations because male plants are more vigorous and productive. However, some seed lots may contain a significant percentage of female plants. Check with your seed supplier to determine the anticipated proportion of female and/or off-type plants in the lots you procure.

Seed Treatment

Check if seed has been treated; see also Disease Control below.

Growing Crowns and Transplants

Crowns can be purchased or grown from seed. Sow seed 1½ inches deep at a rate of 6-8 lb/A (10-12 seeds per ft) in rows 24-30 inches apart in mid-April in warmer, southern areas to mid-May in cooler areas. Crowns must be grown in an area where asparagus has never been grown.

Grow asparagus transplants in 72-100 cell trays containing artificial growing media formulated for pepper transplants. Grow seedlings for 8-10 weeks in the greenhouse, then harden-off in a protected outdoor area for 2 weeks before transplanting. **Timely irrigation, cultivation and application of herbicides are essential for successful use of seedling transplants**. Contact your County Extension Agent for specific herbicide suggestions.

Planting and Spacing

Plant crowns and transplants April 1 to May 20 when soil conditions are favorable. Early plantings produce more vegetative growth and more vigorous crowns than late plantings. Space 1-year-old crowns and transplants 12 inches apart in rows 4½-5 ft apart. Make furrows 6-8 inches deep, plant crowns 5-7 inches deep. Cover crowns with 1-2 inches of soil. Cultivate and move soil to seedlings carefully to avoid covering foliage with soil. Gradually fill trenches during the growing season and form a 2-inch ridge over the plants after the fern turns brown in the fall.

Harvest and Post-Harvest Considerations

Do not harvest asparagus the year of planting. Harvest for 2 weeks the 2nd year after planting and increase to 6-8 weeks as the planting matures. Stop harvesting by June 15 if fern vigor was good the previous fall. Stop sooner if spear thickness drops. Prolonged cutting increases stress on the plant and can increase root and crown rot. If foliage diseases were severe or fern vigor was low the previous fall, stop harvesting 10 days sooner than normal. Leave soil on young beds unridged for the first 2-3 weeks of harvest. On old beds, and in fields where freezing of early emerged spears occurs frequently, begin ridging at the start of the harvest season. In areas where freeze damage to spears occurs frequently, mulch the beds with straw after herbicide application to delay spear emergence. Remove spears from field promptly after cutting to maintain freshness and a low fiber content. After harvesting, spears should be washed, cooled, trimmed to a uniform length, graded by diameter, and bunched. Spears can be stored for up to 3 weeks at 36°F (2°C) and 95% relative humidity.

Mother Stalk Harvest System for Season Extension

Like many other crop species, asparagus possesses a feedback system for spear/shoot initiation from the underground crown. If a few mature shoots ("fern") exist, the crown perceives reduced phytohormone levels and releases additional spears/shoots for elongation. When a threshold number of mature shoots is reached, no more spears/shoots will elongate thereafter from the crown. It is possible to use this system for spear harvest season extension by limiting the number of mature shoots, known as the "mother stalk harvesting system" (MSHS).

MSHS begins by allowing a fixed number of spears to continue to grow into mature shoots, usually 3 to 4. After these shoots are established, all spears that subsequently emerge from the crown are harvested. Research has shown that spears will appear more or less continuously for several months, as long as the mature shoots remain healthy and adequate soil moisture and nutrient levels are maintained. The dynamics of yield are not consistent, however. Following the expected flush of spears in April-June, the rate of new spear emergence may fluctuate with temperature, soil moisture, and light levels. Yields during the summer period can be extremely low, although spear quality remains acceptable. Spears harvested after the fern canopy is present often appear lighter in color, since chlorophyll deposition is associated with light levels. Summer yields are often insufficient to justify the cost of harvesting, but harvesting must continue since new mature shoots will suppress later spear emergence. Continuous spear emergence may be sustained by MSHS to as late as mid-September in the Mid-Atlantic region, but the degree of season extension varies with weather and management practices.

Successful MSHS usually requires more intensive management than conventional harvesting. Spear yields and quality are promoted by regular irrigation and fertilization, and pest and disease management as needed. Staking of the mature foliage prevents crop damage during violent weather events and renders it easier to harvest young spears. The hope is that favorable market conditions will help to infringe the costs of additional management needs.

There are many variations on specific steps taken in MSHS. For example, research has shown that a period of conventional harvest at the beginning of the season (first 2-3 weeks) followed by the imposition of MSHS has a beneficial impact on cumulative season yield. Although data on the long-term effects of MSHS on crown viability are lacking, it is recommended that a minimum of 2 years of conventional harvest separate a season of MSHS on any given asparagus production block.

It is recommended that MSHS is practiced on a small scale by growers participating in direct marketing.

Brush Removal

For very small plantings remove and properly discard brush if possible. Mow or disk brush in February or March. Avoid damage to spear buds by shallow disking. Burn brush during the winter to destroy fungi that cause diseases, such as rust and purple spot. Obtain a burn permit in areas where required.

Weed Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.

Recommended Herbicides

1. Identify the weeds in each field and select recommended herbicides. More information is available in the "Herbicide Effectiveness on Common Weeds in Vegetables" (Table E-3) in Chapter E Pest Management.
2. Minimize herbicide resistance development. Identify the herbicide mode of action group number and follow recommended good management practices; **bolded group numbers in tables below are herbicides at higher risk for selecting resistant weed populations.** Include non-chemical weed control whenever possible.

1.a. Seedbeds, Seeded Fields, and Newly Planted Crowns: Preplant or Preemergence						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient**	**Active Ingredient Rate**	**PHI (d)**	**REI (h)**
3	Prowl H2O 3.8CS	2.4 to 8.2 pt/A	**pendimethalin**	1.14 to 3.9 lb/A	14	24
-Apply only to newly planted crown asparagus. Assure that the crowns are fully covered with 2 to 4 inches of soil. -**Do not** apply to newly seeded asparagus. **Do not** apply more than 2.4 pt/A to sandy soils. **Do not** apply postemergence over the top of emerged spears or severe injury may occur. Maximum for Prowl H2O: 8.2 pt/A per season.						
7	Lorox 50DF	2 to 4 lb/A	**linuron**	1 to 2 lb/A	1	24
-Use lower rate on coarse-textured (sandy) soils low in organic matter, and higher rate on fine-textured (silt and clay) soils. -Make a single application of 2 to 4 lb/A after planting seed ½ inch deep in coarse soil and 1 inch deep in fine soils. -During planting operation, spray activated charcoal as a 1 inch band on soil surface directly over seeded row at rate of 300 lb/A. -Preemergence weed control will be reduced in soils with high organic matter (greater than 5% and peat or muck). -**Do not** use **FLOWABLE** (liquid) formulation, or crop injury may occur. -**Do not** use surfactant or fertilizer solution in spray mixture. -Maximum Lorox 50DF application: 4 lb/A per season.						
9	Roundup PowerMax 4.5L "Generic" glyphosate 3L	16 to 32 fl oz/A 24 to 48 fl oz/A	**glyphosate**	0.75 to 1.1 lb acid equivalent/A	5	4
-Apply before seeding or at least 7 days prior to the emergence of the first asparagus spears. -Some glyphosate formulations may require an adjuvant, refer to label. Tank mix with appropriate herbicides for residual weed control. -Glyphosate controls many perennial weeds as well as annuals if applied when the weed is actively growing and has reached the stage of growth listed on the label. Repeat applications are allowed, with maximum application of 5.3 qt/A per year.						
22	Gramoxone SL 2.0* Gramoxone SL 3.0*	2.5 to 4 pt/A 1.7 to 2.7 pt/A	**paraquat**	0.6 to 1 lb/A	6	24
-Apply before seeding or before spear emergence. Always include an adjuvant (nonionic surfactant or crop oil concentrate). -Tank mix with appropriate herbicides for residual weed control. Paraquat may not control established grasses. -Spray coverage is essential for optimum control. -Rainfastness 30 min. A maximum of 3 applications per year are allowed. -***Restricted-use pesticide***. Only certified applicators, who successfully complete the paraquat-specific training, can mix, load, or apply paraquat. Application of paraquat "under the direct supervision" of a certified applicator is no longer allowed. Required training link (*https://campus.extension.org/enrol/index.php?id=2201*); certified applicators must repeat training every three years.						

1.b. Seedbeds, Seeded Fields, and Newly Planted Crowns: Postemergence						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient**	**Active Ingredient Rate**	**PHI (d)**	**REI (h)**
1	Shadow 3EC Select 2EC Select Max 0.97EC	4 to 5.33 fl oz/A 6 to 8 fl oz/A 9 to 16 fl oz/A	**clethodim**	0.07 to 0.125 lb/A	1	24
	Poast 1.5EC	1 to 2.5 pt/A	**sethoxydim**	0.2 to 0.5 lb/A	1	12
	Fusilade DX 2EC	8 to 24 fl oz/A	**fluazifop**	0.125 to 0.375 lb/A	1	12
-**Select 2EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). **Select Max**: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution). **Shadow 3EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution) for large or stressed grasses; use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution) when crop safety is a concern. **Poast**: use COC at 1.0% v/v. **Fusilade DX:** use COC at 1.0% v/v or NIS at 0.25% v/v. -**The use of COC may increase the risk of crop injury when hot or humid conditions prevail**. To reduce the risk of crop injury, omit additives or switch to NIS when grasses are small and soil moisture is adequate. -Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control. -Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will **not** be controlled. -Controls many annual and certain perennial grasses, including annual bluegrass, but Poast is preferred for goosegrass control. For best results, treat annual grasses when they are actively growing and before tillers are present. Control may be reduced if grasses are large or under hot or dry weather conditions. -Repeated applications may be necessary to control certain perennial grasses. If repeated applications are necessary, allow 14 days between applications. Rainfastness is 1 h. -**Do not** tank mix with or apply within 2 to 3 days of any other pesticide, unless labeled, as this may increase the risk of crop injury or reduce the control of grasses. -**Do not** apply more than 8 fl oz/A of Select 2EC in a single application and **do not** exceed 2 pt/A for the season; **Do not** apply more than 16 fl oz/A of Select Max in a single application and **do not** exceed 4 pt/A for the season. -**Do not** apply more than 5.33 fl oz/A of Shadow 3EC in a single application and **do not** exceed 21.33 fl oz/A for the season. -**Do not** apply more than 2.5 pt/A Poast in a single application and **do not** exceed 5 pt/A for the season. -**Do not** apply more than 24 fl oz/A of Fusilade DX in a single application and **do not** exceed 3 pt/A per season.						

2. Cutting Bed

Use a combination of grass and broadleaf weed herbicides to control a wide spectrum of weeds. Identify the weeds in your field. Split the herbicide application. Spray part of your grass herbicide before harvest and the remainder after harvest, or switch to another grass herbicide after harvest. Rotate the use of metribuzin with Karmex or Sinbar to avoid repeated use of chemically related products. Choose metribuzin or Sinbar when weeds have emerged, unless another effective postemergence herbicide is used.

2.a. Cutting Bed: Before Spear Emergence and/or After Harvest Season

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
3	Prowl H2O 3.8CS	2.4 to 8.2 pt/A	**pendimethalin**	1.14 to 3.9 lb/A	14	24
-Apply only to newly planted crown asparagus. Assure that the crowns are fully covered with 2 to 4 inches of soil. -**Do not** apply to newly seeded asparagus. -**Do not** apply more than 2.4 pt/A to sandy soils. -**Do not** apply postemergence over the top of emerged spears or severe injury may occur. -Maximum for Prowl H2O: 8.2 pt/A per season.						
3	Treflan 4EC	1 to 4 pt/A	**trifluralin**	0.5 to 2 lb/A	--	12
-Apply only to established asparagus as a single or split application. See label for rates and instructions concerning split applications before and after harvest. -Make applications to dormant asparagus in winter or early spring after mature ferns have been removed or post-harvest immediately after harvest in late spring or early summer just before ferns are allowed to develop. -**Do not** apply after new spears begin to emerge. -Maximum use for Treflan: no more than 2 pt/A on coarse soils, 3 pt/A on medium soils, or 4 pt/A on fine soils per calendar year.						
5	Metribuzin 75DF Metribuzin 4L	1.33 to 2 lb/A 2 to 4 pt/A	**metribuzin**	1 to 1.5 lb/A	14	12
-Apply before spears emerge or after final harvest. The maximum rate before spear emergence is 2.67 lb (75DF) and 4 pt (4L); after final harvest is 2 lb (75DF) and 3pt (4L). -Metribuzin primarily controls broadleaf weeds. Tank mix with Devrinol or other residual grass herbicide to control annual grasses. -Use Sinbar or Karmex after harvest when metribuzin is used in the early spring. -For split applications preemergence followed by post-harvest use 0.5 to 1 lb ai/A preemergence followed by 1 to 1.5 lb ai/A post-harvest. For post-harvest applications, apply after last harvest of season but prior to emergence. -Rainfastness is 6 h. -Maximum use for metribuzin 75DF: 2.67 lb/A per season. Maximum use for metribuzin 4L:4 pt/A per season.						
5	Sinbar 80WDG	1.5 to 2.5 lb/A	**terbacil**	1.2 to 2 lb/A	5	12
-Apply prior to spear emergence; application may be made immediately after clean cutting. -Use lower rate on coarse-textured (sandy) soils low in organic matter, and higher rate on fine-textured (silt and clay) soils. -Apply before weeds emerge or to small weeds (1/2 to 2 inches tall). -**Do not** use on areas where subsoil or roots are exposed or on plants that are diseased or lacking in vigor, as crop injury may occur. -Do not use on soils containing less than 1% organic matter. -Not recommended for use at time of planting. -Treated areas may be planted to asparagus 1 year after application. **Do not** replant any other crop within 2 years of last application. -Maximum for Sinbar: 1.5 lb/A per application.						
7	Karmex 80DF	1 to 4 lb/A	**diuron**	0.8 to 3.2 lb/A	--	12
-**Do not** apply to young plants during the first growing season (except as noted below), nor to newly seeded asparagus, nor on plants with exposed roots as severe injury may result. -Apply prior to spear emergence or after harvest when the soil is disked and free of weeds. -Preemergence weed control will be reduced on soils with greater than 5% organic matter. -On light soils and other soils low in clay or organic matter, apply 1 to 2 lb/A. On soils high in clay or organic matter, use 2 to 4 lb/A. -Maximum use for Karmex: 6 lb/A per season, **do not** exceed 3 lb/A per application, no more than 2 applications.						
7	Lorox 50DF	2 to 4 lb/A	**linuron**	1 to 2 lb/A	1	24
-Apply prior to spear emergence, after harvest, or directed postemergence in the fern stage. -Use lower rate on coarse-textured (sandy) soils low in organic matter, and higher rate on fine-textured (silt and clay) soils. -Preemergence weed control will be reduced in soils with high organic matter (greater than 5% and peat or muck). -**Preemergence:** make a single application of 2 to 4 lb/A. -**Postemergence**: make 1 to 3 applications of 1 to 2 lb/A before weeds exceed 4 inches in height. Apply before cutting season or immediately after cutting. -**Directed Postemergence (Fern Stage):** make a single application of 4 lb/A as a directed spray. -**Do not** use **FLOWABLE** (liquid) formulation, or crop injury may occur. -**Do not** use surfactant or fertilizer solution in spray mixture. -Maximum use for Lorox: 4 lb/A per season.						
12	Solicam 80DF	2.5 to 5 lb/A	**norflurazon**	2 to 4 lb/A	14	12
-Apply to asparagus that has been established for at least one growing season. -Apply at the end of the cutting season immediately after the field is cultivated to level the ridges. -Use 2.5 lb/A on sands and loamy sands, 3.75 lb/A on sandy loams, and 3.75 to 5 lb/A on medium and fine textured soils. -Soil should be settled, firm, relatively free of weeds and debris, and free of depressions around asparagus at time of application. -If no rainfall occurs within 4 weeks after application, the product must be incorporated by flood or sprinkler irrigation. -**Do not** plant sensitive crops (see label) for 2 years after application. -Maximum use for Solicam: 5 lb/A per season.						
13	Command 3ME	2.6 pt/A	**clomazone**	1 lb/A	14	12
-Apply prior to spear and weed emergence. If spears have emerged, make an application after a clean harvest. Cover exposed plants with soil prior to application. -Apply to control annual grasses and many broadleaf weeds including common lambsquarters, velvetleaf, spurred anoda, and jimsonweed. Command will not control yellow nutsedge, mustards, morningglory species, or pigweed species. -Use the lower rate on coarse-textured soils low in organic matter and higher rates on fine-textured soils and on soils with high organic matter. -**WARNINGS**: **1**. Command spray *or* vapor drift may injure sensitive crops and other vegetation up to several hundred yards from the point of application. **Do not** apply adjacent to sensitive crops (see label) or vegetation, or under unfavorable wind or weather conditions. **2.** Command may limit subsequent cropping options, see the label. -Maximum use for Command: 2.6 pt/A per application; and 2.6 pt/A per year; no more than 1 application per year.						

2.a. Cutting Bed: Before Spear Emergence and/or After Harvest Season - continued next page

2.a. Cutting Bed: Before Spear Emergence and/or After Harvest Season - continued

15	Devrinol 2-XT 2EC Devrinol DF-XT 50DF	2 gal/A 8 lb/A	**napropamide**	4 lb/A	--	24
-Apply to asparagus that has been established for at least one growing season. Apply before weeds emerge immediately after ridging in the spring. Split the application if ridges are leveled after harvest. Make the second application immediately after leveling the ridge following the harvest season. Incorporation may improve weed control if rainfall does not occur within 24 h of application. -Devrinol primarily controls annual grasses. Tank mix with metribuzin or other broadleaf residual herbicide for broadleaf weed control. -Maximum use for Devrinol: 2 gal/A per season (2-XT) and 8 lb/A per season (DF-XT).						
15	Dual Magnum 7.62E	1.33 to 2 pt/A	***s*-metolachlor**	1.26 to 1.9 lb/A	16	24
-**Special Local Needs Label 24(c) for NJ and DE (DE expires 9/20/2026; NJ expires 1/28/2027). The use of Dual Magnum 7.62E is legal ONLY if a waiver of liability has been completed (see: *https://www.syngenta-us.com/labels/indemnified-label-login*).** -Apply to dormant established asparagus beds in the spring, prior to spear emergence. Use lower rates on coarse-textured soils and higher rates on fine-textured soils. Primarily controls annual grasses, certain broadleaf weeds, and nutsedge. -**Does not** control emerged weeds. Maximum use for Dual Magnum: 2 pt/A per season, no more than 1 application per year.						
22	Gramoxone SL 2.0* Gramoxone SL 3.0*	2.5 to 4 pt/A 1.7 to 2.7 pt/A	**paraquat**	0.6 to 1 lb/A	6	24
-Apply prior to spear emergence or immediately after the last cutting. Emerged spears sprayed after last harvest will be killed but new growth from the crown will not be affected. Always include an adjuvant (nonionic surfactant or crop oil concentrate). -Tank mix with appropriate herbicides for residual weed control. Paraquat may not control established grasses. -Spray coverage is essential for optimum control. -Rainfastness 30 min. A maximum of 3 applications per year are allowed. -***Restricted-use pesticide***. Only certified applicators, who successfully complete the paraquat-specific training, can mix, load, or apply paraquat. Application of paraquat "under the direct supervision" of a certified applicator is no longer allowed. Required training link (*https://campus.extension.org/enrol/index.php?id=2201*); certified applicators must repeat training every three years.						
27	Callisto 4SC	3.0 to 7.7 fl oz/A	**mesotrione**	0.094 to 0.24 lb/A	--	12
-Apply in the spring after fern mowing, disking, or other tillage operations but prior to spear emergence, as a post-harvest application (after final harvest), or both. -Use the 3.0 fl oz/A rate for postemergence control of emerged weeds or the 6.6 to 7.7 fl oz/A rate for preemergence control. -Use the lower rate on coarse-textured (sandy) soils low in organic matter, and the higher rate on fine-textured (silt and clay) soils. -Use crop oil concentrate at 1 gal/100 gal spray solution or nonionic surfactant at 1 qt/100 gal spray solution if target weeds are emerged. A spray grade UAN at 2.5 gal/100 gal spray solution or ammonium sulfate (AMS) at 8.5 lb/100 gal spray solution may be added for improved burndown of emerged weeds. For post-harvest applications, the use of an adjuvant will increase the risk of crop injury. -Till field or tank mix with paraquat to eliminate emerged spears when Callisto is applied after harvest, or crop injury may be observed as bleaching or bleached streaks in the stems and ferns when treated spears grow. -Callisto controls horseweed and common lambsquarters but is weak on annual grasses. Tank mix with a residual annual grass herbicide to control grasses. -Post-harvest applications must be made in a way that minimizes contact with any standing asparagus spears or ferns. -Rainfastness is 1 h. -Maximum use for Callisto: 7.7 fl oz/A per season, no more than 2 applications per year.						

2.b. Cutting Bed: Postemergence

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
1	Shadow 3EC Select 2EC Select Max 0.97EC	4 to 5.33 fl oz/A 6 to 8 fl oz/A 9 to 16 fl oz/A	**clethodim**	0.07 to 0.125 lb/A	1	24
	Poast 1.5EC	1 to 2.5 pt/A	**sethoxydim**	0.2 to 0.5 lb/A	1	12
	Fusilade DX 2EC	8 to 24 fl oz/A	**fluazifop**	0.125 to 0.375	1	12
-**Select 2EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). **Select Max**: use nonionic surfactant (NIS at 0.25% v/v (1 qt/100 gal of spray solution). **Poast**: use COC at 1.0% v/v. **Shadow 3EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution) for large or stressed grasses; use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution) when crop safety is a concern. **Fusilade DX:** use COC at 1.0% v/v or nonionic surfactant at 0.25% v/v. -**The use of COC may increase the risk of crop injury when hot or humid conditions prevail**. To reduce the risk of crop injury, omit additives or switch to NIS when grasses are small and soil moisture is adequate.						
-Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control. -Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will **not** be controlled. -Controls many annual and certain perennial grasses, including annual bluegrass, but Poast is preferred for goosegrass control. Control may be reduced if grasses are large or under hot or dry weather conditions. -Repeated applications may be necessary to control certain perennial grasses. If repeated applications are necessary, allow 14 days between applications. -**Do not** tank mix with or apply within 2 to 3 days of any other pesticide, unless labeled, as this may increase the risk of crop injury or reduce the control of grasses. -Rainfastness is 1 h. -**Do not** apply more than 8 fl oz/A of Select 2EC in a single application and **do not** exceed 32 fl oz/A for the season; **do not** apply more than 16 fl oz/A of Select Max in a single application and **do not** exceed 64 fl oz/A for the season. -**Do not** apply more than 5.33 fl oz/A of Shadow 3EC in a single application and **do not** exceed 21.33 fl oz/A for the season. -**Do not** apply more than 2.5 pt/A Poast in a single application and **do not** exceed 5 pt/A for the season. -**Do not** apply more than 24 fl oz/A of Fusilade DX in a single application and **do not** exceed 48 fl oz/A per season.						

2.b. Cutting Bed: Postemergence - Shadow, Select, Select Max, Poast, Fusilade - continued next page

2.b. Cutting Bed: Postemergence - Shadow, Select, Select Max, Poast, Fusilade - continued

<table>
<tr><td>2</td><td>Sandea 75DF</td><td>0.5 to 1.5 oz/A</td><td>halosulfuron</td><td>0.024 to 0.07 lb/A</td><td>1</td><td>12</td></tr>
<tr><td colspan="7">-Weed control is maximized with the addition of nonionic surfactant at 0.25% v/v (1.0 qt/100 gal of spray solution), however, the addition of surfactants and grass herbicides may enhance crop response.
-Postemergence/Post-transplant: Apply to asparagus before or during the harvesting season.
-Post-harvest: Nonionic surfactant should be used post-harvest. Sandea can be applied post-harvest during the fern stage.
-Split application for enhanced control of nutsedge: Under heavy nutsedge pressure, split applications are recommended. Apply 0.75 to 1 oz/A Sandea during the cutting/harvesting season when the first flush of nutsedge is 3 to 5 leaves, followed by a second application of 0.75 to 1 oz/A at least 21 to 30 days later up to lay-by to control later flushes of nutsedge.
-Sandea may cause temporary stunting or twisting of ferns on certain varieties when applied during spear emergence. Contact with ferns may cause temporary yellowing. Crop injury will be minimized and weed control maximized when applications are made with drop nozzles as a directed spray below the ferns to allow for more complete coverage of target weeds.
-Precaution: For first year transplants, apply no sooner than 6 weeks after fern emergence.
-Provides control of yellow nutsedge and certain annual broadleaf weeds. Control of weeds taller than 3 inches may not be adequate.
-Sandea is an ALS inhibiting herbicide and resistant weed populations are common in the region.
-Do not use Group 2 herbicides repeatedly in the same field. Do not apply Sandea to crops treated with a soil-applied organophosphate insecticide or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application.
-Rainfastness is 4 h.
-Do not apply more than 2 applications, or more than 2 oz/A of product per 12 month period.</td></tr>
<tr><td>4</td><td>Clarity 4SC</td><td>8 to 16 fl oz/A</td><td>dicamba</td><td>0.25 to 0.5 lb ae/A</td><td>24</td><td>24</td></tr>
<tr><td colspan="7">-May be applied immediately after cutting asparagus but at least 24 h before next cutting.
-Controls or suppresses many annual and perennial broadleaf weeds.
-Multiple applications can be made per growing season.
-If spray contacts emerged spears, crooking (twisting) of some spears may result. If crooking occurs, discard affected spears.
-Do not apply Clarity postharvest on spears and young ferns as severe injury may occur.
-Warning: Dicamba spray or vapor drift may injure sensitive crops growing adjacent to treated fields. Do not apply to fields adjacent to sensitive horticultural, fruit, or vegetable crops. Do not apply on days when the temperature is expected to exceed 85 degrees Fahrenheit. Spray residue is difficult to completely remove from sprayers used to apply dicamba. Do not apply dicamba with sprayers which will be used to apply pesticides to sensitive crops.
-Rainfastness is 4 h. Maximum use for Clarity: 16 fl oz/A per season.</td></tr>
<tr><td>4</td><td>Spur 3SL</td><td>0.5 to 0.67 pt/A</td><td>clopyralid</td><td>0.188 to 0.25 lb/A</td><td>2</td><td>12</td></tr>
<tr><td colspan="7">-Other clopyralid formulations may not be labeled (read the label).
-Applications may be made before or during the asparagus cutting season, or after harvest is complete but prior to fern growth.
-Apply Spur to control or suppress sensitive annual and perennial broadleaf weeds, including Canada thistle, goldenrod, mugwort, and wild aster species. Apply when majority of weeds' basal leaves have emerged, but before the flower stalk begins to grow. Use the higher rate for more effective control of perennial weeds.
-Some crooking or twisting of treated spears may occur. Discard crooked or twisted spears. Do not apply if some crooking of emerged spears is not acceptable. Clear-cutting spears just before applying Spur may reduce occurrence of crooking.
-Post-harvest layby applications should be made as soon as possible after cutting. Malformed ferns may result from application when spears are longer than 3 inches or with open seed heads.
-Spur carryover may affect subsequent crops; observe all plant back restrictions list on label.
-Rainfastness is 6 h. Maximum use for Spur: 0.67 pt/A per growing season.</td></tr>
<tr><td>4</td><td>Weedar 64 3.8L</td><td>3 to 4 pt/A</td><td>2,4-D</td><td>1.43 to 1.9 lb
acid equivalent/A</td><td>30</td><td>48</td></tr>
<tr><td colspan="7">-Apply in the spring on actively growing weeds. Use drop nozzles to avoid contact with ferns if applied post-harvest. If asparagus spears are present, treat immediately after cutting. Spears contacted by the spray may be malformed and off-flavored. If spears are malformed by spray, cut immediately and discard.
-Warning: 2,4-D spray or vapor drift may injure sensitive crops growing adjacent to treated fields. Do not apply to fields adjacent to sensitive horticultural, fruit, or vegetable crops. Do not apply on days when the temperature is expected to exceed 85°F. Spray residue is difficult to completely remove from sprayers used to apply 2,4-D. Do not apply 2,4-D with sprayers which will be used to apply pesticides to sensitive crops.
-Minimum of 30 days between applications.
-Rainfastness is 6 to 8 h.
-Maximum use for Weedar 64 3.8L: 2 applications per crop cycle, 4 pt/A per application, or a combined total of 4.0 lb ai/A 2,4-D per year.</td></tr>
<tr><td>7</td><td>Lorox 50DF</td><td>2 to 4 lb/A</td><td>linuron</td><td>1 to 2 lb/A</td><td>1</td><td>24</td></tr>
<tr><td colspan="7">-Apply prior to spear emergence, after harvest, or directed postemergence in the fern stage.
-Use lower rate on coarse-textured (sandy) soils low in organic matter, and higher rate on fine-textured (silt and clay) soils. Preemergence weed control will be reduced in soils with high organic matter (greater than 5% and peat or muck).
-Preemergence: make a single application of 2 to 4 lb/A.
-Postemergence: make 1 to 3 applications of 1 to 2 lb/A before weeds exceed 4 inches in height. Apply before cutting season or immediately after cutting.
-Directed Postemergence (Fern Stage): make a single application of 4 lb/A as a directed spray.
-Do not use FLOWABLE (liquid) formulation, or crop injury may occur.
-Do not use surfactant or fertilizer solution in spray mixture. Maximum for Lorox: 4 lb/A per season.</td></tr>
</table>

3. Other Labeled Herbicides These products are labeled but limited local data are available; and/or are labeled but not recommended in our region due to potential crop injury concerns.		
Group	**Product Name (*=Restricted Use)**	**Active Ingredient**
4	Quinstar	**quinclorac**
14	Aim	**carfentrazone**
14	Chateau	**flumioxazin**
14	Zeus	**sulfentrazone**
22	Reglone	**diquat**

Insect Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.
Recommended Insecticides

Asparagus Aphids

Watch for tiny (1/16 inch long), bluish-green aphids building up on brush. Aphids prefer to feed on ferns. Damage is primarily from a toxin that the aphids inject into the plant when feeding, which causes shortening of the internodes and rosette, brush-like or 'witches broom' appearance of the foliage, especially near the tips of the lower branches. Protection may be crucial in newly seeded plantings and young cutting beds. The recommended economic threshold is when 5% of ferns are injured. New plantings and seedbeds can tolerate less foliar injury than established plantings and may require a lower action threshold. The asparagus aphid overwinters in the egg stage on the fern residue left in the field, so mowing, chopping up, and then incorporating ferns during the dormant season may substantially reduce eggs in the area.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1B	Malathion 57 EC	1.5 to 2.0 pt/A	malathion	1	12	H
3A	PyGanic Crop protection EC 5.0 II (OMRI)	4.5 to 15.61 fl oz/A	pyrethrins	0	12	H
4A	Assail 30SG Assail 30SC	2.5 to 5.3 oz/A 2.1 to 4.5 fl oz/A	acetamiprid	1	12	M
9B	Fulfill 50WDG	2.75 oz/A	pymetrozine - **apply to ferns after harvest**	170	12	L

Asparagus Beetles

Apply when needed during cutting season and late summer. Prevent large numbers of beetles from overwintering and laying eggs on spears in spring by spraying ferns in early fall. Daily harvest will minimize exposure and reduce damage. The recommended economic threshold is when 10% or more of the spears are infested with beetles (1 or more per plant) or 1-2% have eggs or feeding damage. Treat ferns if 50-75% are infested.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	1.5 to 3.0 pt/A	methomyl	1	48	H
1A	Sevin XLR Plus	1.0 qt/A pre-harvest 2.0 qt/A post-harvest	carbaryl	1	12	H
1B	Dimethoate 400	1.0 pt/ A post harvest	dimethoate -**post-harvest protection of ferns only**	180	48	H
1B	Malathion 57EC	1.5 to 2.0 pt/A	malathion	1	12	H
3A	PyGanic Crop protection EC 5.0 II (OMRI)	4.5 to 15.61 fl oz/A	pyrethrins	0	12	H
3A	Permethrin 3.2EC*, others	2.0 to 4.0 fl oz/A	permethrin	1	12	H
4A	Assail 30SG Assail 30SC	2.5 to 5.3 oz/A 2.1 to 4.5 fl oz/A	acetamiprid	1	12	M
5	Entrust SC (OMRI)	4.0 to 6.0 fl oz/A	spinosad -**post-harvest protection of ferns only**	60	4	M
5	Radiant SC	4.0 to 8.0 fl oz/A	spinetoram -**post-harvest protection of ferns only**	60	4	M

Asparagus Fern Caterpillars (Beet Armyworms and Yellow-Striped Armyworms)

Treat when larvae are visibly present in the ferns. Treatments are most effective when larvae are small. Michigan State uses a threshold of 0.7 yellow-striped armyworm per 4 plants. *(continued next page)*

Asparagus Fern Caterpillars (Beet Armyworms and Yellow-Striped Armyworms) - continued

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	1.5 to 3.0 pt/A	methomyl	1	48	H
28	Coragen 1.67SC Coragen eVo	3.5 to 7.5 fl oz/A 1.2 to 2.5 fl oz/A	chlorantraniliprole **- foliar**	1	4	L

Cutworms See also section E 3.1. Soil Pests - Detection and Control.

Note. Early spears are the most heavily damaged because they are first to appear and grow slowest. Dig up to ½ inch deep around crowns and use bait if you find 1 cutworm larva or 1 severely damaged spear per 20 plants.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	1.5 to 3.0 pt/A	methomyl	1	48	H
1A	Sevin XLR Plus	1.0 qt/A pre-harvest 2.0 qt/A post-harvest	carbaryl	1	12	H
3A	Permethrin 3.2EC*, others	2.0 to 4.0 fl oz/A	permethrin	1	12	H
5	Seduce (OMRI)	20 to 44 lb/A	spinosad - **post-harvest protection of ferns only**	60	4	M

Japanese Beetles

Apply to foliage after the cutting season:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
3A	Permethrin 3.2EC*, others	4.0 fl oz/A	permethrin - **post-harvest protection of ferns only**	1	12	H
4A	Assail 30SG Assail 30SC	5.3 oz/A 4.5 fl oz/A	acetamiprid	1	12	M

Thrips

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1B	Malathion 57EC	1.5 to 2.0 pt/A	malathion	1	12	H
3A[1]	PyGanic Crop protection EC 5.0 II (OMRI)	4.5 to 15.61 fl oz/A	pyrethrins	0	12	H
4A[2]	Assail 30SG Assail 30SC	5.3 oz/A 4.5 fl oz/A	acetamiprid	1	12	M

[1]Resistance concerns with western flower thrips [2]Resistance concerns with tobacco thrips

Disease Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F. Recommended Fungicides

Seed Treatment, For NJ Only

Dip seed in a solution containing 1.0 pt/gal of Clorox in water for 1-2 minutes with constant agitation. Use 1.0 gal of this diluted Clorox solution per 2 lb of seed. Prepare a fresh solution for each batch of seed. Wash seed for 5 minutes in running water and dry thoroughly at room temperature.

Bacterial and Fungal Diseases

Asparagus Rust

For long-term management of rust, plant resistant varieties; see the Recommended Varieties table above. Control is especially important in 1- or 2-year-old beds, even with the use of resistant varieties. Scout fields, particularly non-cutting beds, for disease beginning in late June. Traditionally, sprays begin in August depending on weather and disease pressure. Rotate between the fungicides in the table below at the first sign of disease or when conditions favor disease development. Use high rates under severe pressure from rust. *(continued next page)*

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Rotate or tank mix one of the following protectant fungicides						
M03	mancozeb 75DF	2.0 lb/A	mancozeb	180	24	N
M05	chlorothalonil 6F	2.0 to 4.0 pt/A	chlorothalonil	190	12	N
With one of the following fungicides[1]						
3	Rally 40WSP	5.0 oz/A plus adjuvant	myclobutanil	180	24	N
3	tebuconazole 3.6F	4.0 to 6.0 fl oz/A	tebuconazole	180	12	N
M03 + 11	Dexter Max	2.0 to 2.2 lb/A	mancozeb + azoxystrobin	180	24	--

[1]Rally and tebuconazole 3.6F should not be used consecutively; overuse of FRAC code 3 fungicides could lead to fungicide resistance development.

Fusarium Root Rot The pathogen is ubiquitous in soils and may be present in fields where no asparagus has been grown. Plant varieties with tolerance to Fusarium Root Rot; see the Recommended Varieties table above. Stress caused by heavy insect feeding damage, herbicide injury, overharvesting, low soil pH, or low fertility may predispose crowns to Fusarium infection. For crown production, always plant treated seed and select a site where asparagus has never been grown before. For production fields, always plant disease-free crowns, transplants, or seed and select well-drained sites. If this is not possible, select fields that have not been in asparagus production for at least 8 years.

Leaf Blights Excessive rainfall during the summer months may lead to fungal leaf blights caused by *Alternaria* and *Cercospora* spp. Heavy infections may lead to premature defoliation and poor plant vigor later in the season and the following spring. The most noticeable signs of early leaf blight will be sporadic 'hot spots' of brown, dying ferns. Fields should be scouted regularly, especially during periods of prolonged wet weather. Additional fungicide applications may be necessary beyond those for Purple spot and Rust control. Fungicides used to control Purple Spot and Rust, such as chlorothalonil, tebuconazole 3.6F, or mancozeb will be useful for leaf blight control. Apply and rotate the following fungicides on a 7-14 day schedule as long as weather conditions are favorable for disease development.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
M03	mancozeb 75DF	2.0 lb/A	mancozeb	180	24	N
M05	chlorothalonil 6F	2.0 to 4.0 pt/A	chlorothalonil	190	12	N
With one of the following fungicides						
3	tebuconazole 3.6F	4.0 to 6.0 fl oz/A	tebuconazole	180	12	N
M03 + 11	Dexter Max	2.0 to 2.2 lb/A	mancozeb + azoxystrobin	180	24	--

Phytophthora Crown and Spear Rot In fields with poor drainage or low areas, apply one of the following fungicides according to the label. **Cutting fields:** Apply 30-60 days before the first harvest and make a second application prior to first cutting. **Do not** apply Ridomil Gold, Ultra Flourish, MetaStar, or Orondis Gold one day prior to harvest or illegal residues may result. **New plantings:** Apply after planting seedlings or after covering crowns. See labels for specific instructions.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
4	Ridomil Gold 4SL	1.0 pt/A	mefenoxam	AP	48	N
4	Ultra Flourish 2E	2.0 pt/A	mefenoxam	AP	48	N
4	MetaStar 2E AG	2 qt/A	metalaxyl	AP	48	N
4 + 49	Orondis Gold	28.0 to 55.0 fl oz/A	mefenoxam + oxathiapiprolin	AP	48	N

Purple Spot Remove, mow, or burn brush (*i.e.*, dead ferns) after frost or during winter months to destroy the overwintering sources of the fungi (see Brush Removal above). Fungicide applications are not practical during the production season, because new spears emerge daily. Once fern stalks are full size, scout on a weekly basis and rotate the fungicides listed below every 2 to 4 weeks as long as conditions favor disease development or until frost.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
M05	chlorothalonil 6F	2.0 to 4.0 pt/A	chlorothalonil	190	12	N
11	azoxystrobin 2.08F	6.2 to 15.5 fl oz/A	azoxystrobin	100	4	N
M03+11	Dexter Max	2.0 to 2.2 lb/A	mancozeb + azoxystrobin	180	24	--

Beans (Snap and Lima)

Recommended Snap Beans (Bush) Varieties

Snap Beans (Bush)	Variety[1]	Color[2]	Length (inch)	Sieve Size[3]	Use[4]	Days	Heat Tol.[5]	Reported Disease Resistance[6]						
								BCMV	BCTV	Cl	Ua	Psp	Xap	Pss
Green Round Podded Types	Annihilator	DG	6.0	4	F,P	53	X	R	R					
	BA1001	MG	5.9	4-5	P	58		R						I
	Barron	DG	5.5	3-4	F,P	54		R	R			R	I	R
	Bowie	MDG	5.5	3-4	F,P	56		R	R					
	Bridger	MDG	5.5	4-5	F,P	52	X	R	R			I		I
	Bronco	DG	5.3	3-4	F	53		R						
	Caprice	MDG	5.5	3-4	F,P	56		R		R		R	R	I
	Colter	MDG	5.5	4	F	53		R	R		R			
	Crockett	DG	5.25	2-3	F,P	58		R	R		R	R	R	R
	Dominator	DG	6.0	4	F,P	53	X	R	R					
	Greenback	DG	6.0	4	F	56	X	R						
	Jade II	DG	6.5	4	F	60		R			I			
	Jaguar	DG	5.5	3-4	F,P	56	X	R		R	I			
	Lewis	MDG	5.5	3-4	F,P	53		R	R		R	R		I
	Maxibel	MG	7.0	2.3	F	60								
	Momentum	DG	5.8	3-4	F	56		R						
	Nyquist	DG	5.4	4	F,P	56		R						
	Pike	MDG	5.25	3	F	55		R	R			I	I	I
	Prevail	DG	5.5	3-4	F	54		R	I					
	Provider	MG	5.5	4-5	F	55								
	PV857	DG	5.5	4-5	F	54	X	R			I			
	Strike	MG	5.5	3-4	F	55		R						
	Sybaris	DG	5.8	3-4	F,P	56		R			I			
	Tema	DG	5.5	3	F	53		R						
	Valentino	DG	5.75	3	F	53		R			R			
	Wyatt	DG	5.75	3-4	P	54		R	R			R	R	R
Green Flat Podded Types	Greencrop	MG	6.5		F	55								
	Navajo	MDG	5.5-6		P	55				R				
	Roma II	MG	5.5		F,P	58		R						
	Tapia	MG	6		F,P	54		R			I			
	Usambara	MG	5.5		P	54	X	R				I		
	Velero	MDG	6.25		P	56		R	R					
Yellow (Wax) Round Podded Types	Carson	Y	5.5	4-5	F,P	56		R		R				R
	Gold Mine	Y	5.3	4-5	P	56		R				R		
	Gold Rush	MY	6.0	4	F	55		R						
	Rocdor	Y	6.0	4	F	53		R		R		R		
	SV1003GF	MY	5.2	3-4	F	56		R						I

[1]**Listed alphabetically within type**.

[2]G=Green, Y=Yellow, M=Medium and D=Dark.

[3]Bean diameter category for majority of beans at harvest, 2=14.5/64 to 18.5/64 inch, 3=18.5/64 to 21.0/64 inch, 4=21.0/64 to 24.0/64 inch, 5=24.0/64 to 27.0/64 inch.

[4]F=fresh, P=processing Not all processing beans that perform well in the region are listed; consult with your processor for variety recommendations.

[5]Heat Tol.=Heat Tolerance. Heat tolerant varieties produce a high yield and a high percent of marketable pods when plants are exposed to high temperatures during flowering and pod set.

[6]Disease resistance reported from source seed companies. R=Resistant; I=Intermediate/partial resistance; BCMV=Bean Common Mosaic Virus; BCTV=Beet Curly Top Virus; Ua=rust caused by *Uromyces appendiculatus*; Cl=Anthracnose caused by *Colletotrichum lindemuthianum*; Psp=Halo Blight caused by *Pseudomonas savastanoi pv. phaseolicola*; Xap=Common Blight caused by *Xanthomonas axonopodis pv. phaseoli*; Pss=Bacterial Brown Spot caused by *Pseudomonas syringae pv. syringae*.

Recommended Lima Beans Varieties

Type	Variety[1]	Comments and Downy Mildew Resistance[2]
Lima Beans, Fordhook Type[3]	Fordhook 242	90 days, no resistance to current races of Downy Mildew
Lima Beans, Bush Baby Types[3]	Bridgeton	86 days, fresh market
	Cypress	77 days, cold soil tolerance, resistant to Downy Mildew race E
	Dixie Butter Pea	75 days, no resistance to current races of Downy Mildew
	Emperor	79 days, cold soil tolerance, resistant to Downy Mildew race F
	Jackson Wonder	85 days, no resistance to current races of Downy Mildew, speckled type
	Meadow	77 days, resistant to Downy Mildew race E
Lima Beans, Pole Types	Big 6	No resistance to Downy Mildew
	Big Mama	No resistance to Downy Mildew
	Dr. Martin	No resistance to Downy Mildew
	King of the Garden	No resistance to Downy Mildew
	Locally Selected Heirlooms	No resistance to Downy Mildew

[1]**Listed alphabetically within type**. [2]Based on results from University of DE tests. [3]Use varieties recommended by processors. Consult the University of DE Extension at: *http://extension.udel.edu/ag/vegetable-fruit-resources/vegetable-small-fruits-program/variety-trial-results/* for variety trial results.

Variety Selection and Seed Treatment

Marketability, adaptability to the area, disease resistance and consistency in production should be considered when selecting snap bean types and varieties. Snap beans varieties can be bush types (can be harvested mechanically), or pole types (usually hand harvested). Pole types yield better in long season areas. Use seeds treated with fungicides to prevent diseases; see the Disease Control section below. Rough handling of seed greatly reduces germination.

Poor Pod Set, Deformed Pods, Split Set

High night temperatures during bloom (> 70°F, > 24°C) cause diminished pollen production and result in poor pod set, deformed pods with missing seeds, and "split set". Varieties differ in their heat susceptibility; choose only heat tolerant varieties for summer flowering plantings. Consult the variety recommendations table above or your seed supplier for information on heat tolerant varieties for your area.

Recommended Nutrients Based on Soil Tests

Before using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and Chapter B Soil and Nutrient Management. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede the recommendations found below.

Beans[1,2]		**Soil Phosphorus Level**				**Soil Potassium Level**				
		Low	**Med**	**High (Opt)**	**Very High**	**Low**	**Med**	**High (Opt)**	**Very High**	
	N (lb/A)	**P_2O_5 (lb/A)**				**K_2O (lb/A)**				**Nutrient Timing and Method**
Snap Beans Single Crop	40-80	80	60	40	0[3]	80	60	40	0[3]	Total nutrient recommended
	20-40	80	60	40	0[3]	80	60	40	0[3]	Broadcast and disk-in
	20-40	0	0	0	0	0	0	0	0	Sidedress 4 weeks after planting
Snap Beans After Peas	20-40	80	60	40	0[3]	80	60	40	0[3]	Total nutrient recommended
	0-20	80	60	40	0[3]	80	60	40	0[3]	Broadcast and disk-in
	0-20	0	0	0	0	0	0	0	0	Sidedress 4 weeks after planting
Lima Beans Single Crop	60-90	100	60	20	0[3]	140	100	60	0[3]	Total nutrient recommended
	30-40	100	60	20	0[3]	140	100	60	0[3]	Broadcast and disk-in
	20	0	0	0	0	0	0	0	0	Band place with planter
	20	0	0	0	0	0	0	0	0	Sidedress 3-5 weeks after emergence
Lima Beans After Peas	30-40	0	0	0	0	0	0	0	0	Total nutrient recommended
	20	0	0	0	0	0	0	0	0	Band place with planter
	20	0	0	0	0	0	0	0	0	Sidedress 3-5 weeks after emergence

[1]Apply 1-2 lb/A of boron (B) every 3 yr on most soils; see also Table B-7. in Chapter B Soil and Nutrient Management. **Do not** place B in starter fertilizers due to sensitivity problems. [2]Apply 25-30 lb/A of sulfur (S) for most soils. [3]In VA, crop replacement values of 20 lb/A of P_2O_5 and 40 lb/A of K_2O are recommended on soils testing Very High.

Plant Tissue Testing

Plant tissue testing can be a valuable tool to assess crop nutrient status during the growing season to aid with in-season fertility programs or to evaluate potential deficiencies or toxicities. Critical snap bean tissue test values for most recently matured leaves up to first bloom: N 3-4%, P 0.3-0.5%, K 2.0-3.0%, Ca 0.8-1.5%, Mg 0.25-0.45% and S 0.2-0.4%. For additional nutrients and other growth stages consult with a tissue testing laboratory or this web link at the University of Florida: *https://edis.ifas.ufl.edu/publication/ep081*.

Site selection, Soil, and Fertilization

Well-drained friable sandy loams to clay loams are well suited for legumes. Avoid compacted soils that can flood. Slightly acid soils (pH 6-6.5) are preferred. If lime is needed, apply it several months before planting. All P and K can be applied before planting. Beans respond to N applications, especially bush types.

Planting and Harvesting Dates

Note: In PA and normally cooler areas, delay the start of planting by 10 days and stop planting 14 days sooner than indicated below. In the southern part of the region, plantings that will result in pod set at temperatures above 90°F (commonly mid-July to early August) are at risk of blossom drop, split set, high cull percentage, and reduced yield.

Variety	Planting Dates	Harvesting Dates
Market Snap	April 10 - August 10	June 20 - October 20
Processing Snap	April 20 - August 10	July 1 - October 20
Fordhook Lima	May 15 - July 10 (June 20 - July 10 in the southern part of the region)	August 1 - October 20
Baby Lima	May 15 - July 20	August 1 - October 30
Pole Lima	May 15 - June 15	July 15 - October 30

Spacing

Snap Beans.

Rows 30-36 inches apart, 6-10 plants/ft. Plant 50-75 lb/A of seed depending on seed size (lower rate for lighter seeds). Narrow rows increase yields but render late-season tillage difficult. Plant in rows 18-24 inches apart with 5-7 plants/ft. Plant 75-120 lb/A of seed, depending on seed size. Calibrate planter according to seed size. Sow 1-1½ inches deep in light sandy soil; shallower in heavier soil.

Lima Beans, Fordhook Type.

Rows 30-36 inches apart, 2 plants/ft. Plant 85 lb/A of seed, 1½ inches deep.

Lima Beans, Baby Types.

Rows 30-36 inches apart, 3-4 plants/ft. Plant 50 lb/A of seed, 1½ inches deep (deeper if soil is dry). For irrigated fields: Rows 18-30 inches apart, 4-5 inches between plants; plant 96 lb/A of seed at close spacing and 78 lb/A at wider spacing.

Lima Beans, Pole Types.

Large-seeded pole lima beans are often started in a cold frame or greenhouse which results in higher germination percentages and earlier crops. Plant 1 seed per cell at a depth of 1 inch in containers or plug flats with cells that are at least 1.5 inches in diameter and 2 inches deep. Use a sterile commercial greenhouse medium. Bottom heat will stimulate growth and help produce transplants quicker. Transplant to the field once plants have the first true leaves. Do not allow transplants to become completely root bound. Do not disturb roots during the transplanting process or stunting may occur. Pole lima beans are very vigorous and should not be planted too close together or excessive vine growth may reduce yields. Space plants at a distance of 3-6 ft in the row (less vigorous types closer, more vigorous types further apart) with a minimum of 5 ft between rows.

Irrigation

Snap and lima beans are grown under irrigated and dryland conditions. Bean crops respond to irrigation and the highest yields are obtained when soil moisture is maintained at 50% of field capacity or higher, from the 2 trifoliate leaf stage through pod sizing. Water use during flowering and pod sizing can be over 0.25 inches/day and water deficit during this period will have the greatest negative impact on yield and pod quality. However, a balance must be struck between maintaining adequate moisture for pod growth and minimizing wetness in the canopy which promotes White Mold in all beans and Downy Mildew and Pod Blight in lima beans.

Trellising Pole Lima Beans

Sturdy wooden or metal posts should be spaced every 15-20 ft in the row. Additional smaller spacer stakes may be needed in between posts. At least 5 ft, preferably 6 ft, of the posts or stakes should be above ground. Tightly stretch a 10-12 gauge wire and attach to wooden posts with fencing staples. Stretch a second wire between posts about 1 ft above the soil and weave twine in a V shaped pattern between the wires for vines to climb. Alternatively, 6 ft plastic netting can be stretched between the top and bottom wire. An individual stake or line should be placed at each plant for the initial climbing to the trellis. Bean supports should be put up before the bean plants begin producing "runners" and falling over. Trellises have to be sturdy enough to support the heavy lima bean vines.

No-Till / Conservation Tillage

Snap and lima beans have been successfully grown in no-till and conservation tillage systems, though lima bean yields are often lower, and residues can make harvest more difficult. In no-till systems, bean seeds are usually drilled into the stubble/plant residue of a small grain crop. Consider bean variety, date of planting, soil fertility practices, insect control, planting equipment, mulch, residue at harvest, and weed species in the field. For more information on this production method, see section A 6. Conservation Tillage Crop Production.

Harvest and Post-Harvest Considerations

Processing snap beans are usually harvested when 50% of the beans are sieve size 4 or smaller, but this percentage will depend on processor needs and variety. The yield of processing snap beans ranges from 4 to 6 ton/A. Processing should occur soon after harvest and transport times should be minimized. Washing and precooling shelled beans is recommended for distance transport.

Fresh market snap beans are either hand harvested multiple times at the desired size or machine harvested when the highest percentage of marketable beans can be obtained. The yield of fresh market snap beans ranges from 150 to 250 bushel/A. Beans for fresh market shipping should meat US No. 1 standards or higher.

Baby lima beans for mechanical picking are harvested when the highest percentage of full pods can be obtained and when plants have approximately 10% dry pods. Hand-picked lima beans are picked at the full green seed stage.

Fordhook lima beans are harvested when the highest percentage of full pods can be obtained but before any pods have dried.

Grading and Packing

A grading line will typically have offloading and conveying belts, a gravity separator to remove soil, rocks, and heavy field trash, an air blast trash remover for leaves, stems, and other light field trash, a rotating drum tumbler to remove pin beans and immature pods through slots, a broken bean eliminator, vibrating tables where good pods are further segregated from field trash, a sizer for processing beans, vibrating washers where pods are rinsed with water to remove soil particles and to remove some of the field heat, grading tables where pods are manually inspected to remove overmature, blemished, decayed, or other defective pods, and for fresh market beans, a box filler. Beans are moved by vibration into wire bound crates or waxed cartons, which are weighed and unloaded onto a box closing machine after which boxes go to a cold storage area. In smaller operations, many of these tasks will be done by hand at a sorting table. Field packing is practical mainly for direct market and local sales. Beans may also be harvested directly by consumers or local wholesalers as U-pick.

Cooling and Storage

Fresh market snap beans are highly perishable and should be cooled rapidly after harvest, preferably to 40-43°F (4-6°C). Vacuum or forced-air cooling can be effective, but the preferred method is hydrocooling as the cold water cools beans rapidly and the free moisture helps prevent wilting or shriveling. Use chlorinated water with a 55-70 ppm free chlorine concentration and pH of 6.5-7 (neutral) for washing and hydrocooling.

Beans should be stored at 39-45°F (4-7°C) and 95% relative humidity. Under these conditions, beans will maintain quality for 7-10 days. Temperatures of 38°F (3°C) and lower may cause significant chilling injury. Beans lose moisture rapidly if not properly protected by packaging or by a relative humidity of 95% or above. When the relative humidity approaches saturation, as in consumer packages, temperatures above 45°F (7°C) must be avoided to prevent serious decay within a few days. Beans should not be stored or shipped with ethylene generating fruits and vegetables.

Weed Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.

Recommended Herbicides

1. Identify the weeds in each field and select recommended herbicides. More information is available in the "Herbicide Effectiveness on Common Weeds in Vegetables" (Table E-3) in Chapter E Pest Management.
2. Minimize herbicide resistance development. Identify the herbicide mode of action group number and follow recommended good management practices; **bolded group numbers in tables below are herbicides at higher risk for selecting resistant weed populations.** Include non-chemical weed control whenever possible.

1. Non-Selective or Burndown

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
9	Roundup PowerMax 4.5L "Generic" glyphosate 3L	16 to 32 fl oz/A 24 to 48 fl oz/A	**glyphosate**	0.75 to 1.13 lb acid equivalent/A	--	24
-Apply preplant or preemergence. -Some glyphosate formulations may require an adjuvant, refer to label. Tank mix with appropriate herbicides for residual weed control. -Glyphosate controls many perennial weeds as well as annuals if applied when the weed is actively growing and has reached the stage of growth listed on the label. -Repeat applications are allowed, with maximum application of 5.3 qt/A per year.						
22	Gramoxone SL 2.0* Gramoxone SL 3.0*	2.5 to 4 pt/A 1.7 to 2.7 pt/A	**paraquat**	0.6 to 1 lb/A	--	12
-Apply preplant or preemergence. Always include an adjuvant (nonionic surfactant or crop oil concentrate). Tank mix with appropriate herbicides for residual weed control. -Paraquat may not control established grasses. Spray coverage is essential for optimum control. -Rainfastness 30 min. A maximum of 3 applications per year are allowed. -***Restricted-use pesticide***. Only certified applicators, who successfully complete the paraquat-specific training, can mix, load, or apply paraquat. Application of paraquat "under the direct supervision" of a certified applicator is no longer allowed. Required training link (*https://campus.extension.org/enrol/index.php?id=2201*); certified applicators must repeat training every three years.						

2. Soil-Applied (Preplant Incorporated or Preemergence)

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
2	Pursuit 2L	1.5 to 2.0 fl oz/A	**imazethapyr**	0.024 to 0.031 lb/A	30	4
-**Lima beans; labeled for snap bean in NJ only**. -Apply as preplant incorporated or to the soil surface, but shallow, thorough incorporation improves consistency of performance when dry weather follows application. Primarily controls broadleaf weeds. Combine with another herbicide to control annual grasses. -Pursuit residues persist in the soil after harvest and may affect following crops. Follow label instructions. -Pursuit is an ALS inhibitor, Group 2 herbicide, and there is widespread resistance in the region to this family of herbicides. -Maximum Pursuit application at planting: 2 fl oz/A for lima beans and 1.5 fl oz/A for snap beans. -Maximum number of applications per year: 1.						
2	Sandea 75DF	0.5 to 1.0 oz/A	**halosulfuron**	0.024 to 0.047 lb/A	30	12
-Apply after seeding but before cracking. Controls or suppresses yellow nutsedge and many annual broadleaf weeds. Results have been most consistent when the application was followed by rainfall or irrigation. -Use the lower rate on coarse-textured (sandy) soils low in organic matter, and the higher rate on fine -textured (silt and clay) soils. -Heavy rainfall before crop emergence can result in crop stunting. -**Do not** apply Sandea to crops treated with a soil-applied organophosphate insecticide or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application. -Sandea is an ALS inhibitor, Group 2 herbicide, and there is widespread resistance in the region to this family of herbicides. -Maximum Sandea application per season: 1 oz/A.						
3	Prowl H2O 3.8CS Prowl 3.3 EC	1.0 to 3.0 pt/A 1.2 to 3.6 pt	**pendimethalin**	0.48 to 1 lb/A 0.5 to 1.5 lb/A	--	24
-Labeled only for preplant incorporated application; apply before planting and incorporate thoroughly within the top 2-3 inches of soil. -The lower rates are recommended for early planted fields or coarse-textured soils. -Primarily controls annual grasses and certain broadleaf weeds. -**Do not** use when soils are cold and/or wet soil conditions are anticipated during emergence, or crop injury may result. -**Do not** apply more than once per cropping season. **Not recommended in NJ.**						
3	Treflan 4E	1 to 1.5 pt/A	**trifluralin**	0.5 to 0.75 lb/A	--	12
-Labeled for preplant incorporation only; incorporate into 2-3 inches of soil within 8 h after application. -Primarily controls annual grasses and a few broadleaf weeds (weak on ragweed). Poor incorporation can reduce overall weed control. -Treflan may be applied up to 4 weeks prior to planting. -**Do not** use or reduce the rate used when cold, wet soil conditions are expected, or crop injury may result. -Maximum application not addressed on label.						

2. Soil-Applied (Preplant Incorporated or Preemergence) - continued next page

2. Soil-Applied (Preplant Incorporated or Preemergence) - continued

8	Eptam 7E	3 to 3.5 pt/A	**EPTC**	2.5 to 3 lb/A	--	12
-**Snap beans only.** Preplant incorporated applications only; incorporate by disking twice into 3-4 inches of soil immediately after application. Useful for nutsedge control, annual grasses, and some broadleaf weeds. -Combining Eptam with Dual Magnum may improve weed control but may increase the risk of crop injury when weather conditions are adverse. **Do not** exceed 9 pt/A per year (3.5 pt/A on coarse-textured soils).						
13	Command 3ME	4 to 6 fl oz/A	**clomazone**	0.094 to 0.14 lb/A	45	12
-Lima beans only. Special Local Needs Label 24(c) for the use of Command in DE, MD, and VA (expires 4/29/2025 in DE; 12/31/2025 in MD; 12/31/2024 in VA). -Lima bean crop can be planted 60 days after an application of Command to a previous crop, assuming the rate in the previous crop was not above 12 fl oz/A. -Apply to suppress annual grasses and certain broadleaf weeds including common lambsquarters, velvetleaf, spurred anoda, and jimsonweed. Use the lower rate on coarse-textured soils low in organic matter and higher rates on fine-textured soils and on soils with high organic matter. Some temporary crop injury (partial whitening of leaf or stem tissue) may be apparent after crop emergence; beans recover from minor early injury without affecting yield or earliness. -Observe all precautions. Maximum number of applications per season: 1						
13	Command 3ME	6.4 to 10.7 fl oz/A	**clomazone**	0.15 to 0.25 lb/A	45	12
-**Snap beans only.** Apply to control annual grasses and many broadleaf weeds including common lambsquarters, velvetleaf, spurred anoda, and jimsonweed. Command will not control yellow nutsedge, mustards, morningglory species, or pigweed species. -Use the lower rate on coarse-textured soils low in organic matter and higher rates on fine-textured soils and on soils with high organic matter. Some temporary crop injury (partial whitening of leaf or stem tissue) may be apparent after crop emergence; beans recover from minor early injury without affecting yield or earliness. -**WARNINGS**: Command spray *or* vapor drift may injure sensitive crops and other vegetation up to several hundred yards from the point of application. **Do not** apply adjacent to sensitive crops (see label) or vegetation, or under unfavorable wind or weather conditions. Command may limit subsequent cropping options, see the label. -Maximum number of applications per season: 1.						
14	Reflex 2SL	1 to 1.5 pt/A	**fomesafen**	0.25 to 0.375 lb/A	30	24
-**Snap beans only.** Controls several common broadleaf weeds. Tank mix for control of annual grasses. -Maximum of 1.25-1.5 pt/A may be applied either preemergence or postemergence in one year. Maximum rates vary by state (see Regional Use Map on herbicide label for details). -**Do not** apply more than once in a 2-year period (alternate year applications). Rotational restrictions for most vegetables is 18 months.						
14+14	Spartan Charge 3.5EC	3 to 3.75 fl oz/A	**sulfentrazone + carfentrazone**	0.082 to 0.103 lb/A	--	24
-Lima beans only. Special Local Needs Label 24(c) for the use of Spartan Charge for lima beans in DE only (expires 12/31/2026). Labeled for ALS-resistant pigweed (Group 2 herbicides). Do **not** use Spartan Charge if temporary crop injury is not acceptable. -Combine with another herbicide to control annual grasses. Apply no later than 3 days after seeding, but **do not** apply after cracking. Expect some temporary crop injury after emergence.						
15	Dual Magnum 7.62E	1 to 2 pt/A	**s-metolachlor**	0.95 to 1.91 lb/A	--	24
-Preplant incorporated or preemergence; incorporated applications should be worked into the soil 2-3 inches deep by disking twice with blades set 4-6 inches deep. Primarily controls annual grasses and nutsedge; nutsedge control is improved with preplant incorporation. Dual will not control emerged weeds. A postemergence herbicide may be required for adequate broadleaf weed control. -**Do not** apply more than 2 pt/A during any one crop year.						

3. Postemergence

Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient**	**Active Ingredient Rate**	**PHI (d)**	**REI (h)**
1	Shadow 3EC Select 2EC Select Max 0.97EC	4 to 5.33 fl oz/A 6 to 8 fl oz/A 9 to 16 fl oz/A	**clethodim**	0.07 to 0.125 lb/A	21	12
	Assure II/Targa 0.88EC	6 to 14 fl oz/A	**quizalofop**	0.04 to 0.10 lb/A	15	12
	Poast 1.5EC	1 to 2.5 pt/A	**sethoxydim**	0.2 to 0.5 lb/A	15	12
-Select Max and Poast can be applied to snap beans and lima beans; Assure II/Targa labeled for snap beans only. -**Select 2EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal spray solution). **Select Max**: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal spray solution). **Shadow 3EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution) for large or stressed grasses; use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution) when crop safety is a concern. **Poast**: use COC at 1% v/v. **Assure II/Targa**: use COC at 1% v/v. -The use of COC may increase the risk of crop injury under hot or humid conditions. To reduce this risk, omit additives or switch to NIS when grasses are small and soil moisture is adequate. -Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control. -Addition of nitrogen is not recommended. -Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will **not** be controlled. -Controls many annual and certain perennial grasses, including annual bluegrass, but Poast is preferred for goosegrass control. For best results, treat annual grasses when they are actively growing and before tillers are present. Control may be reduced if grasses are large or under hot or dry weather conditions.						

3. Postemergence (Shadow, Select, Select Max, Assure, Targa, Poast) - continued next page

3. Postemergence (Shadow, Select, Select Max, Assure, Targa, Poast) - continued

<table>
<tr><td colspan="7">-Repeated applications may be necessary to control certain perennial grasses. If repeat applications are necessary, allow 14 days between applications. -Do not tank mix with or apply within 2 to 3 days of any other pesticide, unless labeled, as this may increase the risk of crop injury or reduce the control of grasses. -Rainfastness is 1 h.
-Do not apply more than 8 fl oz/A of Select 2EC in a single application and do not exceed 2 pt/A for the season; do not apply more than 16 fl oz/A of Select Max in a single application and do not apply more than 1 application per season.
-Do not apply more than 5.33 fl oz/A of Shadow 3EC in a single application and do not exceed 5.33 fl oz/A for the season.
-Do not apply Assure II/Targa within 7 days of another Assure II/Targa application. Do not make more than 2 applications per season, and do not exceed 14 fl oz/A for the season.
-Do not apply more than 2.5 pt/A Poast in a single application and do not exceed 4 pt/A for the season.</td></tr>
<tr><td>2</td><td>Raptor 1L
Beyond Xtra 1L</td><td>4 fl oz/A</td><td>imazamox</td><td>0.031 lb/A</td><td>--</td><td>4</td></tr>
<tr><td colspan="7">-Apply to control annual broadleaf weeds when the crop has 1-2 fully expanded trifoliate leaves but before bloom stage of bean growth
-Add nonionic surfactant to be 0.25% of the spray solution (1 qt/100 gal of spray).
-Add 0.5 to 1 pt/A of bentazon (Basagran) to reduce the expression of injury symptoms or use Varisto 4.18L which is a prepackaged mixture of Raptor plus Basagran; 21 fl oz/A of Varisto = 4 fl oz/A of Raptor and 21 fl oz/A of Basagran 4L
-Strictly observe all plant back restrictions.
-Raptor is an ALS inhibitor, Group 2 herbicide, and there is widespread resistance in the region to this family of herbicides.
-Rainfastness is 1 h. Do not apply more than 4 fl oz/A per year and more than one application per growing season.</td></tr>
<tr><td>2</td><td>Sandea 75DF</td><td>0.50 to 0.66 oz/A</td><td>halosulfuron</td><td>0.023 to 0.031 lb/A</td><td>30</td><td>12</td></tr>
<tr><td colspan="7">-Apply with nonionic surfactant at 0.25% of the spray solution (1 qt/100 gal of spray solution) to control yellow nutsedge and certain annual broadleaf weeds. Use only the lower rate when treating snap beans.
-Applications should be sprayed when the crop has 2-3 trifoliate leaves and annual weeds are less than 2 inches tall. (Treatments applied when beans are younger increases the risk of temporary stunting, and applications after the 3 trifoliate leaf stage increases the risk of a split set.) Occasionally, slight yellowing of the crop may be observed within a week of Sandea application. When observed, recovery is rapid with no effect on yield or maturity.
-Sandea provides both residual and postemergence control of susceptible weed species. Provides control of yellow nutsedge and certain annual broadleaf weeds. Control of weeds taller than 3 inches may not be adequate.
-Sandea is an ALS inhibiting herbicide and resistant weed populations are common in the region. Do not use Group 2 herbicides repeatedly in the same field.
-Do not apply Sandea to crops treated with a soil-applied organophosphate insecticide or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application.
-Rainfastness is 4 h.
-Do not apply more than 2 applications, or more than 2 oz/A of product per year.</td></tr>
<tr><td>6</td><td>Basagran 4L
Basagran 5L</td><td>1 to 2 pt/A
0.8 to 1.6 pt/A</td><td>bentazon</td><td>0.5 to 1 lb/A</td><td>30</td><td>48</td></tr>
<tr><td colspan="7">-Apply when beans have fully expanded first trifoliate leaves. Use lower rate to control common cocklebur, mustards, and jimsonweed and the higher rate to control yellow nutsedge, common lambsquarters, common ragweed, and Canada thistle (2 applications may be needed to control nutsedge and thistle). Basagran will not control pigweed species.
-Do not cultivate within 5 days before applying Basagran or within 7 days after application.
-Temporary, pronounced crop injury may be observed that can result in delayed maturity.
-The use of oil concentrate may increase the risk and severity of crop injury. To reduce the risk of crop injury, omit additives or switch to a nonionic surfactant when weeds are small and soil moisture is adequate.
-Do not spray when temperatures are over 90°F (32°C).
-Rainfastness is 4 h.</td></tr>
<tr><td>14</td><td>Reflex 2SL</td><td>Rates vary, refer to the specific label</td><td>fomesafen</td><td>0.125 to 0.375 lb/A</td><td>30</td><td>24</td></tr>
<tr><td colspan="7">-Snap beans only. Apply when snap beans have 1-2 fully expanded trifoliate leaves.
-The recommended rate is 0.5 to 0.75 pt/A based on local research. This is lower than the labeled rate to reduce the risk of crop injury.
-Use the lower recommended rate when weeds are small or when there is good soil moisture, high humidity, and warm cloudy weather causing “soft” growing conditions. Add nonionic surfactant to be 0.25% of the spray solution (1 qt/100 gal of spray).
-Tank mix with bentazon to improve the control of common lambsquarters, smartweed, velvetleaf, cocklebur, galinsoga, and yellow nutsedge. Use of crop oil can improve weed control but may slightly reduce crop tolerance.
Do not use urea ammonium nitrate (UAN) or ammonium sulfate (AMS) on snap beans or severe injury may occur.
-Lima beans and most other vegetables are sensitive to fomesafen.
-Reflex provides both residual and postemergence control of susceptible weed species.
-Be sure to consider rotational crops when deciding to apply fomesafen. Rainfastness is 1 h.
-Maximum Reflex application: 1.25 to 1.5 pt/A IN ALTERNATE YEARS.</td></tr>
<tr><td>15</td><td>Dual Magnum 7.62E</td><td>1 to 2 pt/A</td><td>s-metolachlor</td><td>0.95 to 1.91 lb/A</td><td>50</td><td>24</td></tr>
<tr><td colspan="7">-Lima beans only. Special Local Needs Label 24(c) for the use of Dual Magnum applied “over the top” of lima beans in DE only (expires 12/31/2026).
-Apply after the first trifoliate stage of lima bean to extend residual control for Palmer amaranth and grasses. Dual Magnum will not control weeds if they have emerged.
-When Dual Magnum is applied over the top of lima bean, leaf spotting or speckling may be observed.
-Maximum Dual Magnum amount: 2 pt/A for the season.</td></tr>
</table>

3. Postharvest

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
22	Gramoxone SL 2.0* Gramoxone SL 3.0*	2.25 to 3 pt/A 1.5 to 2 pt/A	**paraquat**	0.56 to 0.75 lb/A	--	24

-**Supplemental Label in DE for the use of Gramoxone SL 2.0 and Gramoxone SL 3.0 for postharvest application to desiccate the crop.** -Apply after the last harvest for bareground or plasticulture. Always include an adjuvant.
-Spray coverage is essential for optimum effectiveness. See the label for additional information and warnings.
-Rainfastness 30 min. A maximum of 2 applications for crop desiccation are allowed.
-***Restricted-use pesticide***. Only certified applicators, who successfully complete the paraquat-specific training, can mix, load, or apply paraquat. Application of paraquat "under the direct supervision" of a certified applicator is no longer allowed. Required training link (*https://campus.extension.org/enrol/index.php?id=2201*); certified applicators must repeat training every three years.

4. Other Labeled Herbicides These products are labeled but limited local data are available; and/or are labeled but not recommended in our region due to potential crop injury concerns.

Group	Product Name (*=Restricted Use)	Active Ingredient
14	Aim	**carfentrazone**

Insect Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.

Recommended Insecticides

Soil Pests

Seed Maggots Seed maggots are mostly a problem in soils high in organic matter or with recent organic matter incorporation, under moist conditions, and when cool springs delay seed germination. For the best control, plant seeds commercially treated with thiamethoxam (Cruiser 5FS) **- commercially applied seed treatment only.**

Above-ground Pests

Aphids Treat only if aphids are well distributed throughout the field (50% or more of terminals with 5 or more aphids), when weather favors population increase, and if beneficial species are lacking.

Apply one of the following formulations:

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
1A	Lannate LV*	1.5 to 3.0 pt/A	methomyl	see label	48	H
1B	Dimethoate 400	0.5 to 1.0 pt/A	dimethoate	0[1]	48	H
4A	Neonicotinoid insecticides registered for use on Beans: see table at the end of Insect Control.					
4C	Transform WG	0.75 to 1.0 oz/A	sulfoxaflor	7	24	H
4C + 3A	Ridgeback*	5.5 to 13.8 fl oz/A	sulfoxaflor + bifenthrin	3	24	H
4D	Sivanto Prime or 200SL	7.0 to 14.0 fl oz/A	flupyradifurone	7	4	M
23	Movento	4.0 to 5.0 fl oz/A	spirotetramat	1	24	L
23	Movento HL	2.0 to 2.5 fl oz/A	spirotetramat	1	24	L
23 + 7C	Senstar	8.0 to 10.0 fl oz/A	spirotetramat + pyriproxyfen	7	24	L
29	Beleaf 50SG	2.8 oz/A	flonicamid	7	12	M

[1]Mechanical Harvest only

Bean Leaf Beetles (BLB) and Mexican Bean Beetles (MBB)

Bean leaf beetle adults, which are similar in size to spotted cucumber beetles, and Mexican bean beetle adults (copper-colored ladybeetles with black spots), and larvae (yellow with spines) chew holes in leaves, but also may cause direct injury to pods. Early control measures are recommended to reduce yield loss from defoliation and reduce population levels later in the season. Begin spraying at 20% defoliation or 1 beetle per plant.

Apply one of the following formulations:

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s) and Crop Restrictions	PHI (d)	REI (h)	Bee TR
1A	Lannate LV* (MBB only)	0.75 to 3.0 pt/A	methomyl	see label	48	H
1A	Sevin XLR Plus	0.5 to 1.0 qt/A	carbaryl - **snap beans only**	3	12	H

Bean Leaf Beetles (BLB) and Mexican Bean Beetles (MBB) - continued next page

Bean Leaf Beetles (BLB) and Mexican Bean Beetles (MBB) - continued

1B	Orthene 97	0.5 to 1.0 lb/A	acephate - **lima beans only**	1	24	H
1B	Dimethoate 400	0.5 to 1.0 pt/A	dimethoate	0[1]	48	H
3A	Pyrethroid insecticides registered for use on Beans: see table at the end of Insect Control.					
4A	Neonicotinoid insecticides registered for use on Beans: see table at the end of Insect Control.					

[1]Mechanical Harvest only

Cutworms
See also section E 3.1. Soil Pests - Detection and Control.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s) and Crop Restrictions**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	1.5 pt/A	methomyl	see label	48	H
1A	Sevin XLR Plus	1.0 to 1.5 qt/A	carbaryl	3	12	H
1B	Diazinon AG500*[1]	2.0 to 4.0 qt/A	diazinon	45	72	H
3A	Pyrethroid insecticides registered for use on Beans: see table at the end of Insect Control.					

[1]Broadcast just before planting and immediately incorporate into the soil.

Leafminers

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s) (*=Restricted Use)**	**PHI (d)**	**REI (h)**	**Bee TR**
1B	Dimethoate 400	0.5 to 1.0 pt/A	dimethoate	0[1]	48	H
5	Blackhawk[2] 36WG[2]	2.5 to 3.3 oz/A	spinosad	3	4	M
5	Radiant SC[2]	5.0 to 8.0 fl oz/A	spinetoram	3	4	M
6	Agri-Mek SC*	1.75 to 3.5 fl oz/A	abamectin	7	12	H
17	Trigard 75WSP	2.66 oz/A	cyromazine	7	12	H
28 + 6	Minecto Pro*	7.5 to 10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H
28	Exirel	10.0 to 20.5 fl oz/A	cyantraniliprole	1	12	H
28	Verimark	6.75 to 13.5 fl oz	cyantraniliprole - **soil**	n/a	4	H

[1]Mechanical Harvest only; [2] Control may be improved by addition of an adjuvant

Mites
Spot-treat areas along edges of fields when white stippling along veins on the underside of leaves is first noticed. Broadspectrum insecticides (Groups 1B, 3) will provide initial knockdown, but continued use may result in outbreaks.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s) and Crop Restrictions**	**PHI (d)**	**REI (h)**	**Bee TR**
1B	Dimethoate 400	0.5 to 1.0 pt/A	dimethoate	0[1]	48	H
6	Agri-Mek SC*	1.75 to 3.5 fl oz/A	abamectin	7	12	H
20B	Kanemite 15SC	31.0 fl oz/A	acequinocyl	7	12	L
20D	Acramite 50WS	1.0 to 1.5 lb/A	bifenazate	3	12	M
21A	Magister SC	32.0 to 36.0 fl oz/A	fenazaquin	7	12	H
21A	Portal	2.0 pt/A	fenpyroximate	1	12	L
28 + 6	Minecto Pro*	7.5 to 10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H
N/A	Sulfur 80WG (OMRI)	3 to 10 lb/A	sulfur	0	24	M

[1]Mechanical Harvest only

Potato Leafhoppers (PLH)
PLH can cause hopperburn on leaves, which can reduce photosynthesis and yield. Seeds treated commercially with thiamethoxam (Cruiser 5FS) are protected from PLH for about 3 weeks post-planting. Sweep netting can help determine if pest densities warrant control. Treat if the number of adults plus nymphs exceeds 100 per 20 sweeps.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s) and Crop Restrictions**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Sevin XLR Plus	1.0 qt/A	carbaryl - **snap beans only**	3	12	H
1A	Lannate LV*	0.75 to 3.0 pt/A	methomyl	see label	48	H
1B	Orthene 97	0.5 to 1.0 lb/A	acephate - **lima beans only**	1	24	H

Potato Leafhoppers (PLH) - continued next page

Potato Leafhoppers (PLH) - continued

1B	Dimethoate 400	0.5 to 1.0 pt/A	dimethoate	0[1]	48	H
3A	Pyrethroid insecticides registered for use on Beans: see table at the end of Insect Control.					
4A	Neonicotinoid insecticides registered for use on Beans: see table at the end of Insect Control.					
4D	Sivanto Prime or 200SL	7.0 to 14.0 fl oz/A	flupyradifurone	7	4	M

[1]Mechanical Harvest only

Stink Bugs Sweep netting can be useful to detect stink bugs. Treatment is recommended if the number of adults and nymphs exceed 7 per 50 sweeps during pod development. **Note:** Brown and brown marmorated stink bugs are less susceptible to pyrethroids than green and southern green stink bugs. Careful pyrethroid selection is advised, consult your local Cooperative Extension Service for recommendations for your area.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1B	Orthene 97	0.5 to 1.0 lb/A	acephate – **lima beans only**	1	24	H
3A	Pyrethroid insecticides registered for use on Beans: see table at the end of Insect Control.					

Tarnished Plant Bugs (a.k.a. Lygus bugs)

Treat only if the number of adults and/or nymphs exceeds 15 per 50 sweeps from the pin pod stage until harvest.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	1.5 to 3 pt/A	methomyl	see label	48	H
1A	Sevin XLR Plus	1.0 to 1.5 qt/A	carbaryl	3	12	H
1B	Orthene 97	0.5 to 1.0 lb/A	acephate - **lima beans only**	1	24	H
1B	Dimethoate 400	0.5 to 1.0 pt/A	dimethoate	0[1]	48	H
3A	Pyrethroid insecticides registered for use on Beans: see table at the end of Insect Control.					
4C	Transform WG	1.5 to 2.25 oz/A	sulfoxaflor	7	24	H
29	Beleaf 50SG	2.8 oz/A	flonicamid	7	12	M

[1]Mechanical Harvest only

Thrips

Treatments should be applied if thrips are present from cotyledon stage to when the first true leaves are established and/or when first blossoms form.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	1.5 to 3 pt/A	methomyl	see label	48	H
1B	Orthene 97	0.5 to 1.0 lb/A	acephate - **lima beans only**	1	24	H
3A[1]	Pyrethroid insecticides registered for use on Beans: see table at the end of Insect Control.					
4A[2]	Neonicotinoid insecticides registered for use on Beans: see table at the end of Insect Control.					
5	Radiant SC[3]	5.0 to 8.0 fl oz/A	spinetoram	3	4	M
5	Blackhawk[3]	2.5 to 3.3 oz/A	spinosad	3	4	M

[1]Resistance concerns with western flower thrips; [2]Resistance concerns with tobacco thrips
[3]Control may be improved by addition of an adjuvant

Whiteflies

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
4A	Neonicotinoid insecticides registered for use on Beans: see table at the end of Insect Control.					
4D	Sivanto Prime or 200SL	10.5 to 14.0 fl oz/A	flupyradifurone	7	4	M
21A	Magister SC	32.0 to 36.0 fl oz/A	fenazaquin	7	12	H
23	Movento	4.0 to 5.0 fl oz/A	spirotetramat	1	24	L
23	Movento HL	2.0 to 2.5 fl oz/A	spirotetramat	1	24	L
23 + 7C	Senstar	8.0 to 10.0 fl oz/A	spirotetramat + pyriproxyfen	7	24	L
28	Exirel[1]	13.5 to 20.5 fl oz/A	cyantraniliprole	1	12	H
28	Verimark	6.75 to 13.5 fl oz	cyantraniliprole **- soil**	n/a	4	H
28 + 6	Minecto Pro*	10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H

[1]Control may be improved by addition of an adjuvant

"Worm" Pests, Including: Corn Earworms (CEW), Beet Armyworms (BAW), European Corn Borers (ECB), Yellow-Striped Armyworms, and Loopers There are several species of lepidopteran "worm" pests that can attack beans. These pests feed on leaves and also attack pods. An action threshold of 30 larvae per 3 ft of row or about 20% defoliation is often used pre-pod. Once bean pods form, control measures are often needed weekly to protect the crop from direct damage or infestation of the pods. In processing snap beans, treat every 5-7 days if CEW catches in local blacklight traps average 20 or more per night and most corn in the area is mature. For lima beans, treat when CEW populations exceed 1 per 6 ft of row. **Note that some localized CEW, BAW, and soybean looper populations have developed resistance to pyrethroids (Group 3A), and that these insecticides should be used with caution and rotated to other insecticide classes within a season.**

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s) and Crop Restrictions**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	1.5 to 3 pt/A	methomyl	see label	48	H
1B	Orthene 97	0.5 to 1.0 lb/A	acephate - **lima beans only**	1	24	H
3A	Pyrethroid insecticides registered for use on Beans: see table at the end of Insect Control.					
5	Blackhawk	2.2 to 3.3 oz/A	spinosad	3	4	M
5	Radiant SC	4.0 to 8.0 fl oz/A	spinetoram - except yellow striped armyworm	3	4	M
11A	XenTari (OMRI)	0.5 to 2.0 lb/A	*Bacillus thuringiensis aizawai*	0	4	N
11A	Dipel DF, others (OMRI)	0.5 to 2.0 lb/A	*Bacillus thuringiensis kurstaki*	0	4	N
18	Intrepid 2F	4.0 to16.0 fl oz/A 10.0 to 16.0 fl oz/A CEW	methoxyfenozide	7	4	L
22	Avaunt eVo	3.5 to 6.0 oz/A	indoxacarb (CEW, ECB only)	3	12	H
28	Coragen 1.67SC Coragen eVo	3.0 to 7.5 fl oz/A 1.2 to 2.5 fl oz/A	chlorantraniliprole	1	4	L
28	Exirel	10.0 to 20.5 fl oz/A	cyantraniliprole (CEW, ECB only)	1	12	H
28	Vantacor	1.7 to 2.5 fl oz/A	chlorantraniliprole - **soil**	1	4	L
28	Vantacor	1.2 to 2.5 fl oz/A	chlorantraniliprole - **foliar**	1	4	L
28 + 6	Minecto Pro*	7.5 to 10.0 fl oz/A	cyantraniliprole + abamectin (CEW, ECB only)	7	12	H

Group 3A Pyrethroid Insecticides Registered for Use on Beans

Apply one of the following formulations (check if the product label lists the insect you intend to spray; the label is the law): **Note: Group 3A insecticides <u>not</u> recommended for BAW or soybean looper due to resistance issues.**					
Product Name (*=Restricted Use)	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
Asana XL*	2.9 to 9.6 fl oz/A[1]	esfenvalerate - **snap beans only**	3	12	H
Brigade 2EC*, others	1.6 to 6.4 fl oz/A	bifenthrin	3	12	H
Declare*	1.02 to 1.54 fl oz/A	gamma-cyhalothrin	7	24	H
Hero*	4.0 to 10.3 fl oz/A	zeta-cypermethrin + bifenthrin	3	12	H
Lambda-Cy 1EC*, others	1.92 to 3.84 fl oz/A[1]	lambda-cyhalothrin	7	24	H
Mustang Maxx*	4.0 fl oz/A[1]	zeta-cypermethrin	1	12	H
Warrior II*	0.96 to 1.92 fl oz/A[1]	lambda-cyhalothrin	7	24	H
Combo products containing a pyrethroid					
Besiege*	5.0 to 10.0 fl oz/A[1]	lambda-cyhalothrin + chlorantraniliprole (Group 28)	7	12	H
Brigadier*	3.8 to 5.6 fl oz/A	bifenthrin + imidacloprid (Group 4A) - **foliar only**	7	12	H
Ethos XB*	3.4 to 8.5 fl oz/A	bifenthrin + *Bacillus amyloliquefaciens* - **soil**	3	12	H
Ethos XB*	6.8 to 8.5 fl oz/A	bifenthrin + *Bacillus amyloliquefaciens* - **foliar**	3	12	H
Elevest*	4.8 to 9.6 fl oz/A	bifenthrin + chlorantraniliprole (Group 28)	3	12	H
Ridgeback*	3.4 to 13.8 fl oz/A	bifenthrin + sulfoxaflor (Group 4C)	7	24	H

Group 4A Neonicotinoid Insecticides Registered for Use on Beans

Apply one of the following formulations (check if the product label lists the insect you intend to spray; the label is the law):					
Product Name (*=Restricted Use)	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
Admire Pro	7.0 to 10.5 fl oz/A	imidacloprid - **soil**	21	12	H

Group 4A Neonicotinoid Insecticides Registered for Use on Beans - continued next page

Group 4A Neonicotinoid Insecticides Registered for Use on Beans - continued

Admire Pro	1.2 fl oz/A	imidacloprid - **foliar**	7	12	H
Assail 30SG Assail 30SC	2.5 to 5.3 oz/A 2.1 to 4.5 fl oz/A	acetamiprid	7	12	M
Combo products containing a neonicotinoid					
Brigadier*	3.8 to 5.6 fl oz/A	imidacloprid + bifenthrin (Group 3A) **- foliar only**	7	12	H

Disease Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F. Recommended Fungicides

Nematodes

See also sections E 1.5. Soil Fumigation and E 1.6. Nematode Control. Use fumigants listed in the Pest Management chapter or Mocap 15G at 13 to 20 lb/A (0.9 to 1.4 lb/1000 linear feet of row) in a 12-in. band over the row. Do not use as an in-furrow treatment. A Special Local Needs Label 24(c) is available for use of Mocap EC (2.0 to 3.9 fl oz/1000 linear feet of row or 1.33 to 2.75 qt/A broadcast) on lima and snap beans in DE and MD.

Taking soil samples in the fall for soybean cyst nematode (SCN) and root knot nematode determinations from fields to be planted the following season is highly recommended. Growers who rotate snap beans with soybeans should be alert for problems caused by SCN in infested fields. Snap beans are susceptible, where baby lima beans are resistant to SCN. Snap beans and lima beans are very susceptible to root knot nematode.

Seed Treatment

Use treated seed and avoid rough handling of seed as it greatly reduces germination.

IMPORTANT: Do not use treated seed for food or feed!						
Code	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI(d)**	**REI(h)**	**Bee TR**
For Rhizoctonia and Fusarium:						
12	Maxim 4FS	0.08 to 0.16 fl oz/100 lb seed	fludioxonil	AP	12	L
For Rhizoctonia:						
11	Dynasty	0.15 to 0.76 fl oz/100 lb seed	azoxystrobin	AP	4	N
For Pythium/Phytophthora:						
4	Apron XL	0.16 to 0.64 fl oz/100 lb seed	mefenoxam	AP	48	N
For Rhizoctonia, Fusarium, Pythium, and Phytophthora: (additional Apron XL may be needed under high pressure)						
4 + 12	Apron Maxx RFC	0.15 oz/100 lb seed	mefenoxam + fludioxonil	AP	48	N

Damping-off caused by *Phytophthora*, *Pythium*, and *Rhizoctonia*

Damping-off and root rots are caused by a complex of soilborne fungi including *Rhizoctonia*, *Pythium, Phytophthora,* and *Fusarium* spp. In the Mid-Atlantic region, the primary cause of root rot in beans are *Pythium* spp., which often cause extensive damage during periods of warm, wet, humid weather in July and August. On snap beans, *Pythium* spp. can also cause extensive pod rot.

Rotate beans with non-legume crops. Avoid fields with low lying areas, poorly drained soils, and minimize soil compaction. Plow under previous crop residue rather than disking. Select cultivars that set pods high in the plant, are more upright in architecture and use a close row spacing to help avoid pod contact with the soil surface.

Code	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
Apply one of the following at-planting (see label for application methods and restrictions):						
Pythium root rot						
4	Ridomil Gold 4SL	0.5 to 1.0 pt/A	mefenoxam	AP	48	N
Pythium and Rhizoctonia root rot						
4 + 11	Uniform 3.66SE	0.34 fl oz/1000 ft row[1]	mefenoxam + azoxystrobin	AP	0	N
Rhizoctonia root rot						
7	Fontelis 1.67SC	1.2 to 1.6 fl oz/1000 ft row	penthiopyrad	AP	12	L
11	azoxystrobin 2.08F	0.4 to 0.8 fl oz/1000 ft row	azoxystrobin	AP	4	N

[1]Avoid direct seed contact, which may cause delayed emergence.

Bacterial and Fungal Diseases

Anthracnose (*Colletotrichum* sp.) and Web Blight (*Rhizoctonia* sp.)

Use western-grown, certified seed and rotate to allow 2 years between bean plantings.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Apply one of the following formulations on a 7 to 14-day schedule and rotate between different fungicides:						
3 + 11	Quilt Xcel 2.2SE	10.5 to 14.0 fl oz/A	propiconazole + azoxystrobin	7	12	N
11	azoxystrobin 2.08F	6.2 to 15.5 fl oz/A	azoxystrobin	14	4	N
11	Headline 2.09EC	6.0 to 9.0 fl oz/A	pyraclostrobin	7/21	12	N
7 + 11	Priaxor 4.17SC	4.0 to 8.0 fl oz/A	fluxapyroxad + pyraclostrobin	7/21	12	N

Bacterial Blight

Use western-grown, certified seed. Apply copper as a preventative prior to the onset of disease and on a weekly basis under favorable conditions for disease development to help mitigate the spread of the pathogen. Avoid harvesting during wet conditions.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
When incidence is low, apply the following on a 7 to 10-day schedule:						
M01	copper (OMRI)[1]	at labeled rates	copper	0	48	N

[1]There are several OMRI listed copper-based products; see labels for specifics. Copper applications for bacterial disease management may also help suppress some fungal pathogens in organic production systems.

Bacterial Brown Spot

Use certified pathogen-free seed. Bacterial Brown Spot occurs primarily on lima beans and is more troublesome in irrigated fields and during wet seasons. Apply copper as a preventative prior to the onset of disease and on a weekly basis under favorable conditions for disease development to help mitigate the spread of the pathogen. Avoid harvesting during wet conditions.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
When incidence is low, apply the following on a 7to 10-day schedule:						
M01	copper (OMRI) [1]	at labeled rates	copper	0	48	N

[1] There are several OMRI listed copper-based products; see labels for specifics. Copper applications for bacterial disease control may help suppress some fungal pathogens in organic production systems.

Common Bean Rust (*Uromyces appendiculatus*) on Snap Bean

Rust is often a problem during late summer and early fall. Plant resistant cultivars whenever possible. For susceptible cultivars, start fungicide applications when the disease symptoms first appear.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Apply one of the following formulations on a 7 to14-day schedule and rotate between fungicides with different modes of action:						
M05	chlorothalonil 6F	2.0 to 4.0 pt/A	chlorothalonil	14	12	N
3	Rally 40WSP	4.0 to 5.0 oz/A	myclobutanil	0	24	N
3	tebuconazole 3.6F	4.0 to 6.0 fl oz/A	tebuconazole	7	12	N
3 + 11	Quilt Xcel 2.2SE	10.5 to 14.0 fl oz/A	propiconazole + azoxystrobin	7	12	N
7	Fontelis 1.67SC	14.0 to 30.0 fl oz/A	penthiopyrad	0	12	L
11	Headline 2.09EC	6.0 to 9.0 fl oz/A	pyraclostrobin	7/21	12	N
11	azoxystrobin 2.08F	6.2 to 15.5 fl oz/A	azoxystrobin	0	4	N

Lima Bean Downy Mildew (*Phytophthora phaseoli*)

Races B, D, E, and F of the pathogen have been found in the Mid-Atlantic area over the past 15 years. **Race F has been the only race detected in Delaware since 2006.** Plant resistant varieties when possible (see varieties table above). Avoid excessive irrigation and poorly drained soils.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
When weather conditions are favorable for disease development, apply and rotate between the following fungicides with different modes of action:						
4 + M01	Ridomil Gold Copper 65WP	2.0 lb/A	mefenoxam + copper	3	48	N
11	Headline 2.09EC	6.0 to 9.0 fl oz/A	pyraclostrobin	7/21	12	N

Lima Bean Downy Mildew (Phytophthora phaseoli) - continued next page

Lima Bean Downy Mildew (Phytophthora phaseoli) - continued

21	Ranman 400SC	2.75 fl oz/A	cyazofamid	0	12	L
40	Forum 4.17SC (seed only)	6.0 fl oz/A	dimethomorph	0	12	N
If lima bean Downy Mildew is observed in the field, apply one of the following:						
4 + M01	Ridomil Gold Copper 65WP	2.0 lb/A	mefenoxam + copper	3	48	N
P07	Phosphite	4.0 to 6.0 pt/A	phosphite	0	4	N

Lima Bean Pod Blight (*Phytophthora capsici*)

P. capsici has a very broad host range and can survive in the soil for several years. Avoid heavy irrigation and irrigating at night, especially after pod set. Avoid planting on poorly drained or compacted soils and in fields with rotations of cucurbits and peppers that are also hosts.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
When weather conditions are favorable for disease development, apply and rotate between the following fungicides with different modes of action:						
4 + M01	Ridomil Gold Copper 65WP	2.0 lb/A	mefenoxam + copper	3	48	N
28	Previcur Flex	1.2 to 2.0 pt/A	propamocarb hydrocloride	0.5	12	--
21	Ranman 400SC	2.75 fl oz/A	cyazofamid	0	12	L
29	Omega 500F[1,2]	8.0 fl oz/A	fluazinam	14/30	12	N
40	Forum 4.17SC	6.0 fl. oz/A	dimethomorph	0	12	N
43	Presidio	4 fl oz/A	fluopicolide	0	12	--
P07	Phosphite	4.0 to 6.0 pt/A	phosphite	0	4	N

[1]Applied for Downy Mildew management may also control *P. capsici*. [2]Not labeled for aerial applications.

Pythium blight (Cottony leak)

Cottony leak can be a serious problem during prolonged periods of hot, humid, wet weather. Select cultivars with good plant architecture that keep the pods off the soil surface. Pods in contact with the soil surface are more prone to infection. Using a narrower row spacing may help keep plants more erect, and pods from contacting the soil. Select fields with good drainage and avoid planting in low-lying areas. Avoid overhead watering.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Apply one of the following formulations at disease onset and rotate between different modes of action:						
4 + M01	Ridomil Gold Copper 65WP	2.5 to 5.0 lb/A	mefenoxam + copper	3	48	N
21	Ranman 400SC	2.75 fl oz/A	cyazofamid	0	12	L
P07	Phosphite	4.0 to 6.0 pt/A	phosphite	0	4	N

Southern Blight *(Sclerotium rolfsii)*

Southern Blight can be a serious disease of snap and lima beans in the southern most areas of the region. The pathogen may survive in the soil for many years so avoid planting in fields with a known history of the pathogen. Disease development is favored by high temperatures and wet weather conditions. Rotations will not eliminate the pathogen, but rotations with corn, sorghum, small grains or grasses may help reduce disease severity. Avoid overhead irrigation. Apply the following in a preventative manner, especially in fields with a history of the disease.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
3	Tilt	4.0 fl oz/A	propiconazole	7	24	N
3 + 11	Quilt Xcel	10.5 to 14.0 fl/A	propiconazole + azoxystrobin	7	12	N
11	azoxystrobin 2.08F	15.5 fl oz/A	azoxystrobin	0	4	N

Tan Spot on Lima Bean (*Didymella americana*)

Tan Spot was recently confirmed on lima bean in DE and MD although its occurrence is sporadic. Lesions are tan and irregular in shape with reddish borders. The products listed below are labeled for use on the crop but do not specifically list Tan Spot as a target disease.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
3 + 11	Quilt Xcel 2.2SE	10.5 to 14.0 fl oz/A	propiconazole + azoxystrobin	7	12	N
7	Endura 70W	6.0 oz/A	boscalid	7	12	--
7 + 3 + 11	Miravis Neo	13.7 fl oz/A	pydiflumetofen + propiconazole + azoxystrobin	14	12	N

White Mold (*Sclerotinia*) and Gray Mold (*Botrytis*)

White Mold is caused by *Sclerotinia* which has a broad host range and can persist in the soil for over 5 years. Avoid poorly drained soils and excessive overhead irrigation, especially preceding and during flowering. Rotation to non-hosts (such as corn or small grains) for at least 3 years may help reduce disease levels but will not completely eliminate the pathogen. Always harvest infested fields **after** non-infested fields to help minimize potential spread.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Pre-plant: For White Mold only. Apply 3-4 months prior to disease onset to allow the active agent to reduce levels of sclerotia in the soil. Incorporate 1-2 in. deep but **do not plow before seeding** to avoid spreading of untreated sclerotia from lower to upper soil layers.						
44	Contans 5.3WG (OMRI)	1.0 to 4.0 lb/A	*Coniothyrium minitans*	--	--	N
Post seeding: Close spacing of snap beans may increase the potential for White Mold. **Fungicide sprays are needed *only* when the soil has been wet for 6-10 days before or during bloom.** This causes sclerotia to germinate and eject spores. For snap beans, a fungicide should be applied at 10-20% bloom. <u>A second spray should be made 7-10 days after the first spray if the soil remains wet and blossoms are still present.</u> Check labels for details on fungicide timing. For lima beans, later fungicide applications have been beneficial if favorable environmental conditions persist. **Apply one of the following:**						
1	Topsin M WSB	1.5 to 2.0 lb/A	thiophanate-methyl	14	24	N
2	iprodione 4F	1.5 to 2.0 pt/A	iprodione	see label	24	N
7	Endura 70W	8.0 to 11.0 oz/A	boscalid	7	12	--
7	Fontelis 1.67SC	16.0 to 30.0 fl oz/A	penthiopyrad	0	12	L
7 + 11	Priaxor 4.17SC	4.0 to 8.0 fl oz/A	fluxapyroxad + pyraclostrobin	7	12	N
7 + 11 + 3	Miravis Neo	13.7 fl oz/A	pydiflumetofen + azoxystrobin + prothioconazole	14	12	--
7 + 12	Miravis Prime	10.3 to 13.4 fl oz/A	pydiflumetofen + fludioxonil	14	12	--
9 + 12	Switch 62.5WG	11.0 to 14.0 oz/A	cyprodinil + fludioxonil	7	12	L
29	Omega 500F	8.0 fl oz /A	fluazinam	14/30	12	N

Beets (Garden)

Beets are frost tolerant and produce the best commercial quality when grown during cool temperatures (50-65°F, 10-18°C). Lighter color and wider zoning occur during rapid growth in warm temperatures. Beets will form seed stalks if exposed to temperatures below 50°F (10°C) for 2 or 3 weeks after several true leaves have formed. Beets have a high boron requirement - see Plant Nutrient Recommendations below.

Recommended Varieties[1]

Market	Hybrid	Days	Color	Shape	Use
Avalanche	No	50	White	Round	Roots, bunching
Boro	Yes	51	Red	Globe	Roots, tops, bunching, baby beets
Bulls Blood	No	58	Red with White Zones	Globe	Roots, tops (red)
Chioggia Guardsmark	No	60	Purple with White Zones	Globe	Roots
Cylindra	No	54	Red	Cylindrical	Roots, bunching
Eagle	Yes	50	Red	Globe	Roots, bunching
Early Wonder	No	52	Red	Globe	Greens, bunching
Fresh Pak	Yes	40	Green-Red leaves	Long	Greens
Green Top Bunching	No	58	Red	Round	Greens, bunching
Kestrel	Yes	53	Red	Globe	Roots, bunching
Merlin	Yes	55	Red	Globe	Roots
Moneta (monogerm)	Yes	46	Red	Glove	Roots, bunching
Red Ace	Yes	53	Red	Globe	Roots, bunching
Red Cloud	Yes	53	Red	Round	Roots, bunching
Ruby Queen	No	55	Red	Round	Roots, bunching
Touchstone Gold	No	60	Gold	Round	Roots, bunching
Zeppo	Yes	50	Red	Round	Roots, bunching

[1]**Listed alphabetically**.

Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and Chapter B Soil and Nutrient Management. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede the recommendations found below.

Beets[1,2]		Soil Phosphorus Level				Soil Potassium Level				
		Low	Med	High (Opt)	Very High	Low	Med	High (Opt)	Very High	
	N (lb/A)	P_2O_5 (lb/A)				K_2O (lb/A)				Nutrient Timing and Method
	75-100	150	100	50	0	150	100	50	0	Total nutrient recommended
	50	150	100	50	0	150	100	50	0	Broadcast and disk-in
	25-50	0	0	0	0	0	0	0	0	Sidedress 4-6 weeks after planting

[1]Apply 1.5-3 lb/A of boron (B); see also Table B-7. in Chapter B Soil and Nutrient Management.
[2]Apply 25-30 lb/A of sulfur (S) for most soils.

Boron Deficiency and Black Spot

Boron (B) deficiency can cause black spots inside roots and large black dry rots on root surfaces. B deficiency is most likely to occur in alkaline soils high in calcium and is exacerbated by dry conditions. Apply B at planting according to soil test results.

Seed Treatment

Use treated seed to prevent disease, see Disease Control below for more information.

Seeding and Spacing

Seed from early April to mid-August. Germination temperatures range from 50-85°F (10-29°C). For fresh market beets, sow seeds ½ inch deep at the rate of 12 seeds/ft of row. Space rows 15-20 inches apart; thin plants to 3 inches apart. Narrow row systems with between row spacings of 6-12 inches and in-row seeding rates of 8 seeds per foot are appropriate for processing beets. Processing beets are precision planted to achieve final stands for intended processing use. Beet "seeds" are dried fruits with 1-3 seeds. Seed companies can provide sprout counts to determine seeding rates more accurately for precision planting.

Harvest and Post-Harvest Considerations

Market beets are harvested when they reach a size of 1.5-3 inches in diameter. Beet tops for greens may be cut and handled like spinach or Swiss chard. For bunching beets, roots are undercut and carefully pulled by the tops. For larger acreages, beets for roots may be topped and machine dug using a modified potato digger.

Store beets at 32°F (0°C) and 98-100% relative humidity. Like other root crops, beets are well adapted to storage. Topped beets stored at 32°F can keep 4-6 months. Cold storage or cool-cellar storage are both suitable, provided the humidity is kept sufficiently high to prevent dehydration. Before storage, beets should be topped and sorted to remove the ones with disease symptoms or mechanical injuries. Beets should not be stored in large bulk. They should be stored in well-ventilated containers such as ventilated bin boxes or slatted crates to help dissipate respiratory heat. Increased carbon dioxide concentrations (5-10%) in beet storage increases fungal spoilage.

Bunched beets and beet greens are much more perishable than topped beets, but they can be stored at 32°F for 10-14 days. A relative humidity of at least 95% is desirable to prevent wilting. Air circulation should be adequate to remove respiration heat but not so rapid that it speeds up transpiration and wilting. Satisfactory precooling is accomplished by vacuum cooling or hydrocooling. Crushed ice helps keep the bunched beets cold, especially if refrigeration is not available. Bunched beets are commonly shipped with package and top ice to maintain freshness.

Weed Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.

Recommended Herbicides

1. Identify the weeds in each field and select recommended herbicides. More information is available in the "Herbicide Effectiveness on Common Weeds in Vegetables" (Table E-3) in Chapter E Pest Management.

2. Minimize herbicide resistance development. Identify the herbicide mode of action group number and follow recommended good management practices; **bolded group numbers in tables below are herbicides at higher risk for selecting resistant weed populations.** Include non-chemical weed control whenever possible.

1. Soil-Applied (Preplant Incorporated)

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
8	Ro-Neet 6E	1.67 to 2 qt/A	**cycloate**	2.5 to 3 lb/A	--	48

-Preplant incorporated only; incorporate into 3 to 4 inches of soil immediately after application. Plant any time after treatment. Use on mineral soils **only**. Use lower rate on sandy soils and higher rate on heavier soils.
-**Do not** apply over 150 lb N/A when applying this herbicide in conjunction with a fluid fertilizer.

2. Postemergence

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
1	Shadow 3EC Select 2EC Select Max 0.97EC	4 to 5.33 fl oz/A 6 to 8 fl oz/A 9 to 16 fl oz/A	**clethodim**	0.07 to 0.125 lb/A	30	24
	Poast 1.5EC	1 to 2.5 pt/A	**sethoxydim**	0.2 to 0.5 lb/A	60	12

-**Select 2EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). **Select Max**: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution). **Shadow 3EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution) for large or stressed grasses; use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution) when crop safety is a concern. **Poast**: Apply with COC at 1.0% v/v. -**The use of COC may increase the risk of crop injury when hot or humid conditions prevail**. To reduce the risk of crop injury, omit additives or switch to NIS when grasses are small and soil moisture is adequate. -Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control.
-Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will **not** be controlled.
-Controls many annual and certain perennial grasses, including annual bluegrass, but Poast is preferred for goosegrass control. For best results, treat annual grasses when they are actively growing and before tillers are present. Control may be reduced if grasses are large or under hot or dry weather conditions. Repeated applications may be necessary to control certain perennial grasses. If repeated applications are necessary, allow 14 days between applications.
-**Do not** tank mix with or apply within 2 to 3 days of any other pesticide, unless labeled, as this may increase the risk of crop injury or reduce the control of grasses. **Do not** apply more than 8 fl oz/A of Select 2EC in a single application and **do not** exceed 2 pt/A for the season; **do not** apply more than 16 fl oz/A of Select Max in a single application and **do not** exceed 4 pt/A for the season. **Do not** apply more than 5.33 fl oz/A of Shadow 3EC in a single application and **do not** exceed 21.33 fl oz/A for the season.
-**Do not** apply more than 2.5 pt/A Poast in a single application and **do not** exceed 5 pt/A for the season. Rainfastness is 1 h.

2. Postemergence - continued next page

2. Postemergence - continued

5	Spin-Aid 1.3EC*	1.5 to 3 pt/A	**phenmedipham**	0.244 to 0.488 lb/A	60	12
-**For use in DE, MD, NJ, PA, and VA only. See label for application restrictions, mixing instructions, and weather restriction to prevent crop injury or herbicide failure.** Multiple applications may be applied to ground to control early germinating weeds. Apply 1.5 pt/A after the 2-leaf stage. Increase rate up to 2.3 pt/A after the 4-leaf stage. Increase rate up to 3 pt/A after the 6-leaf stage. Repeat applications may be made 5 to 7 days later, or when another flush of weeds germinates. A maximum of 3 applications is allowed. -Spin-Aid is effective on brassica species including wild mustard, shepherdspurse, and London rocket. Other weeds controlled include common chickweed, common lambsquarters, groundcherry, purslane, common ragweed, and annual sowthistle. -**Do not** apply this product through any type of irrigation system. **Do not** spray when conditions for drift are favorable or while dew is present. Leave a 16 ft buffer from the treated area when the wind direction is toward sensitive plants. -Spin-Aid may cause injury if the crop is under stress as the result of rapid changes in weather from cool, overcast days to hot (>75°F), bright days; windy conditions; drought; use of preplant herbicides, preemergence herbicides, or other chemicals; insect or disease injury; or close cultivation. Rainfastness is 6 h.						

3. Other Labeled Herbicides These products are labeled but limited local data are available; and/or are labeled but not recommended in our region due to potential crop injury concerns.		
Group	**Product Name (*=Restricted Use)**	**Active Ingredient**
2	UpBeet	**triflusulfuron**
4	Stinger	**clopyralid**
14	Vida	**pyraflufen**
14	Aim	**carfentrazone**

Insect Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.

Recommended Insecticides

Aphids

Apply one of the following formulations:

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
4A	Admire Pro	4.4 to 10.5 fl oz/A	imidacloprid - **soil**	21	12	H
4A	Admire Pro	1.2 fl oz/A	imidacloprid - **foliar**	7	12	H
4A	Actara 25WDG	1.5 to 3.0 oz/A	thiamethoxam	7	12	H
4A	Platinum 75SG	1.70 to 4.01 oz/A	thiamethoxam	AP	12	H
4C	Transform WG	0.75 to 1.5 oz/A	sulfoxaflor	7	24	H
4D	Sivanto Prime	7.0 to 14.0 fl oz/A	flupyradifurone	7	4	M
28	Exirel	13.5 to 20.5 fl oz/A	cyantraniliprole	1	12	H
29	Beleaf 50SG	2.0 to 2.8 oz./A	flonicamid	3	12	L

Beet Armyworms and Webworms

Note: Beet armyworm and Hawaiian beet webworm populations may be resistant or less susceptible to pyrethroid insecticides.

Apply one of the following formulations:

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
5	Blackhawk 36WG	2.25 to 3.5 oz/A	spinosad	3	4	M
5	Entrust (OMRI)	4.5 to 10.0 fl oz/A	spinosad	3	4	M
5	Radiant SC	5.0 to 10.0 fl oz/A	spinetoram	7	4	M
11A	XenTari (OMRI)	0.5 to 2.0 lb/A	*Bacillus thuringiensis aizawai*	0	4	N
11A	DiPel DF	05 to 2.0 lb/A	*Bacillus thuringiensis kurstaki*	0	4	N
18	Intrepid 2F	4.0 to 10.0 fl oz/A	methoxyfenozide	1	4	L
18 + 5	Intrepid Edge	4.5 to 12.0 fl oz/A	methoxyfenozide + spinetoram	7	4	M
22	Avaunt 30WDG, Avaunt eVo	3.5 to 6.0 oz/A	indoxacarb	7	12	H
28	Coragen 1.67SC Coragen eVo	3.5 to 7.5 fl oz/A 1.2 to 2.5 fl oz/A	chlorantraniliprole	1	4	L
28	Vantacor	1.2 to 2.5 fl oz/A	chlorantraniliprole	1	4	L
28 + 3A	Elevest*	5.6 to 9.6 fl oz/A	chlorantraniliprole + bifenthrin	21	12	H
28	Exirel	13.5 to 20.5 fl oz/A	cyantraniliprole	1	12	H

Flea Beetles

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Apply one of the following formulations:						
1A	Sevin XLR Plus	0.5 to 1.0 qt/A	carbaryl	7	12	H
3A	Fastac CS*	1.8 to 3.8 fl oz/A	alpha-cypermethrin	7	12	H
3A	Brigade 2EC*	5.12 to 6.40 fl oz/A	bifenthrin	1	12	H
3A	Hero*	2.6 to 6.1 fl oz/A	zeta-cypermethrin + bifenthrin	1	12	H
3A	Mustang Maxx*	1.76 to 4.0 fl oz/A	zeta-cypermethrin	1	12	H
4A	Admire Pro	4.4 to 10.5 fl oz/A	imidacloprid - **soil**	21	12	H
4A	Admire Pro	1.2 fl oz/A	imidacloprid - **foliar**	7	12	H
4A	Actara 25WDG	1.5 to 3.0 oz/A	thiamethoxam	7	12	H
4A	Platinum 75SG	1.70 to 4.01 oz/A	thiamethoxam	AP	12	H
28 + 3A	Elevest*	5.6 to 9.6 fl oz/A	chlorantraniliprole + bifenthrin	21	12	H

Leafminers

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Apply one of the following formulations:						
5	Blackhawk 36WG	2.25 to 3.5 oz/A	spinosad	3	4	M
5	Entrust SC (OMRI)	4.5 to 10.0 fl oz/A	spinosad	3	4	M
5	Radiant SC	6.0 to 10.0 fl oz/A	spinetoram	7	4	M
28	Exirel	13.5 to 20.5 fl oz/A	cyantraniliprole	1	12	H

Disease Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F. Recommended Fungicides

Seed Treatment

Use seed treated with Apron XL (0.085 to 0.64 fl oz/100 lb) or Allegiance FL (0.75 fl oz/100 lb) for *Pythium* damping-off protection *plus* Maxim 4FS (0.08 to 0.16 fl oz/100 lb) for *Rhizoctonia* and *Fusarium* protection. Seed treatments are not a substitute for high quality seed.

Damping-off caused by *Phytophthora, Pythium*, and *Rhizoctonia*

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Apply one of the following preplant incorporated or as a soil-surface spray after planting:						
4	Ridomil Gold 4SL	1.0 to 2.0 pt/A	mefenoxam	0	48	N
4	Ultra Flourish 2E	2.0 to 4.0 pt/A	mefenoxam	0	48	N
4	MetaStar 2E AG (see label)	4.0 to 8.0 pt/A	metalaxyl	14	48	N
Apply the following as an in-furrow spray only for *Pythium* and *Rhizoctonia* control:						
4 + 11	Uniform 3.66SE[1]	0.34 fl oz/1000 ft row	mefenoxam + azoxystrobin	AP	0	N

Bacterial and Fungal Diseases

Leaf Spots (*Cercospora* and *Alternaria*) and other foliar diseases

Allow 2 to 3 years between beet plantings. Thoroughly disc under crop residues as pathogens can overwinter on residues. Warm, wet weather and rainfall favor leaf spot development. Scout plantings regularly, especially if wet weather persists. Apply one of the fungicides listed below preventatively and/or when weather conditions are favorable for disease development. Repeat every 7 to10 days.

Do not make more than 2 sequential applications of Cabrio, or 1 application of a FRAC code 11 fungicide, before alternating to a non-FRAC code 11 fungicide. **Tank mix fungicides with fixed copper** to help reduce fungicide resistance development. Resistance of Cercospora Leaf Spot (CLS) to FRAC code 11 has been reported in table and sugar beets and to FRAC code 3 in sugar beets. In cases of suspected resistance, tank mixing a copper-based fungicide with the biofungicides Double Nickel (OMRI), LifeGard (OMRI) or Regalia (OMRI) have provided some suppression of CLS. Repeated scouted is needed during the season to identify potential cases of fungicide resistance.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
M01	copper (OMRI)[1]	at labeled rates	copper	0	48	N
Rotate one of the following FRAC code 11 fungicides plus a fixed copper at labeled rates:						
11	azoxystrobin 2.08F[2,3]	6.0 to 15.5 fl oz/A[2,3]	azoxystrobin	0	4	N
11	Cabrio 20EG	8.0 to 12.0 oz/A	pyraclostrobin	0	12	N
11	Flint Extra 500SC	2.0 to 2.9 fl oz/A	trifloxystrobin (**Do not apply near Concord grapes**, see label)	7	12	N
11	Reason 500SC[4]	8.2 fl oz/A[4]	fenamidone	14	12	--
With one of the following:						
3	tebuconazole 3.6F	4.0 to 6.0 fl oz/A	tebuconazole	7	12	N
3	Tilt 3.6EC[5]	3.0 to 4.0 fl oz/A[5]	propiconazole	14	12	N
7	Fontelis 1.67SC	16.0 to 30.0 fl oz/A	penthiopyrad	0	12	L
7 + 9	Luna Tranquility 4.16SC	8.0 to 11.2 fl oz/A	fluopyram + pyrimethanil	7	12	--
7 + 11	Merivon 2.09SC	4.0 to 5.5 fl oz/A[6]	fluxapyroxad + pyraclostrobin	7	12	N
7 + 12	Miravis Prime	6.8 fl oz/A	pydiflumetofen + fludioxonil	7	12	--

[1]There are several OMRI listed copper-based products; see labels for specifics. Copper applications may help suppress some fungal pathogens in organic production systems.
[2]Use 9.0 to 15.5 fl oz/A for Cercospora Leaf Spot
[3]Poor control with azoxystrobin (FRAC code 11) has been reported in southern NJ and across NY
[4]Alternaria Leaf Spot suppression only
[5]Cercospora Leaf Spot only
[6]Use 5.5 fl oz/A for Cercospora Leaf Spot

Pocket Rot, Wirestem, Stem Canker, and Crown Rot (*Rhizoctonia solani*)

Pocket rot and other diseases caused by *Rhizoctonia* are most prevalent in cool, wet soils and especially in plantings showing poor plant vigor. Rotate between fields each year and scout on a regular basis.

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
11	azoxystrobin 2.08F[1]	0.40 to 0.80 fl oz/1000 ft row, banded or in-furrow	azoxystrobin	0	4	N
4 + 11	Uniform 3.66SE [1,2]	0.34 fl oz/1000 ft row	mefenoxam + azoxystrobin	AP	0	N

[1]See label for specific details. [2]Also for *Pythium* damping-off

Carrots

Recommended Varieties[1]

Fresh Market	Bolero*	Goldfinger* (early)	Napoli
	Cellobunch*	Kuroda*	Romance
	Enterprise*	Maverick (early)*	Sugarsnax 54
	Envy* (early)	Mokum (early)	Tendersnax*
	Fuerte* (early)	Nantindo* (early)	Tendersweet*
Processing: Dicing	Danvers 126	Hercules*	Royal Chantenay*
	Danvers Half Long	Red Cored Chantenay	
Processing: "Coins"	Bolero (early)*	Scarlet Nantes	YaYa*
	Goldfinger*	SV2384DL*	

[1]**Listed alphabetically within type**. *Indicates hybrid variety

Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and Chapter B Soil and Nutrient Management. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede the recommendations found below.

Carrots[1,2]		Soil Phosphorus Level				Soil Potassium Level				
		Low	Med	High (Opt)	Very High	Low	Med	High (Opt)	Very High	
	N (lb/A)	P_2O_5 (lb/A)				K_2O (lb/A)				Nutrient Timing and Method
	50-80	150	100	50	0	150	100	50	0	Total nutrient recommended
	50	150	100	50	0	150	100	50	0	Broadcast and disk-in
	25-30	0	0	0	0	0	0	0	0	Sidedress if needed

[1]Apply 12 lb/A of boron (B) with broadcast fertilizer; see also Table B-7. in Chapter B Soil and Nutrient Management.
[2]Apply 25-30 lb/A of sulfur (S) for most soils.

Seed Treatment

See Disease Control below. Seed treatments are not a substitute for high-quality seed.

Seeding Dates

For early harvest (late June to September), sow March 20 to April 30. For late harvest, sow May 1 to July 5 (May 1 to June 15 in PA and northern NJ). Practice crop rotation and plant after a small grain crop for highest yields.

Seeding Rate and Spacing

Processing: Rows 18-36 inches apart. "Coins": sow at a density of 16 plants/ft. Dicing: sow 6 plants/ft (8 if soil is fine-textured). Dicers: 1-2 lb/A using 2-inch scatter shoe. Depth of seeding should be no greater than ¼ inch.
Fresh market and Cut and Peel: Rows 18-36 inches apart; sow for 6-8 plants/ft or 2-4 lb/A using 4-inch scatter shoe. Depth of seeding should be no greater than ¼ inch.
Processing and Fresh: Sowing with a precision vacuum seeder produces more uniform carrots. In a row, each vacuum plate meters seed to three separate lines. Lines are generally 1.5-2 inches apart and seeds are dropped about 1.5-2 inches apart within the line, resulting in 4-6 seeds/ft of seed-line for dicers and 6-8 plants/ft for slicers or fresh market. If triple line sets are used, increase the distance between seeds in the center row.

Cultivation

Hill with 2 inches of soil to cover shoulders to minimize greening.

Harvest and Post-Harvest Considerations

Early fresh market carrots are harvested from July to September. Late market carrots are harvested from September into early winter. Fresh market carrots should be over 5 inches long and 0.751.5 inches in diameter. Carrots harvested and handled in hot weather are more prone to rapid decay, and care should be exercised in handling to prevent wilting. Fresh market carrots in small plantings are harvested by loosening the soil around the plants with a garden fork and then pulling carrots gently out of the ground by the tops. For larger acreages carrots with intact tops are harvested with a belt pick-up harvester that lifts carrots by their foliage. Belt pick up, coulter pick up, or modified potato harvester types are used for processing carrots.

Carrots are processed immediately after harvest. Most are scalped (tops removed) just before digging. A reduction in yield of about 15-20% occurs when carrots are field scalped. Scalped carrots, and those with inadequate, or frozen tops are harvested with a coulter pick-up or a modified potato harvester. Carrots with intact tops are harvested with a belt pick-up harvester that lifts carrots by their foliage then cuts off the tops.

Fresh market carrots are washed, sorted, and packed into 48 1-lb plastic bags, or 24 2-lb plastic bags per carton, or loose in 50-lb mesh or plastic sacks. Store carrots at 32°F (0°C) and 98100% relative humidity. Carrots for processing may be given a pre-storage dip treatment in a 0.1% solution of sodium o-phenylphenate- (SOPP) to reduce storage decay. The solution is not rinsed off after treatment. Careful handling during and after harvest to avoid bruising, cutting and breakage, will help ensure successful storage.

Mature topped carrots can be stored 7-9 months at 32-34°F (0- 1°C) and 98-100% relative humidity. Prompt cooling- to 40°F (4°C) or below is essential for extended storage. Humidity should be kept high to prevent wilting. Carrots stored at 98-100% relative humidity develop less decay, lose less moisture, and remain crisper than those stored at 90-95% relative humidity. A temperature of 32-34°F is essential to minimize decay and sprouting.

Pre-storage washing of carrots may be desirable if they are harvested under wet conditions. Many potential decay-causing organisms are removed by washing and air circulation is improved. Otherwise, storing unwashed, brushed, and topped carrots is desirable for long-term storage. Air circulation between crates or pallet boxes with carrots is desirable to remove respiratory heat, maintain uniform temperatures, and help prevent condensation. An air velocity of about 14-20 ft/min is adequate at low storage temperatures.

Bitterness in carrots, which may develop in storage, is due to ethylene exposure. This gas is given off by apples, pears, and certain other fruits and vegetables and from decaying tissues. Bitterness can be prevented by storing carrots away from such products. Also, ethylene and development of bitterness can be minimized by low temperature. Surface browning or oxidative discoloration often develops in carrots stored for extended periods.

Weed Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.

Recommended Herbicides

1. Identify the weeds in each field and select recommended herbicides. More information is available in the "Herbicide Effectiveness on Common Weeds in Vegetables" (Table E-3) in Chapter E Pest Management.
2. Minimize herbicide resistance development. Identify the herbicide mode of action group number and follow recommended good management practices; **bolded group numbers in tables below are herbicides at higher risk for selecting resistant weed populations.** Include non-chemical weed control whenever possible.

1. Soil-Applied (Preplant Incorporated or Preemergence)

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
3	Treflan 4EC	1 to 2 pt/A	**trifluralin**	0.50 to 1 lb/A	--	12
-Labeled for preplant incorporated only; incorporate into 2-3 inches of soil within 8 h after application. -Primarily controls annual grasses with a few broadleaf weeds. -**Do not** use (or reduce the rate) when cold, wet soil conditions are expected, or crop injury may result. -Poor incorporation can reduce overall weed control. Maximum application not addressed on label.						
5	Caparol 4L	2 to 4 pt/A	**prometryn**	1 to 2 lb/A	30	12
-Apply after seeding, but before crop emergence. Use lower rate on lighter coarse-textured sandy soils and the higher rate on heavier fine-textured soils. Follow with overhead irrigation if rainfall does not occur. -Primarily controls annual broadleaf weeds. Annual grasses may only be suppressed.						
7	Lorox 50DF	1 to 3 lb/A	**linuron**	0.5 to 1.5 lb/A	14	24
-Apply after seeding, but before crop emergence. Determine carrot variety tolerance to Lorox prior to use. Sow seed at least ½ inch deep. Use lower rate on lighter coarse-textured sandy soils and the higher rate on heavier fine-textured soils. Follow with overhead irrigation if rainfall does not occur. -Primarily controls annual broadleaf weeds. Annual grasses may only be suppressed. -**Do not** exceed a total of 2 lb/A of active ingredient linuron per season.						
15	Dual Magnum 7.62E	1.33 to 2 pt/A	***s*-metolachlor**	1.26 to 1.9 lb/A	64	24
-**Special Local Needs Label 24(c) for the use of Dual Magnum 7.62E to control weeds in carrots in NJ (expires 1/28/2027). The use of Dual Magnum is legal ONLY if a waiver of liability has been completed (see: *https://www.syngenta-us.com/labels/indemnified-label-login*).** -**Do not** incorporate. Use only on high organic matter (>20%) muck soils. -Primarily controls annual grasses, certain broadleaf weeds, and nutsedge. Dual will not control emerged weeds. -**Do not** apply more than 2 pt/A during any one crop year. -Other generic versions of metolachlor and *s*-metolachlor may be available and may or may not be labeled for use in the crop.						

2. Postemergence

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
1	Shadow 3EC Select 2EC Select Max 0.97EC	4 to 5.33 fl oz/A 6 to 8 fl oz/A 9 to 16 fl oz/A	**clethodim**	0.07 to 0.125 lb/A	30	24
	Poast 1.5EC	1 to 2.5 pt/A	**sethoxydim**	0.2 to 0.5 lb/A	30	12
	Fusilade DX 2EC	8 to 24 fl oz/A	**fluazifop**	0.125 to 0.375 lb/A	45	12

-**Select 2EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). **Select Max**: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution). **Poast**: use COC at 1.0% v/v. **Shadow 3EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution) for large or stressed grasses; use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution) when crop safety is a concern. **Fusilade DX:** use COC at 1.0% v/v or NIS at 0.25% v/v.
-**The use of COC may increase the risk of crop injury when hot or humid conditions prevail**. To reduce the risk of crop injury, omit additives or switch to NIS when grasses are small and soil moisture is adequate.
-Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control.
-Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will **not** be controlled.
-Controls many annual and certain perennial grasses, including annual bluegrass, but Poast is preferred for goosegrass control. For best results, treat annual grasses when they are actively growing and before tillers are present. Control may be reduced if grasses are large or under hot or dry weather conditions.
-Repeated applications may be necessary to control certain perennial grasses. If repeated applications are necessary, allow 14 days between applications.
-**Do not** tank mix with or apply within 2 to 3 days of any other pesticide, unless labeled, as this may increase the risk of crop injury or reduce the control of grasses.
-Rainfastness is 1 h.
-**Do not** apply more than 8 fl oz/A of Select 2EC in a single application and **do not** exceed 2 pt/A for the season; **do not** apply more than 16 fl oz/A of Select Max in a single application and **do not** exceed 4 pt/A for the season.
-**Do not** apply more than 5.33 fl oz/A of Shadow 3EC in a single application and **do not** exceed 21.33 fl oz/A for the season.
-**Do not** apply more than 2.5 pt/A of Poast in a single application and **do not** exceed 5 pt/A for the season.
-**Do not** apply more than 24 fl oz/A of Fusilade DX in a single application and **do not** exceed 3 pt/A per season.

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
5	Caparol 4L	2 to 4 pt/A	**prometryn**	1 to 2 lb/A	30	12

-Apply 4L after the crop has 3 true leaves, through the 6 true leaf stage of growth.
-Add nonionic surfactant at 0.5% of the spray solution (2 qt/100 gal) or oil concentrate at 1% of the spray solution (1 gal/100 gal).
-Primarily controls many annual, broadleaf weed seedlings less than 2 inches tall. Annual grasses may only be suppressed.
-Follow with overhead irrigation if rainfall does not occur.
-Use lower rate when the crop and weeds are small, or when cloudy, humid growing conditions prevail and the higher rate when the crop and weeds are more mature and hot dry growing conditions prevail.
-One preemergence treatment of up to 4 pt/A plus two postemergence treatments of 2 pt/A may be applied, but **do not** exceed 8 pt/A per crop cycle.

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
5	Metribuzin 75DF Metribuzin 4L	0.33 lb/A 0.5 pt/A	**metribuzin**	0.25 lb/A	60	12

-Apply after carrots have formed 5 to 6 true leaves, but before weeds are 1 inch in height or diameter.
-Controls many broadleaf weeds, including tropic croton, spotted spurge, and horseweed.
-**Do not** use to control triazine-resistant weeds.
-**Do not** apply to carrots grown for seed.
-**Do not** apply within 3 days after periods of cool, wet, cloudy weather.
-**Do not** tank mix with any other pesticide or apply within 3 days, or excessive crop injury may result.
-If needed a second application may be made after an interval of at least 3 weeks.
-**Do not** apply more than 0.67 lb/A per season of metribuzin 75DF or 1 pt/A per season of metribuzin 4L.
-Following application of metribuzin chlorosis (yellowing) and burning of the leaf tissue may occur. Varietal differences exist in carrot tolerance to metribuzin. **Use caution when treating new varieties.**
-Rainfastness is 6 h.

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
7	Lorox 50DF	1.5 to 3 lb/A	**linuron**	0.75 to 1.5 lb/A	14	24

-Apply when carrots are approximately 3 to 6 inches tall. Avoid postemergence applications when daily temperatures are 90°F (32°C) or above or during a period of cloudy weather or just after rain or irrigation.
-Linuron is effective on most weeds including ragweed.
-**Do not** plant treated area to crops not on the label within a 4-month period after treatment.

3. Other Labeled Herbicides

These products are labeled but limited local data are available; and/or are labeled but not recommended in our region due to potential crop injury concerns.

Group	Product Name (*=Restricted Use)	Active Ingredient
3	Prowl H2O	**pendimethalin**
14	Aim	**carfentrazone**

Insect Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.

Recommended Insecticides

Aphids

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1B	Malathion 57 EC	1.5 to 2.0 pt/A	malathion	7	24	H
4A	Actara 25WDG	1.5 to 3.0 oz/A	thiamethoxam	7	12	H
4A	Admire Pro	4.4 to 10.5 fl oz/A	imidacloprid - **soil** (in furrow spray)	21	12	H
4A	Admire Pro	1.2 fl oz/A	imidacloprid - **foliar**	7	12	H
4C	Transform WG	0.75 to 1.0 oz/A	sulfloxaflor	7	24	H
4D	Sivanto Prime	7.0 to 14.0 fl oz/A	flupyradifurone	7	4	M
23+7C	Senstar	10 fl oz/A	spirotetramat + pyriproxifen	7	24	L
28	Exirel	13.5 to 20.5 fl oz/A	cyantraniliprole	1	12	H
29	Beleaf 50SG	2.0 to 2.8 oz/A	flonicamid	3	12	L

Carrot Weevils

Begin treatment when weevils become active, usually when the soil surface reaches 60°F (16°C). Tillage of previous crop residue and rotating fields at least ¼ mile from previous carrot-family plantings are important cultural practices.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Vydate L*	2.0 to 4.0 pt/A	oxamyl - **foliar**	14	48	H
3A	Asana XL*	9.6 fl oz/A	esfenvalerate	7	12	H
3A	Baythroid XL*	2.8 fl oz/A	beta-cyfluthrin	0	12	H
3A	Tombstone*	2.8 fl oz/A	cyfluthrin	0	12	H
3A + 4A	Leverage 360*	2.4 to 2.8 fl oz/A	imidacloprid + beta-cyfluthrin	7	12	H
28	Exirel	13.5 to 20.5 fl oz/A	cyantraniliprole	1	12	H

Cutworms

See also section E 3.1. Soil Pests - Detection and Control.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	0.75 to 1.5 pt/A	methomyl	1	48	H
3A	Asana XL*	5.8 to 9.6 fl oz/A	esfenvalerate	7	12	H
3A	Baythroid XL*	0.8 to 1.6 fl oz/A	beta-cyfluthrin	0	12	H
3A	Tombstone*	0.8 to 1.6 fl oz/A	cyfluthrin	0	12	H
28	Exirel	10 to 20.5 fl oz/A	cyantraniliprole	1	12	H
28 + 3A	Elevest*	5.6 to 9.6 fl oz/A	chlorantraniliprole + bifenthrin	21	12	H

Leafhoppers

Begin spraying when true leaves first appear. Repeat every 14 days or as needed. Leafhoppers transmit Aster Yellows. Seedling protection from leafhoppers is important.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	1.5 to 3.0 pt/A	methomyl	1	48	H
1B	Malathion 57 EC	2.0 pt/A	malathion	7	24	H
3A	Asana XL*	5.8 to 9.6 fl oz/A	esfenvalerate	7	12	H
3A	Baythroid XL*	1.6 to 2.8 fl oz/A	beta-cyfluthrin	0	12	H
3A	Tombstone*	1.6 to 2.8 fl oz/A	cyfluthrin	0	12	H
3A + 4A	Leverage 360*	2.4 to 2.8 fl oz/A	imidacloprid + beta-cyfluthrin	7	12	H
4A	Actara 25WDG	1.5 to 3.0 oz/A	thiamethoxam	7	12	H
4A	Admire Pro	4.4 to 10.5 fl oz/A	imidacloprid - **soil**	7	12	H
4A	Admire Pro	1.2 fl oz/A	imidacloprid - **foliar**	7	12	H
4C	Transform WG	1.5 to 2.75 oz/A	sulfloxaflor	7	24	H

Disease Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.
Recommended Fungicides

Nematodes

Avoid seeding in fields with a known history of nematode problems. Nematode control is essential for successful production. See fumigants listed in sections E 1.5. Soil Fumigation and E 1.6. Nematode Control.

Seed Treatment

Use seed treated with Maxim 4FS (0.08 to 0.16 fl oz/100 lb seed) for *Rhizoctonia* and *Fusarium* control or Apron XL (0.32 to 0.64 fl oz/100 lb seed) or Allegiance FL (0.75 fl oz/100 lb seed) for *Pythium* damping-off protection. Seed treatments are not a substitute for high-quality seed.

Damping-off caused by *Phytophthora* and *Pythium*

Use seed treatments as instructed above.

Apply one of the following preplant incorporated or as a soil-surface spray after seeding. Note: If seed treatment contains mefenoxam (Apron XL) or metalaxyl (Allegiance) do not use soil application.						
Code	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
4	Ridomil Gold 4SL	0.5 to 1.3 pt/A	mefenoxam	AP	48	N
4	Ultra Flourish 2E	2.0 to 4.0 pt/A	mefenoxam	AP	48	N

Bacterial and Fungal Diseases

Aster Yellows

Use insecticides to control leafhoppers. Control weed populations (including carrot volunteers) on the periphery of fields early in the season to prevent transmission by leafhoppers from the weeds into the crop. The severity of Aster Yellows and damage to the crop will depend on the age of the crop. The earlier the infection occurs, the more severe and widespread the symptoms may become later in the season. See leafhopper management under Insect Control.

Bacterial Blight (*Xanthomonas*)

Initiate a fixed copper-based program as soon as symptoms are observed. Copper content and active ingredient(s) vary between copper-based products. See label for specific rates and use. Avoid working in fields when the foliage is wet to reduce the spread of the disease. Some copper-based products are OMRI listed and may be helpful in suppressing Bacterial Blight and some fungal leaf blights in organic production systems.

Leaf Blights (*Alternaria* and *Cercospora*)

Begin fungicide applications when disease threatens or start preventative fungicide programs in early July and continue every 7 to 10 days as long as conditions favor disease development. For processing crops or situations where the crop is not being marketed with its foliage, a 25% disease incidence threshold may be used to time the first fungicide application. Scout carrot fields by variety. While walking across the field in a ‘V’ or ‘W’ shaped transect for each variety, evaluate disease incidence on 5 leaves from 5 adjacent plants in a minimum of 10 locations. A leaf is infected if one or more fungal leaf blight lesions are observed. Apply the first fungicide spray when 12 of the 50 leaves (~25%) scouted show symptoms. Subsequent sprays should be applied based on the label recommended spray interval or on increased disease severity. Under severe defoliation, add urea (10.0 lb/A) to encourage new leaf growth.

Code	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
Tank mix one of the following fungicides *with* chlorothalonil 6F 1.5 to 2.0 pt/A and rotate between different FRAC codes[1] from below:						
7	Fontelis 1.67SC	16.0 to 30.0 fl oz/A	penthiopyrad	0	12	L
7 + 11	Pristine 38WG	8.0 to 10.5 oz/A	boscalid + pyraclostrobin	0	12	--
7 + 11	Luna Sensation 4.2SC	4.0 to 7.6 fl oz/A	fluopyram + trifloxystrobin	0	12	--

Leaf Blights (Alternaria and Cercospora) - continued next page

Leaf Blights (Alternaria and Cercospora) - continued

7 + 12	Miravis Prime	6.8 fl oz/A	pydiflumetofen + fludioxonil	7	12	--
11	azoxystrobin 2.08F	9.0 to 15.5 fl oz/A	azoxystrobin	0	4	N
11	Cabrio 20EG	8.0 to 12.0 oz/A	pyraclostrobin	0	12	N
For Alternaria Leaf Blight only, tank mix one of the following fungicides *with* chlorothalonil 6F 1.5 to 2.0 pt/A and rotate between different FRAC codes[1]:						
2	iprodione 4F[2]	1.0 to 2.0 pt/A[2]	iprodione	0	24	N
7	Endura 70W	4.5 oz /A	boscalid	0	12	--
3 + 9	Inspire Super 2.82EW	16.0 to 20.0 fl oz/A	difenoconazole + cyprodinil	7	12	--
7 + 11	Merivon 2.09SC	4.0 to 5.5 fl oz/A	fluxapyroxad + pyraclostrobin	7	12	N
9 + 12	Switch 62.5WG	11.0 to 14.0 oz/A	cyprodinil + fludioxonil	7	12	L

[1]Chlorothalonil applied alone will not provide adequate control of *Cercospora*, *Alternaria*, or Powdery Mildew.
[2]Check label for rotational restrictions.

For Alternaria Leaf Blight only in organic production systems apply one of the following every 7 to 14 days to help suppress disease development:						
Code	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
44	Serenade Opti (OMRI)	14.0 to 20.0 oz/A	*Bacillus subtilis* (QST 713 strain)	0	4	N
44	LifeGard WG (OMRI)	4.5 oz/100 gal	*Bacillus mycoides* isolate J	0	4	N

Powdery Mildew

Initiate a fungicide program to protect foliage if symptoms are observed early in the season. Disease development mid- to late-season rarely results in reduced yield. Under severe defoliation, add urea (10.0 lb/A) to encourage new leaf growth.

Code	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
Tank mix one of the following fungicides with chlorothalonil 6F[1] 1.5 to 2.0 pt/A and rotate:						
7	Fontelis 1.67SC	16.0 to 30.0 fl oz/A	penthiopyrad	0	12	L
11	Cabrio 20EG	8.0 to 12.0 oz/A	pyraclostrobin	0	12	N
with one of the following fungicides plus chlorothalonil 6F 1.5 to 2.0 pt/A:						
3 + 9	Inspire Super 2.82EW	16.0 to 20.0 fl oz/A	difenoconazole + cyprodinil	7	12	--
7 + 11	Merivon 2.09SC	4.0-5.5 fl oz/A	fluxapyroxad + pyraclostrobin	7	12	N
7 + 11	Pristine 38WG	8.0 to 10.5 oz/A	boscalid + pyraclostrobin	0	12	--

[1]Chlorothalonil applied alone will not provide adequate control of *Cercospora*, *Alternaria*, or Powdery Mildew.

Southern Blight (*Sclerotium rolfsii*)

Southern Blight can cause significant losses. Once established, Southern Blight will persist in infested soils for many years. Rotate away from known infested fields. Apply a fungicide every 7-14 days and rotate between the following fungicides with different modes of action when symptoms appear:

Code	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
3 + 11	Quadris Top 1.67SC	14.0 fl oz/A	difenoconazole + azoxystrobin	7	12	--
7	Fontelis 1.67SC	16.0 to 30.0 fl oz/A	penthiopyrad	0	12	L
11	azoxystrobin 2.08F	15.5 fl oz/A	azoxystrobin	0	4	N
29	Omega 500F	1.0 pt/A	fluazinam	7	12	N

Storage Rots caused by *Botrytis* and White Mold (*Sclerotinia sclerotiorum*)

Remove roots from field, separate and discard all damaged roots before placing them in storage at 32°F (0°C) and 90-95% relative humidity immediately after digging.

Code	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
Prior to harvest apply:						
7	Fontelis 1.67SC	16.0 to 30.0 fl oz/A	penthiopyrad	0	12	L
Or, as carrots are placed into storage, dip into:						
1	Mertect 340-F	41.0 fl oz/100 gal water for 5-10 seconds	thiabendazole	NA	NA	N

Celery

Recommended Varieties Check with your seed supplier or other growers for recommendations on locally adapted varieties. Any new variety should be tested on a small scale before planting in a large area.

Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and Chapter B Soil and Nutrient Management. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede the recommendations found below.

		Soil Phosphorus Level				Soil Potassium Level				
		Low	Med	High (Opt)	Very High	Low	Med	High (Opt)	Very High	
Celery[1]	N (lb/A)	P_2O_5 (lb/A)				K_2O (lb/A)				Nutrient Timing and Method
	150-175	250	150	100	0	250	150	100	0	Total nutrient recommended
	50-75	250	150	100	0	250	150	100	0	Broadcast and disk-in
	25-50	0	0	0	0	0	0	0	0	Sidedress 2-3 weeks after planting
	25-50	0	0	0	0	0	0	0	0	Sidedress 6-8 weeks after planting

[1]Apply 1.5-3 lb/A of boron (B) with broadcast fertilizer; see also Table B-7. in Chapter B Soil and Nutrient Management. See also **Brown Check** under Celery Disorders below.

Seed Treatment

Freshly harvested seed may exhibit dormancy leading to poor germination. Seeds should either be stored below 40°F (4°C) for 6 months or longer or treated with phytohormones. For seed treatments, see Disease Control below.

Transplant Production

Transplants grown locally in greenhouses are commonly used. Sow seed 10-12 weeks before field planting. About 35,000 plants can be produced from 2½ oz seed. Maintain the greenhouse at 70-75°F (21-24°C) until emergence, and after that at 65-70°F (18-21°C) for steady growth. Maintain night temperatures above 55°F (13°C) to avoid the production of "seeders". Plants for an early crop should be set in the field when there is no more risk of frost or a cold period. If plants become too tall or spindly before field setting, they can be clipped back to a height of 5-6 inches. Plants can be hardened by withholding water 7-10 days before field planting. Never harden celery plants by lowering temperatures.

Planting and Spacing

Celery is a cool-season crop that grows most rapidly and develops the best yield and quality at moderately cool temperatures (55-75°F, 13-24°C), good soil moisture, and relatively high humidity. Satisfactory crops can be produced on fertile, medium-textured mineral soils with irrigation. The usual planting period is May 1 to June 30 with rows 16-32 inches apart and plants 8 inches apart in row. Set 30,000-45,000 plants/A.

Celery will withstand light freezes but both young and old plants are damaged by moderate freezes. After exposure to temperatures below 55°F (13°C) for a number of days, celery (a biennial) initiates seed stalks (bolts). Under satisfactory growing conditions, celery reaches usable size 85-100 days from transplanting. High plant populations can promote blanching. For non self-blanching cultivars, blanching can be accomplished by trenching or other mechanical means. Special blanching practices can improve color and eating quality.

Since celery is expensive to grow, experience in both production and marketing is desirable before large-scale operations are attempted.

Harvest and Post-Harvest Considerations

Harvest when stalks are of sufficient size but before any pithiness has developed in the petioles. Harvested celery should be cooled quickly to temperatures below 45°F (7°C) by hydrocooling, vacuum-cooling, icing, or other means of refrigeration. Stalks can be held 5-7 weeks if storage is near 32°F (0°C) with 98% relative humidity.

Celery Disorders

Blackheart: Internal leaves develop a brown discoloration which eventually becomes deep black. The cause is similar to tip-burn of lettuce or blossom-end rot of tomato. The development of blackheart is promoted by environmental conditions that favor rapid growth, such as heavy rain or irrigation before drought, or high nitrogen, potassium, and sodium levels. Water stress may result in a calcium deficiency disorder causing cell death. The risk of blackheart is reduced by avoiding wide fluctuations in moisture and nutrients and ensuring steady plant growth. Drip irrigation, which provides more even moisture levels can help reduce the risk. Drench applications of soluble calcium can lessen or prevent the development of blackheart.

Brown Check: A physiological disorder called "brown check," is characterized by russeting and cracking on the inner side of the petiole. Brown check may be caused by high levels of soil potassium and/or high potassium fertilization rates, although boron nutrition may also be involved.

Weed Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.

Recommended Herbicides

1. Identify the weeds in each field and select recommended herbicides. More information is available in the "Herbicide Effectiveness on Common Weeds in Vegetables" (Table E-3) in Chapter E Pest Management.
2. Minimize herbicide resistance development. Identify the herbicide mode of action group number and follow recommended good management practices; **bolded group numbers in tables below are herbicides at higher risk for selecting resistant weed populations.** Include non-chemical weed control whenever possible.

1. Soil-Applied (Preplant Incorporated or Preemergence)						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient**	**Active Ingredient Rate**	**PHI (d)**	**REI (h)**
5	Caparol 4L	2.4 to 3.3 pt/A	**prometryn**	1.2 to 1.6 lb/A	--	12
-Apply after seeding, but before crop emergence. Use lower rate on lighter coarse-textured sandy soils and the higher rate on heavier fine-textured soils; **Do not** use on sand or loamy sand soils, or crop injury may occur. Follow with overhead irrigation if rainfall does not occur. Primarily controls annual broadleaf weeds; annual grasses may only be suppressed. -Only 1 application per crop per year, **Do not** use both at planting and postemergence applications.						
8	Prefar 4E	5 to 6 qt/A	**bensulide**	5 to 6 lb/A	--	--
-Labeled for preplant incorporated or preemergence applications; **do not** incorporate more than 2 inches deep (1 inch is optimum). -Irrigate within 36 h of application with ½ inch of water; if not incorporated with irrigation or rainfall within 36 h, weed control maybe reduced. Provides control/suppression of some annual grass weeds and pigweeds, purslane, and lambsquarters. -**Do not** apply more than 6 lb ai/A per season.						

2. Postemergence						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient**	**Active Ingredient Rate**	**PHI (d)**	**REI (h)**
1	Shadow 3EC Select 2EC Select Max 0.97EC	4 to 5.33 fl oz/A 6 to 8 fl oz/A 9 to 16 fl oz/A	**clethodim**	0.07 to 0.125 lb/A	30	24
	Poast 1.5EC	1 to 1.5 pt/A	**sethoxydim**	0.2 to 0.3 lb/A	30	12
-**Select 2EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). **Select Max**: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution). **Shadow 3EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution) for large or stressed grasses; use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution) when crop safety is a concern. **Poast**: use COC at 1.0% v/v. -**The use of COC may increase the risk of crop injury when hot or humid conditions prevail**. To reduce the risk of crop injury, omit additives or switch to NIS when grasses are small and soil moisture is adequate. -Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control. -Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will **not** be controlled. -Controls many annual and certain perennial grasses, including annual bluegrass, but Poast is preferred for goosegrass control. For best results, treat annual grasses when they are actively growing and before tillers are present. Control may be reduced if grasses are large or under hot or dry weather conditions. If repeated applications are necessary, allow 14 days between applications. -**Do not** tank mix with or apply within 2 to 3 days of any other pesticide, unless labeled, as this may increase the risk of crop injury or reduce the control of grasses. -Rainfastness is 1 h. -**Do not** apply more than 8 fl oz/A of Select 2EC in a single application and **do not** exceed 2 pt/A for the season; **do not** apply more than 16 fl oz/A of Select Max in a single application and **do not** exceed 4 pt/A for the season. -**Do not** apply more than 5.33 fl oz/A of Shadow 3EC in a single application and **do not** exceed 21.33 fl oz/A for the season. -**Do not** apply more than 1.5 pt/A Poast in a single application and **do not** exceed 3 pt/A for the season.						
5	Caparol 4L	1.6 to 2 pt/A	**prometryn**	0.8 to 1 lb/A	40	12
-Postemergence application can be made after the crop has 3 to 5 true leaves. Primarily controls many annual broadleaf weed seedlings less than 2 inches tall. Annual grasses may only be suppressed. Use lower rate when the crop and weeds are small, or when cloudy,						

2. Postemergence (Caparol) - continued next page

2. Postemergence (Caparol)- continued

humid growing conditions prevail and the higher rate when the crop and weeds are larger or hot dry growing conditions prevail. -**Do not** use on sand or loamy sand soils, or crop injury may occur. -**Do not** tank mix Caparol with any other pesticide. -**Do not** use spray additives such as nonionic surfactant or oil concentrate. -**Do not** apply within 2 weeks of any herbicidal oil such as "carrot oil" or Stoddard Solvent. -Only 1 application per crop per year. -**Do not** use both at planting and postemergence applications.						
7	Lorox 50DF	1.5 to 3 lb/A	**linuron**	0.75 to 1.5 lb/A	45	24
-**For use on celery grown on muck soils only.** -Make a single application after celery transplants are established, but before celery is 8 inches tall Lorox will provide broadleaf weed control when applied to small weeds; will not control grass weeds. -**Do not** exceed 40 psi or apply when temperatures exceed 85°F. -**Do not** add surfactants, oil concentrate, or liquid fertilizer. -Use only the Lorox 50DF formulation of linuron. Only 1 application per season is allowed.						

3. Other Labeled Herbicides These products are labeled but limited local data are available; and/or are labeled but not recommended in our region due to potential crop injury concerns.

Group	Product Name (*=Restricted Use)	Active Ingredient
3	Treflan	**trifluralin**
14	Aim	**carfentrazone**
14	Tuscany SC, numerous	**flumioxazin**
15	Zidua SC	**pyroxasulfone**

Insect Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.

Recommended Insecticides

Aphids

There are many species of aphids that feed on celery with green peach being the most common. Aphids feed with their needle-like mouths and suck the plant's juices. While feeding they also can inject toxins and viruses that affect the plant's growth. There are no thresholds for aphids. Application of systemic insecticides can be effective but will not stop the transmission of most viruses.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1B	Malathion 57 EC	1.5 pt/A	malathion	7	24	H
1B	Orthene 97	0.5 to 1 lb/A	acephate	21	24	H
4A	Actara 25WDG	1.5 to 3.0 oz/A	thiamethoxam	7	12	H
4A	Admire Pro	4.4 to 10.5 fl oz/A	imidacloprid - **soil**	45	12	H
4A	Assail 30SG Assail 30SC	2.0 to 4.0 oz/A 1.7 to 3.4 fl oz/A	acetamiprid	7	12	M
4A	Belay 2.13SC	9.0 to 12.0 fl oz/A	clothianidin - **soil**	21	12	H
4A	Belay 2.13SC	3.0 to 4.0 fl oz/A	clothianidin - **foliar**	7	12	H
4D	Sivanto Prime or 200SL	7 to 14 fl oz/A	flupyradifurone - **foliar**	1	4	M
9B	Fulfill 50WDG	2.75 oz/A	pymetrozine	7	12	L
9B	PQZ	2.4 to 3.2 fl oz/A	pyrifluquinazon	1	12	L
9D	Versys	1.5 fl oz/A	afidopyropen	0	12	L
21A	Torac	17.0 to 21.0 fl oz/A	tolfenpyrad	1	12	H
23	Movento	4 to 5 fl oz/A	spirotetramat	3	24	L
23 + 7C	Senstar	8.0 to 10.0 fl oz/A	spirotetramat + pyriproxyfen	14	24	L
28	Exirel	13.5 to 20.5 fl oz/A	cyantraniliprole	1	12	H
28	Verimark	6.75 to 13.5 fl oz/A	cyantraniliprole	1	4	H
28 + 6	Minecto Pro*	10 fl oz/A	cyantraniliprole + abamectin	7	12	H
29	Beleaf	2.0 to 2.8 oz/A	flonicamid	0	12	L

Beet Armyworms (BAW), Fall Armyworms (FAW)

Small beet armyworm larvae feed on celery leaves while larger larvae feed on petioles which can cause significant damage. In addition to the feeding damage larvae drop fecal matter throughout the plant, which makes the celery unmarketable. Moths lay masses of eggs and cover them with scales, giving them a cottony appearance. Check fields weekly for damage, look for egg masses on leaves, and consider using pheromone traps to monitor moths.

(continued next page)

Beet Armyworms (BAW), Fall Armyworms (FAW) - continued

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Apply one of the following formulations:						
1A	Lannate LV*	1.5 to 3.0 pt/A	methomyl	7	48	H
1A	Sevin XLR Plus	1.0 to 2.0 qt/A	carbaryl	14	12	H
1B	Orthene 97	1 lb/A	acephate	21	24	H
5	Entrust SC (OMRI)	4.0 to 8.0 fl oz/A	spinosad	1	4	M
5	Radiant SC	5.0 to 10.0 fl oz/A	spinetoram	1	4	M
6	Proclaim 5SG*	2.4 to 4.8 oz/A	emamectin benzoate	7	12	H
11A	Dipel	1.0 to 2.0 lb/A	*Bacillus thuringiensis kurstaki*	0	4	L
11A	Xentari	0.5 to 2.0 lb/A	*Bacillus thuringiensis aizawai*	0	4	L
22	Avaunt 30WDG, Avaunt eVo	3.5 oz/A	indoxacarb	3	12	H
28	Coragen 1.67SC Coragen eVo	3.5 to 7.5 fl oz/A 1.2 to 2.5 fl oz/A	chlorantraniliprole	1	4	L
28	Exirel	7.0 to 13.5 fl oz/A	cyantraniliprole	1	12	H
28	Verimark	5 to 10 fl oz/A	cyantraniliprole	n/a	4	H
28 + 6	Minecto Pro*	5.5 to 10 fl oz/A	cyantraniliprole + abamectin	7	12	H

Cabbage Loopers

The larvae cause similar damage as beet armyworms, but it is not as serious. Like the beet armyworm, fields should be scouted weekly for cabbage looper. Natural enemies, such as parasitoid wasps and flies, can help in control.

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Apply one of the following formulations:						
1A	Lannate LV*	3 pt/A	methomyl	7	48	H
1A	Sevin XLR Plus	1.0 to 2.0 qt/A	carbaryl	14	12	H
1B	Orthene 97	1 lb/A	acephate	21	24	H
3A	Permethrin 3.2EC*, others	2 to 8 fl oz/A	permethrin	1	12	H
3A	Tombstone*	1.6 to 2.4 fl oz/A	cyfluthrin	0	12	H
5	Entrust SC (OMRI)	3.0 to 6.0 fl oz/A	spinosad	1	4	M
5	Radiant SC	5.0 to 10.0 fl oz/A	spinetoram	1	4	M
6	Proclaim 5SG*	3.2 to 4.8 oz/A	emamectin benzoate	7	12	H
11A	Dipel DF, others (OMRI)	1.0 to 2.0 lb/A	*Bacillus thuringiensis kurstaki*	0	4	N
11A	XenTari (OMRI)	0.5 to 2.0 lb/A	*Bacillus thuringiensis aizawai*	0	4	N
22	Avaunt 30WDG, Avaunt eVo	3.5 to 6.0 oz/A	indoxacarb	3	12	H
28	Coragen 1.67SC Coragen eVo	3.5 to 7.5 fl oz/A 1.2 to 2.5 fl oz/A	chlorantraniliprole	1	4	L
28	Exirel	10 to 17 fl oz/A	cyantraniliprole	1	12	H
28	Verimark	6.75 to 13.5 fl oz/A	cyantraniliprole	n/a	4	H
28 + 6	Minecto Pro*	5.5 to 10 fl oz/A	cyantraniliprole + abamectin	7	12	H

Cutworms See also section E 3.1. Soil Pests - Detection and Control.

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Apply one of the following formulations:						
1A	Lannate LV*	1.5 pt/A	methomyl	7	48	H
3A	Baythroid XL*	0.8 to 1.6 fl oz/A	beta-cyfluthrin	0	12	H
3A	Brigade 2EC*, others	2.1 to 6.4 fl oz/A	bifenthrin	7	12	H
3A	Permethrin 3.2EC*, others	4.0 to 8.0 fl oz/A	permethrin	1	12	H
3A	Tombstone*	0.8 to 1.6 fl oz/A	cyfluthrin	0	12	H

Flea Beetles

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Apply one of the following formulations:						
1A	Sevin XLR Plus	0.5 to 1 qt/A	carbaryl	14	12	H
3A	Baythroid XL*	2.4 to 3.2 fl oz/A	beta-cyfluthrin	0	12	H
3A	Brigade 2EC*, others	2.1 to 6.4 fl oz/A	bifenthrin	7	12	H

Flea Beetles - continued next page

Flea Beetles - continued

3A	Fastac CS*	2.2 to 3.8 fl oz/A	alpha-cypermethrin	1	12	H
3A	Permethrin 3.2EC*, others	2 to 8 fl oz/A	permethrin	1	12	H
3A	Tombstone*	2.4 to 3.2 fl oz/A	cyfluthrin	0	12	H
4A	Actara 25WDG	1.5 to 3.0 oz/A	thiamethoxam	7	12	H
4A	Scorpion 35 SL	9 to 10.5 fl oz/A	dinetofuran - **soil**	21	12	H
4A	Scorpion 35 SL	2 to 5.25 fl oz/A	dinotefuran - **foliar**	7	12	H
4A	Venom 70SG	5 to 7.5 oz/A	dinotefuran - **soil**	21	12	H
4A	Venom 70SG	1.0 to 3.0 oz/A	dinotefuran - **foliar**	7	12	H

Leafhoppers

Leafhoppers feed by sucking sap from leaf material, which causes a stippling mark on the leaf. If there is very heavy feeding this can cause leaves to turn brown and wither at the edges. Aster leafhoppers can vector Aster Yellows, a phytoplasmid disease that causes a general yellowing and stunting but seldom occurs in Mid-Atlantic celery crops.

Apply one of the following formulations:

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
1A	Lannate LV*	1.5 to 3.0 pt/A	methomyl	7	48	H
1A	Sevin XLR Plus	0.5 to 1 qt/A	carbaryl	14	12	H
3A	Baythroid XL*	2.4 to 3.2 fl oz/A	beta-cyfluthrin	0	12	H
3A	Brigade 2EC*, others	2.1 to 6.4 fl oz/A	bifenthrin	7	12	H
3A	Permethrin 3.2EC*, others	2 to 8 fl oz/A	permethrin	1	12	H
3A	Tombstone*	2.4 to 3.2 fl oz/A	cyfluthrin	0	12	H
4A	Actara 25WDG	1.5 to 3.0 oz/A	thiamethoxam	7	12	H
4A	Admire Pro	4.4 to 10.5 fl oz/A	imidacloprid - **soil**	45	12	H
4A	Belay 2.13SC	9.0 to 12.0 fl oz/A	clothianidin - **soil**	21	12	H
4A	Belay 2.13SC	3.0 to 4.0 fl oz/A	clothianidin - **foliar**	7	12	H
4A	Scorpion 35 SL	9 to 10.5 fl oz/A	dinetofuran - **soil**	21	12	H
4A	Scorpion 35 SL	2 to 5.25 fl oz/A	dinotefuran - **foliar**	7	12	H
4A	Venom 70SG	5 to 7.5 oz/A	dinotefuran - **soil**	21	12	H
4A	Venom 70SG	1.0 to 3.0 oz/A	dinotefuran - **foliar**	7	12	H
4D	Sivanto Prime or 200SL	7 to 14 fl oz/A	flupyradifurone - **foliar**	1	4	M
16	Courier SC	9.0 to 13.6 fl oz/A	buprofezin	7	12	L

Leafminers

Adults are small black/gray flies with yellow markings. Females puncture leaves with their ovipositor and feed on plant sap and lay eggs within the leaf tissues. When eggs hatch larvae begin feeding between the upper and lower surface of the leaves, making meandering mines. These pests usually only cause minor damage in our area as long as broad-spectrum insecticides are not commonly used.

Apply one of the following formulations:

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
4A	Scorpion 35 SL	9 to 10.5 fl oz/A	dinotefuran - **soil**	21	12	H
4A	Scorpion 35 SL	2 to 5.25 fl oz/A	dinotefuran - **foliar**	7	12	H
4A	Venom 70SG	5 to 7.5 oz/A	dinotefuran - **soil**	21	12	H
4A	Venom 70SG	1.0 to 3.0 oz/A	dinotefuran - **foliar**	7	12	H
5	Entrust SC (OMRI)	6.0 to 10.0 fl oz/A	spinosad	1	4	M
5	Radiant SC	6.0 to 10.0 fl oz/A	spinetoram	1	4	M
6	Agri-Mek SC*	1.75 to 3.5 fl oz/A	abamectin	7	12	H
17	Trigard 75WSP	2.66 oz/A	cyromazine	7	12	H
28	Coragen 1.67SC Coragen eVo	5.0 to 7.5 fl oz/A 1.7 to 2.5 fl oz/A	chlorantraniliprole	1	4	L
28	Exirel	13.5 to 20.5 fl oz/A	cyantraniliprole	1	12	H
28	Verimark	6.75 to 13.5 fl oz/A	cyantraniliprole	1	4	H
28 + 6	Minecto Pro*	5.5 to 10 fl oz/A	cyantraniliprole + abamectin	7	12	H

Mites

Feeding damage is recognized by stippling (small scratches) marks on the foliage. Watch for mite activity in mid-late summer during hot dry periods. *(continued next page)*

Mites - continued

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
6	Agri-Mek SC*	1.75 to 3.5 fl oz/A	abamectin	7	12	H
28 + 6	Minecto Pro*	5.5 to 10 fl oz/A	cyantraniliprole + abamectin	7	12	H

Tarnished Plant Bugs

This pest feeds using its needle-like mouth parts to suck fluids from the plant. Early season feeding can cause heart injury, while late-season feeding can produce large dark spots at the celery joint, resulting in 'black joint'. Look for bugs on leaves shortly after transplanting and when nearby alfalfa or grain is cut.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Sevin XLR Plus	1 to 2 qt/A	carbaryl	14	12	H
3A	Baythroid XL*	2.4 to 3.2 fl oz/A	beta-cyfluthrin	0	12	H
3A	Tombstone*	2.4 to 3.2 fl oz/A	cyfluthrin	0	12	H
21A	Torac	17.0 to 21.0 fl oz/A	tolfenpyrad	1	12	H
29	Beleaf 50SG	2.0 to 2.8 fl oz/A	flonicamid	0	12	L

Disease Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.

Recommended Fungicides

Seed Treatment

Use seed that is at least 2 years old. Soak the new seed in hot water at 118°F (48°C) for 30 minutes. Use seed treated with Maxim 4F (0.08 to 0.16 fl oz/100 lb) for *Rhizoctonia* and *Fusarium* management and Apron XL (0.085 to 0.64 fl oz/100 lb seed) for *Pythium* damping-off protection.

Damping-off caused by *Phytophthora*, *Pythium* and *Rhizoctonia*

Damping-off is favored by excessive soil moisture. Avoid over-saturation of seedbeds and do not transplant unhealthy plants in the field.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Apply one of the following in a 7-inch band:						
Phytophthora and Pythium root rot						
4	Ridomil Gold 4SL	1.0 to 2.0 pt/A	mefenoxam	0	48	N
4	Ultra Flourish 2E	2.0 to 4.0 pt/A	mefenoxam	7	48	N
Pythium and Rhizoctonia root rot						
4 + 11	Uniform 3.66SE	0.34 fl oz/1000 ft row in-furrow, see label	mefenoxam + azoxystrobin	AP	0	N

Bacterial and Fungal Diseases

Celery Leaf Curl/Anthracnose (*Colletotrichum* spp.)

This disease is characterized by curled, cupped, and twisted leaves, and dark, brownish necrotic lesions near the base of the petioles. It is suspected to be seedborne; planting high quality seed is recommended. Consider hot water seed treatment.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
For resistance management, alternate one of the following protectant fungicides:						
M01	copper (OMRI)[1]	at labeled rates	copper	0	see label	N
M05	chlorothalonil 6F	2.0 pt/A	chlorothalonil	7	12	N
With *one* of the following FRAC code 3 or 11 fungicides also tank mixed with a protectant fungicide:						
3	Rhyme 2.08SC	5.0 to 7.0 fl oz/A	flutriafol	7	12	--
3 + 11	Topguard EQ	6.0 to 8.0 fl oz/A	flutriafol + azoxystrobin	7	12	N

Celery Leaf Curl/Anthracnose (Colletotrichum spp.) - continued next page

Celery Leaf Curl/Anthracnose (Colletotrichum spp.) - continued

7 + 11	Pristine 38WG	10.0 to15.0 oz/A	boscalid + pyraclostrobin	0	12	--
11	azoxystrobin 2.08F	9.0 to 15.5 fl oz/A	azoxystrobin	0	4	N
11	Cabrio 20EG	12.0 to 16.0 oz/A	pyraclostrobin	0	12	N

[1]There are several OMRI listed copper-based products; see labels for specifics. Copper applications may help suppress some fungal pathogens in organic production systems.

Crater and Petiole Rot or Basal Stalk Rot (*Rhizoctonia*)

Rotate out of celery for at least 3 years to ensure crop residue is thoroughly decomposed. Avoid planting transplants too deep and in poorly drained soils. In soils where problems occur, apply fungicides regularly.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Apply in a 7-in band in-furrow or shortly after emergence directed at the stem:						
11	azoxystrobin 2.08F	0.40 to 0.80 fl oz/1000 ft row	azoxystrobin	0	4	N
11+M05	Quadris Opti 5.5SC	2.4 to 3.7 pt/A	azoxystrobin + chlorothalonil	7	12	N
M05	chlorothalonil 6F	2.0 pt/A	chlorothalonil	7	12	N

Fusarium Yellows

Do not obtain plants from areas of known infestation. There are no means of chemical management. Avoid seeding or transplanting into infested soil or use resistant cultivars.

Leaf Blights (*Cercospora* and *Septoria*)

Use certified, pathogen-free seed or hot water treated seed or fungicide seed treatments. Practice careful sanitation in transplant production. Use 3 or 4-year crop rotation.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Alternate one of the following FRAC code 11 fungicides:						
7 + 11	Merivon 2.09SC	4.0 to 11.0 fl oz/A	fluxapyroxad + pyraclostrobin	1	12	N
11+M05	Quadris Opti 5.5SC	2.4 to 3.7 pt/A	azoxystrobin + chlorothalonil	7	12	N
11	azoxystrobin 2.08F	9.0 to 15.5 fl oz/A	azoxystrobin	0	4	N
11	Cabrio 20EG	12.0 to 16.0 oz/A	pyraclostrobin	0	12	N
With one of the following fungicides:						
M01	copper (OMRI)[1]	at labeled rates	copper	0	see label	N
M05	chlorothalonil 6F	2.0 pt/A	chlorothalonil	7	12	N
3	Tilt 3.6EC	4.0 fl oz/A	propiconazole	14	12	N
3	Rhyme 2.08SC	5.0 to 7.0 fl oz/A	flutriafol	7	12	--
7	Fontelis 1.67SC	14.0 to 24.0 fl oz/A	penthiopyrad	3	12	L
7 + 12	Miravis Prime	9.2 to 13.4 fl oz/A	pydiflumetofen + fludioxonil	0	12	--

[1] There are several OMRI listed copper-based products; see labels for specifics. Copper applications may help suppress some fungal pathogens in organic production systems.

Pink Rot (*Sclerotinia sclerotiorum*)

Under moist conditions, white to pinkish cottony growth develops on the petioles and around the base of the plant. This is followed by a pink, watery, soft rot that causes a rapid collapse and death of the plant. Few products are available for managing Pink Rot. Avoid planting in shaded or poorly drained areas and areas with a history of Pink Rot. Rotate fields for at least 2 or 3 years. Maximize air movement through the plant canopy.

Apply Contans 3 to 4 months prior to the onset of disease to allow the mycoparasite to reduce soil inoculum (sclerotia) levels. Following application, incorporate 1-2 inches deep; however, to avoid the chance of infesting the upper soil layer with untreated sclerotia from the lower soil layer, **do not plow** between treatment and planting.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Apply 3 to 4 months prior to the onset of disease (see instructions above and on the label):						
44	Contans 5.3WG (OMRI)	1.0 to 4.0 lb/A	*Coniothyrium minitans*	0	4	N
Rotate between the following fungicides as long as weather conditions are favorable for disease development:						
M05	chlorothalonil 6F[1]	3.0 pt/A[1]	chlorothalonil	7	12	N
9 + 12	Switch 62.5WG	11.0 to 14.0 oz/A	cyprodinil + fludioxonil	0	12	L
12	Cannonball 50WP	7.0 oz/A	fludioxonil	0	12	L

[1]Shortly after plants emerge and repeat on a 7-day schedule (suppression only).

Cole Crops: Broccoli, Brussels Sprouts, Cabbage, Cauliflower, Collards, Kale, and Kohlrabi

Recommended Varieties   For all Cole Crops, varieties are listed alphabetically.

Crop	Variety	F1[1]	Maturity[2]	BR[3]	DM[3]	HS[3]	Cold[3]	Heat[3]	S/F[4]
Broccoli	Abrams	Yes	Mid					X	S,F
	Apollo (Sprouting)[5]	Yes	Mid						S,F
	Atlantis (Sprouting)[5]	Yes	Mid						S,F
	BC1611 (Sprouting)[5]	Yes	Early						S,F
	BC1691	Yes	Late					X	S,F
	BC1764	Yes	Early						F
	Burney	Yes	Mid					X	S,F
	DeCicco (Sprouting)[5]	No	Mid				X		F
	Diamante	Yes	Late						F
	Diplomat	Yes	Early		X	X	X	X	S,F
	Eastern Crown	Yes	Early-Mid					X	S,F
	Emerald Crown	Yes	Early-Mid				X		F
	Emerald Jewel	Yes	Late						F
	Fiesta	Yes	Early				X		F
	Green Gold	Yes	Mid					X	S,F
	Green Magic	Yes	Early					X	S,F
	Gypsy	Yes	Mid		X		X		F
	Imperial	Yes	Mid-Late					X	S,F
	Ironman	Yes	Late			X			F
	Lieutenant	Yes	Mid			X		X	S,F
	Luna	Yes	Mid					X	S,F
	Marathon	Yes	Mid				X		F
	Millennium	Yes	Mid					X	S,F
	Montebello (Sprouting)[5]	Yes	Mid						S,

[1]F1=Hybrid. [2]Early, Midseason (Mid), or Late. [3]X denotes some degree of resistance or tolerance to disease or environmental condition. BR=Black Rot, DM=Downy Mildew, HS=Hollow Stem. [4]Recommended for Spring (S) or Fall (F) production. [5]Sprouting types produce a loose head for spear production.

Crop	Variety	Hybrid	Maturity
Brussels Sprouts	Dagan	Yes	Midseason
	Gustus	Yes	Midseason
	Hestia	Yes	Early
	Marte	Yes	Early

Crop	Variety	F1[1]	Maturity[2]	Lb	Shape	Use[3]	Y[4]	BR[4]	TB[4]	Thr[4]	SH[4]
Green Cabbage	Artost	Yes	Early	3-6	Round	F,P	H		H		H
	Bajonet	Yes	Midseason	3-5	Round	F	H				
	Blue Dynasty	Yes	Midseason	4	Round	F	H	H			H
	Blue Vantage	Yes	Midseason	4	Round	F	H	L	H	H	
	Bobcat	Yes	Midseason	4-6	Round	F	H		H	H	H
	Bravo	Yes	Late	4-10	Round	F, P	H	H			
	Bronco	Yes	Midseason	3-5	Round	F	H		M	M	
	Bruno	Yes	Late	4	Round	F	H	H			
	Capture	Yes	Late	3-6	Round	F, P	H	M			
	Caraflex	Yes	Early	2-3	Pointed	F	H			H	
	Charmant	Yes	Early	3	Round	F	H	H		L	H
	Checkmate	Yes	Early	2-3	Round	F	H				H

Cabbage - continued next page

Cabbage - continued

Crop	Variety	F1[1]	Maturity[2]	Lb	Shape	Use[3]	Y[4]	BR[4]	TB[4]	Thr[4]	SH[4]
Green Cabbage *(continued)*	Cheers	Yes	Midseason	5	Round	F	H	H		H	
	Early Thunder	Yes	Midseason	3-4	Round	F	H	M	M	H	
	Emblem	Yes	Late	3-5	Round	F	H	H	H		H
	Grand Vantage	Yes	Midseason	5-6	Round	F	H				
	Megaton	Yes	Late	10-20	Round	P	H		H		
	Padoc	Yes	Midseason	5-8	Round	P	H		H		
	Platinum Dynasty	Yes	Midseason	4-10	Round	F, P	H	H	H		H
	Primo Vantage	Yes	Midseason	4-5	Round	F	H				
	Quick Start	Yes	Early	3-4	Round	F	H		H	M	
	Ramada	Yes	Late	3-6	Round	F	H	H			
	Royal Vantage	Yes	Midseason	3-5	Round	F	H	H	H	H	
	Superstar	Yes	Late	3-4	Round	F	H	H	H	M	
	Supreme Vantage	Yes	Early	4-5	Round	F, P	H				
	Thunderhead	Yes	Midseason	3-5	Round	F	H	H	H	H	
	Tiara	Yes	Early	1-2	Round	F					
	Vantage Point	Yes	Late	5-6	Round	F	H	H	H	H	
	Viceroy	Yes	Late	4-8	Round	F, P	H	I	H	H	
Green Savoy Cabbage	Alcosa	Yes	Early	2-4	Round	F	H		H		
	Clarissa	Yes	Midseason	2-3	Round	F	H		H		
	Melissa	Yes	Midseason	2-4	Round	F	H		H		
	Savoy Ace	Yes	Midseason	3-4	Round	F	M				
	Savoy Blue	Yes	Late	3-5	Round	F					
	Savoy King	Yes	Midseason	4	Round	F			H		
Red Cabbage	Azurro	Yes	Midseason	3-4	Round	F			H	H	
	Cairo	Yes	Late	3-6	Round	F	M		H	H	H
	Red Dynasty	Yes	Midseason	5-12	Round	F, P			H		H
	Red Jewel	Yes	Midseason	3-5	Round	F			H		
	Ruby Perfection	Yes	Late	3-4	Round	F	M	M	M	H	
Red Savoy Cabbage	Deadon	Yes	Late	3-5	Round	F					

[1]F1=Hybrid. [2]Early, Midseason (Mid), or Late. [3]F=Fresh market, P=Processing (slaw, kraut). [4]Pest or Abiotic Stress Reaction: Y=Yellows, BR=Black rot, TB=Tip Burn, Thr=Thrips, SH=Split Head; M=Moderate or intermediate and H=high level of resistance or tolerance.

Crop	Variety	Shape/Color	Hybrid	Days to maturity
Chinese Cabbage	Blues	Napa (barrel)	Yes	57
	China Express	Napa (barrel)	Yes	62
	China Gold	Napa (barrel)	Yes	65
	Emiko	Napa (barrel)	Yes	55
	Green Rocket	Narrow	Yes	70
	Optiko	Napa (barrel)	Yes	60
	Rubicon	Napa (barrel)	Yes	52
	Spring Crisp	Napa (barrel)	Yes	75
	Yuki	Napa (barrel)	Yes	67
Pak Choi	Black Summer	Green petiole	Yes	45
	Bopak	White petiole	Yes	45
	Joi Choi	White petiole	Yes	50
	Mei Quing Choi	Green petiole	Yes	40

Crop	Variety	Hybrid	Color	Maturity	Season	Self-Wrapping
Cauliflower	Absolute	Yes	White	Midseason	Fall	Yes
	Alcala	Yes	White	Mid-Late	Fall	Yes
	Amazing	No	White	Midseason	Fall	Yes
	Apex	Yes	White	Midseason	Fall	Yes
	Aquarius	Yes	White	Midseason	Fall	Yes
	Bermeo	Yes	White	Early-Mid	Spring-Fall	Yes

Cauliflower - continued next page

Cauliflower - continued

Crop	Variety	Hybrid	Color	Maturity	Season	Self-Wrapping
Cauliflower *(continued)*	Bishop	Yes	White	Early	Spring-Fall	Partial
	Candid Charm	Yes	White	Midseason	Fall	Partial
	Cheddar	Yes	Orange	Late	Fall	No
	Denali	Yes	White	Early	Spring-Fall	Yes
	Flamenco	Yes	White	Midseason	Fall	Yes
	Flame Star	Yes	Yellow	Early	Fall	No
	Freedom	Yes	White	Early	Fall	Yes
	Graffiti	Yes	Purple	Late	Fall	No
	Minuteman	Yes	White	Early	Spring-Fall	No
	Steady	Yes	White	Early	Fall	Partial
	Symphony	Yes	White	Late	Fall	Yes
	Synergy	Yes	White	Midseason	Fall	Yes
	Toledo	Yes	White	Midseason	Fall	Yes
	Twister	Yes	White	Midseason	Fall	Yes
	Vitaverde	Yes	Green	Midseason	Fall	No
	26-701 RZ	Yes	Green	Midseason	Fall	No

Crop	Variety	Hybrid	Color	Comments
Collards	Champion	No	Deep Green	Flat to lightly waved leaves
	Flash	Yes	Deep Green	Flat to lightly waved leaves
	Hi-Crop	Yes	Deep Green	Semi-savoyed leaves
	Top Bunch	Yes	Blue Green	Lightly savoyed leaves
	Vates	No	Deep Green	Flat to lightly waved leaves
Kale	Black Magic	No	Dark Blue Green	Broader leaved lance leaf type
	Blue Ridge	Yes	Blue Green	Very curled leaf
	Dwarf Blue Curled (Vates)	No	Blue Green	Curled leaf
	Dwarf Siberian	No	Green	Light to medium curl, overwinters
	Lacinato	No	Blue Green	Puckered strap-like lance leaf
	Redbor	Yes	Deep Red	Curled leaf
	Red Russian	No	Blue Green-Red	Flat toothed leaf green with red midrib
	Starbor	Yes	Blue Green	Curled leaf
	Winterbor	Yes	Dark Green	Curled leaf
Kohlrabi	Azur Star	Yes	Deep Blue-Purple	
	Grand Duke	Yes	Light Green	
	Kolibri	Yes	Deep Purple	
	Konan	Yes	Light Green	
	Quickstar	Yes	Light Green	
	Winner	Yes	Light Green	

Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and Chapter B Soil and Nutrient Management. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede the recommendations found below.

Cole Crops[1,2]		**Soil Phosphorus Level**				**Soil Potassium Level**				
		Low	**Med**	**High (Opt)**	**Very High**	**Low**	**Med**	**High (Opt)**	**Very High**	
	N (lb/A)	**P_2O_5 (lb/A)**				**K_2O (lb/A)**				**Nutrient Timing and Method**
Broccoli	150-200	200	100	50	0[3]	200	100	50	0[3]	Total nutrient recommended
	50-100	200	100	50	0[3]	200	100	50	0[3]	Broadcast and disk-in
	50	0	0	0	0	0	0	0	0	Sidedress 2-3 weeks after planting
	50	0	0	0	0	0	0	0	0	Sidedress 4-6 weeks after planting
Brussels Sprouts, Cabbage, Cauliflower	100-150	200	100	50	0[3]	200	100	50	0[3]	Total nutrient recommended
	50-75	200	100	50	0[3]	200	100	50	0[3]	Broadcast and disk-in
	25-50	0	0	0	0	0	0	0	0	Sidedress 2-3 weeks after planting

Recommended Nutrients Based on Soil Tests - Kale, Collards, and Kohlrabi on next page

F. Cole Crops

Recommended Nutrients Based on Soil Tests - Kale, Collards, and Kohlrabi

Cole Crops[1,2]		Soil Phosphorus Level				Soil Potassium Level				
		Low	Med	High (Opt)	Very High	Low	Med	High (Opt)	Very High	
	N (lb/A)	P_2O_5 (lb/A)				K_2O (lb/A)				Nutrient Timing and Method
Kale, Collards	100-200	200	100	50	0[3]	200	100	50	0[3]	Total nutrient recommended
	50-100	200	100	50	0[3]	200	100	50	0[3]	Broadcast and disk-in
	25-50	0	0	0	0	0	0	0	0	Sidedress after each cutting or stripping
Kohlrabi	25-50	0	0	0	0	0	0	0	0	Total nutrient recommended
	25-50	0	0	0	0	0	0	0	0	Sidedress if needed according to weather

[1]For broccoli, apply 1.5-3 lb/A of boron (B). For Brussels sprouts, cabbage and cauliflower, apply 1.5-3 lb/A of B and 0.2 lb molybdenum (Mo) applied as 0.5 lb/A sodium molybdate with broadcast fertilizer; see also Table B-7. in Chapter B Soil and Nutrient Management.
[2]Include 25-40 lb/A of sulfur (S) in the fertilizer program for cole crops.
[3]In VA, crop replacement values of 25 lb/A of P_2O_5 and 25 lb/A of K_2O are recommended on soils testing Very High.

Plant Tissue Testing

Plant tissue testing can be a valuable tool to assess crop nutrient status during the growing season to aid with in-season fertility programs or to evaluate potential deficiencies or toxicities. Critical cabbage tissue test values for most recently matured leaves 8 weeks after transplanting: N 3-6%, P 0.3-0.6 %, K 2.0-4.0 %, Ca 1.5-2.0%, Mg 0.25-0.6% and S 0.3%. For additional nutrients, other cole crops and other growth stages consult with a tissue testing laboratory or this web link at the University of Florida: *https://edis.ifas.ufl.edu/publication/ep081*.

Seed Treatment

Check with your seed company if seed is hot water-treated for Black Rot; see also Disease Control below.

Planting and Spacing

All cole crops may be direct-seeded or transplanted.

Direct Seeding:
Precision seeders are recommended. Sow 15-20 days before the normal transplant date for the same maturity date.

Transplant Production and Handling for All Cole Crops:
Sow in 72-128 cell plug trays or in transplant production beds at 10 seeds/ft of row in rows 12-18 inches apart. Early transplant production will require heated greenhouse facilities or frames. Transplants for summer plantings may be produced in field beds. Transplants are ready in 4-6 weeks. Bare root transplants should be planted soon after lifting. Storage of pulled, field-grown cabbage transplants should not exceed 9 days at 32°F (0°C) or 5 days at 66°F (19°C) prior to planting in the field.

Broccoli - Fall Production
Direct field seeding: Rows 30-36 inches apart; seed: ½-1 lb/A so that plants are 12-18 inches apart in row. Make successive plantings June 20 to July 20 (June 20 to July 5 in PA and northern NJ).
Transplants: Successive plantings between July 15 and August 20, depending on location. Set transplants 12-18 inches apart in rows 36 inches apart (14,520 plants/A).
High population planting for crown cut and bunched broccoli: 2-4 rows per bed, rows 18-20 inches apart, plants 9-12 inches in row (27,000-32,000 plants/A). Seed June 25 to July 10; transplant July 20 to August 20, depending on location.
For fall plasticulture double cropping, remove previous crop debris and set broccoli transplants 12-21 inches apart in double rows 10-12 inches apart. For larger heads allow greater in-row spacing. Set plants in late July through mid-August, depending on variety maturity and location.

Broccoli - Spring Production Spring production of broccoli is successful in cooler areas of the region but is limited by heat in southern areas. Use heat tolerant varieties. For spring production transplant March 15-April 20.

Brussels Sprouts Brussels sprouts are a long season crop grown for fall production. Transplant rows 3 ft apart; plants 15 inches apart in row. Start planting transplants June 20. Start field seeding June 1.

Cabbage Cabbage is planted from March through early August depending on location, variety, and intended harvest date. Early varieties require 85-90 days from seeding to harvest, and main-season crops require 110-115 days. Crops grown from transplants are 14-21 days earlier. Transplants are set in rows 2-3 ft apart and 9-15 inches apart in the row for early plantings and 9-18 inches apart for late plantings, depending on variety, fertility, and market use.

Cauliflower Transplants are set in rows 3-4 ft apart, and plants are set 18-24 inches apart in the row. Make successive plantings in the field between July 15 and August 20, depending on location. **Note**. In some areas, early maturing or heat tolerant cultivars can be grown in the spring. Transplant to the field in early April. Spring production in the southern part of the region is riskier.

Collards Direct-seeded: Seed at the rate of 2 lb/A. Transplanting: Transplants are set in rows 16-36 inches apart and 6-12 inches apart in the row. Use wider between-row and in-row spacing for multiple hand harvests by stripping leaves. Collards for spring and early summer harvest can be transplanted or seeded starting April 1 in VA and warmer, southern areas and April 20 in PA and normally cooler areas. Collards can be seeded starting in mid-July through late August for fall harvest. Collards for processing are planted in 4-6 row beds, 12-16 inches between rows at a rate of 10-16 seeds/ft of row.

Kale Direct Seeding: Sow seed at 3-4 lb/A in rows spaced 16-36 inches apart. Thin seedlings to 4-5 inches apart in the row. Transplanting: Transplants are set in rows 16-36 inches apart and 6-12 inches apart in the row. Use wider between-row and in-row spacing for multiple hand harvests by stripping leaves. Kale for spring and early summer harvest can be transplanted or seeded starting April 1 in VA and warmer, southern areas and April 20 in PA and normally cooler areas. Kale can be seeded or transplanted starting in mid-July through late August for fall harvest. Kale for processing is planted in 4-6 row beds, 12-16 inches between rows at a rate of 10-16 seeds per foot of row.

Kohlrabi Transplants may be used for a spring crop. Plant in the field at the same time as broccoli or cabbage. Fall crops can be established by direct seeding between June 25 and July 15. Seed open-pollinated varieties at the rate of 2-3 lb/A and thin to 6-8 inches between plants in the row. Precision-seed hybrid varieties. Set transplants July 20 to August 15. Space rows 18-24 inches apart.

No-Till / Conservation Tillage

Cabbage and broccoli have been successfully grown by transplanting into rolled or herbicide killed cover crops using a no-till transplanter.

Irrigation and Water Use

All cole crops benefit from irrigation to achieve the highest yields and quality. Cole crops require a seasonal total of 10-15 inches of water. Amounts will depend on planting date, seasonal variation, variety, and number of times the field is harvested. For spring crops, the highest demand is near harvest. For fall crops, the highest demand is mid-season Consistent soil moisture level is especially critical to achieve maximum quality in cauliflower. Any moisture stress, especially when plants reach the 6-7 leaf stage may cause cauliflower to button or form heads prematurely.

Common Physiological Disorders

Black Petiole in Cabbage Black petiole or black midrib is an internal disorder of cabbage that has been observed in recent years. As heads approach maturity, the underside of the internal leaf petioles or midribs turn dark gray or black at or near the point where the midrib attaches to the main stem. It is believed that this disorder is associated with a potassium (K) -phosphorus (P) imbalance. Proper nutrient management and choice of cultivar will help minimize this condition.

Blanching and Off-Colors in Cauliflower Heads exposed to sunlight may develop a yellow and/or red to purple pigment. Certain varieties (*e.g*., Snow Crown) are more predisposed to purple off-colors, especially in hot weather. Self-blanching varieties have been developed to reduce problems with curd yellowing. For open headed varieties, the usual method to exclude light is to tie the outer leaves when the curd is 8 cm in diameter. Leaves may also be broken over the curd to prevent yellowing. In hot weather, blanching may take 3-4 days, but in cool weather, 8-12 or more days may be required. Cauliflower fields scheduled to mature in cool weather (September and October) that are well supplied with water and planted with “self-blanching” cultivars do not require tying. Newer orange cauliflower and green broccoflower varieties are less susceptible to off-colors but can still turn purple under warm conditions.

Bolting/Buttoning Due to Low Temperatures in Broccoli, Cabbage, Cauliflower, Collards and Kale Bolting in cabbage, collards and kale, and "buttoning" in cauliflower can occur if early planted crops are subjected to low temperatures (between 35-50°F/2-10°C for 10 or more continuous days). Temperature-induced bolting responses depend on variety.

Boron Deficiencies Cole crops have a high boron requirement. Boron deficiency results in cracked and corky stems, petioles, and midribs for most cole crops. For broccoli, cabbage and cauliflower, stems can be hollow and sometimes discolored. Cauliflower curds become brown, and leaves may roll and curl, while cabbage heads may be small and yellow.

Brown Floret (Bead) and Yellowing Floret in Broccoli
Brown Floret is thought to be caused by plant nutritional imbalances but also may be due to insect feeding damage (*e.g.*, harlequin bugs). Areas of florets do not develop properly, die and lead to brown discolored areas.
Yellowing florets may be due to over-maturity at harvest, high storage temperatures and/or exposure to ethylene. Any development of yellow beads ends commercial marketability. Bead yellowing due to senescence should not be confused with the yellow to light-green color of areas of florets not exposed to light during growth, sometimes called "marginal yellowing". Proper post-harvest handling and packaging will help minimize this problem.

Curd Bracts in Cauliflower Development of curd bracts or small green leaves between the segments of the curd in cauliflower is caused by high temperature or drought. Heat-resistant cultivars and proper water management can help minimize this condition.

Edema on Cole Crop Leaves Edema is water blistering on cole crop leaves. The most common cause of edema is the presence of abundant, warm soil water and a cool, moist atmosphere. Proper water management can help to minimize this condition.

Hollow Stem in Broccoli and Cauliflower Not Caused by Boron Deficiency This condition starts with gaps that develop in stem tissues. These gaps gradually enlarge to create a hollow stem. Ordinarily, there is no discoloration of the surface of these openings at harvest but both discoloration and tissue breakdown may develop soon after harvest. Some cultivars of hybrid cauliflower and broccoli may have openings from the stem into the head. Hollow stem increases with wider plant spacing and as the rate of nitrogen increases. The incidence of hollow stem can be greatly reduced by increasing the density of the plant population.

Lack of Heads in Broccoli and Cauliflower During periods of extremely warm weather, *i.e.*, days over 86°F (30°C) and nights over 77°F (25°C), broccoli and cauliflower can remain vegetative due to inadequate cold exposure. This can cause a problem in scheduling the maturation and marketing dates for these crops.

Premature Heading (Buttoning) in Broccoli and Cauliflower Losses are usually most severe when transplants have gone past the juvenile stage before setting in the field. Stress factors such as low soil nitrogen, low soil moisture, disease, insects, or micronutrient deficiencies can also cause this problem. Some cultivars, particularly early ones, are more susceptible to buttoning than others.

Ricing and Fuzziness in Cauliflower "Riciness" and "fuzziness" in heads is caused by high temperatures, exposure to direct sun, rapid growth after the head is formed, high humidity, or high nitrogen. When "ricing" occurs, flower buds develop, elongate and separate, making the curd unmarketable. Proper cultivar and nutrient management can help minimize this condition.

Splitting in Cabbage Cabbage splitting mainly occurs in early cabbage when moisture stress is followed by heavy rain. Rapid growth associated with rain, high temperatures and high fertility can cause splitting. Proper irrigation and deep cultivation may help prevent splitting. There are significant differences between cultivars in their susceptibility to this problem.

Tipburn in Cauliflower, Cabbage, and Brussels Sprouts Tipburn is a breakdown of plant tissue inside the head of cabbage, individual sprouts in Brussels sprouts, and on the inner wrapper leaves of cauliflower. It is associated with an inadequate supply of calcium in the affected leaves, causing a collapse of the tissue and death of the cells. Calcium deficiency may occur where the soil calcium is low or where there is an imbalance of nutrients in the soil along with certain weather conditions (high humidity, low soil moisture, high potash and high nitrogen aggravate calcium availability). Secondary rots caused by bacteria can follow the onset of tipburn and heads of cauliflower can be severely affected. Some cabbage and cauliflower cultivars are relatively free of tipburn problems. This problem can cause severe economic losses.

Harvest and Post-Harvest Considerations

Broccoli

Broccoli should be harvested when heads have reached maximum diameter and flower buds (beads) are still tight. Bunched broccoli heads are tied together in groups of 3-4 with a rubber band. Broccoli should be hydrocooled or packed in ice immediately after harvest and stored at 32°F (0°C) and relative humidity of 95-100% to maintain salable condition. Under these conditions, broccoli should keep satisfactorily 10-14 days. For processing, broccoli has the potential to be machine harvested but due to uniformity differences at harvest, hand harvest produces the highest yields and best quality.

Cabbage

Cabbage is harvested when heads are tight and have reached the desired size for the variety and spacing. The head is harvested by bending it to one side and cutting the base with a knife. Harvesting knives should be sharpened frequently. The stalk should be cut flat and as close to the head as possible, yet long enough to retain 2-4 wrapper leaves. Extra leaves act as cushions during handling and may be desired in certain markets. Yellowed, damaged, or diseased wrapper leaves should be removed. Heads with insect damage and other defects should be discarded. It is important that unharvested immature heads are undamaged because fields will be harvested multiple times. Harvested cabbage can be placed in bags, boxes, wagons, or pallet bins, depending on the harvesting method. Holding cabbage too long past harvest maturity will result in head splitting. Store the harvested cabbage at 32°F (0°C) and a relative humidity of 98-100%. For processing, cabbage has the potential to be machine harvested but due to uniformity differences at harvest, hand harvest produces the highest yields and the best quality.

Cauliflower

Cauliflower is harvested while the heads are pure white and before the curds become loose and ricey. Most varieties are self-blanching. For those that are not, blanching is achieved by tying outer leaves over the heads when heads are 3 to 4 inches in diameter. Blanching takes about 1 week in hot weather and 2 weeks in cooler weather. Store the harvested cauliflower at 32°F (0°C) and a relative humidity of at least 95%. Avoid bruising heads in harvest, handling, and packing.

Kale and Collards

Kale and Collards are harvested by cutting off entire plants near ground level. Whole plants are then bunched, or lower leaves may be stripped from plants and packed individually. For processing, kale and collards are machine cut 4-6 inches from the ground when full tonnage has been achieved but before petioles have elongated. Multiple harvests are possible. Because of their perishability, kale and collards should be held as close to 32°F (0°C) as possible. At this temperature, they can be held for 10-14 days. Relative humidity of at least 95% is desirable to prevent wilting. Air circulation should be adequate to remove heat of respiration, but excessive air circulation will speed transpiration and wilting. Satisfactory precooling is accomplished by vacuum cooling or hydrocooling. These leafy greens are commonly shipped with package and top ice to maintain freshness. Kale packed in polyethylene-lined crates and protected by crushed ice keeps in excellent condition for 3 weeks at 32°F (0°C).

Kohlrabi

Kohlrabi is harvested when stems are full sized but before they begin to split.

Weed Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.

Recommended Herbicides

1. Identify the weeds in each field and select recommended herbicides. More information is available in the "Herbicide Effectiveness on Common Weeds in Vegetables" (Table E-3) in Chapter E Pest Management.
2. Minimize herbicide resistance development. Identify the herbicide mode of action group number and follow recommended good management practices; **bolded group numbers in tables below are herbicides at higher risk for selecting resistant weed populations.** Include non-chemical weed control whenever possible.

1.a. Soil-Applied (Preplant Incorporated or Preemergence)						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient**	**Active Ingredient Rate**	**PHI (d)**	**REI (h)**
3	Dacthal 6F Dacthal W-75	6 to 14 pt/A 6 to 14 lb/A	**DCPA**	4.5 to 10.5 lb/A	--	12
-Labeled for broccoli, Brussels sprouts, cabbage, cauliflower, collards, kale, and kohlrabi. -Apply after seeding to a clean, weed-free soil. Primarily controls annual grasses and a few broadleaf weeds, including common purslane. Results have been most consistent when used in fields with coarse-textured soils low in organic matter, and when the application is followed by rainfall or irrigation. -Maximum application not addressed on label.						
3	Treflan HFP	Seeded: 1 to 1.5 pt/A Transplanted: to 2 pt/A	**trifluralin**	Seeded: 0.50 to 0.75 lb/A Transplanted: 0.5 to 1 lb/A	**--**	12
-Labeled for broccoli, Brussels sprouts, cabbage, cauliflower, collards, and kale only. Labeled seeded-crop as well as transplants. -Apply only as preplant incorporated and incorporate into 2-3 inches of soil within 8 h after application. -See label for incorporation equipment recommendations. Primarily controls annual grasses and a few broadleaf weeds. -**Do not** use (or reduce the rate) used when cold, wet soil conditions are expected, or crop injury may result. -Poor incorporation can reduce overall weed control. -Maximum application not addressed on label.						
8	Prefar 4E	5 to 6 qt/A	**bensulide**	5 to 6 lb/A	--	12
-Labeled for broccoli, Brussels sprouts, cabbage, cauliflower, collards, kale, and kohlrabi. -Labeled for seeded-crop as well as transplants. -Labeled for preplant incorporated or preemergence applications; **do not** incorporate more than 2 inches deep (1 inch is optimum). -If applied preemergence, irrigate within 36 h of application with ½ inch of water; if not incorporated with irrigation or rainfall within 36 h, weed control maybe reduced. Provides control/suppression of some annual grass weeds and some broadleaves including pigweeds, purslane, and lambsquarters. **Do not** apply more than 6 lb ai/A per season.						
14	Goal 2XL or Galigan 2E GoalTender 4F	1 to 2 pt/A 0.5 to 1 pt/A	**oxyfluorfen**	0.25 to 0.5 lb/A	--	24
-Labeled for broccoli, cabbage, and cauliflower only. -Labeled for transplanting only. Apply before transplanting and transplant through the herbicide on the soil surface -Use lower rates on coarse-textured soils low in organic matter. Cold, wet conditions in early spring may increase the risk of temporary crop injury which could delay maturity. Use of transplants less than 5 weeks old or use of succulent transplants grown in containers less than 1-inch square may increase severity of crop injury. -Controls broadleaf weeds including common lambsquarters, common purslane, common ragweed, pigweed sp., and galinsoga. -Treflan or Dual Magnum may increase the potential for crop injury, especially when conditions are cold and wet, and it is not recommended for use prior to Goal application. -Delay cultivation after Goal application, when possible, to reduce deactivation of the Goal by incorporation. -**Do not** apply more than 1 pt/A per season of GoalTender or more than 2 pt/A of Goal 2XL.						
14	Spartan Charge 3.5F	2.9 to 15.2 fl oz/A	**sulfentrazone** **carfentrazone**	0.075 to 0.39 lb/A 0.008 to 0.043 lb/A	80	12
-Labeled for transplanted cabbage only. -Refer to label for rates, rates vary by soil type and organic matter content. -Can be applied preplant, preplant incorporated, or surface applied up until transplanting. For preplant incorporated treatments do not incorporate more than 2 inches. -Do not use on soils classified as sand with less than 1% organic matter. -Do not make more than one application per year; do not apply more than 15.2 fl oz/A in a 12 month period.						
15	Devrinol 2-XT 2EC Devrinol DF-XT 50DF	2 qt/A 2 lb/A	**napropamide**	1 lb/A	--	24
-Labeled for broccoli, Brussels sprouts, cabbage, cauliflower, collards, and kale only. Recommended in PA ONLY! **-Labeled for direct-seeded-crops as well as transplants.** -Apply preplant incorporated or preemergence; if incorporated do no incorporate deeper than seeding depth; if surface applied then irrigate within 24-72 h with sufficient water to wet the soil to a depth of 4 to 8 inches. Controls annual grasses and certain broadleaf weeds. -Tank mix with minimum recommended rate of Treflan 4EC to improve the spectrum of broadleaf weeds controlled. -Use only on fine-textured soils such as silt or clay loams with more than 2% organic matter. Crop injury has occurred when used on coarse-textured soils low in organic matter. -**Do not** exceed a maximum application rate of 2 qt/A (2-XT) or 2 lb/A (DF-XT) per crop cycle.						
15	Dual Magnum 7.62E	0.5 to 1.33 pt/A	**s-metolachlor**	0.48 to 1.27 lb/A	60	24
-Special Local Needs Label 24(c) for transplanted cabbage in DE, NJ, and PA ONLY! (expires in DE 12/31/2028: NJ 1/28/2027; PA 12/31/2027). The use of this product is legal ONLY if a waiver of liability has been completed (see: *https://www.syngenta-us.com/labels/indemnified-label-login*). -Apply before transplanting. **Do not** mechanically incorporate Dual Magnum prior to transplanting. -Risk of injury is less with post-transplanted applications than pre-transplant applications. Chinese cabbage varieties are more sensitive to Dual injury. Make only 1 application per crop and **do not** apply more than 1.33 pt/A.						

1.b. Post-Transplant Application / Preemergence Control

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
3	Dacthal 6F Dacthal W-75	6 to 14 pt/A 6 to 14 lb/A	**DCPA**	4.5 to 10.5 lb/A	--	12

-**Labeled for broccoli, Brussels sprouts, cabbage, cauliflower, collards, kale, and kohlrabi.**
-Apply after seeding or transplanting to a clean, weed-free soil. Labeled for over the top application of transplants without injury (will not control emerged weeds). Primarily controls annual grasses and a few broadleaf weeds, including common purslane.
-Results have been most consistent when used in fields with coarse-textured soils low in organic matter, and when the application is followed by rainfall or irrigation. Maximum application not addressed on label.

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
15	Dual Magnum 7.62E	0.5 to 1.33 pt/A	**s-metolachlor**	0.48 to 1.27 lb/A	60	24

-**Special Local Needs Label 24(c) for the use of Dual Magnum 7.62E for transplanted cabbage or emerged cabbage ONLY in DE, NJ, and PA! (Expires in DE 12/31/2028: NJ 1/28/2027; PA 12/31/2027). The use of this product is legal ONLY if a waiver of liability has been completed (see: *https://www.syngenta-us.com/labels/indemnified-label-login*).**
-Apply directly over the top of transplants within 48 h of transplanting.
-**Do not** mechanically incorporate prior to transplanting. May be applied over the top of direct-seeded cabbage after cabbage has developed 3 to 4 leaves. **Do not** apply to direct-seeded cabbage prior to the 3 to 4-leaf growth stage or the risk of crop injury may be increased.
-Use of an adjuvant or another registered herbicide will increase the risk of injury from postemergence applications
-Risk of injury is less with post-transplanted applications than pre-transplant applications. -Chinese cabbage varieties are more sensitive to Dual injury.
-Dual Magnum will **not** control emerged weeds. Emerged weeds should be controlled by cultivation, hoeing, or postemergence herbicides prior to Dual Magnum application.
-Make only 1 application per crop and **do not** apply more than 1.33 pt/A

2. Postemergence

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
1	Shadow 3EC Select 2EC Select Max 0.97EC	4 to 5.33 fl oz/A 6 to 8 fl oz/A 9 to 16 fl oz/A	**clethodim**	0.07 to 0.125 lb/A	30/14	24
	Poast 1.5EC	1 to 1.5 pt/A	**sethoxydim**	0.2 to 0.3 lb/A	30	12

-**Select 2EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). **Select Max**: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution). **Shadow 3EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution) for large or stressed grasses; use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution) when crop safety is a concern. **Poast**: use COC at 1% v/v
-**The use of COC may increase the risk of crop injury when hot or humid conditions prevail**. To reduce the risk of crop injury, omit additives or switch to NIS when grasses are small and soil moisture is adequate.
-Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control.
-Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will **not** be controlled. -Controls many annual and certain perennial grasses, including annual bluegrass, but Poast is preferred for goosegrass control. For best results, treat annual grasses when they are actively growing and before tillers are present. Control may be reduced if grasses are large or under hot or dry weather conditions.
-Repeated applications may be necessary to control certain perennial grasses. If repeat applications are necessary, allow 14 days between applications. -Rainfastness 1 h.
-**Do not** tank mix with or apply within 2 to 3 days of any other pesticide, unless labeled, as this may increase the risk of crop injury or reduce the control of grasses.
-PHI of Select, Select Max, and Shadow 3EC for broccoli, Brussel sprouts, cabbage, cauliflower, and kohlrabi is 30 d; PHI for collards and kale is 14 d.
-**Do not** apply more than 8 fl oz/A of Select 2EC in a single application and **do not** exceed 2 pt/A for the season; **do not** apply more than 16 fl oz/A of Select Max in a single application and **do not** exceed 4 pt/A for the season; **do not** apply more than 5.33 fl oz/A of Shadow 3EC in a single application and **do not** exceed 21.33 fl oz/A for the season.
-**Do not** apply more than 1.5 pt/A Poast in a single application and **do not** exceed 3 pt/A for the season.

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
4	Stinger 3SL	4 to 8 fl oz/A	**clopyralid**	0.094 to 0.188 lb/A	30	12

-Spray additives are not required by the label and are not recommended.
-Stinger controls composite and legume weeds including galinsoga, ragweed species, common cocklebur, groundsel, pineappleweed, clover, and vetch. Perennials suppressed or controlled include Canada thistle, goldenrod species, aster species, and mugwort.
-Stinger is very effective on small seedling annual and emerging perennial weeds less than 2-4 inches tall but is less effective and takes longer to work when weeds are larger. Use 4 fl oz/A to control annual weeds less than 2 inches tall. Increase the rate to 4 to 8 fl oz/A to control larger annual weeds. Apply the maximum rate of 8 fl oz/A to suppress or control perennial weeds.
-Observe crop restrictions or injury may occur from herbicide carryover.
-Rainfastness is 6 h. Maximum Stinger applications per year is 2, but not to exceed a total of 8 fl oz/A per season.

2. Postemergence - continued on next page

2. Postemergence - continued

14	GoalTender 4F	4 to 6 fl oz/A	**oxyfluorfen**	0.125 to 0.188 lb/A	35	24
-**Special Local Needs Label 24(c) for broccoli, cabbage, and cauliflower for the use of GoalTender postemergence in DE, NJ, and PA ONLY! (Expires in DE 12/31/2027; NJ 12/31/2024; PA 12/31/2025).** -Apply after direct-seeded crops reach a minimum of 4 true leaves; for transplanted crops apply after a minimum of 2 weeks after transplanting. Expect some temporary crop injury (speckling and/or crinkling of foliage) after treatment. -**Do not** tank mix with any other pesticide or use any spray additive, or severe crop injury may result. -**Do not** use any oxyfluorfen formulation other than GoalTender 4F, or severe crop injury may result. -GoalTender will provide residual control, but **do not** cultivate after application, or the herbicide will be deactivated. Weeds controlled or suppressed include common groundsel, common lambsquarters, pigweeds, purslane, shepherdspurse, and annual sowthistle when applied to weeds with 1 to 4 true leaves. Rainfastness is not specified. -Maximum GoalTender per application is 8 fl oz/A; a pre-transplant application followed by a post-transplant application can be made but the combined amount may not exceed 16 fl oz/A per season.						
27	Optogen 1.67	3.5 fl oz/A	**bicyclopyrone**	0.046 lb/A	14	24
-**Labeled for broccoli only.** -Use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution) or crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). Ammonium sulfate (AMS) at 8.5 to 17 lb/100 gal spray solution may be added for improved control of emerged weeds. -Apply after broccoli emergence or transplanting as either row middle treatment or as a directed spray. Hooded or shielded sprayers will reduce the risk of injury for row middle or directed sprays. **-Contact with broccoli foliage will cause injury.** -Apply to small weeds (less than 2" tall). Optogen provides control for only a few weed species and should be used in combination with other herbicides. -Rainfastness is not specified on the label. -Do not make more than one application per year.						

3. Postharvest

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
22	Gramoxone SL 2.0* Gramoxone SL 3.0*	2.25 to 3 pt/A 1.5 to 2 pt/A	**paraquat**	0.56 to 0.75 lb/A	--	24
-**Supplemental Label in DE for the use of both Gramoxone formulations for postharvest application to desiccate the crop.** -Apply after the last harvest for bareground or plasticulture. Always include an adjuvant. -Spray coverage is essential for optimum effectiveness. See the label for additional information and warnings. -Rainfastness 30 min. A maximum of 2 applications for crop desiccation are allowed. -***Restricted-use pesticide***. Only certified applicators, who successfully complete the paraquat-specific training, can mix, load, or apply paraquat. Application of paraquat "under the direct supervision" of a certified applicator is no longer allowed. Required training link (*https://campus.extension.org/enrol/index.php?id=2201*); certified applicators must repeat training every three years.						

4. Other Labeled Herbicides These products are labeled but limited local data are available; and/or are labeled but not recommended in our region due to potential crop injury concerns.

Group	Product Name (*=Restricted Use)	Active Ingredient
3	Prowl H2O	**pendimethalin** (broccoli, Brussel sprouts, cabbage, cauliflower)
3	Satellite Hydrocap	**pendimethalin** (broccoli, Brussel sprouts, cabbage, cauliflower, collards, kohlrabi)
13	Command	**clomazone** (broccoli)
14	Aim	**carfentrazone** (broccoli, Brussel sprouts, cabbage, cauliflower, collards, kale, kohlrabi)
14	Spartan Charge	**carfentrazone + sulfentrazone** (cabbage)
14	Spartan/Zeus	**sulfentrazone** (cabbage)
14	Vida	**pyraflufen** (broccoli, Brussel sprouts, cabbage, cauliflower, collards, kale, kohlrabi)

Insect Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F. Recommended Insecticides

Soil Pests

Cabbage Maggots

Cabbage maggots overwinter as pupae. Overwintered adults (flies) emerge when yellow rocket (mustard) first blooms, then begin laying eggs on roots or soil near roots. All cole crops are affected. Eggs hatch within 3-7 days. As maggots feed on roots, plants begin to wilt. Ultimately, infested plants become severely stunted, or die outright. This pest has 3-4 generations per growing season, although the first generation is often the most economically damaging. The last larval generation is in October, particularly in warmer years. Treatments for cabbage maggot must be done preventively, as once damage is evident, loss of plants is unavoidable. Barriers, such as row covers, may be useful in excluding flies from smaller plantings. Prompt and complete destruction of crop residue is helpful. Chemical treatments should be applied preplant, or at planting, depending on the product used.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s) and Crop Restrictions**	**PHI (d)**	**REI (h)**	**Bee TR**
1B	Diazinon AG500*	2.0 to 3.0 qt/A preplant broadcast **OR** 4.0 to 8.0 fl oz/50 gal transplant water	diazinon - **not labeled for cabbage maggot control on collards, kale, and kohlrabi**	AP	96	H
3A	Pyrethroid insecticides registered for use on Cole Crops: see table at the end of Insect Control.					
21A	Torac	21.0 fl oz/A	tolfenpyrad - **soil**	1	12	H
28	Verimark	10.0 to 13.5 fl oz/A	cyantraniliprole	AP	4	H

Cutworms See also section E 3.1. Soil Pests - Detection and Control.

Cutworms are moth larvae (caterpillars) that live in the soil and feed on plant roots and stems. Cutworms chew through plant stems at or near the soil line, causing young plants to topple over. Larvae are typically active at night and spend most of this stage belowground. Conventional tillage and incorporation of crop debris into the soil helps reduce populations. There are several species that are capable of causing injury to young plants. In general, there are two generations per season. If cutworm damage is anticipated, it is best to treat it preventively with insecticide.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s) and Crop Restrictions**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	1.5 pt/A	methomyl - **not labeled for kohlrabi**	see label	48	H
1B	Diazinon AG500*	2.0 to 4.0 qt/A	diazinon	AP	96	H
3A	Pyrethroid insecticides registered for use on Cole Crops: see Group 3A table below.					

[1]REI on cauliflower 72 h

Aboveground Pests

Aphids

Aphids can occasionally become a problem, particularly as a contaminant in Brussels sprouts, cabbage and some types of kale. To prevent flare-ups, avoid overuse of pyrethroid (Group 3A) insecticides for caterpillar control. If growing transplants for field use, control aphid populations in the greenhouse to avoid transplanting infested crops.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s) and Crop Restrictions**	**PHI (d)**	**REI (h)**	**Bee TR**
1B	Orthene 97	0.5 to 1.0 lb/A	acephate - **Brussels sprouts and cauliflower only**	14	24	H
4A	Neonicotinoid insecticides registered for use on Cole Crops: see table at the end of Insect Control.					
4D	Sivanto Prime or 200SL	7.0 to 14.0 fl oz/A	flupyradifurone	1	4	M
9B	Fulfill 50WDG	2.75 oz/A	pymetrozine	7	12	L
9B	PQZ	2.4 to 3.2 fl oz/A	pyrifluquinazon	1	12	L
9D	Versys	1.5 fl oz/A	afidopyropen	0	12	L
21A	Torac	17.0 to 21.0 fl oz/A	tolfenpyrad	1	12	H
23	Movento	4.0 to 5.0 fl oz/A	spirotetramat	1	24	L
23 + 7C	Senstar	6.0 to 10.0 fl oz/A	spirotetramat + pyriproxyfen	7	24	L
28	Exirel	13.5 to 20.5 fl oz/A	cyantraniliprole	1	12	H
28	Verimark	6.75 to 13.5 fl oz/A	cyantraniliprole	AP	4	H
29	Beleaf 50SG	2.0 to 2.8 oz/A	flonicamid	0	12	L

Caterpillar "Worm" Pests Including:
Cabbage Loopers (CL), Diamondback Moths (DBM), Imported Cabbageworms (ICW), Cross-striped Cabbageworms, Cabbage Webworms, and Armyworms

Cole crops may require multiple treatments per season. **Not all materials are labeled for all crops, insects, or application methods; be sure to read the label. Due to resistance development, pyrethroid insecticides (Group 3A) are not recommended for control of DBM or beet armyworm (BAW). Other insecticides may no**

longer be effective in certain areas due to DBM resistance; consult your county Extension office for most effective insecticides in your area. Rotation of insecticides with different modes of action is recommended to reduce the development of resistance. Insecticides in the 1A and 1B class are harmful to beneficials, and should ideally be used later in the season, when necessary, to preserve natural enemies for as long as possible.

Threshold: For fresh-market cabbage, Brussels sprouts, broccoli, and cauliflower, treat when 20% or more of the plants are infested with any species during seedling stage, then 30% infestation from early vegetative to cupping stage. From early head to harvest in cabbage and Brussels sprouts use a 5% threshold. For broccoli and cauliflower, use 15% at curd initiation/cupping, then 5% from curd development to harvest. Spray coverage under the leaves is essential for effective control particularly with *Bacillus thuringiensis* and contact materials. With boom-type rigs, apply spray with at least 3 nozzles per row - one directed downward, and one directed toward each side. Evaluate effectiveness to consider the need for further treatment.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s) and Crop Restrictions**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	0.75 to 3.0 pt/A	methomyl - **not labeled for kohlrabi**	see label	48	H
1B	Dibrom 8E*	1 to 2 pt/A Check the label for details.	naled	1	48	H
1B	Orthene 97	1.0 lb/A	acephate - **only labeled for Brussels sprouts and cauliflower**	14	24	H
3A	Pyrethroid insecticides registered for use on Cole Crops: see table at the end of Insect Control.					
5	Entrust SC (OMRI)	3.0 to 10.0 fl oz/A	spinosad	1	4	M
5	Radiant SC	5.0 to 10.0 fl oz/A	spinetoram	1	4	M
6	Proclaim 5SG*	3.2 to 4.8 oz/A	emamectin benzoate (PHI on collards and kale 14 d)	7/14	12	H
11A	XenTari (OMRI)	0.5 to 1.5 lb/A	*Bacillus thuringiensis aizawai*	0	4	N
11A	Dipel DF, others (OMRI)	0.5 to 2.0 lb/A	*Bacillus thuringiensis kurstaki*	0	4	N
15	Rimon 0.83EC	6.0 to 12.0 fl oz/A	novaluron - **not labeled for collards and kale**	7	12	M
18	Confirm 2F	6.0 to 8.0 fl oz/A	tebufenozide	7	4	M
18	Intrepid 2F	10 to 16 fl oz/A	methoxyfenozide	1	4	L
21A	Torac	21.0 fl oz/A	tolfenpyrad – not for cabbage looper	1	12	H
22	Avaunt 30WDG, Avaunt eVo	2.5 to 3.5 oz/A	indoxacarb	3	12	H
28	Coragen 1.67SC Coragen eVo	7.5 fl oz/A 2.5 fl oz/A	chlorantraniliprole	3	4	L
28	Exirel	10.0 to 17 fl oz/A	cyantraniliprole - **foliar**	1	12	H
28	Verimark	5.0 to 10.0 fl oz/A	cyantraniliprole - **soil**	1	4	H
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H
28 +3A	Besiege*	5.0 to 9.0 fl oz/A	chlorantraniliprole + lambda-cyhalothrin	3	24	H
28+4A	Durivo	10.0 to 13.0 fl oz/A	thiamethoxam + chlorantraniliprole - **soil**	30	12	H
28+4A	Voliam Flexi	4.0 to 7.0 oz/A	thiamethoxam + chlorantraniliprole (PHI on collards and kale 7 days)	3/7	12	H
32	Spear-Lep	1.0 to 2.0 pt/A	GS-omega/kappa-Hxtx-Hv1a (must use a B.t.)	0	4	L

Flea Beetles

Treat if the population reaches 1 beetle per transplant or 5 beetles per 10 plants during cotyledon stage. Crop rotation, management of wild hosts (wild mustard, rocket etc.) and prompt destruction of crop residue are helpful in population suppression. Sequential plantings of host crops can result in population build-up.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s) and Crop Restrictions**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Sevin XLR Plus	0.5 to 1.0 qt/A	carbaryl (PHI on leafy brassicas 14 d)	3/14	12	H
3A	Pyrethroid insecticides registered for use on Cole Crops: see table at the end of Insect Control.					
4A	Neonicotinoid insecticides registered for use on Cole Crops: see table at the end of Insect Control.					
5	Entrust SC (OMRI)	4.0 to 8.0 fl oz/A	spinosad (suppression only)	1	4	M
21A	Torac	17.0 to 21.0 fl oz/A	tolfenpyrad	1	12	H
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H
28	Exirel	13.5 to 20.5 fl oz/A	cyantraniliprole	1	12	H
28	Verimark	6.75 to 13.5 fl oz/A	cyantraniliprole - **soil**	1	4	H

Harlequin Bugs

These orange, black and white stinkbugs can be quite destructive, particularly on leafy cole crops like collards. Egg masses consist of numerous white and black barrel-shaped eggs in neat rows. Nymphs remain clustered near the eggs until molting. Infestations can be quite heavy. Feeding results in pale blotches with scalloped edges on foliage.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s) and Crop Restrictions**	**PHI (d)**	**REI (h)**	**Bee TR**
3A	Pyrethroid insecticides registered for use on Cole Crops: see table at the end of Insect Control.					
4A	Neonicotinoid insecticides registered for use on Cole Crops: see table at the end of Insect Control.					

Slugs

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s) and Crop Restrictions**	**PHI (d)**	**REI (h)**	**Bee TR**
n/a	Sluggo (OMRI)	20 to 44.0 lb/A	iron phosphate	0	0	N
n/a	Ferroxx AQ	4.0 to 15.0 lb/A	iron phosphate	0	4	N
n/a	Deadline Bullets	Up to 25 lb/A	metaldehyde	0	12	N

Swede Midge

Swede midge was confirmed in Pennsylvania in 2020. Larval feeding results in growth distortions and can be mistaken for molybdenum injury, herbicide injury, and abiotic stressors. Symptoms include 'blind heads', leaf puckering, multiple shoots, many small heads, brown corky scarring, swollen flower buds/florets or leaves. Field rotation is important to limit population growth. Adults are poor fliers and move into plantings from overwintering sites in previous cole crops and weedy brassica host locations.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s) and Crop Restrictions**	**PHI (d)**	**REI (h)**	**Bee TR**
4A	Assail 30SG Assail 30SC	4.0 to 5.3 oz/A 3.4 to 4.5 fl oz/A	acetamiprid	3	12	M
4A + 15	Cormoran	12.0 fl oz	acetamiprid + novaluron **- not labeled for collards or kale**	7	12	M
23	Movento	4.0 to 5.0 fl oz/A	spirotetramat	1	24	L
23 + 7C	Senstar	6.0 to 10.0 fl oz/A	spirotetramat + pyriproxyfen	7	24	L
28	Exirel	13.5 to 20.5 fl oz/A	cyantraniliprole	1	12	H

Thrips

The small size of thrips, their habit of feeding near growing points, and the waxy nature of cole crop foliage can result in poor control with contact insecticides. The addition of a wetting agent may improve efficacy. Thrips can cause leaf distortions on cabbage. Pyrethroids may not provide acceptable control of thrips.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s) and Crop Restrictions**	**PHI (d)**	**REI (h)**	**Bee TR**
3A[1]	Pyrethroid insecticides registered for use on Cole Crops: see table at the end of Insect Control.					
4A[2]	Neonicotinoid insecticides registered for use on Cole Crops: see table at the end of Insect Control.					
5	Entrust SC (OMRI)	4.0 to 10.0 fl oz/A	spinosad	1	4	M
5	Radiant SC	6.0 to 10.0 fl oz/A	spinetoram	1	4	M
21A	Torac	21.0 fl oz/A	tolfenpyrad	1	12	H
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H

[1] Resistance concerns for western flower thrips [2]Resistance concerns for tobacco thrips

Whiteflies

Due to insecticide resistance issues with several species, rotation among insecticide groups is essential for control and management of resistance in local populations. Thorough coverage, use of wetting agents, and initiation of treatment at low population levels will all improve control.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s) and Crop Restrictions**	**PHI (d)**	**REI (h)**	**Bee TR**
4A	Neonicotinoid insecticides registered for use on Cole Crops: see table at the end of Insect Control.					

Whiteflies - continued next page

Whiteflies - continued

4D	Sivanto Prime or 200SL	10.5 to 14.0 fl oz/A	flupyradifurone	1	4	M
7C	Knack	8.0 to 10.0 fl oz/A	pyriproxifen	7	12	L
9B	PQZ	2.4 to 3.2 fl oz/A	pyrifluquinazon	1	12	L
9D	Versys	5.0 to 7.0 fl oz/A	afidopyropen	0	12	L
15	Rimon 0.83EC	12.0 fl oz/A	novaluron **- not labeled for collards and kale**	7	12	M
16	Courier SC	9.0 to 13.6 fl oz/A	buprofezin	1	12	L
23	Movento	4.0 to 5.0 fl oz/A	spirotetramat	1	24	L
23 + 7C	Senstar	6.0 to 10.0 fl oz/A	spirotetramat + pyriproxyfen	7	24	L
28	Exirel	13.5 to 20.5 fl oz/A	cyantraniliprole	1	12	H
28	Verimark	6.75 to 13.5 fl oz/A	cyantraniliprole - **soil**	1	4	H

Group 3A Pyrethroid Insecticides Registered for Use on Cole Crops

Apply one of the following formulations (check if the product label lists the insect you intend to spray; not all pyrethroids are labeled for all Cole Crops; the label is the law):

Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Asana XL*	2.9 to 9.6 fl oz/A	esfenvalerate - **not labeled for kale**	3/7 collards	12	H
Baythroid XL*	1.6 to 3.2 fl oz/A	beta-cyfluthrin	0	12	H
Brigade 2EC*, others	2.1 to 6.4 fl oz/A	bifenthrin	7	12	H
Capture LFR*	3.4 to 6.8 fl oz/A	bifenthrin	AP	12	H
Declare*	0.77 to 1.54 fl oz/A	gamma-cyhalothrin **- not labeled for kale or collards**	1	24	H
Fastac CS*	2.2 to 3.8 fl oz/A	alpha-cypermethrin **- not labeled for kale or collards**	1	12	H
Proaxis*	1.92 to 3.84 fl oz/A	gamma-cyhalothrin **- not labeled for kale or collards**	1	24	H
Lambda-Cy 1EC*, others	2.56 to 3.84 fl oz/A	lambda-cyhalothrin **- not labeled for kale or collards**	1	24	H
Warrior II*	0.96 to 1.92 fl oz/A	lambda-cyhalothrin **- not labeled for kale or collards**	1	24	H
Permethrin 3.2EC*	2.0 to 8.0 fl oz/A	permethrin **- not labeled for kale or collards**	1	12	H
Mustang Maxx*	2.24 to 4.0 fl oz/A	zeta-cypermethrin	1	12	H
Hero*	4.0 to 10.3 fl oz/A	zeta-cypermethrin + bifenthrin	7	12	H
Tombstone*	0.8 to 3.2 fl oz/A	cyfluthrin	0	12	H
Combo products containing a pyrethroid					
Besiege*	5.0 to 9.0 fl oz/A	lambda-cyhalothrin + chlorantraniliprole (Group 28) **- not labeled for kale**	3	24	H
Brigadier*	3.8 to 6.1 fl oz/A	bifenthrin + imidacloprid (Group **4A**) - **foliar**	7	12	H
Endigo ZC* and ZCX*	4.0 to 4.5 fl oz/A	lambda-cyhalothrin + thiamethoxam (Group **4A**)	1	24	H
Leverage 360*	3.0 fl oz/A	beta-cyfluthrin + imidacloprid (Group **4A**)	7	12	H

Group 4A Neonicotinoid Insecticides Registered for Use on Cole Crops

Apply one of the following formulations (check if the product label lists the insect you intend to spray; not all neonicotinoids are labeled for all Cole Crops; the label is the law):

Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Actara 25WDG	1.5 to 5.5 oz/A	thiamethoxam (PHI on collards, kale, kohlrabi 7 d)	0/7	12	H
Platinum 75SG	1.66 to 3.67 oz/A	thiamethoxam	30	12	H
Admire Pro	4.4 to 10.5 fl oz/A	imidacloprid - **soil**	21	12	H
Admire Pro	1.3 fl oz/A	imidacloprid - **foliar**	7	12	H
Assail 30SG Assail 30SC	2.0 to 5.3 oz/A 1.7 to 4.5 fl oz/A	acetamiprid	7/3 (leafy)	12	M
Belay 2.13SC	9.0 to 12.0 fl oz/A	clothianidin - **soil**	21	12	H
Belay 2.13SC	3.0 to 4.0 fl oz/A	clothianidin - **foliar**	7	12	H
Venom 70SG	5.0 to 7.5 oz/A	dinotefuran - **soil**	21	12	H
Venom 70SG	1.0 to 4.0 oz/A	dinotefuran - **foliar**	1	12	H

Group 4A Neonicotinoid Insecticides Registered for Use on Cole Crops - Combo products on next page

Group 4A Neonicotinoid Insecticides Registered for Use on Cole Crops - Combo products

Combo products containing a neonicotinoid					
Brigadier*	3.8 to 6.1 fl oz/A	imidacloprid + bifenthrin (Group 3A) - **foliar**	7	12	H
Durivo	10.0 to 13.0 fl oz/A	thiamethoxam + chlorantraniliprole (Group 28) **- soil**	30	12	H
Endigo ZC* and ZCX*	4.0 to 4.5 fl oz/A	thiamethoxam + lambda-cyhalothrin (Group 3A)	1	24	H
Leverage 360*	3.0 fl oz/A	imidacloprid + beta-cyfluthrin (Group 3A)	7	12	H
Savoy EC*	4.9 to 9.6 fl oz/A	acetamiprid + bifenthrin (Group 3A)	7	12	H
Voliam Flexi	4.0 to 7.0 oz/A	thiamethoxam + chlorantraniliprole (Group 28) (PHI on collards and kale 7 days)	3/7	12	H

Disease Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.
Recommended Fungicides

Nematodes

See sections E 1.5. Soil Fumigation and E 1.6. Nematode Control.

Seed Treatment

Purchase hot water treated, certified seed, or request hot water seed treatment by the seed company. If you are unsure whether your seeds have been treated, consult a qualified seed testing service.

Hot water seed treatment is a non-chemical alternative to conventional chlorine treatment which only kills pathogens on the surface of the seed. Heat-treatment done correctly kills pathogens inside the seed as well. If done incorrectly, it may not eradicate pathogens and may reduce germination and vigor. For cole crops, it is especially important to follow treatment protocols as seeds can split.

Seed heat treatment follows a strict time and temperature protocol and is best done with thermostatically controlled water baths. Two baths are required: one for pre-heating, and a second for the effective (pathogen killing) temperature. For cole crops, the initial pre-heating is at 100°F (38°C) for 10 minutes. The effective temperature is 122°F (50°C). Soaking at the effective temperature should be done for 20 minutes for broccoli, cauliflower, collards, kale, and Chinese cabbage, and 25 minutes for Brussels sprouts and cabbage. Immediately after removal from the bath, seeds should be rinsed with cool water to stop the heating process. After that, seeds should be dried on a screen or paper. Pelleted seeds are not recommended for heat treatment. **Only treat seed that will be used immediately.**

As an alternative to hot water seed treatment, use 1 part Alcide (sodium chlorite), 1 part lactic acid, and 18 parts water as a seed soak. Treat seed 1-2 minutes and rinse for 5 minutes in running water at room temperature.

Following hot water or chlorine treatment, dust the dried seed with Captan 50WP or Thiram 480DP at 1 level tsp/lb of seed (3 oz/100 lb).

Damping-off caused by *Pythium*, *Phytophthora*, and *Rhizoctonia*

Apply one of the following formulations:						
Code	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
After seeding, apply one of the following in a band up to 7 inches wide. See labels for rates based on row spacing.						
Phytophthora and Pythium root rot						
4	Ridomil Gold 4SL	0.5 to 1.0 pt/A	mefenoxam	AP	48	N
Phytophthora, Pythium, and Rhizoctonia root rot						
4 + 11	Uniform 3.66SE	0.34 fl oz/1000 ft row. Avoid direct seed contact, which may cause delayed emergence.	mefenoxam + azoxystrobin	AP	0	N
Rhizoctonia root rot						
11	azoxystrobin 2.08F	0.40 to 0.80 fl oz/1000 ft row	azoxystrobin	AP	4	N

Bacterial and Fungal Diseases

Bacterial Head Rot

Bacterial head rot can be a problem on broccoli. The only effective control strategy is to plant tolerant varieties. Tolerant varieties to bacterial head rot have dome-shaped, tight heads with very small beads.

Black Rot

Black rot caused by a bacterium, *Xanthomonas campestris*, and can cause serious losses. Symptoms of black rot include large, V-shaped chlorotic lesions that develop on the margins of leaves and its development is favored by warm, wet weather. The pathogen can be seed borne, thus purchase certified seed or use hot water seed treatment.

For black rot control, rotate at least 2 years between plantings. Fixed copper sprays (1.0 lb active ingredient/A) will reduce the spread of black rot if treatments are started as soon as the disease is present and applied throughout the season. Some copper-based products are OMRI listed and may help suppress these diseases in organic production systems. Copper applied at high rates may cause phytotoxicity for some cabbage cultivars in the form of flecking on the wrapper leaves.

Blackleg

Blackleg (Phoma Stem Canker) is caused by the fungus, *Phoma lingam*, and can survive in the soil for up to 3 years and on related weed hosts. On seedlings, pale gray lesions develop near the soil line causing the seedling to die off. On infected stems, elongated light brown sunken lesions with purple margins develop. Spores are spread rapidly via rainfall and overhead irrigation. Blackleg can be seed borne, thus purchase certified seed or use hot water seed treatment. For blackleg control, rotate fields to allow 4 years between plantings and control related weeds.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Apply one of the following at the first sign of disease and continue every 7-10 days. Rotate between fungicides with different modes of action as long as conditions favor disease development.						
M01	copper (OMRI)[1]	at labeled rates	copper	0	48	N
3	tebuconazole 3.6F	3.0 to 4.0 fl oz/A	tebuconazole	7	12	N
3 + 9	Inspire Super 2.82EW	16.0 to 20.0 fl oz/A	difenoconazole + cyprodinil	7	12	--
3 + 11	Quadris Top 1.67SC	12.0 to 14.0 fl oz/A	difenoconazole + azoxystrobin	1	12	--
7 + 11	Priaxor 4.17SC	6.0 to 8.2 fl oz/A	fluxapyroxad + pyraclostrobin	3	12	N
11	Cabrio 20EG[2]	12.0 to 16.0 oz/A	pyraclostrobin	0/3[2]	12	N

[1]Some copper-based products are OMRI listed and may help suppress some fungal diseases in organic production systems. Copper applied at high rates may cause phytotoxicity for some cabbage cultivars in the form of flecking on the wrapper leaves.

[2]For Cabrio, PHI=0 d for broccoli, Brussels sprouts, cabbage, tight-heading varieties of Chinese cabbage, cauliflower, and kohlrabi; PHI=3 d for collards and kale.

For blackleg control in <u>broccoli only</u>:
use iprodione 4L at 2.0 lb/A immediately after thinning as a directed spray to the base of the plant and adjacent soil surface. A second application may be made up to the day of harvest.

Clubroot

Use of irrigation water containing clubroot spores is the principal way the disease spreads to other fields. If clubroot occurs, clean and disinfest all equipment. Adjust soil pH with hydrated lime to as close to 7.0 as possible. Improve the drainage in the field and grow the crop on raised beds.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Use Terraclor 75WP in one of the following ways. Do not use the Terraclor 2EC formulation.						
14	Terraclor 75WP	**Option 1:** Use 30.0 lb/A or 37.0 oz/1000 ft of row. Apply in a 12-15 inch band and incorporate 4-6 inches deep before planting **Option 2:** Use 40.0 lb/A, broadcast and incorporate 4-6 inches deep before planting, **Option 3:** Use 2.0 lb/100 gal of solution and 0.5 pt/plant as a transplant solution.	pentachloro -nitrobenzene (PCNB)	AP	12	H
In addition, Ranman 400SC can be used in the following ways, see label for additional instructions.						
21	Ranman 400SC	**Option 1:** 12.9 to 25.75 fl oz/A use as a transplant soil drench **Option 2:** 20.0 fl oz/A use incorporated into the soil	cyazofamid	0	0	L

Downy Mildew

Downy Mildew, caused by *Peronospora parasitica*, can cause serious losses if left uncontrolled. Symptoms include light green, chlorotic spots on the upper leaf surface. During periods of high humidity, grayish white spores may develop on the underside of leaves. High humidity, fog, drizzling rains, and heavy dew favor disease development. Optimum conditions for disease development are night temperatures of 46-61°F for 4 or more successive nights, and day temperature ~75°F or lower. Control related weeds and avoid overhead irrigation. Initiate fungicide applications prior to the onset of disease symptoms and continue as long as weather conditions favor disease development. Rotate and/or tank mix chlorothalonil 6F with one of the following fungicides. Rotate between fungicides with different modes of action.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
M05	chlorothalonil 6F (not labeled for collards, kale, and kohlrabi)	1.5 pt/A	chorothalonil	7	12	N
11	azoxystrobin 2.08F	6.0 to 15.5 fl oz/A	azoxystrobin	0	4	N
11	Cabrio 20EG	12.0 to 16.0 oz/A	pyraclostrobin	0/3[2]	12	N
21	Ranman 400SC	2.75 fl oz/A	cyazofamid	0	0	L
22	Elumin	8.0 fl oz/A	ethaboxam	2	12	--
40	Revus 2.08F	8.0 fl oz/A	mandipropamid	1	4	--
40 + 45	Zampro 5.25SC	14.0 fl oz/A	dimethomorph + ametoctradin	0	12	--
40 + 49	Orondis Ultra 2.33SC	5.5 to 8.0 fl oz/A	mandipropamid + oxathiapiprolin	1	4	--
43	Presidio 4SC	3.0 to 4.0 fl oz/A	fluopicolide	2	12	L
49+M05	Orondis Opti	1.75 to 2.5 pt/A	oxathiapiprolin + chlorothalonil	7	12	N
P07	Aliette 80WDG	3.0 to 5.0 lb/A (every 14 d)	fosetyl-Al	3	12	N
P07	Phosphite	1.0 to 3.0 qt/A	phosphite	0	4	N
Actigard is a plant defense activator. Begin applications 7-10 d after thinning and reapply every 7 d for a total of 4 applications per season.						
P01	Actigard 50WG	1.0 oz/A	acibenzolar-S-methyl	7	12	N

Leaf Spots (Caused by *Alternaria* and *Pseudocercosporella*)

Leaf Spots can cause serious losses if left uncontrolled. Leaf Spots caused by *Alternaria* and *Pseudocercosporella* are favored by long extended periods of cool, wet weather and favored by rain, heavy dews, and overhead irrigation. Symptoms of *Alternaria* spp. include yellow, dark brown to black circular leaf spots with target like, concentric rings. *Pseudocercospora capsallae*, also known as White Leaf Spot, causes tannish-white, irregular, or roundish spots develop on infected leaves, especially near leaf tips and edges, spots later become ash-gray to white with a brownish margin and sometimes have a yellowish halo. Initiate fungicide applications prior to the onset of disease symptoms and continue as long as weather conditions favor disease development. Rotate and/or tank mix chlorothalonil 6F at 1.5 pt/A with one of the following fungicides.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Tank mix one of the following with chlorothalonil at the first sign of disease and continue every 7-10 days. Rotate between fungicides with different modes of action as long as conditions favor disease development.						
M01	copper (OMRI)[1]	at labeled rates	copper	0	48	N
3 + 9	Inspire Super 2.82EW	16.0 to 20.0 fl oz/A	difenoconazole + cyprodinil	7	12	--
3 + 11	Quadris Top 1.67SC	12.0 to 14.0 fl oz/A	difenoconazole + azoxystrobin	1	12	--
4 + M05	Ridomil Gold Bravo 76WP	1.5 lb/A (14-day schedule)	mefenoxam + chlorothalonil - **not labeled for collards, kale, and kohlrabi**	7	48	N
7	Endura 70W[2]	6.0 to 9.0 oz/A	boscalid	0/14[1]	12	--
7	Fontelis 1.67SC	14.0 to 30.0 fl oz/A	penthiopyrad	0	12	L
7 + 3	Luna Flex	10.0 to 13.6 fl oz/A	fluopyram + difenoconazole	1	12	--
7 + 11	Luna Sensation	5.0 to 7.6 fl oz/A	fluopyram + trifloxystrobin	0	12	--
7 + 11	Priaxor 4.17SC	6.0 to 8.2 fl oz/A	fluxapyroxad + pyraclostrobin	3	12	N
7 + 12	Miravis Prime	10.3 to 13.4 fl oz/A	pydiflumetofen + fludioxonil	7	12	--
9 + 12	Switch 62.5WG	11.0 to 14.0 oz/A	cyprodinil + fludioxonil	7	12	L
11	Cabrio 20EG[3]	12.0 to 16.0 oz/A	pyraclostrobin	0/3[2]	12	N

[1]There are several OMRI listed copper-based products; see labels for specifics. Copper applications may help suppress some fungal pathogens in organic production systems.
[2]See Endura label for specific recommendations.
[3]For Cabrio, PHI=0 d for broccoli, Brussels sprouts, cabbage, tight-heading varieties of Chinese cabbage, cauliflower, and kohlrabi, and PHI=3 d for collards and kale.

White Mold

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Apply Contans 5.3WG 3-4 months prior to the onset of disease to allow the active agent to reduce inoculum levels of sclerotia in the soil. Following application, incorporate 1-2 inches deep but do not plow before seeding cole crops to avoid untreated sclerotia in lower soil layers from infesting the upper soil layer. See label for specifics.						
44	Contans 5.3WG (OMRI)	2.0 to 4.0 lb/A	*Coniothyrium minitans*	--	--	N
Alternatively, during seasons when soils remain wet for an extended period of time apply one of the following preventatively:						
7	Endura 70W	6.0 to 9.0 oz/A	boscalid	0/14[1]	12	--
7	Fontelis 1.67SC	16.0 to 30.0 fl oz/A	penthiopyrad	0	12	L
7 + 3	Luna Flex	10.0 to 13.6 fl oz/A	fluopyram + difenoconazole	1	12	--
7 + 12	Luna Sensation 500SC	7.6 fl oz/A	fluopyram + trifloxystrobin	0	12	L

[1]See Endura label for specific recommendations.

Yellows (*Fusarium*)

Use resistant varieties when possible and practice long crop rotations.

Cucumbers

For earlier cucumber production and higher, more concentrated yields, use gynoecious varieties. A gynoecious plant produces a high percentage of female flowers and fruit. To produce pollen, 1 to 15% of pollinator must be planted and seed companies add this seed to the gynoecious variety. Both pickling and slicing gynoecious varieties are available. Parthenocarpic cucumbers that produce fruit without pollination are also available for protected culture and field production.

Recommended Varieties

Type	Variety[1]	Days	F1[2]	Type[3]	Use[4]	Reported Disease Resistance[5] Scab (Ccu)	PM (Px)	AN (Co)	DM[6] (Pcu)	ALS (Psl)	CMV	WMV	ZMV	PRSV
Standard Slicing Varieties	Bristol	54	Yes	Gyn	F	X	X	X		X	X	X	X	X
	Brickyard	53	Yes	Gyn	F	X	X	X	X	X	X	X	X	X
	Dasher II	58	Yes	Gyn	F	X	X	X		X	X			
	Dominator	55	Yes	Gyn	F	X	X	X		X	X			
	Mongoose	55	Yes	Gyn	F	X	X	X		X	X	X	X	X
	Speedway	56	Yes	Gyn	F	X	X	X		X	X			
	Stonewall	53	Yes	Gyn	F	X	X	X		X	X			
	SV4719CS	56	Yes	Gyn	F	X	X	X	X	X			X	
	Thunder	58	Yes	Gyn	F	X	X	X		X	X		X	
Slicers Long Types	Tasty Green	52	Yes	Mon	F		X							
Pickles	Bowie	51	Yes	Parth	MP	X	X							
	Citadel	52	Yes	Gyn	HMP	X	X	X	X	X	X			
	Eureka	57	Yes	Mon	HF	X	X	X		X	X	X		X
	Max Pack	57	Yes	Mon	FH	X	X	X		X	X	X	X	X
	Puccini	50	Yes	Parth	HMFP	X	X	X		X	X			
	Supremo	55	Yes	Mon	HP	X	X	X	X	X	X	X	X	X
Protected Culture / High Tunnels	Corinto	48	Yes	Parth	F	X					X			
	Excelsior	50	Yes	Parth	F	X	X				X			
	Katrina	52	Yes	Parth	F	X	X				X			
	Lisboa	60	Yes	Parth	F	X								

[1]**Listed alphabetically within type**. [2]Hybrid.
[3]Gyn=Gynoecious or mostly female flowers; 5-15% of a monoecious pollinizer variety added; Mon=Monoecious type with female and male flowers; Parth=Parthenocarpic type that sets fruit without pollination.
[4]F=Fresh Market, P=Processing (pickling), H=Hand harvest multiple times, M=Machine harvest once.
[5]X=high or intermediate level of resistance to Scab, PM=Powdery Mildew, AN=Anthracnose, DM=Downy Mildew, ALS=Angular Leaf Spot, CMV=Cucumber Mosaic Virus, WMV=Watermelon Mosaic Virus, ZMV=Zucchini Yellows Mosaic Virus, PRSV=Papaya Ring Spot Virus.
[6]Only varieties with some resistance to Downy Mildew are noted with an X.

Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and Chapter B Soil and Nutrient Management. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede the recommendations found below.

		Soil Phosphorus Level				Soil Potassium Level				
		Low	Med	High (Opt)	Very High	Low	Med	High (Opt)	Very High	
Cucumbers[1]	**N (lb/A)**	**P_2O_5 (lb/A)**				**K_2O (lb/A)**				**Nutrient Timing and Method**
	80-150	150	100	50	0[2]	200	150	100	0[2]	Total nutrient recommended
	25-50	125	75	25	0[2]	175	125	75	0[2]	Broadcast and disk-in
	25	25	25	25	0	25	25	25	0	Band place with planter
	25-75	0	0	0	0	0	0	0	0	Sidedress when vines begin to run

For plasticulture, fertilization rates are based on a standard row spacing of 6 ft.
[1]Sulfur (S) at a rate of 25-30 lb/A is recommended for most soils.
[2]In VA, crop replacement values of 25 lb/A of P_2O_5 and 50 lb/A of K_2O are recommended on soils testing Very High.

Fertigation Schedule Examples

This table provides examples of fertigation schedules based on two common scenarios - sandy coastal plain soils and heavier upland soils. It should be modified according to specific soil tests and base fertility.

Fertigation recommendations for 125 lb N and 125 lb K_2O[1,2] For soils with organic matter content less than 2% or coarse texture and low to medium or deficient K								
			Nitrogen			**Potash**		
Preplant (lb/A)[3]			**25**			**50**		
			N	**N**	**N**	**K_2O**	**K_2O**	**K_2O**
Stage and Description	Weeks	Days	lb/day	lb/week	lb/stage	lb/day	lb/week	lb/stage
1 Early vegetative	1	1-7	0.5	3.5	3.5	0.4	2.8	2.8
2 Late vegetative	2-3	8-14	0.9	6.3	12.6	0.7	4.9	9.8
3 Fruiting and harvest	4-7	15-42	1.4	9.8	39.2	0.9	6.3	25.2
4 Later harvest[4]	8-10	43-70	0.9	6.3	18.9	0.6	4.2	12.6
Fertigation recommendations for 75 lb N and 50 lb K_20[1,2] For soils with organic matter content greater than 2% or fine texture and high or optimum K								
			Nitrogen			**Potash**		
Preplant (lb/A)[3]			**50**			**50**		
			N	**N**	**N**	**K_2O**	**K_2O**	**K_2O**
Stage and Description	Weeks	Days	lb/day	lb/week	lb/stage	lb/day	lb/week	lb/stage
1 Early vegetative	1	1-7	1	7	7	1	7	7
2 Late vegetative	2-3	8-14	1.5	10.5	21	1.6	11.2	22.4
3 Fruiting and harvest	4-7	15-42	2.2	15.4	61.6	2.2	15.4	61.6
4 Later harvest[4]	8-10	43-70	1.7	11.9	35.7	1.6	11.2	33.6

[1]Rates are based on 7,260 linear bed ft/A (6 ft bed spacing). If beds are closer or wider, fertilizer rates should be adjusted proportionally. Drive rows should not be used in acreage calculations (see section C 3. Fertigation). [2]Base overall application rate on soil test recommendations. [3]Applied under plastic mulch to effective bed area using modified broadcast method. [4]For extended harvest after 10 weeks continue fertigation at this rate.

Plant Tissue Testing

Plant tissue testing can be a valuable tool to assess crop nutrient status during the growing season, to aid with in-season fertility programs or to evaluate potential deficiencies or toxicities. Critical cucumber tissue test values for most recently matured leaves at first bloom are: N 3.5-6 %, P 0.3-0.6 %, K 1.6-3.0 %, Ca 2-4 %, Mg 0.5-0.7% and S 0.3-0.8%. For additional nutrients and other growth stages consult with a tissue testing laboratory or this weblink at the University of Florida: *https://edis.ifas.ufl.edu/publication/ep081*.

Seed Treatment

Seed should be treated; check with your seed company and see Disease Control below.

Planting Dates

Direct seeding starts late-April in warmer, southern areas and after May 10 in PA and other cool areas. Successive plantings can be made through early August. Container-grown plug plants are started 3 weeks ahead of transplanting. On plastic mulch, planting starts when daily mean temperatures have reached 60°F (16°C). First transplanting dates vary from April 10 in southern regions to June 1 in northern areas. Early plantings should be protected from winds with row covers or rye windbreaks.

Spacing

Slicers: Space rows 3-4 ft apart with plants 9-12 inches apart using transplants or seed for bare ground. Seeding rate: 0.1-1.5 lb/A. For plasticulture, space beds 6-8 feet apart and seed or transplant 1- 2 rows per bed, 9-12 inches apart in the row.

Hand Harvest Pickles: Space rows 3-4 ft apart with plants 6-8 inches apart. Seeding rate: 1-2 lb/A.

Mulching and Fumigation

Plastic mulch laid on moist soil before field planting conserves moisture and increases soil temperature and early and total yield. Various widths of plastic are available; choose one that works with your production system and equipment. Fumigation will be necessary when there is a history of soil-borne diseases in the field; several fumigants can be used on cucumber depending on what the predominant pests are (see section E 1.5. Soil Fumigation). Fumigation also aids in the control of weeds. Fumigant and mulch should be applied to well-prepared planting beds;

check the fumigant label for the plant-back period that must be adhered to for crop safety. Plastic should be laid immediately over the fumigated soil. Fumigation alone may not provide satisfactory weed control under plastic. Black plastic can be used without a herbicide to provide control of most weeds.

Fertilizer must be applied during bed preparation. At least 50% of the N should be in the nitrate (NO_3^-) form. Drip (trickle) irrigation is recommended for plastic mulch systems and tape is laid at the same time as mulch. Foil and highly reflective mulches can be used to repel aphids that transmit viruses in fall-planted (after July 1) cucurbits. Direct seeding through the mulch is recommended for maximum virus protection; transplants should not be used with foil mulches. Also, using an herbicide is not necessary.

Cucumbers also have been successfully grown in no-till systems on cover crop mulch.

Irrigation

Cucumbers require irrigation for the best yield and quality. During flowering and fruiting water use can be over 0.25 inches/day and the water deficit during this period will have the greatest negative impact on yield and fruit quality. A balance must be struck, however, between maintaining adequate moisture for fruiting, while minimizing wetness in the canopy and on the soil surface which promotes fruit rots and Downy Mildew.

Trellising

Fresh market slicer cucumbers and pickles may be produced on trellises which may result in 2-3 times greater average yield than in non-trellised fields. Trellising is the preferred system in high tunnels. Trellising incurs a higher cost than growing cucumbers on the ground, but it has the following benefits: 1) Improved fruit quality, particularly with respect to color and shape (no yellow “ground spot”); 2) More effective control of many diseases and insects.; 3) Less damage to vines resulting in a longer harvest season; 4) More consistent and thorough harvesting resulting in fewer jumbos and culls; and 5) Easier harvesting than ground grown cucumbers.

Erect the trellis so that it is 6 ft high with a top (No. 8) and bottom (No. 12) wire and plastic twine or netting tied between the two wires at each plant. Posts or poles should be no more than 15 ft apart and the top wire should be very taut. An additional brace between posts may be required when the fruit load becomes heavy. In high tunnels, wires are stretched at the height desired and plastic twine is used to train plants. Training the main stem is required until it reaches and extends over the top wire. Pruning lateral runners near the base of the plant will result in higher yields. The first 4-6 lateral runners that appear should be removed. Other runners above this point should be allowed to run. Single stem systems are often used in high tunnels.

Pollination (see also sections A 12. Pollination and D 6.3.1. Protection of Pollinators)

Honey bees, squash bees, bumble bees and other wild bees are important for proper cucumber pollination and fruit set. In high tunnels bumble bees are particularly effective. Populations of pollinating insects may be adversely affected by insecticides applied to flowers or weeds in bloom. Apply insecticides only in the evening hours or wait until bloom is completed before application. Follow all label requirements for pollinator protection. Bee Toxicity ratings are available in the insecticide tables that follow.

Parthenocarpic Cucumbers

Parthenocarpic cucumbers do not require pollination to set fruit. They will be nearly seedless or have unformed seeds. They should be isolated from seeded cucumber types to increase productivity and maintain the seedless nature. Parthenocarpic types should be considered when bee activity is limited such as in high tunnels, under row covers, or in very early plantings.

Season Extension

Low Tunnel Cucumber Production:

Cucumbers for early production may be successfully grown in high tunnels, in low tunnels with perforated clear plastic row covers, or using floating row covers. Use plastic mulch and trickle irrigation as discussed above. The following field system - similar to that used for early sweet corn - is also successful: A modified bedshaper is used to form a ridge on each side of the plant row, leaving a suitable area for planting. A 36-inch wide piece of embossed clear plastic is then used to cover the plant row, leaving a 5-6 inch high space between the planted row and the plastic cover. It is estimated that temperatures may increase by 10-20°F depending on time of planting and sunlight availability and intensity.

F. Cucumbers

High Tunnel Cucumber Production:
Cucumbers are a potentially profitable crop for spring and fall production within a high tunnel. Cucumbers mature in approximately half the length of time required for tomato ripening. Cucumbers are also amenable to vertical trellising which increases production and quality. High tunnel cucumber varieties are often parthenocarpic (requiring no pollenizers) although gynoecious varieties can also be used (with pollenizers). Cucumbers can be established by direct seeding or transplanting. Space plants 12-18 inches apart in-row on 42-48 inch bed centers. High tunnel varieties can remain unpruned, though pruning can reduce pest infestation and improve marketable yield. If pruning is done, the lower laterals (suckers) should be pruned on the bottom 2 ft leaving 1 or 2 stems per plant to trellis. More information on relative planting and harvesting dates is available in section A 9 High Tunnels in the General Production Recommendations chapter.
Greenhouse Production:
Varieties are usually parthenocarpic varieties bred specifically for the lower light conditions of fall, winter, and early spring. European "English" or "Dutch" types and Asian types are available. Hydroponic nutrient solution systems are commonly used, and cucumbers are trellised with single or double stems trained onto twine; see also section A 10. Greenhouse Production.

Harvest and Storage

Cucumbers should be harvested when they have reached full size for the variety but while seeds are still soft. For slicers and manually harvested pickles, multiple harvests at 2-3 day intervals will be necessary. Machine-harvested pickles are harvested once, when less than 5% have become oversized, as this produces the highest bushel yields. Size requirements of processors will also dictate schedules for machine and hand harvesting pickles.

Cucumbers can be held for 10-14 days at 50-54°F with a relative humidity of 85-90%. At 50°F and above, cucumbers ripen rapidly, with the green color changing to yellow, starting after about 10 days. The color change is accelerated if cucumbers are stored in the same room as apples, tomatoes, or other ethylene-producing crops. Cucumbers for fresh market are usually waxed to reduce moisture loss. Cucumbers are subject to chilling injury if held below 50°F for longer than about 2 days.

Weed Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.

Recommended Herbicides

1. Identify the weeds in each field and select recommended herbicides. More information is available in the "Herbicide Effectiveness on Common Weeds in Vegetables" (Table E-3) in Chapter E Pest Management.
2. Minimize herbicide resistance development. Identify the herbicide mode of action group number and follow recommended good management practices; **bolded group numbers in tables below are herbicides at higher risk for selecting resistant weed populations.** Include non-chemical weed control whenever possible.

Labeled Application Sites for Cucumbers

Herbicide (*=Restricted Use)	HRAC group number	Plastic mulch production					Bareground production		
		Soil-Applied		Postemergence					
		Under Plastic	Row Middles	Over Plastic	Row Middles	Post-Harvest	Soil-applied	POST	Post-harvest
Sandea	2	YES	YES	YES	YES		YES	YES	
Treflan	3		YES						
Curbit	3		YES				YES		
Prefar	8	YES	YES				YES		
Command	13		YES				YES		
Strategy	3+13		YES				YES		
Select / Select Max Shadow 3EC	1			YES	YES			YES	
Poast	1			YES	YES			YES	
Gramoxone*[1]	22					YES		YES	

[1] Special Local Needs Label 24(c), be sure it is registered for the specific state and for the intended use.

1. Soil-Applied

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
2	Sandea 75DF	0.5 to 1 oz/A	**halosulfuron**	0.023 to 0.047 lb/A	14	12
-**Plasticulture**: can be applied in a band under the plastic, immediately before laying the mulch; delay seeding or transplanting for 7 days after application. Row middles: apply before or after weed emergence; apply as a shielded application to avoid contact with the crop. If weeds have emerged, use a non-ionic surfactant at 0.25% v/v or include a non-selective herbicide. -**Bareground**: apply broadcast after seeding but before crop emergence or no sooner than 7 days before transplanting. -Suppresses or controls yellow nutsedge and certain broadleaf weeds. -Sandea is an ALS inhibiting herbicide and resistant weed populations are common in the region. **Do not** use Group 2 herbicides repeatedly in the same field. -**Do not** apply Sandea to crops treated with a soil applied organophosphate insecticide or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application. -Maximum Sandea applications per year is 2 and **do not** exceed 2 oz/A during the crop season.						
3	Curbit 3EC	1 to 3 pt/A	**ethalfluralin**	0.38 to 1.13 lb/A	--	24
-**Plasticulture** row middles only: apply as a banded spray after crop emergence or transplanting. **Do not** soil incorporate. -**Bareground**: apply broadcast after direct-seeding but prior to crop emergence; **do not** use on transplanted cucumbers. -Controls annual grasses and certain annual broadleaf weeds, including carpetweed and pigweed sp. -Use lower rate for coarse-textured soils or soils with low organic matter. -Where overhead irrigation is available, activate Curbit with 0.5 inch of irrigation within 2 days after application; if no irrigation or rainfall occurs within 5 days of application, activity of Curbit can be reduced. -Available as a pre-mix herbicide Strategy. Strategy at 3 pt/A= Curbit at 26 fl oz/A (0.6 lb ai) and Command at 8 fl oz/A (0.188 lb ai) -Maximum applications per season: not specified						
3	Treflan 4EC	1 to 2 pt/A	**trifluralin**	0.5 to 1 lb/A	30	12
-**Plasticulture** row middles only: apply as a directed spray after emergence when plants have reached the 3 to 4 true leaf stage of growth. -**Not labeled for bareground production**. Primarily controls annual grasses with a few broadleaf weeds. -**Do not** use (or reduce the rate) when cold, wet soil conditions are expected, or crop injury may result. -Maximum applications per season: not specified.						
3 + 13	Strategy 2.1SC	1.5 to 6 pt/A	**ethalfluralin *plus* clomazone**	0.39 to 1.58 lb/A	45	24
-**Plasticulture**: row middles application. -**Bareground**: apply broadcast just before planting or after planting but before crop emergence. -Strategy is a prepackage mixture of Curbit 3EC and Command 3ME. Refer to individual products for comments. -Clomazone spray or vapor drift may injure susceptible crops and other vegetation, refer to Command 3ME for comments. -**Do not** apply prior to planting the crop. -**Do not** soil incorporate. -Maximum applications per season: not specified.						
8	Prefar 4E	5 to 6 qt/A	**bensulide**	5 to 6 lb/A	45	12
-**Plasticulture**: under plastic: apply in a band under the plastic, immediately before laying the mulch. Allow 7 days before making transplant holes to allow condensation to incorporate the herbicide. Plasticulture: row middles application is labeled. -**Bareground**: apply preemergence or preplant incorporated. -Preemergence applications should be followed by irrigation within 36 h (apply enough water to wet the soil at least 2 to 4 inches deep). Preplant incorporated applications should be incorporated 1 to 2 inches deep (deeper than 2 inches will result in reduced weed control). -Provides control/suppression of some annual grass weeds and some broadleaves including pigweeds, purslane, and lambsquarters. -**Do not** apply more than 6 lb ai/A per season.						
13	Command 3ME	0.4 to 1 pt/A	**clomazone**	0.15 to 0.375 lb/A	30	12
-**Plasticulture**: row middles application only. -**Bareground**: apply broadcast just before planting or after planting but before crop emergence. -Use the lower rate when used on coarse-textured soils low in organic matter, when weed pressure is light, or to minimize herbicide carryover that could affect subsequent crops. -Controls annual grasses and many broadleaf weeds including common lambsquarters, velvetleaf, spurred anoda, and jimsonweed. Carpetweed, morningglory sp., pigweed sp., and yellow nutsedge will **not** be controlled. Higher rates will improve control (or expand number of species controlled) such as common cocklebur, common ragweed, or jimsonweed (refer to label for specific weeds and rates). -**WARNINGS**: Command spray *or* vapor drift may injure sensitive crops and other vegetation up to several hundred yards from the point of application. **Do not** apply adjacent to sensitive crops (see label) or vegetation, or under unfavorable wind or weather conditions. Command may limit subsequent cropping options, see the label. -Available as a pre-mix herbicide Strategy: Strategy at 3 pt/A= Command at 8 fl oz/A (0.188 lb ai) and Curbit at 26 fl oz/A (0.6 lb ai) -Maximum number of Command applications per year: 1.						

<table>
<tr><th colspan="7">2. Postemergence</th></tr>
<tr><th>Group</th><th>Product Name
(*=Restricted Use)</th><th>Product Rate</th><th>Active Ingredient</th><th>Active Ingredient Rate</th><th>PHI
(d)</th><th>REI
(h)</th></tr>
<tr><td>1</td><td>Shadow 3EC
Select 2EC
Select Max 0.97EC</td><td>4 to 5.33 fl oz/A
6 to 8 fl oz/A
9 to 16 fl oz/A</td><td>clethodim</td><td>0.07 to 0.125 lb/A</td><td>14</td><td>24</td></tr>
<tr><td></td><td>Poast 1.5EC</td><td>1 to 1.5 pt/A</td><td>sethoxydim</td><td>0.19 to 0.28 lb/A</td><td>3</td><td>12</td></tr>
<tr><td colspan="7">-Select 2EC: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution).
-Select Max: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution).
-Shadow 3EC: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution) for large or stressed grasses; use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution) when crop safety is a concern.
-Poast: Apply with COC at 1.0% v/v.
-The use of COC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to NIS when grasses are small and soil moisture is adequate.
-Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control.
-Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will not be controlled.
-Controls many annual and certain perennial grasses, including annual bluegrass, but Poast is preferred for goosegrass control. For best results, treat annual grasses when they are actively growing and before tillers are present. Control may be reduced if grasses are large or under hot or dry weather conditions.
-Repeated applications may be necessary to control certain perennial grasses. If repeat applications are necessary, allow 14 days between applications.
-Do not tank mix with or apply within 2 to 3 days of any other pesticide, unless labeled, as this may increase the risk of crop injury or reduce the control of grasses.
-Do not apply more than 8 fl oz/A of Select 2EC in a single application and do not exceed 32 fl oz/A for the season; do not apply more than 16 fl oz/A of Select Max in a single application and do not exceed 64 fl oz/A for the season.
-Do not apply more than 5.33 fl oz/A of Shadow 3EC in a single application and do not exceed 21.33 fl oz/A for the season.
-Do not apply more than 1.5 pt/A Poast in a single application and do not exceed 3 pt/A for the season.
-Rainfastness is 1 h.</td></tr>
<tr><td>2</td><td>Sandea 75DF</td><td>0.5 to 1 oz/A</td><td>halosulfuron</td><td>0.023 to 0.047 lb/A</td><td>14</td><td>12</td></tr>
<tr><td colspan="7">-Plasticulture: broadcast (over the top) or directed to row middles; broadcast for bareground.
-Bareground: apply Sandea after the crop has at least 3 to 5 true leaves but before first female flowers appear and no sooner than 14 days after transplanting. If weeds have emerged, use a non-ionic surfactant at 0.25% v/v.
-Suppresses or controls yellow nutsedge and certain broadleaf; control of weeds taller than 3 inches may not be adequate. Sandea will not control common lambsquarters or eastern black nightshade if applied postemergence; for row middle application, tank mix with a non-selective herbicide to increase spectrum of control.
-Sandea provides both residual and postemergence control of susceptible weed species. Effective postemergence control requires an adjuvant. Sandea is an ALS inhibiting herbicide and resistant weed populations are common in the region. Do not use Group 2 herbicides repeatedly in the same field.
-Do not apply Sandea to crops treated with a soil applied organophosphate insecticide or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application.
-Rainfastness is 4 h. Sandea applications per year is 2 and do not exceed 2 oz/A during the crop season</td></tr>
<tr><td>10</td><td>Rely 280 2.34L</td><td>29 to 62 fl oz/A</td><td>glufosinate</td><td>0.53 to 1.13 lb/A</td><td>14</td><td>12</td></tr>
<tr><td colspan="7">-Supplemental Label expires 12/1/2025 for hooded spray application between the rows. If the crop is planted without plastic, do not spray within 6 inches of running vines.
-Ammonium sulfate (AMS) can be used at 1.5 lb/A to 3 lb/A.
-Do not allow spray to come in contact with crop foliage or damage will occur.
-Control is best when applied to weeds less than 4 inches, temperatures are above 80, high humidity, and bright sunlight.
-Separate sequential applications by at least 14 days.
-Do not apply more than 62 fl oz/A in a single application, do not apply more than 87 fl oz/A per season; maximum number of applications is three per season.
-Rainfastness is 4 h.</td></tr>
<tr><td>22</td><td>Gramoxone SL 2.0*
Gramoxone SL 3.0*</td><td>1.95 pt/A
1.3 pt/A</td><td>paraquat</td><td>0.49 lb/A</td><td>14</td><td>24</td></tr>
<tr><td colspan="7">-Supplemental Label for the use of Gramoxone 2SL or 3SL for postemergence weed control in DE, MD, NJ, PA, and VA. Row middles as a shielded application. Apply as a directed spray in a minimum of 20 gal spray mix/A to control emerged weeds between the rows after crop establishment. Include a nonionic surfactant at 0.25% v/v.
-Use shields or hoods to prevent spray contact with the crop and low spray pressure (maximum of 30 psi) to reduce small droplets that are prone to drift. See the label for additional information and warnings.
-Rainfastness is 30 min.
-A maximum of 3 applications per year are allowed.
-Restricted-use pesticide. Only certified applicators, who successfully complete the paraquat-specific training, can mix, load, or apply paraquat. Application of paraquat "under the direct supervision" of a certified applicator is no longer allowed. Required training link (https://campus.extension.org/enrol/index.php?id=2201); certified applicators must repeat training every three years.</td></tr>
</table>

3. Postharvest						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient**	**Active Ingredient Rate**	**PHI (d)**	**REI (h)**
22	Gramoxone SL 2.0* Gramoxone SL 3.0*	2.25 to 3 pt/A 1.5 to 2 pt/A	**paraquat**	0.56 to 0.75 lb/A	--	24

-**Supplemental Label in DE for the use of both Gramoxone formulations for postharvest application to desiccate the crop.**
-Apply after the last harvest for bareground or plasticulture. Always include an adjuvant.
-Spray coverage is essential for optimum effectiveness. See the label for additional information and warnings.
-Rainfastness 30 min. -A maximum of 2 applications for crop desiccation are allowed.
-***Restricted-use pesticide***. Only certified applicators, who successfully complete the paraquat-specific training, can mix, load, or apply paraquat. Application of paraquat "under the direct supervision" of a certified applicator is no longer allowed. Required training link (*https://campus.extension.org/enrol/index.php?id=2201*); certified applicators must repeat training every three years.

4. Other Labeled Herbicides These products are labeled but limited local data are available; and/or are labeled but not recommended in our region due to potential crop injury concerns.

Group	Product Name (*=Restricted Use)	Active Ingredient
14	Aim	**carfentrazone**

Insect Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F. Recommended Insecticides

Seed and At-Plant Treatments for Seedcorn Maggot

Farmore DI-400 as a commercially applied seed treatment which contains thiamethoxam (Group 4A).
Verimark (cyantraniliprole, Group 28) applied no earlier than 72 hours prior to planting, at 10-13.5 oz/A using in-furrow spray, transplant tray drench, transplant water treatment, hill drench, or surface band.
Note: The use of neonicotinoid insecticides (Group 4A) at planting may help reduce seedcorn maggot populations. See also Maggots in section E 3.1. Soil Pests - Detection and Control.

Aphids **Note:** Aphids transmit multiple viruses.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	1.5 to 3.0 pt/A	methomyl - **melon aphid only**	1-3	48	H
4A	Neonicotinoid insecticides registered for use on Cucumbers: see table at the end of Insect Control.					
4C+3A	Ridgeback*	5.5 to 13.8 fl oz/A	sulfoxaflor + bifenthrin	3	24	H
4D	Sivanto Prime or 200SL	21.0 to 28.0 fl oz/A	flupyradifurone - **soil**	21	4	M
4D	Sivanto Prime or 200SL	7.0 to 14.0 fl oz/A	flupyradifurone - **foliar**	1	4	M
9B	Fulfill 50WDG	2.75 oz/A	pymetrozine	0	12	L
9B	PQZ	2.4 to 3.2 fl oz/A	pyrifluquinazon	1	12	L
9D	Sefina	3.0 fl oz/A	afidopyropen	0	12	L
21A	Torac	17.0 to 21.0 fl oz/A	tolfenpyrad	1	12	H
28	Exirel	13.5 to 20.5 fl oz/A	cyantraniliprole	1	12	H
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H
28	Verimark	Soil, at planting: 10 to 13.5 fl oz/A Drip chemigation: 6.75 to 10 fl oz/A	cyantraniliprole	1	4	H
28 + 6	Minecto Pro*	10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H
29	Beleaf 50SG	Foliar: 2.0 to 2.8 oz/A Drip: 2.8 to 4.28 oz/A	flonicamid	0	12	M

Armyworms and Cabbage Loopers

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	1.5 to 3.0 pt/A	methomyl	1-3	48	H
3A	Pyrethroid insecticides registered for use on Cucumbers: see table at the end of Insect Control.					

Armyworms and Cabbage Loopers - continued next page

Armyworms and Cabbage Loopers - continued

5	**Entrust SC (OMRI)**	**4.0 to 8.0 fl oz/A**	**spinosad**	**1**	**4**	**M**
5	Radiant SC	5.0 to 10.0 fl oz/A	spinetoram	1	4	M
6	Proclaim 5SG*	3.0 to 4.8 oz/A	emamectin benzoate	7	12	H
11A	Dipel DF, others (OMRI)	0.5 to 2.0 lb/A	*Bacillus thuringiensis kurstaki*	0	4	N
11A	XenTari (OMRI) (armyworms)	0.5 to 2.0 lb/A	*Bacillus thuringiensis aizawai*	0	4	N
11A	XenTari (OMRI) (cabbage loopers)	0.5 to 1.0 lb/A	*Bacillus thuringiensis aizawai*	0	4	N
18	Intrepid 2F	4.0 to 10.0 fl oz/A	methoxyfenozide	3	4	L
22	Avaunt 30WDG, Avaunt eVo	2.5 to 6.0 oz/A	indoxacarb	3	12	H
28	Coragen 1.67SC Coragen eVo	3.5 to 7.5 fl oz/A 1.2 to 2.5 fl oz/A	chlorantraniliprole - **soil and foliar**	1	4	L
28	Exirel	7.0 to 17.0 fl oz/A	cyantraniliprole	1	12	H
28	Verimark	6.75 to 13.5 fl oz/A	cyantraniliprole- **soil**	1	4	H
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H
28 + 4A	Voliam Flexi	4.0 to 7.0 oz/A	chlorantraniliprole + thiamethoxam	1	12	H
28 + 6	Minecto Pro*	5.5 to 10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H

Cucumber Beetles

Cucumber beetles can transmit bacterial wilt; however, losses from this disease vary greatly between fields and varieties. Pickling cucumbers grown in high-density rows for once-over harvesting can compensate for at least 10% stand losses. On farms with a history of bacterial wilt control adult beetles before they feed extensively on the cotyledons and first true leaves. If foliar insecticides are used, begin spraying shortly after plant emergence and repeat weekly if new beetles continue to invade fields. Treatments may be required until vines begin to run (usually about 3 weeks after plant emergence). Seeds pretreated with a neonicotinoid seed treatment such as Farmore DI-400 should provide up to 14 days of control of cucumber beetle. Note: some populations of striped cucumber beetle on the Delmarva Peninsula may be less susceptible to pyrethroids; caution is advised when applying this chemistry.

Apply one of the following formulations:

Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	1.5 to 3.0 pt/A	methomyl	1-3	48	H
1A	Sevin XLR Plus	1.0 qt/A	carbaryl	3	12	H
3A	Pyrethroid insecticides registered for use on Cucumbers: see table at the end of Insect Control.					
4A	Neonicotinoid insecticides registered for use on Cucumbers: see table at the end of Insect Control.					
28	Exirel	20.5 fl oz/A	cyantraniliprole			
28	Verimark	Soil, at planting: 13.5 fl oz/A Drip chemigation: 10 fl oz/A	cyantraniliprole	1	4	H
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H

Cutworms

See also section E 3.1. Soil Pests - Detection and Control.

Apply one of the following formulations:

Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	1.5 to 3.0 pt/A	methomyl	1-3	48	H
3A	Pyrethroid insecticides registered for use on Cucumbers: see table at the end of Insect Control.					

Leafminers

Apply one of the following formulations:

Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
3A	Pyrethroid insecticides registered for use on Cucumbers: see table at the end of Insect Control.					
4A	Neonicotinoid insecticides registered for use on Cucumbers: see table at the end of Insect Control.					
5	Entrust SC (OMRI)	6.0 to 8.0 fl oz/A	spinosad	1	4	M
5	Radiant SC	6.0 to 10.0 fl oz/A	spinetroram	1	4	M
6	Agri-Mek SC*	1.75 to 3.5 fl oz/A	abamectin	7	12	H
17	Trigard 75WSP	2.66 oz/A	cyromazine	0	12	H

Leafminers - continued next page

Leafminers - continued

28	**Coragen 1.67SC** **Coragen eVo**	**5.0 to 7.5 fl oz/A** **1.7 to 2.5 fl oz/A**	**chlorantraniliprole - larvae**	**1**	**4**	**L**
28	Exirel	13.5 to 20.5 fl oz/A	cyantraniliprole	1	12	H
28	Verimark	6.75 to 13.5 fl oz/A	cyantraniliprole	1	4	H
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H
28 + 6	Minecto Pro*	5.5 to 10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H

Melonworms and Pickleworms

Apply one of the following formulations. When using foliar materials, make one treatment prior to fruit set, and then treat weekly. Check the label for additional instructions when using soil or drip applications.

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
1A	Lannate LV*	1.5 to 3.0 pt/A	methomyl	1-3	48	H
1A	Sevin XLR Plus	0.5 to 1.0 qt/A	carbaryl	3	12	H
3A	Pyrethroid insecticides registered for use on Cucumbers: see table at the end of Insect Control.					
5	Entrust SC (OMRI)	4.0 to 8.0 fl oz/A	spinosad	1	4	M
5	Radiant SC	5.0 to 10.0 fl oz/A	spinetoram	1	4	M
6	Proclaim 5SG*	3.0 to 4.8 oz/A	emamectin benzoate	7	12	H
18	Intrepid 2F	4.0 to 10.0 fl oz/A	methoxyfenozide	3	4	L
22	Avaunt 30WDG, Avaunt eVo	2.5 to 6.0 oz/A	indoxacarb	3	12	H
28	Coragen 1.67SC Coragen eVo	2.0 to 7.5 fl oz/A 0.7 to 2.5 fl oz/A	chlorantraniliprole	1	4	L
28	Exirel	7. 0 to 13.5 fl oz/A	cyantraniliprole	1	12	H
28	Verimark	5.0 to 10.0 fl oz/A	cyantraniliprole - **soil**	1	4	H
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H
28 + 4A	Durivo	10.0 to 13.0 fl oz/A	thiamethoxam + chlorantraniliprole	30	12	H
28 + 4A	Voliam Flexi	4.0 to 7.0 oz/A	thiamethoxam + chlorantraniliprole	1	12	H
28 + 6	Minecto Pro*	5.5 to 10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H

Mites

Mite infestations generally begin around field margins and grassy areas. **Do not mow or maintain field margins and grassy areas after midsummer since this causes mites into the crop**. Local infestations can be spot-treated. Begin treatment when 10-15% of the crown leaves are infested early in the season, or when 50% of the terminal leaves are infested later in the season. **Note:** Continuous use of carbaryl or pyrethroids may result in mite outbreaks.

Apply one of the following formulations:

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
6	Agri-Mek SC*	1.75 to 3.5 fl oz/A	abamectin	7	12	H
10B	Zeal Miticide	2.0 to 3.0 oz/A	etoxazole	7	12	L
20B	Kanemite 15SC	31.0 fl oz/A	acequinocyl	1	12	L
20D	Acramite 50WS	0.75 to 1.0 lb/A	bifenazate	3	12	M
21A	Magister SC	24.0 to 36.0 fl oz/A	fenazaquin	3	12	H
21A	Portal	2.0 pt/A	fenpyroximate	1	12	L
23	Oberon 2SC	7.0 to 8.5 fl oz/A	spiromesifen	7	12	M
28 + 6	Minecto Pro*	5.5 to 10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H

Thrips

Apply one of the following formulations:

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
3A[1]	Pyrethroid insecticides registered for use on Cucumbers: see table at the end of Insect Control.					
4A[2]	Neonicotinoid insecticides registered for use on Cucumbers: see table at the end of Insect Control.					
5	Entrust SC (OMRI)	6.0 to 8.0 fl oz/A	spinosad	1	4	M
5	Radiant SC	6.0 to 10.0 fl oz/A	spinetroram	1	4	M
21A	Torac	21.0 fl oz/A	tolfenpyrad	1	12	H
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H
29	Beleaf 50SG	Drip: 2.8 to 4.28 oz/A	flonicamid	0	12	M

[1]Resistance concerns with western flower thrips [2]Resistance concerns with tobacco thrips

Group 3A Pyrethroid Insecticides Registered for Use on Cucumbers					
Apply one of the following formulations (check if the product label lists the insect you intend to spray; the label is the law):					
Product Name (*=Restricted Use)	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
Asana XL*	5.8 to 9.6 fl oz/A	esfenvalerate	3	12	H
Baythroid XL*	0.8 to 2.8 fl oz/A	beta-cyfluthrin	0	12	H
Brigade 2EC*, others	2.6 to 6.4 fl oz/A	bifenthrin	3	12	H
Danitol 2.4EC*	10.67 to 16.0 fl oz/A	fenpropathrin	7	24	H
Declare*	1.02 to 1.54 fl oz/A	gamma-cyhalothrin	1	24	H
Hero*	4.0 to 10.3 fl oz/A	zeta-cypermethrin + bifenthrin	3	12	H
Lambda-Cy 1EC*, others	2.56 to 3.84 fl oz/A	lambda-cyhalothrin	1	24	H
Mustang Maxx*	1.28 to 4.0 fl oz/A	zeta-cypermethrin	1	12	H
Permethrin 3.2EC*, others	4.0 to 8.0 fl oz/A	permethrin	0	12	H
Tombstone*	0.8 to 2.8 fl oz/A	cyfluthrin	0	12	H
Warrior II*	1.28 to 1.92 fl oz/A	lambda-cyhalothrin	1	24	H
Combo products containing a pyrethroid					
Besiege*	6.0 to 9.0 fl oz/A	lambda-cyhalothrin + chlorantraniliprole (Group 28)	1	24	H
Endigo ZC* and ZCX*	4.0 to 4.5 fl oz/A	lambda-cyhalothrin + thiamethoxam (Group 4A)	1	24	H
Ridgeback*	5.5 to 13.8 fl oz/A	bifenthrin + sulfoxaflor (Group 4C)	3	24	H
Savoy EC*	6.0 to 12.9 fl oz/A	bifenthrin + acetamiprid (Group 4A)	7	12	H

Group 4A Neonicotinoid Insecticides Registered for Use on Cucumbers					
Apply one of the following formulations (check if the product label lists the insect you intend to spray; the label is the law):					
Product Name (*=Restricted Use)	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
Actara 25WDG	1.5 to 5.5 oz/A	thiamethoxam	0	12	H
Platinum 75SG	1.66 to 3.67 oz/A	thiamethoxam	30	12	H
Admire Pro	7.0 to 10.5 fl oz/A	imidacloprid - **soil**	21	12	H
Assail 30SG	2.5 to 5.3 oz/A	acetamiprid	0	12	M
Belay 2.13SC	9.0 to 12.0 fl oz/A	clothianidin - **soil/drip**	21	12	H
Belay 2.13SC	3.0 to 4.0 fl oz/A	clothianidin - **foliar** (note: PHI: do not make application after 4th true leaf has unfolded)	see note	12	H
Scorpion 35SL	9.0 to 10.5 fl oz/A	dinotefuran - **soil/drip**	21	12	H
Scorpion 35SL	2.0 to 7.0 fl oz/A	dinotefuran - **foliar**	1	12	H
Venom 70SG	5.0 to 7.5 oz/A	dinotefuran - **soil/drip**	21	12	H
Venom 70SG	1.0 to 4.0 oz/A	dinotefuran - **foliar**	1	12	H
Combo products containing a neonicotinoid					
Durivo	10.0 to 13.0 fl oz/A	thiamethoxam + chlorantraniliprole (Group 28)	30	12	H
Endigo ZC* and ZCX*	4.0 to 4.5 fl oz/A	thiamethoxam + lambda-cyhalothrin (Group 3A)	1	24	H
Savoy EC*	6.0 to 12.9 fl oz/A	acetamiprid + bifenthrin	7	12	H
Voliam Flexi	4.0 to 7.0 oz/A	thiamethoxam + chlorantraniliprole (Group 28)	1	12	H

Disease Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.

Recommended Fungicides

Nematode Control See sections E 1.5. Soil Fumigation and E 1.6. Nematode Control, or apply one of the following:

Code	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Vydate L*	1.0 to 2.0 gal/A Incorporate into top 2-4 inches of soil, ***OR*** 2.0 to 4.0 pt/A apply 2 w after planting and repeat 2-3 w later.	oxamyl	1	48	H
7	Velum Prime 4.16SC	6.5 to 6.84 fl oz/A	fluopyram	0	12	--
--	Nimitz 4EC	3.5 to 5.0 pt/A Incorporate or drip-apply 7 d before planting	fluensulfone	n/a	12	N

Seed Treatment Check if seed has been treated with an insecticide and fungicide. If it has not been treated, use a mixture of Thiram 480DP (4.5 fl oz/100 lb seed) and an approved commercially available insecticide.

Damping-off caused by *Pythium*, *Phytophthora*, and *Rhizoctonia*

Code	**Product Name (*=Restricted Use)**	Product Rate	**Active Ingredient(s)**	PHI (d)	REI (h)	Bee TR
Apply one of the following at-planting (see label for application methods and restrictions):						
Phytophthora and Pythium root rot						
4	Ridomil Gold 4SL	1.0 to 2.0 pt/A	mefenoxam	5	48	N
4	Ultra Flourish 2E	2.0 to 4.0 pt/A	mefenoxam	5	48	N
4	MetaStar 2E AG	4.0 to 8.0 pt/A	metalaxyl	AP	48	N
49 + **4**	Orondis Gold[1]	28.0 to 55.0 fl oz/A	oxathiapiprolin + mefenoxam	AP	48	N
Phytophthora, Pythium, and Rhizoctonia root rot						
4 + 11	Uniform 3.66SE	0.34 fl oz/1000 ft row. Avoid direct seed contact, which may cause delayed emergence.	mefenoxam + azoxystrobin	AP	0	N
Rhizoctonia root rot						
11	azoxystrobin 2.08F	0.40 to 0.80 fl oz/1000 ft row	azoxystrobin	1	4	N
Pythium root rot only						
28	Previcur Flex 6F	1.2 pt/A in transplant water, drip irrigation, or direct spray at base of plant and soil	propamocarb hydrochloride	2	12	N

[1] may cause some yellowing in cucurbit leaves

Bacterial and Fungal Diseases

Angular Leaf Spot

Resistant varieties should be used when possible (see table Recommended Varieties). At first sign of disease, apply the labeled rates of fixed copper plus mancozeb. Some copper-based products are OMRI listed and can be used in organic production systems to help suppress Angular leaf spot and some fungal diseases. Repeat every 7 days. To minimize the spread of disease, avoid working in the field while foliage is wet.

Anthracnose

Resistant varieties should be used when possible (see table Recommended Varieties). Begin fungicide applications when vines begin to run, or earlier if symptoms are detected. Alternate chlorothalonil or mancozeb with other effective fungicides every 7 days. Fungicides with a high risk for resistance development such as FRAC code 11 fungicides that do not come in a mix with another fungicide active ingredient that is effective on Anthracnose, should be tank-mixed with a protectant fungicide. Use at least the minimum labeled rate of each fungicide in the tank-mix. **Do not** apply FRAC code 11 fungicides more than 4 times total per season. **Do not** apply FRAC code 11 fungicides if resistance exists in the area: use fungicides with a different FRAC code instead.

Code	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
Under LIGHT or MODERATE disease pressure ALTERNATE:						
M05	chlorothalonil 6F	1.5 to 2.0 pt/A	chlorothalonil	0	12	N
WITH a TANK MIX the following fungicide PLUS mancozeb 75DF 2.0 to 3.0 lb/A OR chlorothalonil 6F 2.0 to 3.0 pt/A:						
1	Topsin M WSB	0.5 lb/A	thiophanate-methyl	1	24	N
Under HIGH disease pressure, TANK-MIX one of the following fungicides WITH chlorothalonil 6F 2.0 to 3.0 pt/A:						
3 + 7	Luna Flex 3.13SC	8.0 fl oz/A	difenoconazole + fluopyram	0	12	--
3 + 7	Luna Experience 3.34SC	8.0 to 17.0 fl oz/A	tebuconazole + fluopyram	7	12	--
3 + 11	Quadris Top 1.67SC[1]	12.0 to 14.0 fl oz/A	difenoconazole + azoxystrobin	1	12	--
7 + 11	Merivon 2.09SC[2]	5.5 fl oz/A	fluxapyroxad + pyraclostrobin	0	12	N
7 + 11	Pristine 38WG[2]	18.5 oz/A	boscalid + pyraclostrobin	0	12	--
11	azoxystrobin 2.08F[1,3]	11.0 to 15.5 fl oz/A	azoxystrobin	1	4	N
11	Cabrio 20EG[2]	12.0 to 16.0 fl oz/A	pyraclostrobin	0	12	N
AND ROTATE with a TANK-MIX of the following fungicide PLUS mancozeb 75DF 2.0 to 3.0 lb/A OR chlorothalonil 6F 2.0 to 3.0 pt/A every 7 days						
1	Topsin M WSB	0.5 lb/A	thiophanate-methyl	1	24	N

[1]**Do not apply near apples**, see label.
[2]Tank mixes of additives, adjuvants, and/or other products may result in crop injury.
[3]Do not tank mix with crop oil concentrates, methylated spray oil, or silicon adjuvants. Do not tank mix with Malathion, Thiodan, Lannate, MPede, or Botran.

Bacterial Wilt

Controlling striped and spotted cucumber beetles is essential for preventing bacterial wilt. See preceding "Cucumber Beetle" section under Insect Control for specific recommendations. Insecticide applications made at seeding may not prevent beetle damage all season; additional foliar insecticide applications may be necessary.

Belly Rot (*Rhizoctonia*)

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Apply at the 1 to 3 leaf stage. Make a 2nd application 10-14 d later or just prior to vine tip–over (whichever occurs first):						
11	azoxystrobin 2.08F[1,2]	11.0 to 15.5 fl oz/A	azoxystrobin	1	4	N

[1]Do not tank mix with crop oil concentrates, methylated spray oil, or silicon adjuvants. Do not tank mix with Malathion, Thiodan, Lannate, MPede, or Botran. [2]**Do not apply near apples**, see label.

Cottony Leak (*Pythium*) - See also Damping-off

At planting, apply mefenoxam (Ridomil Gold 4SL, Ultra Flourish 2E) or metalaxyl (MetaStar 2E AG).

Downy Mildew

The pathogen does not overwinter, but introduction to the region can occur early in the year. Newly developed cultivars with resistance or tolerance should be planted where available (see table Recommended Varieties). Even when using resistant cultivars, a good fungicide program is important. However, fungicide efficacy may vary, as strains of the pathogen may vary between seasons.

Scout fields beginning at plant emergence. Strains of Downy Mildew that infect one cucurbit crop may not affect cucumber. Unnecessary fungicide application can be avoided by not spraying until disease is predicted in the region on cucumber. Begin sprays when vines run or earlier if disease occurrence is predicted for the region (check the Cucurbit Downy Mildew Forecasting website at *https://cdm.ipmpipe.org*). Once the disease has become established in an area, new plantings should receive an application of Ranman, or Previcur Flex at the 1-3 leaf stage. **Preventative applications are much more effective than applications made after disease is detected. In addition, spray programs that include fungicides with several different modes of action (FRAC codes) are more effective than programs with one mode of action.** For example, alternate Ranman (Code 21) *PLUS* Gavel (Codes M03 + 22), with Orondis Ultra (Codes 49 + 40) *PLUS* chlorothalonil (Code M05). Follow all fungicide label precautions in order to reduce the chance of resistance development.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
The following are the most effective products. Sprays should be applied on a 7-day schedule. Under severe disease conditions spray interval may be reduced IF the label allows. ALWAYS tank mix these products with a protectant fungicide (listed below):						
49 + 40	Orondis Ultra 2.33SC	5.5 to 8.0 fl oz/A	oxathiapiprolin + mandipropamid	0	4	--
49+M05	Orondis Opti	1.75 to 2.5 pt/A	oxathiapiprolin + chlorothalonil	0	12	--
21	Ranman 400SC	2.10 to 2.75 fl oz/A (**do not apply with copper**; see label for details)[1]	cyazofamid	0	12	L
28	Previcur Flex 6F	1.2 pt/A	propamocarb hydrochloride	2	12	N
43	Presidio 4SC	4.0 fl oz/A (caution: pathogen is now less sensitive to Presidio)	fluopicolide	2	12	L
M05+22	Zing! 4.9SC	36.0 fl oz/A **contains protectant**	chlorothalonil + zoxamide	0	12	N
M05+27	Ariston 42SC	1.9 to 3.0 pt/A **contains protectant**	chlorothalonil + cymoxanil	3	12	--
M03+22	Gavel 75DF	1.5 to 2.0 lb/A **contains protectant**	mancozeb + zoxamide	5	48	--
11 + 27	Tanos 50DF	8.0 oz/A	famoxadone + cymoxanil	3	12	--
27	Curzate 60DF	3.2 to 5.0 oz/A	cymoxanil	3	12	N
40	Forum 4.17SC	6.0 fl oz/A	dimethomorph	0	12	N
40 + 45	Zampro 525SC	14.0 fl oz/A	dimethomorph + ametoctradin	0	12	--
22	Elumin 4SC	8.0 fl oz/A	ethaboxam	2	12	--
29	Omega 500F	12.0 to 24.0 fl oz/A	fluazinam	7	12	N
***TANK-MIX WITH* protectant fungicides:**						
M03	mancozeb 75DF	2.0 to 3.0 lb/A	mancozeb	5	24	N
M05	chlorothalonil 6F	1.5 to 2.0 pt/A	chlorothalonil	0	12	N

[1]Ranman should be tank mixed with an organosilicone surfactant when disease is severe, or a non-ionic surfactant or blend of organosilicone and non-ionic surfactant disease is moderate or light.

Gummy Stem Blight

Gummy Stem Blight occurs primarily in the late summer. Fungicides with a high-risk for resistance development such as Pristine (FRAC code 11) should be tank-mixed with a protectant fungicide to reduce the chances for resistance development. Use at least the minimum labeled rate for each fungicide in the tank mix. **Do not** apply FRAC code 11 fungicides more than 4 times total per season. Apply fungicides from a different FRAC code if resistance to FRAC code 11 fungicides exists in the area. Begin sprays when vines begin to run.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
***ALTERNATE* one of the following formulations:**						
M03	mancozeb 75DF	2.0 to 3.0 lb/A	mancozeb	5	24	N
M05	chlorothalonil 6F	2.0 to 3.0 pt/A	chlorothalonil	0	12	N
WITH A TANK-MIX containing either chlorothalonil or mancozeb PLUS one of the following fungicides:						
3	Proline 480SC	5.7 fl oz/A	prothioconazole	7	12	--
3	Rhyme 2.08SC	5.0 to 7.0 fl oz/A	flutriafol	0	12	--
3 + 9	Inspire Super 2.82EW	16.0 to 20.0 fl oz/A	difenoconazole + cyprodinil	7	12	--
3 + 7	Luna Experience 3.34SC[1]	10.0 to 17.0 fl oz/A	tebuconazole + fluopyram	7	12	--
9 + 12	Switch 62.5WG	11.0 to 14.0 oz/A	cyprodinil + fludioxonil	1	12	L
3 + 7	Aprovia Top 1.62EC	10.5 to 13.5 fl oz/A	difenoconazole + benzovindiflupyr	0	12	--
3 + **11**	Topguard EQ 4.29SC[2,3]	5.0 to 8.0 fl oz/A	flutriafol + azoxystrobin	1	12	--
7 + **11**	Merivon 2.09SC[4]	5.5 fl oz/A	fluxapyroxad + pyraclostrobin	0	12	N
7 + **11**	Pristine 38WG[4]	12.5 to 18.5 oz/A	boscalid + pyraclostrobin	0	12	--
7 + 12	Miravis Prime	9.2 to 11.4 fl oz/A	pydiflumetofen + fludioxonil	1	12	--
11	azoxystrobin 2.08F[2,3,5]	11.0 to 15.5 fl oz/A	azoxystrobin	1	4	N
11	Cabrio 20EG[4,5]	12.0 to 16.0 oz/A	pyraclostrobin	0	12	N

[1]A mild yellowing on leaf margins is sometimes seen following application of Luna Experience in cucurbits.
[2]Do not tank mix with crop oil concentrates, methylated spray oil, or silicon adjuvants. Do not tank mix with Malathion, Thiodan, Lannate, MPede, or Botran.
[3]**Do not apply near apples**, see label. [4]Tank mixes of additives, adjuvants, and/or other products may result in crop injury.
[5]azoxystrobin 2.08F and Cabrio 20EG are not recommended in MD, DE, and VA due to resistance development.

Phytophthora Crown and Fruit Rot

Different strategies should be used to minimize the occurrence of this disease. Rotate away from susceptible crops (such as cucurbits, peppers, lima and snap beans, eggplants, and tomatoes) for as long as possible, improve field drainage, and apply pre-plant fumigants. When conditions favor disease development apply fungicides following excellent resistance management practices. Fungicides provide suppression only. Fruit are susceptible at all growth stages and must be protected season-long.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Apply one of the following fungicides. Rotate fungicides with different FRAC codes and tank mix with a fixed copper.						
49 + 40	Orondis Ultra 2.33SC	5.5 to 8.0 fl oz/A	oxathiapiprolin + mandipropamid	0	4	--
49+M05	Orondis Opti	1.75 to 2.5 pt/A	oxathiapiprolin + chlorothalonil	0	12	--
40	Revus 2.08F	8.0 fl oz/A	mandipropamid	0	4	--
40 + 45	Zampro 525SC	14.0 fl oz/A	dimethomorph + ametoctradin	0	12	--
22	Elumin 4SC	8.0 fl oz/A	ethaboxam	2	12	--
43	Presidio 4SC[1]	4.0 fl oz/A	fluopicolide	2	12	L
M03+22	Gavel 75DF	1.5 to 2.0 lb/A	mancozeb + zoxamide	5	48	--
M05+22	Zing! 4.9SC	36.0 fl oz/A	chlorothalonil + zoxamide	0	12	N
21	Ranman 400SC	2.75 fl oz/A (**Do not apply with copper**; see label for details)[2]	cyazofamid	0	12	L
40	Forum 4.17SC	6.0 fl oz/A	dimethomorph	0	12	N

[1]Presidio may also be applied through the drip irrigation (see supplemental label). Soil drench followed by drip application has given good results in some trials on crown rot caused by *Phytophthora capsici*.
[2]Ranman should be tank mixed with an organosilicone surfactant when disease is severe, or a non-ionic surfactant or blend of organosilicone and non-ionic surfactant disease is moderate or light.

Powdery Mildew

Excellent resistance is available (see table Recommended Varieties). The fungus that causes cucurbit Powdery Mildew has developed resistance to high-risk fungicides. In the Eastern US, resistance to strobilurin (FRAC code 11), DMI (FRAC code 3), and SDHI (FRAC code 7) fungicides has been reported. Proper fungicide resistance management should be followed to help delay the development of resistance and minimize control failures.

Powdery Mildew generally occurs from mid-July until the end of the season. Observe plants for the presence of Powdery Mildew. If one lesion is found on the underside of 45 old leaves/A, begin the following fungicide program:

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
TANK MIX one of these products with a protectant such as chlorothalonil 6F at 2.0 to 3.0 pt/A:						
50	Vivando 2.5SC[1]	15.4 fl oz/A	metrafenone	0	12	--
3 + 7	Luna Experience 3.34SC[2]	6.0 to 17.0 fl oz/A	tebuconazole + fluopyram	7	12	--
AND ALTERNATE with a TANK MIX of one of the following with a protectant such as chlorothalonil 6F at 2.0 to 3.0 pt/A						
3	Proline 480SC	5.7 fl oz/A	prothioconazole	7	12	--
3	Procure 480SC	4.0 to 8.0 fl oz/A	triflumizole	0	12	N
3	Rally 40WSP	2.5 to 5.0 oz/A	myclobutanil	0	24	N
3	tebuconazole 3.6F	4.0 to 6.0 fl oz/A	tebuconazole	7	12	N
3	Rhyme 2.08SC	5.0 to 7.0 fl oz/A	flutriafol	0	12	--
3 + 9	Inspire Super 2.82EW	16.0 to 20.0 fl oz/A	difenoconazole + cyprodinil	7	12	--
3 + 7	Aprovia Top 1.62EC	10.5 to 13.5 fl oz/A	difenoconazole + benzovindiflupyr	0	12	--
3 + **11**	Topguard EQ 4.29SC[3,4]	5.0 to 8.0 fl oz/A	flutriafol + azoxystrobin	1	12	--
7 + **11**	Pristine 38WG[5]	12.5 to 18.5 oz/A	boscalid + pyraclostrobin	0	12	--
U13	Gatten 5EC	6.0 to 8.0 fl oz/A	flutianil	0	12	--
P05	Regalia (OMRI)	4.0 qt/A	Extract of *Reynoutria sachalinensis*	0	4	--
39	Magister 1.6SC[6]	24.0 to 36.0 fl oz/A	fenazaquin	3	12	H
7 + 12	Miravis Prime	9.2 to 11.4 fl oz/A	pydiflumetofen + fludioxonil	1	12	--
U06	Torino 0.85SC	3.4 fl oz/A	cyflufenamid	0	4	--

[1]Do not mix Vivando with horticultural oils.
[2]A mild yellowing on leaf margins is sometimes seen following application of Luna Experience in cucurbits.
[3]Do not tank mix with crop oil concentrates, methylated spray oil, or silicon adjuvants. Do not tank mix with Malathion, Thiodan, Lannate, MPede, or Botran.
[4]**Do not apply near apples**, see label. [5]Tank mixes of additives, adjuvants, and/or other products may result in crop injury.
[6]Do not make more than one application per year of Magister.

Scab

Scab typically occurs during cool periods. Excellent resistance is available in some varieties, and they should be used when possible.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Apply one of the following as true leaves form and repeat every 5-7 days:						
M03	mancozeb 75DF	2.0 to 3.0 lb/A	mancozeb	5	24	N
M05	chlorothalonil 6F	2.0 to 3.0 pt/A	chlorothalonil	0	12	N

Viruses

The most prevalent virus in the Mid-Atlantic region is WMV2, followed by PRSV, ZYMV and CMV. Use varieties with multiple virus resistance when possible (see table Recommended Varieties). Plant fields far away from existing cucurbit plantings to help reduce aphid transmission of viruses into new fields.

Edamame

Edamame (*Glycine max*) is a specialty soybean (immature soybean pod), also known as vegetable soybean, edible soybean, or sweet bean. Although edamame is the same species as the grain (field or oilseed) soybean, edamame seeds are traditionally larger and sweater.

Recommended Varieties

Variety	Estimated Days to Maturity
Besweet 292	87
Chiba Green	82
Gardensoy 31	90's
Gardensoy 41	80's
Midori Giant	75
Tohya	78
VT Sweet	129

Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and Chapter B Soil and Nutrient Management. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede the recommendations found below.

Edamame		Soil Phosphorus Level				Soil Potassium Level				
		Low	Med	High (Opt)	Very High	Low	Med	High (Opt)	Very High	
	N (lb/A)	P_2O_5 (lb/A)				K_2O (lb/A)				Nutrient Timing and Method
	25	120	80	40	0	120	80	40	0	Preplant incorporated
	25									Sidedressed

Pod characteristics

The majority of the commercial edamame cultivars are classified as "short day" in reference to the daily amount of light necessary for their flowering. Pod and seed color, size, pubescence, and number of beans per pod will vary according to the selected cultivars.

Site Selection, Optimum Soil pH

Deep or moderately deep, well drained, and fertile soils are recommended for edamame production. The optimum soil pH for edamame is between 6.0 and 6.5. Avoid fields with a history of heavy disease pressure for legume crops. Plant pathogenic nematodes and soil-borne diseases can negatively affect edamame plant performance. Avoid fields with a history of soil-borne pathogens and high population of cyst nematodes.

Seed treatment

Before edamame planting, it is recommended to inoculate the seeds with a nitrogen fixing bacterium (Rhizobium strain for soybean). If edamame is planted in a field with a history of soybean production, seed inoculation may not be necessary. Alternatively, if seed inoculum is not available, farmers should complement with supplemental fertilizer to meet the crop nitrogen requirements.

Plant Bed Preparation and planting density

Plow and harrow the soil prior to planting to ensure a smooth, leveled soil bed. Plant population can vary between 52,000 and 70,000 plants per acre. There are 1,200 to 1,600 seeds in a pound of edamame seeds. Place rows 30 to 36 inches apart from center to center and plant the seeds 2 to 4 inches apart within the row, no deeper than 0.5 inches. This is equivalent to a seedling rate of 40 to 60 lb/A.

Conservation Tillage

An alternative production system for soybeans consists of crop establishment with minimal disturbance of the soil and therefore, minimal soil erosion. This system is commonly known as conservation tillage. Although conservation tillage has been evaluated in soybean production, it still needs further evaluation for edamame varieties on the east coast of the U.S.

Irrigation

Edamame is a relatively drought-tolerant plant, which tends to respond well to irrigation. Irrigation regimens should be determined by the location's potential evapotranspiration, adjusted to the specific crop coefficient for each growing stage. More research is required to determine edamame irrigation requirements for the east coast of the U.S. Irrigation intervals in a frequency higher than every 3 to 5 days can increase the risk of plant disease. For more information about edamame irrigation management visit: ***https://pubs.extension.wsu.edu/edamame***.

Harvesting

Harvest edamame when the pods are plump, and the beans start to touch within the pod. Whole pods are harvested when bright green, if the pods start to turn yellow, they will be considered unmarketable. Edamame can be harvested either by hand or mechanically. Post-harvest cooling is essential to maintain product quality. The window for harvesting can be as short as 3–4 days, so frequent monitoring is paramount as plants approach maturity. Cooling may be accomplished using forced air, vacuum or hydrocooling. Edamame will retain flavor and appearance for approximately one week after harvest when properly stored.

Weed Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.

Recommended Herbicides

1. Identify the weeds in each field and select recommended herbicides. More information is available in the "Herbicide Effectiveness on Common Weeds in Vegetables" (Table E-3) in Chapter E Pest Management.

2. Minimize herbicide resistance development. Identify the herbicide mode of action group number and follow recommended good management practices; **bolded group numbers in tables below are herbicides at higher risk for selecting resistant weed populations.** Include non-chemical weed control whenever possible.

Labeled Herbicides for Edamame.
Be sure to read labels before purchase to be sure the label specifies either **edamame, vegetable soybeans,** or **immature soybeans. Be sure to check use rates.**

1. Soil-Applied (Preplant Incorporated or Preemergence)

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
2	Pursuit 2L	4 fl oz/A	**imazethapyr**	0.062 lb/A	30	4
-Apply as preplant or preemergence to the soil surface, Primarily controls broadleaf weeds. Combine with another herbicide to control annual grasses. -Pursuit residues persist in the soil after harvest and may affect following crops. Follow label instructions. -Pursuit is an ALS inhibitor, Group 2 herbicide, and there is widespread resistance in the region to this family of herbicides. -Maximum number of applications per year: 1.						
3	Satellite 3.3 Satellite HydroCap 3.8ME	1.5 to 3.6 pt/A 1.5 to 3.0 pt/A	**pendimethalin**	0.62 to 1.5 lb/A	85	24
-Refer to label for rates. Rates vary by application method, soil type, and organic matter content. -Labeled only for preplant incorporated or surface applied application; apply before planting and incorporate thoroughly within the top 2-3 inches of soil. -The lower rates are recommended for early planted fields or coarse-textured soils. -Primarily controls annual grasses and certain broadleaf weeds. -**Do not** use when soils are cold and/or wet soil conditions are anticipated during emergence, or crop injury may result. -**Do not** apply more than once per cropping season.						
7	Lorox 50DF	1.0 to 2.0 lb/A	**linuron**	0.5 to 1.0 lb/A	--	24
-Primarily controls broadleaf weeds and is weak on grasses. Tank mix with Dual Magnum for preemergence annual grass control. -Use lower rates on coarse-textured soil low in organic matter and higher rates on medium- or fine-textured soils with greater organic matter. Lorox has some postemergence activity. -Soybeans planted too shallow have increased risk of injury. -Maximum for Lorox: 2 lb/A per application.						
13	Command 3ME	21.3 fl oz/A	**clomazone**	0.5 lb/A	14	12
-Apply to control annual grasses and many broadleaf weeds including common lambsquarters, velvetleaf, spurred anoda, and jimsonweed. Command will **not** control yellow nutsedge, mustards, morningglory species, or pigweed species. -Use the lower rate on coarse-textured soils low in organic matter and higher rates on fine-textured soils and on soils with high organic matter. Some temporary crop injury (partial whitening of leaf or stem tissue) may be apparent after crop emergence; beans recover from minor early injury without affecting yield or earliness. -**WARNINGS**: Command spray *or* vapor drift may injure sensitive crops and other vegetation up to several hundred yards from the point of application. **Do not** apply adjacent to sensitive crops (see label) or vegetation, or under unfavorable wind or weather conditions. Command may limit subsequent cropping options, see the label. -Maximum number of applications per season: 1.						

1. Soil-Applied (Preplant Incorporated or Preemergence) - continued next page

1. Soil-Applied (Preplant Incorporated or Preemergence) - continued

14	Reflex 2SL	1 to 1.5 pt/A	**fomesafen**	0.25 to 0.375 lb/A	--	24
-Controls several common broadleaf weeds. Tank mix for control of annual grasses. -Maximum of 1.25-1.5 pt/A may be applied either preemergence or postemergence in one year. Maximum rates vary by state (see Regional Use Map on herbicide label for details). -**Do not** apply more than once in a 2-year period (alternate year applications). Rotational restrictions for most vegetables is 18 months.						

2. Postemergence

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
1	Select Max 0.97EC	9 to 16 fl oz/A	**clethodim**	0.07 to 0.125 lb/A	21	12
-**Select Max**: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal spray solution). -Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control. -Addition of nitrogen is not recommended. -Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will **not** be controlled. -For best results, treat annual grasses when they are actively growing and before tillers are present. Control may be reduced if grasses are large or under hot or dry weather conditions. -Repeated applications may be necessary to control certain perennial grasses. If repeat applications are necessary, allow 14 days between applications. -**Do not** tank mix with or apply within 2 to 3 days of any other pesticide, unless labeled, as this may increase the risk of crop injury or reduce the control of grasses. -**Do not** apply more than 16 fl oz/A of Select Max in a single application and **do not** apply more than 1 application per season. -Rainfastness is 1 h						
2	Raptor 1L Beyond Xtra 1L	4 fl oz/A	**imazamox**	0.031 lb/A	--	4
-Apply to control annual broadleaf weeds when the crop has 1-2 fully expanded trifoliate leaves but before bloom stage of bean growth -Add nonionic surfactant to be 0.25% of the spray solution (1 qt/100 gal of spray). **-Strictly observe all plant back restrictions.** -Raptor/Beyond Xtra are ALS inhibitors, Group 2 herbicides, and there is widespread resistance in the region to this family of herbicides. -Rainfastness is 1 h. **Do not** apply more than 4 fl oz/A per year and more than one application per growing season.						
2	Pursuit 2L	4 fl oz/A	**imazethapyr**	0.062 lb/A	--	4
-Add nonionic surfactant to be 0.25% of the spray solution (1 qt/100 gal of spray). -Pursuit residues persist in the soil after harvest and may affect following crops. Follow label instructions. -Pursit is moste effective on weeds less than 3-inches tall. -Pursuit is an ALS inhibitor, Group 2 herbicide, and there is widespread resistance in the region to this family of herbicides. -Rainfastness is 1 h.						
6	Basagran 4L Basagran 5L	1 to 2 pt/A 0.8 to 1.6 pt/A	**bentazon**	0.5 to 1 lb/A	--	48
-Apply when beans have fully expanded first trifoliate leaves. Use lower rate to control common cocklebur, mustards, and jimsonweed and the higher rate to control yellow nutsedge, common lambsquarters, common ragweed, and Canada thistle (2 applications may be needed to control nutsedge and thistle). Basagran will not control pigweed species. -Do not cultivate within 5 days before applying Basagran or within 7 days after application. -Temporary injury may be observed but edamame recover quickly. -The use of oil concentrate may increase the risk and severity of crop injury. To reduce the risk of crop injury, omit additives or switch to a nonionic surfactant when weeds are small and soil moisture is adequate. **Do not** spray when temperatures are over 90°F (32°C). -Rainfastness is 4 h.						
14	Reflex 2SL	Rates vary, refer to the specific label	**fomesafen**	0.125 to 0.375 lb/A	30	24
-Apply when beans have 1-2 fully expanded trifoliate leaves. -Use the lower recommended rate when weeds are small or when there is good soil moisture, high humidity, and warm cloudy weather causing "soft" growing conditions. Add nonionic surfactant at 0.25% of the spray solution (1 qt/100 gal of spray). -Tank mix with bentazon to improve the control of common lambsquarters, smartweed, velvetleaf, cocklebur, galinsoga, and yellow nutsedge. -Reflex provides both residual and postemergence control of susceptible weed species. -Be sure to consider rotational crops when deciding to apply fomesafen. Rainfastness is 1 h. -Maximum Reflex application: 1.25 to 1.5 pt/A IN ALTERNATE YEARS.						

Insect Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F. Recommended Insecticides

Soil Pests

Seed Maggots

Seed maggots are mostly a problem in soils high in organic matter, under moist conditions, and when cool springs delay seed germination. For the best control, plant seeds commercially treated with thiamethoxam (Cruiser 5FS or Cruiser Max), or another comparable neonicotinoid seed treatment.

Above-ground Pests

Bean Leaf Beetles (BLB), Mexican Bean Beetles (MBB), Japanese beetles (JB)

Several beetle species feed on the leaves and pods of beans including BLB (which are similar in size to spotted cucumber beetles), Mexican bean beetle adults (copper-colored ladybeetles with black spots) and larvae (yellow with spines), and JB adults. Early control measures are recommended to reduce yield loss from defoliation and to suppress pest population levels later in the season when pods are forming. Begin spraying at 20% defoliation or 2 to 3 beetles per plant.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1B	Dimethoate 400 (4EC)	0.5 to 1.0 pt/A	dimethoate	0[1]	48	H
3A	Pyrethroid insecticides registered for use on Edamame: see table at the end of Insect Control.					
4A	Neonicotinoid insecticides registered for use on Edamame: see table at the end of Insect Control.					

[1]Mechanical Harvest only

Cutworms See also section E 3.1. Soil Pests - Detection and Control.

Cutworms are a pest of seedling beans, where a single larva can mow down multiple plants. Cutworms hide during the day, but the presence of severed seedlings on the ground usually suggests their presence.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1B	Diazinon AG500*[1]	2.0 to 4.0 qt/A[2]	diazinon	45	72	H
3A	Pyrethroid insecticides registered for use on Edamame: see table at the end of Insect Control.					
28	Coragen 1.67SC Coragen eVo	3.5 to 7.5 fl oz/A 1.2 to 2.5 fl oz/A	chlorantraniliprole	1	4	L

[1]Broadcast just before planting and immediately incorporate into the soil.

Leafminers

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1B	Dimethoate 400	0.5 to 1.0 pt/A	dimethoate	0[1]	48	H
5	Blackhawk 36WG[2]	2.5 to 3.3 oz/A	spinosad	3	4	M
5	Entrust SC (OMRI)	4.5 to 6.0 fl oz/A	spinosad	3	4	M
5	Radiant SC[2]	5.0 to 8.0 fl oz/A	spinetoram	3	4	M
6	Agri-Mek SC*	1.7 to 3.5 fl oz/A	abamectin	7	12	H
17	Trigard 75WSP	2.66 oz/A	cyromazine	7	12	H
28+6	Minecto Pro*	7.5 to 10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H
28	Exirel	10.0 to 20.5 fl oz/A	cyantraniliprole - **foliar**	1	12	H
28	Verimark	6.75 to 13.5 fl oz	cyantraniliprole - **soil**	n/a	4	H

[1]Mechanical Harvest only; [2] Control may be improved by addition of an adjuvant

Mites

Check weekly for mites, starting throughout the summer, especially during a hot, dry season. Concentrate on the field borders and look for the early signs of white stippling at the bases of the leaves. If feeding injury is evident, press the undersides of a few damaged leaves on white paper to reveal any crushed mites. Spot-treat areas along edges of fields when white stippling along veins on the underside of leaves is first noticed. Treatment of the entire field is suggested if live mites are numerous (20 to 30 per leaflet) and more than 50 percent of the plants show stippling, yellowing, or defoliation. Broadspectrum insecticides (Group 1B, 3) will provide initial knockdown, but their continued use may result in outbreaks.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1B	Dimethoate 400	0.5 to 1.0 pt/A	dimethoate	0[1]	48	H
6	Agri-Mek SC*	1.7 to 3.5 fl oz/A	abamectin	7	12	H
20B	Kanemite 15SC	31.0 fl oz/A	acequinocyl	7	12	L
20D	Acramite 50WS	1.0 to 1.5 lb/A	bifenazate	3	12	M

Mites - continued next page

Mites - continued

20D	Acramite 4SC	16.0 to 24.0 fl oz/A	bifenazate	3	12	M
21A	Magister SC	32.0 to 36.0 fl oz/A	fenazaquin	7	12	H
21A	Portal	2.0 pt/A	fenpyroximate	1	12	L
N/A	Sulfur 80WG (OMRI)	3 to 10 lb/A	sulfur	0	24	M

[1]Mechanical Harvest only

Potato Leafhoppers (PLH)

PLH can cause hopperburn on leaves, which can reduce photosynthesis and yield. Seeds treated commercially with thiamethoxam (Cruiser 5FS) are protected from PLH for about 3 weeks post-planting. Sweep netting can help determine if pest densities warrant control. Treat if the number of adults plus nymphs exceeds 100 per 20 sweeps.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	0.75 to 3.0 pt/A	methomyl	see label	48	H
1B	Dimethoate 400	0.5 to 1.0 pt/A	dimethoate	0[1]	48	H
3A	Pyrethroid insecticides registered for use on Edamame: see table at the end of Insect Control.					
4A	Neonicotinoid insecticides registered for use on Edamame: see table at the end of Insect Control.					
4D	Sivanto Prime	7.0 to 14.0 fl oz/A	flupyradifurone	7	4	M
4D	Sivanto 200SL	7.0 to 10.5 fl oz/A	flupyradifurone	7	4	M

[1]Mechanical Harvest only

Soybean Aphids

In our region, soybean aphids are a sporadic pest that typically occurs late in the season. The economic threshold is 250 aphids per plant through the R5 growth stage (pods), after which time plants can tolerate >1,000 aphids with no threat to yield.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	1.5 to 3.0 pt/A	methomyl	see label	48	H
1B	Dimethoate 400	0.5 to 1.0 pt/A	dimethoate	0[1]	48	H
4A	Neonicotinoid insecticides registered for use on Edamame: see table at the end of Insect Control.					
4C	Transform WG	0.75 to 1.0 oz/A	sulfoxaflor	7	24	H
4D	Sivanto 200SL	7.0 to 10.5 fl oz/A	flupyradifurone	7	4	M
4D	Sivanto Prime	7.0 to 14.0 fl oz/A	flupyradifurone	7	4	M
7C + 23	Senstar	8.0 to 10.0 fl oz/A	pyriproxyfen + spirotetramat	7	24	L
23	Movento	4.0 to 5.0 fl oz/A	spirotetramat	1	24	L
29	Beleaf 50SG	2.8 oz/A	flonicamid	7	12	L

[1]Mechanical Harvest only

Stink Bugs

Sweep netting can also be useful to detect stink bugs. Treatment is recommended if adults and nymphs exceed 7 per 50 sweeps during pod development. **Note:** Brown and brown marmorated stink bugs are less susceptible to pyrethroids than green and southern green stink bugs. Careful pyrethroid selection is advised, consult your local Cooperative Extension Service for recommendations for your area.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
3A	Pyrethroid insecticides registered for use on Edamame: see table at the end of Insect Control.					
4A	Neonicotinoid insecticides registered for use on Edamame: see table at the end of Insect Control.					

Tarnished Plant Bugs

Treat only if the number of adults and/or nymphs exceeds 15 per 50 sweeps from the pin pod stage until harvest.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	1.5 to 3 pt/A	methomyl	see label	48	H
1B	Dimethoate 400	0.5 to 1.0 pt/A	dimethoate	0[1]	48	H

Tarnished Plant Bugs - continued next page

Tarnished Plant Bugs - continued

3A	Pyrethroid insecticides registered for use on Edamame: see table at the end of Insect Control.					
4C	Transform WG	1.5 to 2.25 oz/A	sulfoxaflor	7	24	H
29	Beleaf 50SG	2.8 oz/A	flonicamid	7	12	L

[1]Mechanical Harvest only

Thrips

Treatments should be applied if thrips are present from cotyledon stage to when the first true leaves are established and/or when first blossoms form.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	1.5 to 3 pt/A	methomyl	see label	48	H
3A[1]	Pyrethroid insecticides registered for use on Edamame: see table at the end of Insect Control.					
4A[2]	Neonicotinoid insecticides registered for use on Edamame: see table at the end of Insect Control.					
5	Radiant SC[3]	5.0 to 8.0 fl oz/A	spinetoram	3	4	M
5	Blackhawk 36WG[3]	2.5 to 3.3 oz/A	spinosad	3	4	M
5	Entrust SC (OMRI)	4.5 to 6.0 fl oz/A	spinosad	3	4	M

[1]Resistance concerns with western flower thrips **[2]Resistance concerns with tobacco thrips** [3]Control may be improved by addition of an adjuvant

Whiteflies

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
4A	Neonicotinoid insecticides registered for use on Edamame: see table at the end of Insect Control.					
4D	Sivanto Prime	10.5 to 14.0 fl oz/A	flupyradifurone	7	4	M
4D	Sivanto 200SL	10.5 to 14.0 fl oz/A	flupyradifurone	7	4	M
7C + 23	Senstar	8.0 to 10.0 fl oz/A	pyriproxyfen + spirotetramat	7	24	L
21D	Portal	2.0 pt/A	fenpyroximate	1	12	L
23	Movento	4.0 to 5.0 fl oz/A	spirotetramat	1	24	L
28	Exirel	10.0 to 20.5 fl oz/A	cyantraniliprole - **foliar**	1	12	H
28	Verimark	6.75 to 13.5 fl oz	cyantraniliprole - **soil**	n/a	4	H
28	Vantacor	2.5 fl oz/A	chlorantraniliprole (nymphs only)	1	4	L

"Worm" Pests, Including:
Corn Earworms (CEW), Beet Armyworms (BAW), European Corn Borers (ECB), Yellow-Striped Armyworms, and Loopers

Several species of lepidopteran "worm" pests attack beans. The larvae feed on leaves and many also attack pods. An action threshold of about 20% defoliation is often used pre-pod. Once bean pods form, control measures are often needed weekly to protect the crop from direct damage or infestation of the pods. It is usually recommended to include an insecticide that also kills stink bugs. **Note that some localized CEW, BAW, and soybean looper populations have developed resistance to pyrethroids (Group 3A), and that these insecticides should be used with caution and rotated to other insecticide classes within a season. Efficacy of many products can be inconsistent with Soybean Looper. Consult your County Extension Service for local recommendations.**

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	1.5 to 3 pt/A	methomyl	see label	48	H
3A	Pyrethroid insecticides registered for use on Edamame: see table at the end of Insect Control.					
5	Blackhawk 36WG	2.2 to 3.3 oz/A	spinosad	3	4	M
5	Entrust SC (OMRI)	4.0 to 6.0 fl oz/A	spinosad	3	4	M
5	Radiant SC	4.0 to 8.0 fl oz/A	spinetoram - except yellow striped armyworm	3	4	M
11A	XenTari, others (OMRI)	0.5 to 1.5 lb/A	*Bacillus thuringiensis aizawai*	0	4	N
11A	Dipel DF, others (OMRI)	0.5 to 2.0 lb/A	*Bacillus thuringiensis kurstaki*	0	4	N

"Worm" Pests (Corn Earworms (CEW), Beet Armyworms (BAW), European Corn Borers (ECB), Yellow-Striped Armyworms, and Loopers) - continued next page

"Worm" Pests (Corn Earworms (CEW), Beet Armyworms (BAW), European Corn Borers (ECB), Yellow-Striped Armyworms, and Loopers) - continued

18	Intrepid 2F	4.0 to16.0 fl oz/A; 10.0 to 16.0 fl oz/A (CEW)	methoxyfenozide	7	4	L
22	Avaunt Evo	3.5 to 6.0 oz/A	indoxacarb (CEW, ECB only)	3	12	H
28	Coragen 1.67SC Coragen eVo	3.5 to 7.5 fl oz/A 1.2 to 2.5 fl oz/A	chlorantraniliprole	1	4	L
28	Exirel	10.0 to 20.5 fl oz/A	cyantraniliprole - **foliar** (CEW, ECB only)	1	12	H
28	Vantacor	1.2 to 2.5 fl oz/A	chlorantraniliprole - **foliar**	1	4	L
28	Vantacor	1.7 to 2.5 fl oz/A	chlorantraniliprole - **soil**	1	4	L

Group 3A Pyrethroid Insecticides Registered for Use on Edamame

Apply one of the following formulations (check if the product label lists the insect you intend to spray; the label is the law):
Note: Group 3A insecticides are <u>not</u> recommended for BAW or soybean looper due to resistance issues.

Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Asana XL*	2.9 to 9.6 fl oz/A[1]	esfenvalerate	3	12	H
Brigade 2EC*	1.6 to 6.4 fl oz/A	bifenthrin	3	12	H
Hero*	4.0 to 10.3 fl oz/A	zeta-cypermethrin + bifenthrin	3	12	H
Lambda-Cy 1EC*, others	1.92 to 3.84 fl oz/A[1]	lambda-cyhalothrin	7	24	H
Mustang Maxx*	1.28 to 4.0 fl oz/A[1]	zeta-cypermethrin	1	12	H
Warrior II*	0.96 to 1.92 fl oz/A[1]	lambda-cyhalothrin	7	24	H
Combo products containing a pyrethroid					
Besiege*	5.0 to 8.0 fl oz/A[1]	lambda-cyhalothrin + chlorantraniliprole (Group 28)	7	12	H
Brigadier*	3.8 to 5.6 fl oz/A	bifenthrin + imidacloprid (Group 4A)	7	12	H
Ethos XB*	3.4 to 8.5 fl oz/A	bifenthrin + *Bacillus amyloliquefaciens* - **soil**	3	12	H
Ethos XB*	2.8 to 8.5 fl oz/A	bifenthrin + *Bacillus amyloliquefaciens* - **foliar**	3	12	H
Elevest*	4.8 to 9.6 fl oz/A	bifenthrin + chlorantraniliprole (Group 28)	3	12	H

Group 4A Neonicotinoid Insecticides Registered for Use on Edamame

Apply one of the following formulations (check if the product label lists the insect you intend to spray; the label is the law):

Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Admire Pro	7.0 to 10.5 fl oz/A	imidacloprid - **soil**	21	12	H
Admire Pro	1.2 fl oz/A	imidacloprid - **foliar**	7	12	H
Assail 30SG	2.5 to 5.3 oz/A	acetamiprid	7	12	M
Combo products containing a neonicotinoid					
Brigadier*	3.8 to 5.6 fl oz/A	imidacloprid + bifenthrin (Group 3A)	7	12	H

Disease Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.
Recommended Fungicides

<u>Nematodes</u>

See sections E 1.5. Soil Fumigation and E 1.6. Nematode Control. Edamame is susceptible to soybean cyst and root-knot nematodes (among others) and crop rotation away from soybean, other legumes and root-knot susceptible crops is recommended.

<u>Damping-off caused by *Phytophthora, Pythium and Rhizoctonia*</u>

Few seed treatments are labeled for edamame currently and most seed are sold nontreated. Edamame seed germination is typically less than soybean seed. Avoid fields where damping-off has been an issue in the past. Avoid over irrigation, wet soils, or poorly drained fields. Crop rotation to non-leguminous crops may also reduce disease levels. In-furrow applications of Uniform 3.72SE (mefenoxam + azoxystrobin) at 0.34 fl oz/1,000 ft row can be utilized in conventional plantings. See label for application details.

Bacterial and Fungal Diseases

Bacterial Pustule/Blight

Bacterial pustule, caused by *Xanthomonas axonopodis*, has been observed on edamame across the region, however, other bacterial diseases are possible. The disease first appears in the tops of the canopy infecting leaflets during periods of heavy dew or rainfall. Severe infections can lead to damaging defoliation which can cause sunscald on pods. In addition, pod infections are possible deeming them nonmarketable. Cultivars vary widely in their susceptibility to the disease. Cultural practices that reduce canopy moisture (such as avoiding overhead or over irrigation, planting in areas that receive full sunshine, etc.) are recommended. Applications of fixed copper may offer some suppression of disease; however, plant coverage is essential (check individual label for application details).

Fungal Diseases (Anthracnose, Cercospora, Phomopsis/Diaporthe, Septoria)

Edamame is susceptible to several fungal diseases, similar to those seen in commercial soybean. If there is a history of soybean production on your farm, fungicide resistant isolates may be present, and it is advisable to use a tank mix of fungicides or a premix fungicide that possesses multiple mode of actions to ensure the best disease control. In general, applications should begin around flowering (R1 growth stage). Cultivar differences in susceptibility to diseases have been noted in preliminary research on edamame in the Mid-Atlantic region, however, these differences have not been fully documented. As with bacterial diseases, cultural practices that reduce canopy moisture are encouraged (listed in the above section).

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Rotate one of the following FRAC code 7 fungicides:						
7	Endura 70WG	6 to 11 fl oz/A	boscalid	7	12	--
7	Fontelis 1.67SC	14 to 30 fl oz/A	penthiopyrad	0	12	L
With one of the following FRAC code 11 fungicides:						
11	Headline 2.08SC	6 to 9 fl oz/A	pyraclostrobin	7	12	N
11	Aproach 2.08SC	6 to 12 fl oz/A	picoxystrobin	0	12	N
11	azoxystrobin 2.08F	6 to 15.5 fl oz/A	azoxystrobin	0	4	N
3 + 7 + 11	Revytek 3.33SC	8 to 15 fl oz/A	mefentrifluconazole + fluxapyroxad + pyraclostrobin	21	12	--

Eggplant

Recommended Varieties[1]

Type	Variety[1,2]	Days[3]	F_1[4]	Color	Calyx Color	Shape	Type	TMV[5]
Standard Market Type	Gaudi	75	Yes	Black	Green	Oval Long		
	Nadia	70	Yes	Black	Green	Oval Long		X
	Night Shadow	68-75	Yes	Black	Green	Teardrop		
	Picasso	65	Yes	Purple/Black	Green	Teardrop		
	Santana	80	Yes	Black/Purple	Green	Elongated Oval		
	White Star	55	Yes	White	Green	Teardrop		
Specialty Types	Annina	67	Yes	Purple Variegated	Green	Teardrop		
	Barbarella	65	Yes	Purple	Purple	Round	Sicilian	
	Calliope	64	Yes	Purple variegated	Green	Oval	Asian	
	Gretel	55	Yes	White	Green	Mini Slender	Japanese	
	Hansel	55	Yes	Purple	Green	Mini Slender	Japanese	
	Kermit	60	Yes	Green and White	Green	Mini Round	Thai	
	Megal	60	Yes	Purple/Black	Green	Elongated Oval	Italian	X
	Millionaire	55	Yes	Black	Purple	Slender	Japanese	
	Orient Express	58	Yes	Purple	Purple	Slender Long	Asian	
	Palermo	70	Yes	Purple	Purple	Round	Sicilian	
	Purple Shine	70	Yes	Purple	Purple	Slender Long	Chinese	
	Shooting Stars	57	No	Purple variegated	Green	Elongated Oval		
	Shoya Long	55-60	Yes	Purple	Purple	Slender Long	Japanese	

[1]**Listed alphabetically within type**. [2]Variety attributes based on Seed Company information. [3]Days from transplanting till harvest. [4]Hybrid (yes/no). [5]TMV=Tobacco Mosaic Virus. Only those varieties with some resistance or tolerance to TMV are noted with an X.

Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and Chapter B Soil and Nutrient Management. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede the recommendations found below.

Eggplant[1,2]		Soil Phosphorus Level				Soil Potassium Level				
		Low	Med	High (Opt)	Very High	Low	Med	High (Opt)	Very High	
	N (lb/A)	P_2O_5 (lb/A)				K_2O (lb/A)				Nutrient Timing and Method
	125-150[3]	250	150	100	0	250	150	100	0	Total nutrient recommended
	50-100	250	150	100	0	250	150	100	0	Broadcast and disk-in
	25-50	0	0	0	0	0	0	0	0	Sidedress 3-4 weeks after planting
	25-50	0	0	0	0	0	0	0	0	Sidedress 6-8 weeks after planting

For plasticulture, fertilization rates are based on a standard row spacing of 6 ft. [1]Apply 1-2 lb/A of boron (B) with broadcast fertilizer; see also Table B-7. in Chapter B Soil and Nutrient Management. [2]Apply 25-30 lb/A of sulfur (S) for most soils. [3]If crop is to be mulched with plastic but not drip/trickle fertilized, broadcast 125 lb/A N with recommended P_2O_5 and K_2O and disk-in or incorporate prior to laying mulch.

Plant Tissue Testing

Plant tissue testing can be a valuable tool to assess crop nutrient status during the growing season to aid with in-season fertility programs or to evaluate potential deficiencies or toxicities. Critical eggplant tissue test values for most recently matured leaves at early fruit set are N 4.2-6.0 %, P 0.3-0.7 %, K 3.5-5.0 %, Ca 0.8-1.5%, Mg 0.25-0.6% and S 0.4-0.6%. For additional nutrients and other growth stages consult with a tissue testing laboratory or this web link at the University of Florida: *https://edis.ifas.ufl.edu/publication/ep081*.

Seed Treatment

Use hot water seed treatment - see section E 4.3. Disease Control in Seeds, Plant Growing Mix and Plant Beds.

Transplant Production and Transplanting Dates

Sow seeds in the greenhouse 8-10 weeks before field planting. Three to four ounces of seed are necessary to produce plants for 1 acre. Optimum temperatures for germination and growth are 70-75°F. Seedlings should be transplanted to 2-inch or larger pots any time after the first true leaves appear, or seed can be sown directly into the pots and thinned to a single plant per pot.

Harden plants for a few days at 60-65°F and set in field after danger of frost when average daily temperatures have reached 65-70°F. Usual transplanting period is May 15 to June 5. Eggplant is a warm-season crop that grows best at temperatures between 70-85°F. Temperatures below 65°F result in poor growth and fruit set.

Spacing Rows: 4-5 feet apart; plants: 2-3 feet apart in the row. Space plants 18-30 inches apart in PA.

Drip/Trickle Fertilization

Before mulching, adjust soil pH to around 6.5 and then apply enough farm-grade fertilizer to supply 60 lb/A of N, P_2O_5 and K_2O. Thoroughly incorporate fertilizer into the soil. If soil tests medium or less in soil K, apply a fertilizer with a ratio of 1-1-2 or 1-1-3 carrying 60 lb/A of N. After mulching and installing the drip irrigation system, apply completely soluble fertilizers to supply 40 lb/A (10-20 lb/A in PA) of N, P_2O_5 and K_2O during each application. On soils testing low and low to medium in B and that have not received any preplant B fertilizer, include 0.25 lb/A of actual B in each soluble fertilizer application. The first soluble fertilizer application should be applied through the trickle irrigation system within 1 week after field transplanting. The same rate of soluble fertilizer should be applied about every 3 weeks during the growing season for a total of 6-7 applications.

Mulching and Fumigation

The use of black plastic mulch can increase eggplant yield and promote earliness. Various widths of plastic are available for different production systems and available equipment. At least 50% of the N should be in nitrate form (NO_3^{-1}) when planting in fumigated soil under plastic mulch. For more details, see the Weed Control section below.

Staking

High intensity eggplant production can benefit from staking, but the heavy fruit load results in a high cost for staking materials. Use a staking system similar to that described for tomatoes. Pruning is not required for eggplant but removing the two lowest branches helps with plastic removal at seasons end if the plants are mowed off.

Harvest and Post-Harvest Considerations

Fruit should be harvested when the skin is still a glossy color, and the seed and pulp are white. Soft fruit and dark seed indicate over maturity. Mature fruit must be harvested to ensure continued fruit set. Harvested fruit should be moved to a protected area as soon as possible. If left in direct sunlight the fruit will sunburn. Cool eggplants in a cold room with forced-air, or with forced-air and evaporative cooling. Fruit are sensitive to temperatures below 50°F (see fruit disorders below) but can be stored for 1-2 weeks at 50-54°F and 90-95% relative humidity.

Fruit Disorders

Liver Spot and Pitting: 'Liver spot' and 'pitting' are late season physiological disorders that become apparent on the fruit surface post-harvest. Light tan to copper colored spots and scratching may appear after washing; scratching is most likely caused by rough handling or contact of fruit with the ground. Pitting (small slightly sunken brown pits) may also occur. Liver spot and/or pitting are thought to be caused by a thinner waxy fruit cuticle as a result of cooler temperatures. Temperatures at or below 50°F are often associated with both disorders.

Internal Seed Cavity Browning: Symptoms of internal seed cavity browning include the discoloration or browning of the fruit tissue directly surrounding the seed cavity. The discoloration can be caused by low temperatures and/or bruising and compression injury during harvest and post-harvest handling.

Weed Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.

Recommended Herbicides

1. Identify the weeds in each field and select recommended herbicides. More information is available in the "Herbicide Effectiveness on Common Weeds in Vegetables" (Table E-3) in Chapter E Pest Management.

2. Minimize herbicide resistance development. Identify the herbicide mode of action group number and follow recommended good management practices; **bolded group numbers in tables below are herbicides at higher risk for selecting resistant weed populations.** Include non-chemical weed control whenever possible.

Labeled Application Sites for Eggplant

Herbicide (*=Restricted Use)	HRAC group number	Plastic mulch production					Bareground production		
		Soil-Applied		Postemergence					
		Under Plastic	Row Middles	Over Plastic	Row Middles	Post-Harvest	Soil-applied	POST	Post-harvest
Sandea	2		YES		YES		directed[1]		
Dacthal	3							YES[2]	
Prowl H20	3		YES				YES[3]		
Prefar	8	YES	YES				YES		
Devrinol	15	YES	YES				YES		
Poast	1			YES				YES	
Select / Select Max Shadow 3EC	1			YES				YES	
Gramoxone*[5]	22				YES	YES	YES[4]		YES

[1] Sandea is labeled for bareground only if the spray is directed to the row middles. [2] Dacthal is labeled for over the top application, but it will not control emerged weeds. [3] Transplants only. [4] Gramoxone can be applied early preplant, or after planting but before crop emergence. [5] Special Local Needs Label 24(c), be sure it is registered for the specific state and for the intended use.

1. Soil-Applied

<table>
<tr><th>Group</th><th>Product Name (*=Restricted Use)</th><th>Product Rate</th><th>Active Ingredient</th><th>Active Ingredient Rate</th><th>PHI (d)</th><th>REI (h)</th></tr>
<tr><td>2</td><td>Sandea 75DF</td><td>0.5 to 1 oz/A</td><td>halosulfuron</td><td>0.023 to 0.047 lb/A</td><td>30</td><td>12</td></tr>
<tr><td colspan="7">-Plasticulture: row middles only; adjust equipment to keep the spray off the plastic. Bareground: apply between rows of direct-seeded or transplants. Do not apply as broadcast application; avoid contact of the herbicide with the planted crop
-Suppresses or controls yellow nutsedge and certain broadleaf weeds. Sandea provides both residual and postemergence control of susceptible weed species. Effective postemergence control requires an adjuvant.
-Sandea is an ALS inhibiting herbicide and resistant weed populations are common in the region. -Do not use Group 2 herbicides repeatedly in the same field. Do not apply Sandea to crops treated with a soil applied organophosphate insecticide or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application.
-Maximum Sandea applications per year is 2 and do not exceed 2 oz/A during the crop season.</td></tr>
<tr><td>3</td><td>Dacthal 6F
Dacthal W-75</td><td>8 to 14 pt/A
6 to 14 lb/A</td><td>DCPA</td><td>6 to 10.5 lb/A</td><td>--</td><td>12</td></tr>
<tr><td colspan="7">-Labeled for applications over the top of transplants without injury (will not control emerged weeds); transplants should be well established and growing conditions favorable for good plant growth. Label recommends 4 to 6 weeks after transplanting or direct-seeded plants at 4 to 6 inches in height. Post-transplant applications can only be made with bareground production.
-Dacthal will not control emerged weeds; apply to weed-free soils. Primarily controls annual grasses and a few broadleaf weeds, including common purslane. Results have been most consistent when used in fields with coarse -textured soils low in organic matter, and when the application are followed by rainfall or irrigation. Maximum application not addressed on label.</td></tr>
<tr><td>3</td><td>Prowl H2O 3.8CS</td><td>1 to 3 pt/A</td><td>pendimethalin</td><td>0.48 to 1.42 lb/A</td><td>70</td><td>24</td></tr>
<tr><td colspan="7">-Plasticulture: recommended for row middles only. Labeled for under plastic, but no local data or experience with this application.
-Bareground: broadcast preplant or preplant incorporated before transplanting; not labeled for direct-seeded crop.
-Avoid root contact with Prowl-treated soil when placing transplants into furrow or hole or injury may occur.
-Prowl labeled for directed application to transplanted or established direct-seeded eggplant; avoid contact with leaves or stems.
-Prowl will not control emerged weeds, only provides residual control; row middle applications may be made with Gramoxone using shielded sprayers. Use the lower rate on coarse-textured or sandy soils. Activate with ½ inch of rainfall or sprinkler irrigation within 48 hours of application to control most annual grasses and certain broadleaf weeds.
-Maximum Prowl H2O application per season: 3 pt/A.</td></tr>
<tr><td>8</td><td>Prefar 4E</td><td>5 to 6 qt/A</td><td>bensulide</td><td>5 to 6 lb/A</td><td>--</td><td>12</td></tr>
<tr><td colspan="7">-Plasticulture under plastic: apply in a band under the plastic, immediately before laying the mulch. Allow 7 days before making transplant holes to allow condensation to incorporate the herbicide. Plasticulture: row middles application is labeled.
-Bareground: apply preemergence or preplant incorporated.
-Do not incorporate more than 2 inches deep (1 inch is optimum). If applied preemergence, irrigate within 36 h of application with ½ inch of water; if not incorporated with irrigation or rainfall within 36 h, weed control maybe reduced.
-Provides control/suppression of some annual grass weeds and some broadleaves including pigweeds, purslane, and lambsquarters.</td></tr>
<tr><td>15</td><td>Devrinol 2-XT 2EC
Devrinol DF-XT 50DF</td><td>2 to 4 qt/A
2 to 4 lb/A</td><td>napropamide</td><td>1.0-2 lb/A</td><td>--</td><td>24</td></tr>
<tr><td colspan="7">-Plasticulture: labeled for under plastic mulch; apply in a band under the plastic, immediately before laying mulch. Condensation that forms on the underside of the mulch will activate the herbicide. Plasticulture: row middles application is labeled.
-Bareground: apply as broadcast, preemergence treatment for transplanted eggplant. Rainfall or irrigation within 24 h after application improves performance (½ inch sprinkler irrigation).
-Annual grasses and certain annual broadleaf weeds will be suppressed or controlled. May reduce stand and yield of fall planted small grain crop. Moldboard plowing will reduce the risk of injury. -Maximum application per season: 4 qt/A (2-XT) or 4 lb/A (DF-XT).</td></tr>
</table>

2. Postemergence

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
1	Shadow 3EC Select 2EC Select Max 0.97EC	4 to 5.33 fl oz/A 6 to 8 fl oz/A 9 to 16 fl oz/A	**clethodim**	0.07 to 0.125 lb/A	20	24
	Poast 1.5EC	1 to 1.5 pt/A	**sethoxydim**	0.2 to 0.3 lb/A	20	12

-**Select 2EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). **Select Max**: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution). **Shadow 3EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution) for large or stressed grasses; use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution) when crop safety is a concern. **Poast**: Use COC at 1.0% v/v.
-**The use of COC may increase the risk of crop injury when hot or humid conditions prevail**. To reduce the risk of crop injury, omit additives or switch to NIS when grasses are small and soil moisture is adequate.
-Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control.
-Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will **not** be controlled. -Controls many annual and certain perennial grasses, including annual bluegrass, but Poast is preferred for goosegrass control. For best results, treat annual grasses when they are actively growing and before tillers are present. Control may be reduced if grasses are large or if the weather is hot or dry.
-Repeated applications may be necessary to control certain perennial grasses. If repeat applications are necessary, allow 14 days between applications. -Rainfastness is 1 h.
-**Do not** tank mix with or apply within 2 to 3 days of any other pesticide, unless labeled, as this may increase the risk of crop injury or reduce the control of grasses.
-**Do not** apply more than 8 fl oz/A of Select 2EC in a single application and **do not** exceed 2 pt/A for the season; **do not** apply more than 16 fl oz/A of Select Max in a single application and **do not** exceed 4 pt/A for the season.
-**Do not** apply more than 5.33 fl oz/A of Shadow 3EC in a single application and **do not** exceed 21.33 fl oz/A for the season.
-**Do not** apply more than 1.5 pt/A Poast 1.5EC in a single application and **do not** exceed 4.5 pt/A for the season.

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
3	Dacthal 6F Dacthal W-75	8 to 14 pt/A 6 to 14 lb/A	**DCPA**	6.0 to 10.5 lb/A	--	12

-Labeled for applications over the top of transplants. Dacthal will not control emerged weeds; apply to weed-free soils.
-**See comments under soil applied section**

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
22	Gramoxone SL 2.0* Gramoxone SL 3.0*	2 pt/A 1.3 pt/A	**paraquat**	0.5 lb/A	--	24

-Gramoxone can be applied before or after seeding to control emerged broadleaf weeds and grass seedlings.
-For use in plasticulture: row middles as a shielded application.
-Include a nonionic surfactant at 0.25% v/v. **Do not** allow spray to contact crop foliage as injury may result. Use flaps that drag along the edge of plastic mulch and use low spray pressure (maximum of 30 psi) to reduce small droplets that are prone to drift.
-See the label for additional information and warnings. Rainfastness is 30 min. A maximum of 3 applications per year are allowed.
-***Restricted-use pesticide***. Only certified applicators, who successfully complete the paraquat-specific training, can mix, load, or apply paraquat. Application of paraquat "under the direct supervision" of a certified applicator is no longer allowed. Required training link (*https://campus.extension.org/enrol/index.php?id=2201*); certified applicators must repeat training every three years.

3. Postharvest

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
22	Gramoxone SL 2.0* Gramoxone SL 3.0*	2.25 to 3 pt/A 1.5 to 2 pt/A	**paraquat**	0.56 to 0.75 lb/A	--	24

-**Supplemental Label in DE for the use of both Gramoxone formulations for postharvest application to desiccate the crop.**
-Apply after the last harvest for bareground or plasticulture. Always include an adjuvant. -Spray coverage is essential for optimum effectiveness. See the label for additional information and warnings. -Rainfastness 30 min. A maximum of 2 applications for crop desiccation are allowed. -***Restricted-use pesticide***. Only certified applicators, who successfully complete the paraquat-specific training, can mix, load, or apply paraquat. Application of paraquat “under the direct supervision” of a certified applicator is no longer allowed. Required training link (*https://campus.extension.org/enrol/index.php?id=2201*); certified applicators must repeat training every three years.

4. Other Labeled Herbicides

These products are labeled but limited local data are available; and/or are labeled but not recommended in our region due to potential crop injury concerns.

Group	Product Name (*=Restricted Use)	Active Ingredient
14	Aim	**carfentrazone**
14	Vida	**pyraflufen**
14	Aquestra, others	**sulfentrazone**

Insect Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.
Recommended Insecticides

Aphids

Green peach aphids (GPA) are the most common aphids on eggplant. Winged females can produce numerous live pale, yellow or pink-colored young (nymphs). Tremendous numbers can build up on the undersides of leaves often following pyrethroid insecticide applications. Aphids are sucking insects. They excrete a sugary, sticky substance ("honeydew") that can cause growth of black sooty mold fungus. Both honeydew and mold on fruit can hurt its marketability. Predators and parasitoids (braconid wasps) often can keep aphid populations below damaging levels. Broad-spectrum insecticides, like pyrethroids, destroy these natural enemies. Use selective insecticides whenever possible. Sample plants for aphids as well as the presence of natural enemy species. Spray only when aphid densities appear to be increasing in the absence of predators.

Apply one of the following formulations (note: spray coverage to the underside of the leaf is important):						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV* (GPA only)	0.75 to 3.0 pt/A	methomyl	5	48	H
1B	Malathion 57 EC	1 to 1.5 pt/A	malathion	3	12	H
4A	neonicotinoid insecticides registered for use on eggplant: see table at the end of insect control.					
4C	Transform WG	0.75 to 1.0 oz/A	sulfoxaflor	1	24	H
4C + 3A	Ridgeback*	4.5 to 13.8 fl oz/A	sulfoxaflor + bifenthrin	7	24	H
4D	Sivanto Prime or 200SL	21.0 to 28.0 fl oz/A	flupyradifurone - **soil**	45	4	M
4D	Sivanto 200SL	7.0 to 12.0 fl oz/A	flupyradifurone - **foliar**	1	4	M
4D	Sivanto Prime	7.0 to 14.0 fl oz/A	flupyradifurone - **foliar**	1	4	M
9B	Fulfill 50WDG	2.75 oz/A	pymetrozine	0	12	L
9B	PQZ	2.4 to 3.2 fl oz/A	pyrifluquinazon	1	12	L
9D	Sefina	3.0 fl oz/A	afidopyropen	0	12	L
21A	Torac	17.0 to 21.0 fl oz/A	tolfenpyrad	1	12	H
23	Movento	4.0 to 5.0 fl oz/A	spirotetramat	1	24	L
23 + 7C	Senstar	8 to 10 fl oz/A	spirotetramat and pyriproxyfen	1	24	L
28 + 6	Minecto Pro*	10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H
29	Beleaf 50SG	2.8 to 4.28 oz/A	flonicamid	0	12	L
UNF	Botani Gard ES	0.25 to 1 qt/A	*Beauveria bassiana,* strain GHA	0	4	L

Colorado Potato Beetles (CPB)

CPB has the ability to rapidly develop resistance to insecticides (see also section E 3.2. Insecticide Mode of Action: Reducing the Risk of Insecticide Resistance Development). Augmentative releases of the egg parasitoid, *Edovum puttleri*, has been shown to control CPB effectively in eggplant, or apply one of the following insecticides.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Vydate L*	2.0 to 4.0 pt/A	oxamyl – **foliar**	1	48	H
4A	Neonicotinoid insecticides registered for use on Eggplant: see table at the end of Insect Control.					
4D	Sivanto Prime or 200SL	10.5 to 14.0 fl oz/A	flupyradifurone - **foliar**	1	4	M
5	Entrust SC (OMRI)	3.0 to 6.0 fl oz/A	spinosad	1	4	M
5	Radiant SC	5.0 to 10.0 fl oz/A	spinetoram	1	4	M
6	Agri-Mek SC*	1.75 to 3.5 fl oz/A	abamectin	7	12	H
11A	Trident (OMRI) [1]	3.0 to 6.0 qt/A	*Bacillus thuringiensis tenebrionis*[1]	0	4	L
15	Rimon 0.83EC	9.0 to 12.0 fl oz/A	novaluron	1	12	M
21A	Torac	14.0 to 21.0 fl oz/A	tolfenpyrad	1	12	H
28	Coragen 1.67SC Coragen eVo	3.5 to 7.5 fl oz/A 1.2 to 2.5 fl oz/A	chlorantraniliprole	1	4	L
28	Exirel	7.0 to 13.5 fl oz/A	cyantraniliprole	1	12	H
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H
28	Verimark	5.0 to 10.0 fl oz/A	cyantraniliprole - **soil (drip or injection)**	1	4	H
28 + 6	Minecto Pro*	5.5 to 10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H

[1]Larval reduction may not be noticeable for 48-72 h. Apply when eggs begin to hatch and repeat at 5-7-day intervals. If rainfall occurs within 24 h post-treatment, reapplication may be necessary.

Eggplant Lacebugs

Eggplant lacebug is a small sucking insect with lacey wings and conspicuous veins. It can cause stippling and yellowing/whitening of leaves. Most insecticides are not labeled for this sporadic pest; however, use of any insecticide labeled for flea beetles will provide adequate control of this pest. Good insecticide coverage is essential.

Flea Beetles

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
3A	Pyrethroid insecticides registered for use on Eggplant: see table at the end of Insect Control.					
4A	Neonicotinoid insecticides registered for use on Eggplant: see table at the end of Insect Control.					
5	Entrust SC (OMRI)	4.0 to 8.0 fl oz/A	spinosad	1	4	M
21A	Torac	17.0 to 21.0 fl oz/A	tolfenpyrad	1	12	H
28	Verimark	6.75 to 13.5 fl oz/A	cyantraniliprole - **soil at planting**	1	4	H
UNF	Botani Gard ES	0.25 to 1 qt/A	*Beauveria bassiana*, strain GHA	0	4	L

Leafminers

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
3A	Pyrethroid insecticides registered for use on Eggplant: see table at the end of Insect Control.					
4A	Neonicotinoid insecticides registered for use on Eggplant: see table at the end of Insect Control.					
5	Entrust SC (OMRI)	6.0 to 10.0 fl oz/A	spinosad	1	4	M
5	Radiant SC	6.0 to 10.0 fl oz/A	spinetoram	1	4	M
6	Agri-Mek SC*	1.75 to 3.5 fl oz/A	abamectin	7	12	H
15	Rimon 0.83EC	12 fl oz/A	novaluron	1	12	M
28	Exirel	13.5 to 20.5 fl oz/A	cyantraniliprole	1	12	H
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H
28	Verimark	6.75 to 13.5 fl oz/A	cyantraniliprole - **soil at planting**	1	4	H
28	Verimark	6.75 to 10.0 fl oz/A	cyantraniliprole - **soil (drip or injection)**	1	4	H
28 + 6	Minecto Pro*	5.5 to 10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H

Mites

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
6	Agri-Mek SC*	1.75 to 3.5 fl oz/A	abamectin	7	12	H
6 + 28	Minecto Pro*	5.5 to 10.0 fl oz/A	abamectin + cyantraniliprole	7	12	H
10A	Onager 1EC	12 to 24 fl oz/A	hexythiazox	1	12	N
10B	Zeal Miticide	2.0 to 3.0 oz/A	etoxazole	7	12	L
10B	Zeal MVP	23.0 to 34.6 fl oz/A	etoxazole	7	12	L
12B	Vendex 50WP*	2.0 to 3.0 lb/A	fenbutatin-oxide	3	48	N
20B	Kanemite 15SC	31 fl oz/A	acequinocyl	1	12	L
21A	Magister SC	24.0 to 31.0 fl oz/A	fenazaquin	3	12	H
21A	Portal	2.0 pt/A	fenpyroximate	1	12	L
21A	Torac (broad mite only)	14.0 to 21.0 fl oz/A	tolfenpyrad	1	12	H
23	Oberon 2SC	7.0 to 8.5 fl oz/A	spiromesifen	1	12	M
23	Movento (broad mite and tomato russet mite)	4.0 to 5.0 fl oz/A	spirotetramat	1	24	L
20D	Acramite 50WS	0.75 to 1.0 lb/A	bifenazate	3	12	M

Thrips

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
3A[1]	Pyrethroid insecticides registered for use on Eggplant: see table at the end of Insect Control.					
4A[2]	Neonicotinoid insecticides registered for use on Eggplant: see table at the end of Insect Control.					
5	Entrust SC (OMRI)	4.0 to 8.0 fl oz/A	spinosad	1	4	M

Thrips - continued next page

Thrips - continued

5	Radiant SC	6.0 to 10.0 fl oz/A	spinetoram	1	4	M
21A	Torac	21.0 fl oz/A	tolfenpyrad	1	12	H
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H

[1]Resistance concerns with western flower thrips [2]Resistance concerns with tobacco thrips

Group 3A Pyrethroid Insecticides Registered for Use on Eggplant

Apply one of the following formulations (check if the product label lists the insect you intend to spray; the label is the law):

Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Asana XL*	5.8 to 9.6 fl oz/A	esfenvalerate	7	12	H
Baythroid XL*	1.6 to 2.8 fl oz/A	beta-cyfluthrin	7	12	H
Brigade 2EC*, others	2.1 to 6.4 fl oz/A	bifenthrin	7	12	H
Hero*	4.0 to 10.3 fl oz/A	zeta-cypermethrin + bifenthrin	7	12	H
Lambda-Cy EC*, others	1.92 to 3.84 fl oz/A	lambda-cyhalothrin	5	24	H
Mustang Maxx*	2.24 to 4.0 fl oz/A	zeta-cypermethrin	1	12	H
Permethrin 3.2EC*, others	4.0 to 6.0 fl oz/A	permethrin	3	12	H
Proaxis*	2.56 to 3.84 fl oz/A	gamma-cyhalothrin	5	24	H
PyGanic Crop protection EC 5.0 II (OMRI)	4.5 to 15.61 fl oz/A	pyrethrins	0	12	H
Tombstone*	1.6 to 2.8 fl oz/A	cyfluthrin	7	12	H
Warrior II*	1.28 to 1.92 fl oz/A	lambda-cyhalothrin	5	24	H
Combo products containing a pyrethroid					
Besiege*	6.0 to 9.0 fl oz/A	lambda-cyhalothrin + chlorantraniliprole (Group 28)	5	24	H
Brigadier*	3.8 to 9.85 fl oz/A	bifenthrin + imidacloprid (Group 4A) **- foliar**	7	12	H
Endigo ZC* and ZCX*	4.0 to 4.5 fl oz/A	lambda-cyhalothrin + thiamethoxam (Group 4A)	5	24	H
Leverage 360*	3.8 to 4.1 fl oz/A	beta-cyfluthrin + imidacloprid (Group 4A)	7	12	H
Ridgeback*	4.5 to 13.8 fl oz/A	bifenthrin + sulfoxaflor (Group 4C)	7	24	H

Group 4A Neonicotinoid Insecticides Registered for Use on Eggplant

Apply one of the following formulations (check if the product label lists the insect you intend to spray; the label is the law):

Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Admire Pro	7.0 to 10.5 fl oz/A	imidacloprid - **soil**	21	12	H
Admire Pro	1.3 to 2.2 fl oz/A	imidacloprid - **foliar**	0	12	H
Assail 30SG	1.5 to 4.0 oz/A	acetamiprid	7	12	M
Assail 30SC	1.3 to 3.4 fl oz/A	acetamiprid	7	12	M
Belay 50WDG	1.6 to 2.1 oz/A	chlothianidin - **foliar**	7	12	H
Belay 50WDG	4.8 to 6.4 oz/A	clothianidin - **soil**	7	12	H
Actara 25WDG	2.0 to 3.0 oz/A	thiamethoxam	0	12	H
Platinum 75SG	1.66 to 3.67 oz/A	thiamethoxam	30	12	H
Scorpion 35SL	9.0 to 10.5 fl oz/A	dinotefuran - **soil**	21	12	H
Scorpion 35SL	2.0 to 7.0 fl oz/A	dinotefuran - **foliar**	1	12	H
Venom	5.0 to 7.5 oz/A	dinotefuran - **soil**	21	12	H
Venom	1.0 to 4.0 oz/A	dinotefuran - **foliar**	1	12	H
Combo products containing a neonicotinoid					
Brigadier*	3.80 to 9.85 fl oz/A	imidacloprid + bifenthrin (Group 3A) - **foliar**	7	12	H
Durivo	10.0 to 13.0 fl oz/A	thiamethoxam + chlorantraniliprole (Group 28)	30	12	H
Endigo ZC and ZCX*	4.0 to 4.5 fl oz/A	thiamethoxam + lambda-cyhalothrin (Group 3A)	5	24	H
Leverage 360*	3.8 to 4.1 fl oz/A	imidacloprid + beta-cyfluthrin (Group 3A)	7	12	H
Voliam Flexi	4.0 to 7.0 oz/A	thiamethoxam + chlorantraniliprole (Group 28)	1	12	H

Disease Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.
Recommended Fungicides

Nematodes

See sections E 1.5. Soil Fumigation and E 1.6. Nematode Control.

Seed Treatment

Use hot water seed treatment - see section E 4.3. Disease Control in Seeds, Plant Growing Mix and Plant Beds.

Damping-off caused by *Phytophthora*, *Pythium*, and *Rhizoctonia*

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Apply one of the following at-planting (see label for application methods and restrictions):						
Phytophthora and Pythium root rot[1]						
4	Ridomil Gold 4SL	0.5 to 1.0 pt/A	mefenoxam	5	48	N
4	Ultra Flourish 2E	2.0 to 4.0 pt/A	mefenoxam	5	48	N
4	MetaStar 2E AG	4.0 to 8.0 pt/A	metalaxyl	AP	48	N
4 + 49	Orondis Gold	28.0 to 55.0 fl oz/A	mefenoxam + oxathiapiprolin	AP	48	N
Phytophthora, Pythium, and Rhizoctonia root rot						
4 + 11	Uniform 3.66SE	0.34 fl oz/1000 ft row. Avoid direct seed contact, which may cause delayed emergence.	mefenoxam + azoxystrobin	AP	0	N
Rhizoctonia root and stem rot						
11	azoxystrobin 2.08F[2]	0.40 to 0.80 fl oz/1000 ft row	azoxystrobin	AP	4	N
3 + 7	Aprovia Top 1.62EC[3]	10.5 to 13.5 fl oz/A	difenoconazole + benzovindiflupyr	14	12	--

[1]Also see Phytophthora Blight - Root and Crown Rot below.
[2]Rhizoctonia can become a problem in transplants that have been in transplant trays for too long prior to transplanting, or in transplants shortly after planting where the root zone is allowed to become excessively dry. To help suppress Rhizoctonia root rot apply the following via drip at transplanting.
[3]Apply as a foliar application for bare soil beds; will also help suppress Southern Blight

Bacterial and Fungal Diseases

Phytophthora Blight (*Phytophthora capsici*) - Root and Crown Rot

To minimize the occurrence of Phytophthora blight, rotate fields away from susceptible crops (such as cucurbits, peppers, eggplants, and tomatoes) for as many years as possible. Avoid using mefenoxam if insensitivity is known to exist. Sensitivity to mefenoxam can return if it has not been used in recent years.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Apply one of the following formulations via drip application at transplanting and 30 days later:						
4	Ridomil Gold 4SL	1.0 pt/A	mefenoxam	7	12	N
4	Ultra Flourish 2E	1.0 qt/A	mefenoxam	7	12	N
4 + 49	Orondis Gold[1,2]	28.0 to 55.0 fl oz/A	mefenoxam + oxathiapiprolin	7	48	--
If conditions favor disease development, apply the following drip application 14 d after at-transplanting applications:						
43	Presidio 4SC	3.0 to 4.0 fl oz/A	fluopicolide	2	12	L

[1]If Orondis Gold is applied via drip application it cannot be applied as a foliar spray.
[2]Orondis Gold can be applied in transplant water, see label for rates and restrictions.

Phytophthora Blight (*Phytophthora capsici*) - Fruit and Stem Rot

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
For suppression of the aerial stem and fruit rot phase of Phytophthora blight, apply and rotate the following with a fixed copper at labeled rates on a 7 to 10 day schedule or when environmental conditions are conducive for disease development:						
21	Ranman 400SC	2.75 fl oz/A *PLUS* a non-ionic surfactant **(do not apply Ranman with copper)**	cyazofamid	0	12	L

Phytophthora Blight (Phytophthora capsici) - Fruit and Stem Rot - continued next page

Phytophthora Blight (Phytophthora capsici) - Fruit and Stem Rot - continued

40	Forum 4.17SC	6.0 fl oz/A	dimethomorph	0	12	N
43	Presidio 4SC	3.0 to 4.0 fl oz/A	fluopicolide	1	12	L
4 + 49	Orondis Gold	28.0 to 55.0 fl oz/A	mefenoxam + oxathiapiprolin	7	48	--

[1]If Orondis Gold is applied via a foliar application it cannot be applied via drip system. See label for restrictions.

Fungal Fruit Rots

Scout regularly and begin preventative sprays when weather conditions favor disease development and repeat every 7-10 days. Do not apply FRAC code 11 fungicides more than 4 times in a single year. Tank mix and rotate with a protectant fungicide such as fixed copper or chlorothalonil and rotate with other FRAC codes to help reduce resistance development.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Tank mix chlorothalonil 1.5 pt 6F/A or fixed copper at labeled rates with one of the following FRAC code 11 fungicides:						
3 + 11	Quadris Top 1.67SC	8.0 to 14.0 fl oz/A	difenoconazole + azoxystrobin	0	12	--
7 + 11	Priaxor 4.17SC	4.0 to 8.0 fl oz/A	fluxapyroxad + pyraclostrobin	7	12	N
And rotate with one of the following:						
M01	copper (OMRI)[1]	at labeled rates	copper	0	24	N
M05	chlorothalonil 6F	1.5 pt/A	chlorothalonil	3	12	N

[1]There are several OMRI listed copper-based products; see labels for specifics. Copper applications may help suppress some fungal pathogens in organic production systems.

Fungal Leaf Spots

Scout on a regular basis and begin preventative sprays when weather conditions favor disease development, or when symptoms of disease first appear, and repeat every 7-10 days. Do not apply FRAC code 11 fungicides more than 4 times in a single year. Tank mix FRAC code 7 or 11 fungicides with a protectant fungicide and rotate with other FRAC codes to help reduce resistance development.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Tank mix chlorothalonil 6F 1.5 pt/A or fixed copper at labeled rates with one of the following fungicides:						
7	Fontelis 1.67SC	10.0 to 24.0 fl oz/A	penthiopyrad	7	12	L
7 + 12	Miravis Prime	9.2 to 11.4 fl oz/A	pydiflumetofen + fludioxonil	0	12	--
Tank mix chlorothalonil 6F 1.5 pt/A or fixed copper at labeled rates with one of the following fungicides:						
11	azoxystrobin 2.08F	6.0 to 15.5 fl oz/A	azoxystrobin	0	4	N
11	Cabrio 20EG	8.0 to 12.0 oz/A (Leaf spots only)	pyraclostrobin	0	12	N
3 + 11	Quadris Top 1.67SC	8.0 to 14.0 fl oz/A	difenoconazole + azoxystrobin	0	12	--
And rotate with one of the following:						
M01	copper (OMRI)[1]	at labeled rates	copper	0	24	N
M05	chlorothalonil 6F	1.5 pt/A	chlorothalonil	3	12	N

[1]There are several OMRI listed copper-based products; see labels for specifics. Copper applications may help suppress some fungal pathogens in organic production systems.

Verticillium Wilt

The best control can be accomplished by using a 4 to 5 year rotation with crops other than tomato, potato, pepper, strawberry, or any of the brambles. Varieties which appear to maintain yield in infested fields include Classic, and Epic. Soil fumigation will provide some control by delaying symptom expression. Use metam-sodium (Vapam HL - see label for specifics and restrictions). Broadcast treatments are superior to row treatments. Refer to section E 1.5. Soil Fumigation for details on application.

Viruses

Tomato Spotted Wilt Virus

Tomato Spotted Wilt Virus is spread by thrips from flowering ornamental plants to eggplant. Do not grow any ornamental bedding plants in the same greenhouse as eggplant transplants. Monitor and scout greenhouses for thrips and begin an insecticide control program once observed.

Garlic

Recommended Varieties

Obtain the best strains of Italian or German "Rocambole" garlic (late or pink-skinned type), Polish softneck types that will braid (no hard seed stalk), or Elephant types from a reputable agriculture products vendor or a local grower who has had success with fall-planted garlic. A locally grown strain will be hardy and may overwinter better than many commercially available strains. Avoid Creole garlics (also called Early, Louisiana, White Mexican, etc.), since they are not very winter-hardy and do not keep well.

Bulbs of both Creole and Italian garlic have a white outer skin, but the Italian type has a pink skin around each clove. Elephant garlic (*Allium ampeloprasum*) is a type of leek that produces bulbils, is milder than regular garlic, and up to four times larger. However, Elephant garlic may not yield well when fall-planted in areas with severe cold or extensive freezing and thawing cycles, which cause heaving. The Italian and Elephant types take about 220 days to mature.

Many of the most productive Italian garlic strains will produce seed stalks prior to harvest. Snap these seed stalks just as they begin to coil for the best yields. "Rocambole" types have coiled seed stalks that are perfectly normal and not the result of any poor cultural practice or herbicide contamination.

Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and Chapter B Soil and Nutrient Management. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede the recommendations found below.

		Soil Phosphorus Level				Soil Potassium Level				
		Low	Med	High (Opt)	Very High	Low	Med	High (Opt)	Very High	
Garlic[1]	N (lb/A)	P_2O_5 (lb/A)				K_2O (lb/A)				Nutrient Timing and Method
	125	150	150	150	0	150	150	150	0	Total nutrient recommended
	75	150	150	150	0	150	150	150	0	Broadcast and disk-in
	25[2]	0	0	0	0	0	0	0	0	Topdress[2] when 6 inches tall (March 15)
	25[2]	0	0	0	0	0	0	0	0	Topdress[2] 6 weeks after first split (May 1)

[1]Apply a total of 25-30 lb/A of sulfur (S) for most soils.

[2]Apply all topdressing at mid-day when plants are dry to reduce the chance of burn. Use ammonium sulfate for the second topdressing to help with pungency.

Planting

Garlic cloves should be planted in mid-October in central PA. They could be planted up to 10 days earlier in cool, short-season areas and up to 3 weeks later in warm, long-season areas. Growers should plant as late as possible to escape damage from the fall generation of the allium leafminer if present in the growing area (See "Allium Leafminers" in Insect Control section.) Yield tends to increase with the size of the mother bulb. Do **not** use the following for planting: long, slender cloves in the center of the bulb, cloves weighing less than 1 gram, or bulbs with side growths and very poor skin covering of cloves.

Garlic must be exposed to temperatures between 32-50°F (0-10°C) for about 2 months prior to the long day-length periods that induce bulbing. Fall-planted garlic establishes an excellent root system and receives a natural cold treatment that produces the highest possible garlic yields. Spring-planted garlic (*e.g.*, Elephant type) may be successful where it can be planted by early March.

Spacing

Cloves should be planted 4 by 4 inches apart in triple rows or multiple beds 16-18 inches apart. Between-row spacing depends on the equipment available. Clove tops should be covered with 1-1½ inches of soil. Cloves must not be so deep that the soil will interfere with the growth of the bulbs, nor so shallow that rain, heaving from alternate freezing and thawing, and birds may dislodge them. Cloves placed with the root end down give optimum results. Cloves dropped into furrows will be in various positions and may produce plants with crooked necks.

Harvest and Post-Harvest Considerations

Fall-planted garlic is ready for harvesting about the second week in July when 40-60% of the leaves have yellowed (garlic generally has 6 leaves). When plants reach this stage pull a sample. There are only about 10-14 days for optimum harvest, when each clove is fully segmented and yet fully covered by a tight outer skin. Before the optimum harvest time, garlic is unsegmented like an onion. After the optimum time, cloves may have separated, the outer sheath split, and part of the naked cloves may be exposed.

Run a cutter bar under the bulbs to cut the extensive root system and partially lift the bulbs. Bulbs can be pulled and gathered into windrows. Tops are placed uppermost in the windrow to protect bulbs from the sun. Garlic is left in the field for a week or more to dry or cure thoroughly. Curing can also be accomplished in a well-ventilated shed or barn. Use this option when rain is forecasted. Bulbs must be thoroughly dried before being shipped or stored.

After curing, remove the outer loose portions of the sheath, and trim the roots close to the bulbs. Braid or bunch the tops together or cut off the tops and bag the bulbs like dry onions. Discard diseased and damaged bulbs.

When properly cured, garlic keeps well under a wide range of temperatures. Temporary storage in open-mesh sacks in a dry, well-ventilated storage room at 60-90°F is acceptable. However, storage at 32-35°F and 65% relative humidity (the same conditions as required for onions) is best. Avoid prolonged storage near 40°F to prevent sprouting of cloves. and avoid a relative humidity above 70% to prevent sprouting and development of mold. Do not store bulbs for planting next fall below 50°F to prevent vernalization of the cloves.

If dry bulb mites have been a problem, garlic bulbs should be handled as follows: after a brief period of field drying, move the crop into a high tunnel for 7 to 14 days to complete drying. Use shade cloth to keep the bulbs from getting too hot and the bulbs should be cut from the stems before drying. When drying is done, move the bulbs indoors and store at 70°F and 70% relative humidity. Avoid temperatures above 80°F. For direct marketing the bulbs can be stored below 40°F and removed from cold storage just before selling.

Marketing

New growers should develop a local retail market (roadside stands, night markets, and gourmet restaurants), wholesale shipper, or processing market before planting. The demand for garlic is increasing due to recent reports about its health and medical benefits.

Weed Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.

Recommended Herbicides

1. Identify the weeds in each field and select recommended herbicides. More information is available in the “Herbicide Effectiveness on Common Weeds in Vegetables” (Table E-3) in Chapter E Pest Management.

2. Minimize herbicide resistance development. Identify the herbicide mode of action group number and follow recommended good management practices; **bolded group numbers in tables below are herbicides at higher risk for selecting resistant weed populations.** Include non-chemical weed control whenever possible.

1. Soil-Applied (Preplant Incorporated or Preemergence)						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient**	**Active Ingredient Rate**	**PHI (d)**	**REI (h)**
8	Prefar 4E	5 to 6 qt/A	**bensulide**	5 to 6 lb/A	--	12
-Labeled for preplant incorporated or preemergence applications; **do not** incorporate more than 2 inches deep (1 inch is optimum). -If applied preemergence, irrigate within 36 h of application with ½ inch of water; if not incorporated with irrigation or rainfall within 36 h, weed control maybe reduced. -Provides control/suppression of some annual grass weeds and some broadleaves including pigweeds, purslane, and lambsquarters. -**Do not** apply more than 6 lb ai/A per season.						
27	Optogen 1.67	2.6 to 3.5 fl oz/A	**bicyclopyrone**	0.034 to 0.046 lb/A	45	24
-**Labeled for transplants only. DO NOT USE ON MINERAL SOILS.** -Apply prior to transplanting and avoid moving treated soil during transplanting. -No local experience with Optogen as a soil-applied herbicide. -Do not make more than one application per year.						

2. Postemergence

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
1	Shadow 3EC Select 2EC Select Max 0.97EC	4 to 5.33 fl oz/A 6 to 8 fl oz/A 9 to 32 fl oz/A	**clethodim**	0.07 to 0.125 lb/A 0.07 to 0.125 lb/A 0.07 to 0.25 lb/A	45	24
	Fusilade DX 2EC	8 to 24 fl oz/A	**fluazifop**	0.125 to 0.375 lb/A	45	12
	Poast 1.5EC	1 to 1.5 pt/A	**sethoxydim**	0.2 to 0.3 lb/A	30	12

-**Select 2EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). **Select Max**: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution). **Fusilade DX:** use COC at 1.0% v/v or NIS at 0.25% v/v. **Shadow 3EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution) for large or stressed grasses; use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution) when crop safety is a concern. **Poast**: use COC at 1.0% v/v.
-**The use of COC may increase the risk of crop injury when hot or humid conditions prevail**. To reduce the risk of crop injury, omit additives or switch to NIS when grasses are small and soil moisture is adequate.
-Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control.
-Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will **not** be controlled.
-Controls many annual and certain perennial grasses, including annual bluegrass, but Poast is preferred for goosegrass control. For best results, treat annual grasses when they are actively growing and before tillers are present. Control may be reduced if grasses are large or under hot or dry weather conditions. Repeated applications may be necessary to control certain perennial grasses. If repeated applications are necessary, allow 14 days between applications. **-Do not** tank mix with or apply within 2 to 3 days of any other pesticide, unless labeled, as this may increase the risk of crop injury or reduce the control of grasses.
-Rainfastness is 1 h.
-**Do not** apply more than 8 fl oz/A of Select 2EC in a single application and **do not** exceed 2 applications per season; **do not** apply more than 32 fl oz/A of Select Max in a single application and **do not** exceed 4 pt/A for the season.
-**Do not** apply more than 5.33 fl oz/A of Shadow 3EC in a single application and **do not** exceed 21.33 fl oz/A for the season.
-**Do not** apply more than 24 fl oz/A of Fusilade DX in a single application and **do not** exceed 3 pt/A for the season.
-**Do not** apply more than 1.5 pt/A of Poast in a single application and **do not exceed** 4.5 pt/A for the season.

Group	Product Name	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
6	Maestro 2E	1.5 to 2 pt/A	**bromoxynil**	0.38 to 0.5 lb/A	60/112*	24

-Apply after garlic emergence but before 12 inches in height. -Apply in a minimum of 20 gal/A. No surfactant or adjuvant is recommended due to risk of crop injury. -Apply to small broadleaf weeds (up to 4-leaf stage, 2 inches in height or 1 inch diameter).
-Rainfastness 1 h. **Do not** apply more than 2 pt/A during the season.
-**Do not** harvest for 112 days after application on mineral soils or 60 days on muck soils grown in the northeastern US.

Group	Product Name	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
27	Optogen 1.67	3.5 fl oz/A	**bicyclopyrone**	0.046 lb/A	45	24

-For use with transplanted garlic only.
-Use nonionic surfactant (NIS) at 0.25% v/v (1qt/100 gal of spray solution) or crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). Ammonium sulfate (AMS) at 8.5 to 17 lb/100 gal spray solution may be added for improved control of emerged weeds
-Apply after transplanting as either row middle treatment or as a directed spray. Hooded or shielded sprayers will reduce the risk of injury for row middle or directed sprays. **-Contact with foliage will cause injury.**
-Apply to small weeds (less than 2" tall). Optogen provides control for only a few weed species, should be used in combination with other herbicides. -Rainfastness is not specified on the label. -Do not make more than one application per year.

3. Other Labeled Herbicides These products are labeled but limited local data are available; and/or are labeled but not recommended in our region due to potential crop injury concerns.

Group	Product Name (*=Restricted Use)	Active Ingredient
3	Prowl H20 / Prowl 3.3EC	**pendimethalin**
14	Aim	**carfentrazone**
14	Chateau	**flumioxazin**
14	Goal or GoalTender	**oxyfluorfen**
15	Outlook	**dimethenamid**

Insect Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F. Recommended Insecticides

Allium Leafminers

This new pest to the Mid-Atlantic area is a grey-black fly with a distinctive yellow or orange patch on its head, yellow sides and "knees" (femur-tibia junction), and white halteres (knobs in place of 2nd pair of wings). The larvae are a typical whitish maggot. Leek (*A. porrum*) and scallions (green onions) tends to be the most damaged Allium species or cultivars. Adult females repeatedly puncture leaves with their ovipositors, resulting in a line of small white dots. Leaves can be wavy, curled, and distorted. Larvae mine leaves and move towards and into bulbs and leaf sheathes where they pupate. Covering plants in April-May, or September-October, during adult flight, can exclude the pest. Other suggested methods include avoiding the adult oviposition period by delaying planting in the spring. Systemic and contact insecticides can be effective.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
3A	Mustang Maxx*	2.88 to 4.0 fl oz/A	zeta-cypermethrin	7	12	H
3A	Warrior II*	0.96 to 1.60 fl oz/A	lambda-cyhalothrin	14	24	H
4A	Scorpion 35 SL	8.75 to 10.5 fl oz/A	dinotefuran - **soil**	21	12	H
4A	Scorpion 35 SL	5.25 to 7.0 fl oz/A	dinotefuran - **foliar**	1	12	H
4A	Venom 70SG	5.0 to 6.0 oz/A	dinotefuran - **soil**	21	12	H
4A	Venom 70SG	3.0 to 4.0 oz/A	dinotefuran - **foliar**	1	12	H
5	Entrust SC (OMRI)	3.0 to 6.0 fl oz/A	spinosad	1	4	M
5	Radiant SC	6.0 to 10.0 fl oz/A	spinetoram	1	4	M
17	Trigard 75WSP	2.66 oz/A	cyromazine	0	12	H
28	Exirel	13.5 to 20.5 fl oz/A	cyantraniliprole	1	12	H
28 + 6	Minecto Pro*	7.0 to 10.0 fl oz/A	cyantraniliprole + abamectin	30	12	H

Beet Armyworms (BAW)

Beet armyworm comes into our area from the South usually in late July. Female moths lay egg masses on the underside of leaves that are covered in scales with a fuzzy appearance. Young larvae are greyish or dark green with distinct dark heads. Most larvae have a distinct black spot on the second abdominal segment. BAW damage is characterized by leaf skeletonization. One of the best scouting methods is to examine nearby pigweed or lambsquarters weeds, as BAW typically infests those plants first. BAW control can be challenging as they are resistant to certain insecticides, particularly pyrethroids.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	1.5 pt/A	methomyl	7	48	H
5	Entrust SC (OMRI)	3.0 to 6.0 fl oz/A	spinosad	1	4	M
5	Radiant SC	5.0 to 10.0 fl oz/A	spinetoram	1	4	M
28	Vantacor	1.2 to 2.5 fl oz/A	chlorantraniliprole	1	4	L
28	Coragen 1.67SC Coragen eVo	3.5 to 7.5 fl oz/A 1.2 to 2.5 fl oz/A	chlorantraniliprole	1	4	L

Dry Bulb Mite and Bulb Mite

Bulb mites from two different families can infest garlic. Dry bulb mite is a pest of stored garlic that, while not a problem every growing season, has been reported more often in recent years. Dry bulb mite is an Eriophyid mite that cannot be seen without magnification. Dry bulb mites multiply in storage and feed on the surface of stored cloves causing drying and shriveling. There are currently no chemical treatments available for dry bulb mite management (researchers in New York state showed that some previously listed chemical control methods are ineffective). Heat treatment of cloves for planting can be effective but temperature control is critical and reduced germination has been observed. Proper handling and storage procedures for harvested bulbs is currently the only option available to manage these mites. See information in the Harvest and Post-Harvest Considerations section above.

Another bulb mite pest is the larger and visible Acarid bulb mite, which can damage stored garlic bulbs but also growing plants in fields. Infested cloves exhibit poor root growth and increased incidence of fungal decay.

For both types of mites, do not plant new bulbs into previously infested fields and do not save bulbs from infested fields for replanting.

Thrips

Thrips have mouth parts that pierce plant tissue and remove plant liquids resulting in whitish or chlorotic streaks or blotches. During hot, dry weather, the population of thrips increases following harvest of adjacent alfalfa or grain fields; thrips could at this time pose the most serious insect problem on garlic. *(continued next page)*

Thrips - continued

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Apply one of the following formulations (note: The use of spinosad or methomyl for beet armyworm control will suppress thrips populations):						
1B	Malathion 57 EC	1.5 to 2.0 pt/A	malathion	3	24	H
3A[1]	Mustang Maxx*	2.88 to 4.0 fl oz/A	zeta-cypermethrin	7	12	H
3A[1]	Permethrin*, others	6.0 to 12.0 fl oz/A	permethrin	1	12	H
3A[1]	Proaxis*	2.56 to 3.84 fl oz/A	gamma-cyhalothrin	14	24	H
3A[1]	Warrior II*	1.28 to 1.92 fl oz/A	lambda-cyhalothrin	14	24	H
4A[2]	Assail 30SG	5.0 to 8.0 oz/A	acetamiprid	7	12	M
4A[2]	Assail 30SC	4.2 to 6.7 fl oz/A	acetamiprid	7	12	M
4A[2]	Scorpion 35 SL	8.75 to 10.5 fl oz/A	dinotefuran - **soil**	21	12	H
4A[2]	Scorpion 35 SL	5.25 to 7.0 fl oz/A	dinotefuran - **foliar**	1	12	H
4A[2]	Venom	5.0 to 6.0 oz/A	dinotefuran - **soil**	21	12	H
4A[2]	Venom	3.0 to 4.0 oz/A	dinotefuran - **foliar**	1	12	H
5	Entrust SC (OMRI)	4.0 to 8.0 fl oz/A	spinosad	1	4	M
5	Radiant SC	6.0 to 10.0 fl oz/A	spinetoram	1	4	M
23	Movento	5.0 fl oz/A	spirotetramat - **larvae**	3	24	L
23+7C	Senstar	10.0 fl oz/A	spirotetramat + pyriproxyfen - **larvae**	3	24	L
28 + 6	Minecto Pro*	7.0 to 10.0 fl oz/A	cyantraniliprole + abamectin	30	12	H

[1]Resistance concerns with western flower thrips. [2]Resistance concerns with tobacco thrips

Disease Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.
Recommended Fungicides

Nematodes

Bloat Nematode (*Ditylenchus dipsaci*)

Infected garlic appears bloated and twisted, with swollen leaves and distorted and cracked bulbs. Secondary infection by *Fusarium* spp. is common. Currently there are no certification programs for garlic; make sure your supplier produces clean seed cloves. Avoid planting bulbs that are split, have damaged basal plates or are desiccated. Plant garlic in a location that has not been cropped to garlic or another *Allium* crop for at least 4 years. Following harvest, planting biofumigant cover crops may help reduce nematode levels. Keep soils moist since the bloat nematode cannot survive long periods in high moisture. Implement good sanitation practices and avoid dumping culls and other infested debris in the field.

Damping-off caused by *Pythium* and *Rhizoctonia*

Use clean pathogen-free seed that has been treated with a fungicide.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Apply one of the following at planting to help manage damping-off pathogens:						
For Pythium only:						
4	MetaStar 2E AG	2.0 to 4.0 pt/A	metalaxyl	AP	48	N
4	Ridomil Gold 4SL	0.5 to 1.0 pt/A	mefenoxam	7	12	N
4	Ultra Flourish 2E	1.0 to 2.0 pt/A	mefenoxam	AP	48	N
For Rhizoctonia only:						
11	azoxystrobin 2.08F	0.40 to 0.80 fl oz/1000 row ft	azoxystrobin	0	4	N
For Pythium and Rhizoctonia:						
4 + 11	Uniform 3.66SE	0.34 fl oz/1000 row ft in furrow, see label	mefenoxam + azoxystrobin	AP	0	N

Bacterial and Fungal Diseases

Botrytis Leaf Blight

Scout fields regularly. Cool summer temperatures (55 to 75°F) and long periods of leaf wetness provide optimum environmental conditions for rapid leaf blighting. Older plants are more susceptible to Botrytis infection than younger plants. Apply the following preventatively when weather conditions favor disease development and repeat at 7-10 day intervals. **Do not** make more than 2 consecutive applications of Endura or Pristine before switching to a fungicide with a different mode of action. Thoroughly disc or plow under plant debris after harvest.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Tank mix and/or alternate chlorothalonil 6F						
M05	chlorothalonil 6F	1.0 to 3.0 pt /A	chlorothalonil	7	12	N
With one of the following fungicides and rotate between fungicides with different modes of action (FRAC codes):						
3 + 9	Inspire Super 2.82EW[1]	16.0 to 20.0 fl oz/A	difenoconazole + cyprodonil	7	12	--
3 + 11	Quilt Xcel 2.2SE[2]	17.5 to 26.0 fl oz/A	propiconazole + azoxystrobin	14	12	N
7	Endura 70W[1]	6.8 oz/A	boscalid	7	12	--
7 + 11	Pristine 38WG	14.5 to 18.5 oz/A	boscalid + pyraclostrobin	7	12	--
29	Omega 500F[1,2]	1.0 pt/A	fluazinam	7	12	N

[1]Also manages purple blotch.
[2] Also manages Downy Mildew.

Downy Mildew (*Peronospora destructor*)

The pathogen can survive as oospores in the soil, or on bulbs, sets and seed. Downy Mildew development is promoted by cool, moist conditions. Management begins with planting pathogen-free seed or sets and crop rotations of at least 3 years without related crops. Be sure to eliminate culls and volunteers from the field.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Tank mix chlorothalonil						
M05	chlorothalonil 6F	1.0 to 3.0 pt /A	chlorothalonil	7	12	N
With one of the following fungicides and rotate between fungicides with different modes of action (FRAC codes):						
3 + 11	Quilt Xcel 2.2SE	17.5 to 26.0 fl oz/A	propiconazole + azoxystrobin	14	12	N
11	azoxystrobin 2.08F	9.0 to 15.5 fl oz/A	azoxystrobin	0	4	N
11	Cabrio 20EG	12.0 oz/A	pyraclostrobin	7	12	N
11	Reason 500SC	5.5 fl oz/A	fenamidone	7	12	--
29	Omega 500F[1]	1.0 pt/A	fluazinam	7	12	N
40	Forum 4.17SC	6.0 fl oz/A	dimethomorph	0	12	N
40 + 45	Zampro 525SC	14.0 fl oz/A	dimethomorph + ametoctradin	0	12	--
40 + 49	Orondis Ultra 2.33SC	5.5 to 8.0 fl oz/A	mandipropamid + oxathiapiprolin	7	4	--

[1]Also manages Botrytis leaf blight and purple blotch.

Fusarium Basal Rot (*Fusarium* spp.)

The fungus infects and causes decay of the basal plate. During the growing season, leaves can turn yellow and then brown. This disease is favored by very warm soil temperatures, so symptoms are most frequently observed in mid- to late summer. A 4-year crop rotation with non-hosts is the most effective management strategy. There are currently no fungicides registered for the management of this disease. Hot water treating cloves may reduce disease in low disease pressure environments.

Purple Blotch (*Alternaria porri*)

Scout fields regularly. Purple blotch development increases with high humidity, rain and persistent dews with an optimum 71 to 85°F temperature range. Apply one of the following preventatively when weather conditions favor disease development and repeat at 7 to10-day intervals. **Do not** apply Pristine, azoxystrobin (both FRAC code 11) or Endura (FRAC code 7) more than once before switching to a fungicide with a different mode of action (FRAC code). Thoroughly disc or plow under plant debris after harvest.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Tank mix or rotate						
M05	chlorothalonil 6F	1.0 to 3.0 pt /A	chlorothalonil	7	12	N
With one of the following fungicides and rotate between fungicides with different modes of action:						
3	tebuconazole 3.6F	4.0 to 6.0 fl oz/A	tebuconazole	7	12	N
3 + 9	Inspire Super 2.82EW[1]	16.0 to 20.0 fl oz/A	difenoconazole + cyprodonil	7	12	--
3 + 11	Quilt Xcel 2.2SE	17.5 to 26.0 fl oz/A	propiconazole + azoxystrobin	14	12	N

Purple Blotch (Alternaria porri) - continued next page

Purple Blotch (Alternaria porri) - continued

7	Endura 70W	6.8 oz/A	boscalid	7	12	--
7	Fontelis 1.67SC	16.0 to 24.0 fl oz/A	penthiopyrad	3	12	L
11	azoxystrobin 2.08F	9.0 to 15.5 fl oz/A	azoxystrobin	0	4	N
11	Cabrio 20EG	8.0 to 12.0 oz/A	pyraclostrobin	7	12	N
29	Omega 500F [1,2]	1.0 pt/A	fluazinam	7	12	N

[1]Also labeled for Botrytis leaf blight.
[2]Also labeled for Downy Mildew.

White Rot (*Sclerotium cepivorum*)

Disease development is favored by cool, moist soil conditions. Infection occurs at soil temperatures ranging from 50 to 75°F, with the optimum at 60 to 65°F. The disease is greatly inhibited at soil temperatures above 78°F. Sclerotia can survive for over 20 yr, even in the absence of a host plant. Soil moisture conditions that are favorable for onion and garlic growth are also ideal for white rot development. Rotate between crops for as many years as possible.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
At planting, apply an in-furrow treatment of one of the following:						
2	iprodione 4F (spray both the cloves and the covering soil used to fill furrow; maximum application: 1 per year)	4.0 pt in 20 gal of water minimum based on a 38 to 40-inch row spacing	iprodione	AP	24	N
3	tebuconazole 3.6F (immediately after seeding; can also be applied via drip irrigation)	20.5 fl oz/A in a 4 to6-inch band over the top or in-furrow	tebuconazole	7	12	N
12	Cannonball 50WP (prior to seed placement)	0.5 oz/1000 ft row in-furrow	fludioxonil	7	12	L
Two additional foliar applications of tebuconazole may be applied:						
3	tebuconazole 3.6F	4.0 to 6.0 fl oz/A	tebuconazole	7	12	N
Note: In treated fields, do not grow crops other than garlic and leafy vegetables during the harvest year, and do not grow garlic, leafy vegetables, tomatoes, root crops, cereal grains, or soybeans during the following year.						

Greens (Mustard, Turnip)

Recommended Varieties

Note: For Kale and Collard Greens, see the Cole Crops section

Type	Variety[1]	Use	Hybrid	Season	Description
Asian Mustard[2]	Carlton Komatsuna	Cooked, Salad	Yes	Spring/Fall	Green, flat leaf
	Green Mizuna	Cooked, Salad	No	Spring/Fall	Green, serrated leaf
	Koji Tatsoi	Cooked, Salad	Yes	Spring/Fall	Green, heavy savoy leaf
	Miz America	Cooked, Salad	Yes	Spring/Fall	Dark red, toothed leaf
	Red Kingdom	Cooked, Salad	Yes	Spring/Fall	Purple, serrated leaf
	Senposai	Cooked, Salad	Yes	Spring/Fall	Green, flat leaf
	Tatsoi	Cooked, Salad	No	Spring/Fall	Green, semi savoy leaf
	Tokyo Bekana	Salad	Yes	Spring/Fall	Light-green, non-heading Chinese cabbage
Mustard	Florida Broadleaf	Cooked	No	Fall	Green, flat leaf
	Garnet Giant	Salad	No	Fall	Red, flat leaf
	Green Wave	Cooked, Salad	No	Fall	Green, curled leaf
	Red Giant	Cooked, Salad	No	Fall	Red, crinkled leaf
	Red Splendor	Cooked, Salad	No	Spring/Fall	Red, serrated leaf
	Savannah	Cooked	Yes	Spring/Fall	Green, flat leaf
	Scarlet Frills	Salad	No	Spring/Fall	Red, ruffled leaf
	Southern Giant Curled	Cooked	No	Fall	Green, curled leaf
	Tendergreen	Cooked	No	Fall	Green, flat leaf
Turnip	Alamo	Cooked, Salad	Yes	Spring/Fall	Green, flat leaf
	All Top	Cooked	Yes	Fall	Green, flat leaf
	Seven Top	Cooked	No	Fall	Green, serrated leaf
	Topper	Cooked	Yes	Spring/Fall	Green, serrated leaf

[1]**Listed alphabetically within type**. [2]Asian mustards recommended growing season for full size harvest without bolting. Greens may be planted throughout the year for harvest in the baby stage. For spring planting, Asian mustards should be planted after frost risk to avoid bolting.

Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and Chapter B Soil and Nutrient Management. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede the recommendations found below.

Greens[1] (Mustard, Turnip)		**Soil Phosphorus Level**				**Soil Potassium Level**				
		Low	**Med**	**High (Opt)**	**Very High**	**Low**	**Med**	**High (Opt)**	**Very High**	
	N (lb/A)	**P_2O_5 (lb/A)**				**K_2O (lb/A)**				**Nutrient Timing and Method**
	50-170	150	100	50	0	150	100	50	0	Total nutrient recommended
	50	150	100	50	0	150	100	50	0	Broadcast and disk-in
	25-60	0	0	0	0	0	0	0	0	Topdress after each cutting

[1]Apply 25-30 lb/A of sulfur (S) for most soils.

Seeding

Seed in early- to mid-August for fall harvest. Mustards and turnip greens planted in the spring are susceptible to bolting if exposed to cold temperatures for prolonged periods of time, and only bolt-resistant varieties such as Savanna mustard and Alamo turnip should be grown. Later spring plantings (April) have a lower risk of bolting. For all plantings, sow 3-4 lb/A of seed in rows 12-24 inches apart. A wide variety of mustards are available for incorporating into salad mixes for microgreens or baby salad mixes. These are sown in beds or trays as a broadcast or in narrow rows. They can be seeded from late winter through late fall in high tunnels for successive harvests.

Harvest and Post-Harvest Considerations

Greens for baby salad mixes are cut at ground level for a single harvest, or 1-2 inches from the ground for multiple cuts. Larger turnip, mustard, and Asian mustards may be harvested by cutting off entire plants near ground level for a single harvest, or by cutting 2-6 inches above the ground to allow for regrowth. For processing, greens are machine cut 4-6 inches from the ground when full tonnage has been achieved but before petioles and midribs have become too large. Multiple harvests may be possible.

Greens should be transported as quickly as possible to the packing area. Hydrocooling or vacuum cooling are recommended for pre-cooling. Greens should be held as close to 32°F as possible, because of their perishability. At this temperature, greens can be held for 10-14 days. Relative humidity of at least 95% is desirable to prevent wilting. Air circulation should be adequate to remove heat of respiration, but not too rapid to speed transpiration and wilting. Greens are commonly shipped with plastic package and top ice. Greens packed in polyethylene-lined crates and protected by crushed ice keep in excellent condition if kept near 32°F but deteriorate rapidly at higher temperatures.

Weed Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.

Recommended Herbicides

1. Identify the weeds in each field and select recommended herbicides. More information is available in the "Herbicide Effectiveness on Common Weeds in Vegetables" (Table E-3) in Chapter E Pest Management.

2. Minimize herbicide resistance development. Identify the herbicide mode of action group number and follow recommended good management practices; **bolded group numbers in tables below are herbicides at higher risk for selecting resistant weed populations.** Include non-chemical weed control whenever possible.

1. Soil-Applied (Preplant Incorporated or Preemergence)

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
3	Dacthal 6F Dacthal W-75	6 to 14 pt/A 6 to 14 lb/A	**DCPA**	4.5 to 10.5 lb/A	--	12
-**Labeled for turnip and mustard greens** for preplant incorporated or preemergence; **do not** incorporate deeper than 2 inches. Labeled for applications over the top of transplants without injury (will not control emerged weeds). Primarily controls annual grasses and a few broadleaf weeds, including common purslane. Results have been most consistent when used in fields with coarse -textured soils low in organic matter, and when the application are followed by rainfall or irrigation. Maximum application not addressed on label.						
3	Treflan 4EC	1 to 1.5 pt/A	**trifluralin**	0.5 to 0.75 lb/A	--	12
-**Labeled for turnip greens for processing and mustard greens**. Incorporate into 2-3 inches of soil within 8 h after application. -Primarily controls annual grasses and a few broadleaf weeds. Poor incorporation can reduce overall weed control. **Do not** use (or reduce rate) used when cold, wet soil conditions are expected, or crop injury may result. Maximum application not addressed on label.						
8	Prefar 4E	5 to 6 qt/A	**bensulide**	5 to 6 lb/A	--	--
-**Labeled for mustard greens.** -Labeled for preplant incorporated or preemergence applications; **do not** incorporate more than 2 inches deep (1 inch is optimum). -If applied preemergence, irrigate within 36 h of application with ½ inch of water; if not incorporated with irrigation or rainfall within 36 h, weed control maybe reduced. Provides control/suppression of some annual grass weeds and some broadleaves including pigweeds, purslane, and lambsquarters. -**Do not** apply more than 6 lb ai/A per season.						

2. Postemergence

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
1	Shadow 3EC Select 2EC Select Max 0.97EC	4 to 5.33 fl oz/A 6 to 8 fl oz/A 9 to 16 fl oz/A	**clethodim**	0.07 to 0.125 lb/A	14	24
	Poast 1.5EC	1 to 1.5 pt/A	**sethoxydim**	0.2 to 0.3 lb/A	30	12
-**Select 2EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). **Select Max**: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution). **Shadow 3EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution) for large or stressed grasses; use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution) when crop safety is a concern. **Poast**: Apply with COC at 1.0% v/v. -**The use of COC may increase the risk of crop injury when hot or humid conditions prevail**. To reduce the risk of crop injury, omit additives or switch to NIS when grasses are small and soil moisture is adequate. Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control. -Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will **not** be controlled. Controls many annual and certain perennial grasses, including annual bluegrass, but Poast is preferred for goosegrass control. For best results, treat annual grasses when they are						

2. Postemergence Shadow, Select, Select Max, Poast - continued next page

2. Postemergence Shadow, Select, Select Max, Poast - continued

actively growing and before tillers are present. Control may be reduced if grasses are large or under hot or dry weather conditions. -Repeated applications may be necessary to control certain perennial grasses. If repeat applications are necessary, allow 14 days between applications. -Rainfastness is 1 h. -**Do not** tank mix with or apply within 2 to 3 days of any other pesticide, unless labeled, as this may increase the risk of crop injury or reduce the control of grasses. **Do not** apply more than 8 fl oz/A of Select 2EC in a single application and **do not** exceed 2 pt/A for the season; **do not** apply more than 16 fl oz/A of Select Max in a single application and **do not** exceed 4 pt/A for the season. -**Do not** apply more than 5.33 fl oz/A of Shadow 3EC in a single application and **do not** exceed 21.33 fl oz/A for the season. -**Do not** apply more than 1.5 pt/A Poast in a single application and **do not** exceed 3 pt/A for the season.						
4	Stinger 3SL / Spur 3SL	4 to 8 fl oz/A	**clopyralid**	0.094 to 0.188 lb/A	30/15	12
-**Labeled for mustard greens and turnip greens.** Spray additives are not needed or required by the label, and are not recommended -Stinger controls composite and legume weeds including galinsoga, ragweed species, common cocklebur, groundsel, pineappleweed, clover, and vetch. Perennials controlled include Canada thistle, goldenrod species, aster species, and mugwort (wild chrysanthemum). -Stinger is very effective on small seedling annual and emerging perennial weeds less than 2-4 inches tall but is less effective and takes longer to work when weeds are larger. Use 4 fl oz/A to control annual weeds less than 2 inches tall. Increase the rate to 4 to 8 fl oz/A to control larger annual weeds. Apply the maximum rate of 8 fl oz/A to suppress or control perennial weeds. -Observe follow crop restrictions or injury may occur from herbicide carryover. -Rainfastness is 6 h. **Do not** harvest mustard greens within 30 days of harvest or turnip greens within 15 days of harvest. -Maximum Stinger application per year: 8 fl oz/A; maximum number of applications: 1 for turnip greens, 2 for mustard greens.						

3. Postharvest

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
22	Gramoxone SL 2.0* Gramoxone SL 3.0*	2.25 to 3 pt/A 1.5 to 2 pt/A	**paraquat**	0.56 to 0.75 lb/A	--	24
-**Supplemental Label in DE for the use of both Gramoxone formulations for postharvest application to desiccate the crop.** -Apply after the last harvest for bareground or plasticulture. Always include an adjuvant. Spray coverage is essential for optimum effectiveness. See the label for additional information and warnings. -Rainfastness 30 min. A maximum of 2 applications for crop desiccation are allowed. -***Restricted-use pesticide***. Only certified applicators, who successfully complete the paraquat-specific training, can mix, load, or apply paraquat. Application of paraquat "under the direct supervision" of a certified applicator is no longer allowed. Required training link (*https://campus.extension.org/enrol/index.php?id=2201*); certified applicators must repeat training every three years.						

4. Other Labeled Herbicides

These products are labeled but limited local data are available; and/or are labeled but not recommended in our region due to potential crop injury concerns.

Group	Product Name (*=Restricted Use)	Active Ingredient
3	Satellite Hydrocap (mustard and turnip greens)	**pendimethalin**
14	Aim	**carfentrazone**
15	Devrinol (Mustard greens only)	**napropamide**

Insect Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.

Recommended Insecticides

Aphids

Apply one of the following formulations:

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s) and Crop Restrictions	PHI (d)	REI (h)	Bee TR
1B	Dimethoate 400	0.5 pt/A	dimethoate	14	48	H
1B	Malathion 57 EC[1]	1.0 to 1.6 pt/A[1]	malathion	7	12	H
3A + 4A	Leverage 360*	3.0 fl oz/A	imidacloprid + beta-cyfluthrin	7	12	H
4A	Actara 25WDG	1.5 to 3.0 oz/A	thiamethoxam - **foliar**	7	12	H
4A	Platinum 75SG	5.0 to 11.0 oz/A	thiamethoxam - **soil**	30	12	H
4A	Admire Pro	4.4 to 10.5 fl oz/A	imidacloprid - **soil**	21	12	H
4A	Admire Pro	1.2 fl fl oz/A	imidacloprid - **foliar**	7	12	H
4A	Assail 30SG Assail 30SC	2 to 5.3 oz/A 1.7 to 4.5 fl oz/A	acetamiprid	3	12	M

Aphids - continued next page

Aphids - continued

4A	Belay 2.13SC	9 to 12 fl oz/A	clothianidin - **soil**	21	12	H
4A	Belay 2.13SC	3.0 to 4.0 fl oz/A	clothianidin - **foliar**	7	12	H
4C	Transform WG	0.75 to 1.0 oz/A	sulfloxaflor - turnip greens only	7	24	H
9B	Fulfill 50WDG	2.75 oz/A	pymetrozine	7	12	L
9B	PQZ	2.4 to 3.2 fl oz/A	pyrifluquinazon	1	12	L
9D	Versys	1.5 fl oz/A	afidopyropen	0	12	L
28	Exirel	13.5 to 20.5 fl oz/A	cyantraniliprole	1	12	H
28	Verimark	6.75 to 13.5 fl oz/A	cyantraniliprole	n/a	4	H
29	Beleaf 50SG	2.0 to 2.8 oz/A	flonicamid	0	12	L

[1]Maximum of 3 applications per season at the 1.6 pt/A rate.

Caterpillar "Worms" Pests Including: Beet Armyworms (BAW), Cabbage Loopers (CL), Diamondback Moths (DBM), and Imported Cabbageworms (ICW)

Due to resistance development, pyrethroid insecticides are not recommended for control of BAW or DBM. Other insecticides may no longer be effective in certain areas due to DBM resistance; consult your county Extension. Rotation of insecticides with different modes of action is recommended to reduce the development of resistance.

Apply one of the following formulations.
Note: Not all materials are labeled for all crops, insects, or application methods, check labels.

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s) and Crop Restrictions	PHI (d)	REI (h)	Bee TR
1A	Lannate LV*	1.5 to 3.0 pt/A	methomyl	10	48	H
3A	Asana XL*	2.9 to 9.6 fl oz/A	esfenvalerate **- only CL and ICW**	3/7 collards	12	H
3A	Baythroid XL* (CL, ICW)	1.6 to 2.4 fl oz/A	beta-cyfluthrin **- not recommended for BAW or DBM**	0	12	H
3A	Brigade 2EC*	2.1 to 6.4 fl oz/A	bifenthrin **- not recommended for BAW or DBM**	7	12	H
3A	Hero*	4.0 to 10.3 fl oz/A	bifenthrin + zeta-cypermethrin **- not recommended for BAW or DBM**	7	12	H
3A	Mustang Maxx*	3.2 to 4.0 fl oz/A	zeta cypermethrin **- not recommended for BAW or DBM**	1	12	H
3A	Tombstone* (CL, ICW)	1.6 to 2.4 fl oz/A	cyfluthrin **- not recommended for BAW or DBM**	0	12	H
5	Entrust SC (OMRI)	1.5 to 6.0 fl oz/A	spinosad	1	4	M
5	Radiant SC	5.0 to 10.0 fl oz/A	spinetoram	1	4	M
6	Proclaim 5SG*	2.4 to 4.8 oz/A	emamectin benzoate	14	12	H
11A	Dipel DF, others (OMRI)	0.25 to 1.0 lb/A	*Bacillus thuringiensis kurstaki*	0	4	N
11A	XenTari (OMRI)	0.5 to 1.5 lb/A	*Bacillus thuringiensis aizawai*	0	4	N
18	Intrepid 2F	4.0 to 8.0 fl oz/A early season; 8.0 to 10.0 fl oz/A late season	methoxyfenozide	1	4	L
22	Avaunt 30WDG, Avaunt eVo	2.5 to 3.5 oz/A	indoxacarb	3	12	H
28	Coragen 1.67SC Coragen eVo	3.5 to 7.5 fl oz/A 1.2 to 2.5 fl oz/A	chlorantraniliprole	3	4	L
28	Vantacor	1.2 to 2.5 fl oz/A	chlorantraniliprole - **turnip greens only**	1	4	L
28	Exirel	7.0 to 13.5 fl oz/A 10 to 17 fl oz/A for CL	cyantraniliprole	1	12	H
28	Verimark	5 to 10 fl oz/A	cyantraniliprole	1	4	H
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H

Flea Beetles

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s) and Crop Restrictions**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Sevin XLR Plus	0.5 to 1 qt/A	carbaryl	14	12	H
3A	Baythroid XL*	2.4 to 3.2 fl oz/A	beta-cyfluthrin	0	12	H
3A	Brigade 2EC*	2.1 to 6.4 fl oz/A	bifenthrin	7	12	H
3A	Hero*	4.0 to 10.3 fl oz/A	bifenthrin + zeta-cypermethrin **- mustard greens only**	7	12	H
3A	Mustang Maxx*	3.2 to 4.0 fl oz/A	zeta cypermethrin	1	12	H
3A	Tombstone*	2.4 to 3.2 fl oz/A	cyfluthrin	0	12	H
3A + 4A	Leverage 360*	3.0 fl oz/A	imidacloprid + beta-cyfluthrin	7	12	H
4A	Actara 25WDG	1.5 to 3.0 oz/A	thiamethoxam	7	12	H
4A	Platinum 75SG	5.0 to 11.0 oz/A	thiamethoxam	30	12	H
4A	Admire Pro	1.3 fl oz/A	imidacloprid - **foliar**	7	12	H
4A	Belay 50 WDG	4.8 to 6.4 oz/A	clothianidin - **soil**	AP	12	H
4A	Belay 50 WDG	1.6 to 2.1 oz/A	clothianidin - **foliar**	7	12	H
28	Exirel	13.5 to 20.5	cyantraniliprole	1	12	H
28	Verimark	6.73 to 13.5 fl oz/A	cyantraniliprole	n/a	4	H
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H

Harlequin Bugs

These orange, black and white stinkbugs can be quite destructive, particularly on leafy cole crops like collards. Egg masses consist of numerous white and black barrel-shaped eggs in neat rows. Nymphs remain clustered near the eggs until molting. Infestations can be quite heavy. Feeding results in pale blotches with scalloped edges on foliage.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s) and Crop Restrictions**	**PHI (d)**	**REI (h)**	**Bee TR**
3A	Baythroid XL*	2.4 to 3.2 fl oz/A	beta-cyfluthrin	0	12	H
3A	Brigade 2EC*	2.1 to 6.4 fl oz/A	bifenthrin	7	12	H
3A	Hero*	4.0 to 10.3 fl oz/A	bifenthrin + zeta-cypermethrin **- mustard greens only**	7	12	H
3A	Mustang Maxx*	3.2 to 4.0 fl oz/A	zeta cypermethrin	1	12	H
3A	Tombstone*	2.4 to 3.2 fl oz/A	cyfluthrin	0	12	H
3A + 4A	Leverage 360*	3.0 fl oz/A	imidacloprid + beta-cyfluthrin	7	12	H
4A	Assail 30SG Assail 30SC	4.0 to 5.3 oz/A 3.4 to 4.5 fl oz/A	acetamiprid	3	12	M
4A	Belay 50 WDG	4.8 to 6.4 oz/A	clothianidin - **soil**	AP	12	H
4A	Belay 50 WDG	1.6 to 2.1 oz/A	clothianidin - **foliar**	7	12	H

Leafhoppers

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s) and Crop Restrictions**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Sevin XLR Plus	0.5 to 1 qt/A	carbaryl	14	12	H
1B	Dimethoate 400	0.5 pt/A	dimethoate	14	48	H
3A	Baythroid XL*	0.8 to 1.6 fl oz/A	beta-cyfluthrin	0	12	H
3A	Brigade 2EC*	2.1 to 6.4 fl oz/A	bifenthrin	7	12	H
3A	Hero*	4.0 to 10.3 fl oz/A	bifenthrin + zeta-cypermethrin **- mustard greens only**	7	12	H
3A	Mustang Maxx*	3.2 to 4.0 fl oz/A	zeta cypermethrin	1	12	H
3A	Tombstone*	0.8 to 1.6 fl oz/A	cyfluthrin	0	12	H
3A + 4A	Leverage 360*	3.0 fl oz/A	imidacloprid + beta-cyfluthrin	7	12	H
4A	Admire Pro	4.4 to 10.5 fl oz/A	imidacloprid – **soil**	21	12	H
4A	Admire Pro	1.3 fl oz/A	imidacloprid – **foliar**	7	12	H
4A	Belay 50 WDG	4.8 to 6.4 oz/A	clothianidin -soil	AP	12	H
4A	Belay 50 WDG	1.6 to 2.1 oz/A	clothianidin -foliar	7	12	H

Leafminers

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s) and Crop Restrictions**	**PHI (d)**	**REI (h)**	**Bee TR**
1B	Dimethoate 400	0.5 pt/A	dimethoate	14	48	H
5	Entrust SC (OMRI)	4.0 to 10.0 fl oz/A	spinosad	1	4	M
5	Radiant SC	6.0 to 10.0 fl oz/A	spinetoram	1	4	M
17	Trigard 75WSP	2.66 oz/A	cyromazine	7	12	H
28	Exirel	13.5 to 20.5 fl oz/A	cyantraniliprole	1	12	H
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H
28	Verimark	6.75 to 13.5 fl oz/A	cyantraniliprole	n/a	4	H

Thrips

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s) and Crop Restrictions**	**PHI (d)**	**REI (h)**	**Bee TR**
3A + 4A	Leverage 360* (controls foliage feeding thrips only)	3.0 fl oz/A	imidacloprid + beta-cyfluthrin	7	12	H
4A[1]	Actara 25WDG	3.0 to 5.5 oz/A	thiamethoxam	7	12	H
4A[1]	Platinum 75SG	5.0 to 11.0 oz/A	thiamethoxam	30	12	H
5	Entrust SC (OMRI)	4.0 to 10.0 fl oz/A	spinosad	1	4	M
5	Radiant SC	6.0 to 10.0 fl oz/A	spinetoram	1	4	M
28	Exirel	13.5 to 20.5 fl oz/A	cyantraniliprole	1	12	H
28	Verimark	10 to 13.5 fl oz/A	cyantraniliprole	n/a	4	H
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H

[1]Resistance concerns with tobacco thrips

Disease Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F. Recommended Fungicides

Damping-off caused by *Phytophthora, Pythium* and *Rhizoctonia*

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Apply one of the following at seeding (see label for application methods and restrictions):						
Pythium root rot						
4	Ridomil Gold 4SL	0.5 to 1.0 pt/A	mefenoxam	AP	48	N
Pythium and Rhizoctonia root rot						
4 + 11	Uniform 3.66SE	0.34 fl oz/1000 ft row. Avoid direct seed contact, which may cause delayed emergence	mefenoxam + azoxystrobin	AP	0	N
Rhizoctonia root rot						
11	azoxystrobin 2.08F	0.40 to 0.80 fl oz/1000 ft row	azoxystrobin	AP	4	N

Bacterial and Fungal Diseases

Downy Mildew

The pathogen has a wide host range including broccoli, Brussels sprouts, cauliflower, cabbage, kale, Chinese cabbage, Chinese broccoli, Chinese mustard, radish, etc. and related weeds in the brassica family. Plant certified seed since the pathogen can be seed-borne. Use hot water seed treatment (See Cole Crops, Disease Control section). Avoid overhead watering in the morning when spores are released. *(continued next page)*

Downy Mildew - continued

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Scout regularly. Rotate the following fungicides with different modes of action during periods of high moisture and moderate temperatures and continue as long as weather conditions favor disease development:						
11	azoxystrobin 2.08F	6.0 to 15.5 fl oz/A	azoxystrobin	0	4	N
11	Cabrio 20EG	8.0 to 16.0 oz/A	pyraclostrobin	0	12	N
21	Ranman 400SC	2.75 fl oz/A	cyazofamid	0	12	L
40	Forum 4.17SC/A *plus* fixed copper	6.0 fl oz	dimethomorph	0	12	N
40	Revus 2.08F	8.0 fl oz/A	mandipropamid	1	4	--
40 + 45	Zampro 5.25SC	14.0 fl oz/A	dimethomorph + ametoctradin	0	12	--
40 + 49	Orondis Ultra 2.33SC	5.5 to 8.0 fl oz/A	mandipropamid + oxathiapiprolin	1	4	--
43	Presidio 4SC	4.0 fl oz/A	fluopicolide	2	12	L
P07	Aliette 80WDG (for mustard greens only)	3.0 lb/A	fosetyl-Al	3	12/24	N

Leaf Spots caused by *Alternaria* or *Cercospora* spp.

The fungal pathogens that cause leaf spot overwinter in the soil. Rotate away from fields for as long as possible.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
M01	copper (OMRI)[1]	at labeled rates	copper	0		N
When conditions favor disease development, apply one of the following fungicides every 7 to 10 days for as long as conditions are favorable for disease development. Rotate between fungicides with different mode of actions:						
3	tebuconazole 3.6F	3.0 to 4.0 fl oz/A	tebuconazole	7	12	N
3 + 9	Inspire Super 2.82EW	16.0 to 20.0 fl oz/A	difenoconazole + cyprodinil	7	12	--
3 + 11	Quadris Top 1.67SC	12.0 to 14.0 fl oz/A	difenoconazole + azoxystrobin	1	12	--
7 + 12	Miravis Prime	9.2 to 13.4 fl oz/A	pydiflumetofen + fludioxonil	0	12	--
7	Endura 70W	14.0 oz/A	boscalid	0	12	--
7	Fontelis 1.67SC	14.0 to 30.0 fl oz/A	penthiopyrad	0	12	L
7 + 11	Priaxor 4.17SC	6.0 to 8.2 fl oz/A	fluxapyroxad + pyraclostrobin	3	12	N
9 + 12	Switch 62.5WG	11.0 to 14.0 oz/A	cyprodinil + fludioxonil	7	12	L
11	azoxystrobin 2.08F	6.0 to 15.5 fl oz/A	azoxystrobin	0	4	N
11	Cabrio 20EG	8.0 to 16.0 oz/A	pyraclostrobin	0	12	N

[1]There are several OMRI listed copper-based products; see labels for specifics. Copper applications may help suppress some fungal pathogens in organic production systems.

Horseradish

Horseradish is a hardy perennial from the Mustard family that is grown for its fleshy white roots in annual production systems. Roots that are left in the ground for two or more growing seasons become stringy and woody. If roots are not harvested or killed, horseradish can become a weed.

There are three types of horseradish: "**Common**" types have broad crinkled leaves and high quality, large, smooth roots, but they are susceptible to virus and White Rust. "**Bohemian**" types have medium-sized narrow smooth leaves and somewhat lower quality roots. They are susceptible to virus but have some White Rust tolerance. "**Big Top Western**" types have smooth, large upright leaves and large, good quality roots; however, the roots are rough or corky on the surface. "Big Top Western" types have resistance to virus and White Rust. Use locally selected horseradish strains that are adapted to the area.

Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and Chapter B Soil and Nutrient Management. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede the recommendations found below.

		Soil Phosphorus Level				Soil Potassium Level				
		Low	Med	High (Opt)	Very High	Low	Med	High (Opt)	Very High	
Horse-radish [1,2]	**N (lb/A)**	**P_2O_5 (lb/A)**				**K_2O (lb/A)**				**Nutrient Timing and Method**
	150-200	200	150	100	0	200	150	100	0	Total nutrient recommended
	50	200	150	100	0	200	150	100	0	Broadcast and disk-in
	50-100	0	0	0	0	0	0	0	0	Sidedress 3-5 weeks after planting
	50	0	0	0	0	0	0	0	0	Sidedress 4-6 weeks after planting if needed

[1]Apply 1.0 to 2.0 lb/A of boron (B) with broadcast fertilizer; see also Table B-7. in Chapter B Soil and Nutrient Management.
[2]Apply 25-30 lb/A of sulfur (S) for most soils.

Planting and Spacing

Sets are selected roots from the previous crop. They should be 10-12 inches long and ¼ to 5/8 inch in diameter. Do not allow roots to dry out before planting. To ensure proper orientation at planting, make a square cut at the end of the roots nearest the main root. Make a slanting cut at the other end and plant the slanting cut end downward.

Plant in late April to early May. Place sets at an angle in a furrow so the top will be 1 inch deep and the bottom 2 inches deep. Alternatively, use a dribble to make a slanted planting hole, or leave several inches above the soil surface and cover sets by forming ridges in the row. Sets should point in the same direction that the cultivator will go, *e.g.*, for two-row cultivator, two rows in one direction and the next two rows in the opposite direction. Space rows 34--36 inches apart with 18 inches between sets in the row.

Harvest and Storage

Dig roots as needed. In an annual system, the set will become the main root which is the largest and most valuable for the market. For maximum growth, harvest once tops have died due to frost. Alternatively, tops can be cut off as close to the soil surface as possible. Then wait several days before harvesting. Roots overwinter, but winter soil conditions may prevent harvesting. Store horseradish in the dark with temperatures between 32-40°F (0-4°C) and 98% relative humidity. Roots exposed to light become green. Roots can be stored for 8-9 months. If storage and temperature conditions cannot be met, consider harvesting the following spring by digging the roots as soon as new growth starts to appear. Select the top performing lateral roots for the next crop.

Weed Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.

Recommended Herbicides

1. Identify the weeds in each field and select recommended herbicides. More information is available in the "Herbicide Effectiveness on Common Weeds in Vegetables" (Table E-3) in Chapter E Pest Management.

2. Minimize herbicide resistance development. Identify the herbicide mode of action group number and follow recommended good management practices; **bolded group numbers in tables below are herbicides at higher risk for selecting resistant weed populations.** Include non-chemical weed control whenever possible.

<table>
<tr><td colspan="7">1. Preemergence</td></tr>
<tr><th>Group</th><th>Product Name
(*=Restricted Use)</th><th>Product Rate</th><th>Active Ingredient</th><th>Active Ingredient Rate</th><th>PHI
(d)</th><th>REI
(h)</th></tr>
<tr><td>3</td><td>Dacthal 6F
Dacthal W-75</td><td>8 to 14 pt/A
6 to 14 lb/A</td><td>DCPA</td><td>6 to 10.5 lb/A</td><td>25</td><td>12</td></tr>
<tr><td colspan="7">-Labeled for preemergence; incorporation is not recommended. -Labeled for applications over the top of transplants without injury (will not control emerged weeds). -Primarily controls annual grasses and a few broadleaf weeds, including common purslane. Results have been most consistent when used in fields with coarse-textured soils low in organic matter and when the application are followed by rainfall or irrigation. -Maximum application not addressed on label.</td></tr>
<tr><td>14</td><td>Goal 2XL
GoalTender 4F</td><td>2 pt/A
1 pt/A</td><td>oxyfluorfen</td><td>0.5 lb/A</td><td>--</td><td>48</td></tr>
<tr><td colspan="7">-Apply immediately after planting but before emergence of new leaves. -Emerged leaves that receive direct herbicide application will be injured. It may be desirable to cultivate immediately prior to application to remove emerged weeds. Delay cultivation after Goal application, when possible, to reduce deactivation of Goal by incorporation.
-Do not use Goal herbicide on horseradish plantings which are weak or under stress due to temperature, disease, fertilizer, nematodes, insects, pesticides, drought, or excessive moisture.
-Do not apply more than 2 pt/A of Goal 2XL per crop or no more than 1 pt/A per crop of GoalTender.</td></tr>
<tr><td>14</td><td>Zeus 4L or
Spartan Charge 3.5EC</td><td>2.25 to 8 fl oz/A
2.9 to 10.2 fl oz/A</td><td>sulfentrazone</td><td>0.07 to 0.25 lb/A</td><td>--</td><td>12</td></tr>
<tr><td colspan="7">-Labeled for preplant, preemergence or preplant incorporated. Do not incorporate to a depth greater than 2 inches.
-Preemergence applications should be made at least 5 days prior to crop emergence.
-Do not apply more than 8 fl oz/A per 12-month period for Zeus or 10.2 fl oz/A for Spartan Charge.
-Prepackaged mixtures with sulfentrazone include Authority Elite 7SE or BroadAxe 7SE:
Authority Elite or BroadAxe at 25 fl oz/A = 21 fl oz/A Dual Magnum 7.62E + 5.3 fl oz/A of Spartan Charge.</td></tr>
<tr><td>15</td><td>Dual Magnum 7.62E
generic metolachlor 8EC</td><td>1 to 1.33 pt/A
1 to 2 pt/A</td><td>s-metolachlor
metolachlor</td><td>0.95 to 1.27 lb/A
0.95 to 1.91 lb/A</td><td>--</td><td>24</td></tr>
<tr><td colspan="7">-Apply after planting, but before crop emergence; Dual will not control emerged weeds. Primarily controls annual grasses, certain broadleaf weeds, and nutsedge. Do not make more than one application per crop; do not apply more than 1.33 pt/A per crop.
-Prepackaged mixtures with s-metolachlor include Authority Elite 7SE or BroadAxe 7SE:
Authority Elite or BroadAxe at 25 fl oz/A = 21 fl oz/A Dual Magnum 7.62E + 5.3 fl oz/A of Spartan Charge.</td></tr>
<tr><td colspan="7">2. Postemergence</td></tr>
<tr><th>Group</th><th>Product Name
(*=Restricted Use)</th><th>Product Rate</th><th>Active Ingredient</th><th>Active Ingredient Rate</th><th>PHI
(d)</th><th>REI
(h)</th></tr>
<tr><td rowspan="2">1</td><td>Shadow 3EC
Select 2EC
Select Max 0.97EC</td><td>4 to 5.33 fl oz/A
6 to 8 fl oz/A
9 to 16 fl oz/A</td><td>clethodim</td><td>0.07 to 0.125 lb/A</td><td>30</td><td>24</td></tr>
<tr><td>Poast 1.5EC</td><td>1 to 2.5 pt/A</td><td>sethoxydim</td><td>0.2 to 0.3 lb/A</td><td>60</td><td>12</td></tr>
<tr><td colspan="7">-Select 2EC: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). Select Max: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution). Shadow 3EC: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution) for large or stressed grasses; use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution) when crop safety is a concern. Poast: use COC at 1.0% v/v. -The use of COC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to NIS when grasses are small and soil moisture is adequate.
-Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control.
-Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will not be controlled.
-Controls many annual and certain perennial grasses, including annual bluegrass, but Poast is preferred for goosegrass control. For best results, treat annual grasses when they are actively growing and before tillers are present. Control may be reduced if grasses are large or under hot or dry weather conditions. -If repeat applications are necessary, allow 14 days between applications. Rainfastness is 1 h.
-Do not tank mix with or apply within 2 to 3 days of any other pesticide, unless labeled, as this may increase the risk of crop injury or reduce the control of grasses. -Do not apply more than 8 fl oz/A of Select 2EC in a single application and do not exceed 2 pt/A for the season; do not apply more than 16 fl oz/A of Select Max in a single application and do not exceed 4 pt/A for the season.
-Do not apply more than 5.33 fl oz/A of Shadow 3EC in a single application and do not exceed 21.33 fl oz/A for the season.
-Do not apply more than 2.5 pt/A Poast in a single application and do not exceed 5 pt/A for the season.</td></tr>
<tr><td>15</td><td>Outlook 6E</td><td>12 to 21 fl oz/A</td><td>dimethenamid</td><td>0.56 to 0.98 lb/A</td><td>40</td><td>12</td></tr>
<tr><td colspan="7">-Apply postemergence from the 2-leaf to the 8-leaf stage. Outlook will not control emerged weeds.
-Do not exceed the maximum labeled for the soil type.</td></tr>
</table>

<table>
<tr><td colspan="3">3. Other Labeled Herbicides These products are labeled but limited local data are available; and/or are labeled but not recommended in our region due to potential crop injury concerns.</td></tr>
<tr><th>Group</th><th>Product Name (*=Restricted Use)</th><th>Active Ingredient</th></tr>
<tr><td>7</td><td>Lorox</td><td>linuron</td></tr>
<tr><td>14</td><td>Aim</td><td>carfentrazone</td></tr>
<tr><td>27</td><td>Optogen</td><td>bicyclopyrone</td></tr>
</table>

Insect Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.
Recommended Insecticides

Aphids

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	1.5 pt/A	methomyl	65	48	H
1B	Malathion 57 EC	1.0 to 2.0 pt/A	malathion	7	24	H
4A	Actara 25WDG	1.5 to 3.0 oz/A	thiamethoxam	7	12	H
4A	Admire Pro	4.4 to 10.5 fl oz/A	imidacloprid - **soil**	21	12	H
4A	Admire Pro	1.2 fl oz/A	imidacloprid - **foliar**	7	12	H
4A	Platinum 75SG	1.7 to 4.01 oz/A	thiamethoxam	AP	12	H
4D	Sivanto Prime or 200 SL	7.0 to 14.0 fl oz/A	flupyradifurone	7	4	M
29	Beleaf 50SG	2.0 to 2.8 oz/A	flonicamid	3	12	L

Beet Leafhoppers

Beet leafhoppers can vector brittle root pathogen, and treatment may be justifiable if beet leafhoppers are present by late July.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Sevin XLR Plus	0.5 to 1.0 qt/A	carbaryl	7	12	H
3A	Fastac CS*	1.8 to 3.8 fl oz/A	alpha-cypermethrin	1	12	H
3A	Mustang Maxx	1.76 to 4.0 fl oz/A	zeta-cypermethrin	1	12	H
4A	Actara 25WDG	1.5 to 3.0 oz/A	thiamethoxam	7	12	H
4A	Admire Pro	4.4 to 10.5 fl oz/A	imidacloprid - **soil**	21	12	H
4A	Admire Pro	1.2 fl oz/A	imidacloprid - **foliar**	7	12	H
4A	Platinum 75SG	1.7 to 4.01 oz/A	thiamethoxam	AP	12	H
4D	Sivanto Prime or 200 SL	7.0 to 14.0 fl oz/A	flupyradifurone	7	4	M

Cutworms

See also section E 3.1. Soil Pests - Detection and Control.

Cutworms are moth larvae (caterpillars) that feed on roots and stems. They chew on stems at or near the soil line, severing young plants. Larvae are typically active at night and spend most of this stage belowground. Cutworms are favored by less disturbed soils and debris-covered soil surfaces. Conventional tillage and soil incorporation of crop debris helps reduce populations. Several species are capable of causing injury to young plants. There are usually 2 generations per season. If cutworm damage is anticipated, it is best to treat preventively.

Apply the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
3A	Brigade 2EC*	5.1 to 6.4 fl oz/A	bifenthrin	21	12	H
3A	Fastac CS*	1.8 to 3.8 fl oz/A	alpha-cypermethrin	1	12	H
3A	Hero*	2.6 to 6.1 fl oz/A	bifenthrin + zeta-cypermethrin	21	12	H
3A	Mustang Maxx*	1.28 to 4.0 fl oz/A	zeta-cypermethrin	1	12	H
28	Exirel	13.5 to 20.5 fl oz/A	cyantraniliprole	1	12	

Flea Beetles (FB), Harlequin Bugs

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Sevin XLR Plus (not labeled for harlequin bug)	0.5 to 1.0 qt/A	carbaryl	7	12	H
3A	Brigade 2EC*	5.1 to 6.4 fl oz/A	bifenthrin	21	12	H
3A	Hero*	2.6 to 6.1 fl oz/A	bifenthrin + zeta-cypermethrin	21	12	H

Flea Beetles (FB), Harlequin Bugs - continued next page

Flea Beetles (FB), Harlequin Bugs - continued

3A	Mustang Maxx*	1.76 to 4.0 fl oz/A	zeta-cypermethrin	1	12	H
3A	Fastac CS*	1.8 to 3.8 fl oz/A	alpha-cypermethrin	1	12	H
3A + 28	Elevest* (FB only)	7.7 to 9.6 fl oz/A	bifenthrin + chlorantraniliprole	21	12	H
4A	Actara 25WDG (FB only)	1.5 to 3.0 oz/A	thiamethoxam	7	12	H
4A	Admire Pro (FB only)	10.5 fl oz/A	imidacloprid – **soil**	21	12	H
4A	Admire Pro (FB only)	1.2 fl oz/A	imidacloprid – **foliar**	7	12	H
4A	Platinum 75SG (FB only)	1.7 to 4.01 oz/A	thiamethoxam	AP	12	H
5	Blackhawk 36WG (FB only)	1.7 to 3.3 oz/A	spinosad	3	4	M
5	Entrust SC (OMRI) (FB only)	3.0 to 6.0 fl oz/A	spinosad	3	4	M
5	Radiant SC (FB only)	6.0 to 8.0 fl oz/A	spinetoram	3	4	M
28	Exirel (FB only)	13.5 to 20.5 fl oz/A	cyantraniliprole	1	12	H

Imported Cabbageworm, Diamondback Moth, Cabbage Looper, and Armyworm spp.

Early season infestations rarely warrant control because the plant can outgrow injury unless injury to the growing point prevents new leaf emergence. Mid-season defoliation thresholds are greater than 30% defoliation and defoliators are abundant. Diamondback moths are generally resistant to pyrethroids.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1B	Malathion 57 EC (CL and IC only)	1.0 to 2.0 pt/A	malathion	7	24	H
3A	Brigade 2EC*, others	5.1 to 6.4 fl oz/A	bifenthrin	21	12	H
3A	Hero*	2.6 to 6.1 fl oz/A	bifenthrin + zeta-cypermethrin	21	12	H
3A	Mustang Maxx*	3.2 to 4.0 fl oz/A	zeta-cypermethrin	1	12	H
5	Blackhawk 36WG	1.7 to 3.3 oz/A	spinosad	3	4	M
5	Radiant SC	6.0 to 8.0fl oz/A	spinetoram	3	4	M
5	Entrust SC (OMRI)	3.0 to 6.0 fl oz/A	spinosad	3	4	M
11A	XenTari (OMRI)	0.5 to 1.5 lb/A	*Bacillus thuringiensis aizawai*	0	4	N
11A	Dipel DF, others (OMRI)	0.5 to 2.0 lb/A	*Bacillus thuringiensis kurstaki*	0	4	N
18	Intrepid 2F	8.0 to 16.0 fl oz/A	methoxyfenozide	1	4	L
18 + 5	Intrepid Edge	4.5 to 12.0 fl oz/A	methoxyfenozide + spinetoram	7	4	M
28	Coragen 1.67SC (AW only) Coragen eVo (AW only)	3.5 to 7.5 fl oz/A 1.2 to 2.5 fl oz/A	chlorantraniliprole **- foliar**	1	4	L
28	Vantacor	1.2 to 2.5 fl oz/A	chlorantraniliprole - **foliar**	1	4	L
28 + 3A	Elevest*	5.6 to 9.6 fl oz/A	chlorantraniliprole + bifenthrin	21	12	H

Imported Crucifer Weevil

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
3A	Permethrin 3.2EC*	6.0 fl oz/A	permethrin – **foliar**	30	12	H
3A	Permethrin 3.2EC*	17 fl oz/100 gal	permethrin - **preplant dip**	30	12	H

Swede Midge

Swede midge was confirmed in Pennsylvania in 2020. Horseradish is a host, but it is unclear if swede midge is an economic threat to horseradish. Rotation away from previous cole crop plantings may be important. It is not found on insecticide labels in the sections with horseradish. Consult your local extension office for more information.

Thrips

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	1.5 pt/A	methomyl	65	48	H
4A[1]	Admire Pro	4.4 to 10.5 fl oz/A	imidacloprid - **soil**	21	12	H
5	Entrust SC (OMRI)	4.0 to 10.0 fl oz/A	spinosad	3	4	M
5	Radiant SC	6.0 to 8.0 fl oz/A	spinetoram	3	4	M
5	Blackhawk 36WG	1.7 to 3.3 oz/A	spinosad	3	4	M

[1]Resistance concerns with tobacco thrips

Disease Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.
Recommended Fungicides

Damping-off caused by *Phytophthora, Pythium*, and *Rhizoctonia*

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Apply one of the following at planting (see label for application methods and restrictions):						
Phytophthora and Pythium root rot						
4	Ridomil Gold 4SL	0.5 to 1.0 pt/A	mefenoxam	5	48	N
4	Ultra Flourish 2E	2.0 to 4.0 pt/A	mefenoxam	5	48	N
4	MetaStar 2E AG	4.0 to 8.0 pt/A	metalaxyl	AP	48	N
Pythium, and Rhizoctonia root rot						
4 + 11	Uniform 3.66SE	0.34 fl oz/1000 ft row. Avoid direct seed contact, which may cause delayed emergence. See label.	mefenoxam + azoxystrobin	AP	0	N
Rhizoctonia root rot						
11	azoxystrobin 2.08F	0.4 to 0.8 fl oz/1000 ft row	azoxystrobin	AP	4	N

Bacterial and Fungal Diseases

Bacterial Leaf Spot

Rotate away from cruciferous crops for at least 2 years if the field has a known history of disease. Avoid excessive irrigation and maintain proper drainage. Avoid cultivation or other activity when foliage is wet to minimize spread.

Leaf Spots caused by *Alternaria* and *Cercospora* spp.

Use resistant cultivars where available. A 3-year rotation to non-cruciferous crops may be required if the field has a history of disease.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
When conditions favor disease development, apply one of the following on a 7-14 d schedule and rotate between fungicides with different FRAC codes as long as weather conditions favor disease development:						
7	Endura 70W	4.5 oz/A (Alternaria only)	boscalid	0	12	--
7	Fontelis 1.67SC	16.0 to 30.0 fl oz/A	penthiopyrad	0	12	L
7 + 12	Miravis Prime	6.8 fl oz/A	pydiflumetofen + fludioxonil	7	12	--
11	azoxystrobin 2.08F	6.2 to 15.5 fl oz/A	azoxystrobin	0	12	N
11	Cabrio 20EG	8.0 to 16.0 oz/A	pyraclostrobin	0	12	N

Ramularia Stem and Leaf Spot

In fields with a known history of Ramularia stem and leaf spot apply the following preventatively or when conditions favor disease development.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
M05	chlorothalonil 6F	3.0 pt/A	chlorothalonil	14	12	N

Verticillium Wilt

Rotate away from fields with a known history of Verticillium Wilt. Carefully inspect planting stock for discoloration, streaking and internal flecking. Plant only healthy planting material.

White Rust

Use certified, disease-free seed. A rotation to non-cruciferous crops may be required if the field has a history of disease. Manage weeds and volunteer hosts which may act as reservoirs for the pathogen. Plant “Big Top Western” types which have virus and White Rust resistance.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
When conditions favor disease development, apply one of the following on a 7 to14-day schedule:						
11	azoxystrobin 2.08F	6.2 to 15.5 fl oz/A	azoxystrobin	0	12	N
11	Cabrio 20EG	8.0 to 16.0 oz/A	pyraclostrobin	0	12	N

Leeks

Recommended Varieties

Check with your seed supplier or other growers for recommendations on locally adapted varieties. Any new variety should be tested on a small scale before planting in a large area.

Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and Chapter B Soil and Nutrient Management. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede the recommendations found below.

Leeks[1,2]		Soil Phosphorus Level				Soil Potassium Level				
		Low	Med	High (Opt)	Very High	Low	Med	High (Opt)	Very High	
	N (lb/A)	P_2O_5 (lb/A)				K_2O (lb/A)				Nutrient Timing and Method
	100-125	200	150	100	0	200	150	100	0	Total nutrient recommended
	50-75	200	150	100	0	200	150	100	0	Broadcast and disk-in
	25-50	0	0	0	0	0	0	0	0	Sidedress 3-4 weeks after planting if needed

[1]Apply 3-4 lb/A of boron (B) with broadcast fertilizer; see also Table B-7. in Chapter B Soil and Nutrient Management.
[2]Apply 25-30 lb/A of sulfur (S) for most soils.

Seeding and Transplanting

For early spring plantings, southern transplants are used. For summer plantings, sow in seedbeds or transplant trays from early March to mid-May. About 2 lb of seed are required to provide enough plants to set an acre. Plant seed 1/3 to ½ inch deep 12-16 weeks before field setting. Transplants can be produced in 200-288 deep cell trays. Plants will be ready to set in early August. Spring leeks should be seeded approximately the third week of December and the fall crop approximately the first week of June.

Field Spacing

Rows 20-30 in. apart; plants 4-6 in. apart in the row. Set plants in trenches 3-4 in. deep using celery-type planter.

Culture

Leeks grow slowly for the first 2 or 3 months. To develop a long white stem, start to gradually fill in trenches and then hill soil around stems. Depending on the season it may require up to 20 hilling's to produce long white shank

Harvest and Post-Harvest Considerations

Spring-transplanted leeks are ready for harvest in July. August-planted leeks are ready for harvest by November or can be overwintered. Half-mature leeks of the hardy varieties will stand winter freezing with some protection such as salt hay or straw if planted in very cold areas. In mild winter areas no protection is required, and leeks will be ready for harvesting early in the spring. Undercut the leeks with a bar on a tractor or for smaller plantings dig with a spading fork.

After digging, leeks can be left in the field to dry for a short period. Leeks are bunched with 3-4 leeks per bunch. If soil sticks to the leeks, power wash the bunches before packing. If necessary, leeks can be cooled by icing in the box, hydrocooling or vacuum cooling with a water spray. Store leeks at 32°F and 95-100% relative humidity. Typical storage time is 7-21 days, but up to 2 months is possible.

Weed Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.

Recommended Herbicides

1. Identify the weeds in each field and select recommended herbicides. More information is available in the "Herbicide Effectiveness on Common Weeds in Vegetables" (Table E-3) in Chapter E Pest Management.
2. Minimize herbicide resistance development. Identify the herbicide mode of action group number and follow recommended good management practices; **bolded group numbers in tables below are herbicides at higher risk for selecting resistant weed populations.** Include non-chemical weed control whenever possible.

1. Soil-Applied (Preemergence)

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
3	Dacthal 6F Dacthal W-75	8 to 14 pt/A 6 to 14 lb/A	**DCPA**	6 to 10.5 lb/A	--	12

-Apply at time of seeding or immediately after planting sets. -Labeled for applications directly over transplants without crop damage.
-A second application may be needed for longer season; but will not control emerged weeds. -Primarily controls annual grasses and a few broadleaf weeds, including common purslane. -Results have been most consistent when used in fields with coarse -textured soils low in organic matter, and when the application is followed by rainfall or irrigation. Maximum application not addressed on label.

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
3	Prowl H2O 3.8CS	2 pt/A	**pendimethalin**	0.95 lb/A	30	24

-Apply at time of seeding or postemergence; **do not** mechanically incorporate. -**Do not** apply preemergence to leeks planted on mineral soils with less than 3% organic matter or injury may occur. Seed must be fully covered by soil; injury may occur if seed is exposed. Prowl H2O can be applied directly over emerged plants with 2 to 3 true leaves without crop damage. -If sequential applications are made, allow 30 days between applications. -Primarily controls annual grasses and certain broadleaf weeds.
-**Do not** apply more than 2 pt/A per application; and **do not** apply more than 4 pt/A per season.

2. Postemergence

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
1	Shadow 3EC	4 to 5.33 fl oz/A	**clethodim**	0.07 to 0.125 lb/A	14	24
	Fusilade DX 2EC	8 to 24 fl oz/A	**fluazifop**	0.125 to 0.375 lb/A	14	12
	Poast 1.5EC	1 to 1.5 pt/A	**sethoxydim**	0.2 to 0.3 lb/A	30	12

-**Shadow 3EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution) for large or stressed grasses; use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution) when crop safety is a concern.
Fusilade DX: use COC at 1.0% v/v (1 gal/100 gal of spray solution) or NIS at 0.25% v/v (1 qt/100 gal of spray solution). **Poast**: use COC at 1.0% v/v. **The use of COC may increase the risk of crop injury when hot or humid conditions prevail**. To reduce the risk of crop injury, omit additives or switch to NIS when grasses are small and soil moisture is adequate.
-Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control.
-Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will **not** be controlled.
-Controls many annual and certain perennial grasses, including annual bluegrass, but Poast is preferred for goosegrass control. For best results, treat annual grasses when they are actively growing and before tillers are present. Control may be reduced if grasses are large or under hot or dry weather conditions. -Repeated applications may be necessary to control certain perennial grasses. If repeated applications are necessary, allow 14 days between applications. Rainfastness is 1 h.
-**Do not** tank mix with or apply within 2 or 3 days of any other pesticide unless labeled. The risk of crop injury may be increased, or reduced control of grasses may result. -**Do not** apply more than 5.33 fl oz/A of Shadow 3EC in a single application and **do not** apply more than once per season. -**Do not** apply more than 24 fl oz/A of Fusilade DX in a single application and **do not** exceed 3 pt/A per season. **Do not** apply more than 1.5 pt/A Poast in a single application and **do not exceed** 4.5 pt/A for the season.

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
15	Dual Magnum	0.67 to 1.33 pt/A	**s-metolachlor**	0.64 to 1.27 lb/A	21	24

-**Special Local Needs Label 24(c) for the use of Dual Magnum in leeks in NJ (expires 1/28/2027). The use of Dual Magnum is legal ONLY if a waiver of liability has been completed (see: *https://www.syngenta-us.com/labels/indemnified-label-login*).**
-Apply after leeks have reached the 2 true leaf stage of growth; Dual Magnum will not control weeds that have emerged at time of application. -Use lower rate on lighter coarse-textured sandy soils and the higher rate on heavier fine-textured soils. **Do not** use on coarse textured soils with less than 1% organic matter. -Follow with overhead irrigation if rainfall does not occur.
-Primarily controls annual grass and certain broadleaf weeds, including galinsoga preemergence.
-**Do not** apply more than once per crop season and **do not** exceed 1.33 pt/A per crop season.

3. Other Labeled Herbicides These products are labeled but limited local data are available; and/or are labeled but not recommended in our region due to potential crop injury concerns.

Group	Product Name (*=Restricted Use)	Active Ingredient
15	Outlook	**dimethenamid**
15	Zidua	**pyroxasulfone**

Insect Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.
Recommended Insecticides

Allium Leafminers

This new pest to the Mid-Atlantic area is a long grey-black fly with a distinctive yellow or orange patch on the top of its head, yellow sides, and "knees" (femur-tibia junction), and white halteres (knobs as second pair of wings). The larvae are a typical, whitish maggot. Leek (*A. porrum*) and scallions (green onions) tend to be the most damaged

Allium species or cultivars. Females repeatedly puncture leaves with their ovipositor, resulting in a line of small white dots. Leaves can be wavy, curled, and distorted. The larvae mine leaves and move into bulbs and leaf sheathes where they pupate. Covering plants in April-May, or September-October, during the adult flights can exclude the pest. Avoid the adult oviposition period by delaying planting of spring allium crops. Systemic and contact insecticides can be effective.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
3A	Mustang Maxx*	2.24 to 4.0 fl oz/A	zeta-cypermethrin	7	12	H
4A	Scorpion 35SL	8.75 to 10.5 fl oz/A	dinotefuran - **soil**	AP	12	H
4A	Scorpion 35SL	5.25 to 7.0 fl oz/A	dinotefuran - **foliar**	1	12	H
4A	Venom 70SG	5.0 to 6.0 oz/A	dinotefuran - **soil**	AP	12	H
4A	Venom 70SG	3.0 to 4.0 oz/A	dinotefuran - **foliar**	1	12	H
5	Entrust SC (OMRI)	3.0 to 6.0 fl oz/A	spinosad	1	4	M
5	Radiant SC	6.0 to 10.0 fl oz/A	spinetoram	1	4	M
17	Trigard 75WSP	2.66 oz/A	cyromazine	7	12	H
28	Exirel	13.5 to 20.5 fl oz/A	cyantraniliprole	1	12	H
28 + 6	Minecto Pro*	7.0 to 10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H

Aphids

Aphids found on leeks and other related vegetables are usually dark red or black. They are attracted to the compounds in Allium species that give them their distinctive smell. They walk short distances between plants and spread over long distances via air currents. They can survive on volunteer plants or on bulbs in storage. Aphids suck the sap of leek plants which can cause them to collapse. Look for aphids on leaves in the early to mid-season.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1B	Malathion 57 EC	1.5 to 2.0 pt/A	malathion	3	24	H
3A	Mustang Maxx*	2.24 to 4.00 fl oz/A	zeta-cypermethrin	7	12	H

Armyworms (AW), Cutworms (CW), Cabbage Loopers (CL)

These lepidopteran pests (caterpillars) come in various colors and shapes and can be found from the beginning until the end of the season. Cutworms are found very early in the season. They are immigrants from southern regions or have passed the winter in the area as pupae. Lepidopteran pest infestations are sporadic; no reliable methods have been found for predicting their occurrence. Plants should be scouted from planting until harvest for foliar feeding.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
3A	Mustang Maxx*	2.24 to 4.0 fl oz/A	zeta-cypermethrin	7	12	H
5	Entrust SC (OMRI)	3.0 to 6.0 fl oz/A (AW and CL)	spinosad	1	4	M
5	Radiant SC	5.0 to 10.0 fl oz/A (AW and CL)	spinetoram	1	4	M
11A	Dipel DF, others (OMRI)	1.0 to 2.0 lb/A	*Bacillus thuringiensis kurstaki*	0	4	N
11A	Xentari	1.0 to 2.0 lb/A	*Bacillus thuringiensis azaiwai*	0	4	N
18	Intrepid 2F	4.0 to 8.0 fl oz/A (AW)	methoxyfenozide	1	4	L
28	Coragen 1.67SC Coragen eVo	3.5 to 7.5 fl oz/A (AW) 1.2 to 2.5 fl oz/A (AW)	chlorantraniliprole	1	4	L
28	Vantacor	1.2 to 2.5 fl oz/A	chlorantraniliprole	1	4	L

Onion Maggots

This pest is more important in onions, but it can also be a problem in leeks. Planting successive crops of any Allium species in the same field increases the likelihood of maggot damage. Adults resemble small, slender house flies. There are 3 generations each year, but the spring generation is generally most damaging. Flies live for 2-4 weeks and can migrate about a mile in search of suitable hosts. Females oviposit on the soil near the plants or occasionally on the young leaves or plant necks. Maggot feeding causes wilting of foliage, after which it collapses. Larger leeks may survive but have distorted growth. Control should target adult flies as a preventative measure. Control is warranted if a field experienced more than 5% damage the previous year. Overwinter flight peaks around 735 DD (base temperature of 40°F; see section E.3.1 Using Degree Days to Predict Development Stages of Pests)

Onion Maggots - continued

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
3A	Mustang Maxx*	2.24 to 4.00 fl oz/A (adults only)	zeta-cypermethrin	7	12	H

Thrips

Thrips pierce plant tissue and remove liquids. Immature thrips often feed on young tissue between the leaf sheaths and the stem, adults feed on more mature tissue. Feeding injury results in whitish or chlorotic blotches. Extended feeding can reduce bulb size and increase leaf and bulb rots. Effective management relies on high pressure, high gallonage sprays for thorough coverage and penetration into the foliage.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1B	Malathion 57 EC	1.5 to 2.0 pt/A	malathion	3	24	H
3A[1]	Mustang Maxx*	2.88 to 4.00 fl oz/A	zeta-cypermethrin	7	12	H
4A[2]	Assail 30SG Assail 30SC	5.0 to 8.0 oz/A 4.2 to 6.7 fl oz/A	acetamiprid	7	12	M
4A[2]	Scorpion 35SL	8.75 to 10.5 fl oz/A	dinotefuran - **soil**	AP	12	H
4A[2]	Scorpion 35SL	5.25 to 7.0 fl oz/A	dinotefuran - **foliar**	1	12	H
4A[2]	Venom 70SG	5.0 to 6.0 oz/A	dinotefuran - **soil**	AP	12	H
4A[2]	Venom 70SG	3.0 to 4.0 oz/A	dinotefuran - **foliar**	1	12	H
5	Entrust SC (OMRI)	3.0 to 6.0 fl oz/A	spinosad	1	4	M
5	Radiant SC	6.0 to 10.0 fl oz/A	spinetoram	1	4	M
23	Movento (larvae)	5.0 fl oz/A	spirotetramat	3	24	L
23+7C	Senstar	10.0 fl oz/A	spirotetramat + pyriproxyfen	7	24	L
28 + 6	Minecto Pro*	7.0 to 10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H

[1]Resistance concerns with western flower thrips [2]Resistance concerns with tobacco thrips

Disease Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.
Recommended Fungicides

<u>Damping-off caused by *Phytophthora*, *Pythium*, and *Rhizoctonia*</u>

Code	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
FOR SEEDED BEDS: (Note: Apron XL and Maxim 4FS can be combined**).**						
For Pythium and Phytophthora control, use a seed treatment such as:						
4	Apron XL	0.085 to 0.64 fl oz/100 lb seed	mefenoxam	n/a	n/a	N
For control of other root rots apply:						
12	Maxim 4FS	0.08 to 0.16 fl oz/100 lb seed	fludioxonil	n/a	n/a	L
FOR TRANSPLANTED BEDS:						
For Pythium root rot control apply one of the following as a banded spray:						
4	Ridomil Gold 4SL	0.5 to 1.0 pt/A	mefenoxam	AP	48	N
4	MetaStar 2E AG	2.0 to 4.0 pt/A	metalaxyl	AP	48	N
For Rhizoctonia root rot control apply as in-furrow application:						
11	azoxystrobin 2.08F	0.40 to 0.80 fl oz/1000 ft row	azoxystrobin	0	4	N
For Pythium and Rhizoctonia root rot control apply as banded spray application:						
4 + 11	Uniform 3.66SE	0.34 fl oz/1000 ft row (see label)	mefenoxam + azoxystrobin	AP	0	N

<u>Bacterial and Fungal Diseases</u>

Downy Mildew (*Peronospora destructor*)

Downy Mildew on leeks is caused by the same pathogen on onion and garlic. Its development is promoted by cool, moist conditions. Management begins with planting pathogen-free seed or sets and crop rotations of at least 3 years without related crops. Be sure to eliminate culls and volunteers from the field. (*continued next page*)

Downy Mildew (Peronospora destructor) - continued

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Apply one of the following preventatively prior to the onset of disease.						
M05	chlorothalonil 6F	1.5 to 3.0 pt/A[1]	chlorothalonil	14	12	N
40	Forum 4.17SC	6.0 fl oz/A[2]	dimethomorph	0	12	N
Rotate one of the following FRAC code 7 or 11 fungicides every 7 d when conditions favor disease development or when symptoms are present in the field:						
7	Fontelis 1.67SC	16.0 to 24.0 fl oz/A	penthiopyrad	0	12	L
7 + 11	Merivon 2.09SC	8.0 to 11.0 fl oz/A (for suppression)	fluxapyroxad + pyraclostrobin	7	12	N
7 + 11	Pristine 38WG	18.5 oz/A (for suppression)	boscalid + pyraclostrobin	7	12	--
11	azoxystrobin 2.08F	9.0 to 15.5 fl oz/A	azoxystrobin	0	4	N
11	Cabrio 20EG	12.0 oz/A	pyraclostrobin	7	12	N
Rotate one of the above with the following every 7 d as long as weather conditions favor disease development:						
3	tebuconazole 3.6F	4.0 to 6.0 fl oz/A	tebuconazole	7	12	N
40 + 45	Zampro 525SC	14.0 fl oz/A	dimethomorph + ametoctradin	0	12	--
49+M05	Orondis Opti	1.75 to 2.5 pt/A	oxathiapiprolin + chlorothalonil	0	12	--

[1] Do not apply chlorothalonil more than 3 times per season.
[2] Forum 4.17SC must be tank mixed with another fungicide effective for Downy Mildew.

Fusarium Basil Rot

Leaf tips of infected plants will turn yellow and curl and eventually entire leaves will become chlorotic, turn brown and decay. Infected roots will turn dark brown. The outermost layers of infected bulbs will have a watery, brown discoloration. White mycelium may be present. The pathogen can survive in the soil for many years. Rotate away from leeks, garlic, or onions for 4-5 years minimum. Avoid excess fertility. Insect feeding damage can increase basil rot; control onion maggot and other insects that may feed on bulbs.

Purple Blotch

Begin preventative applications in the fall as soon as transplants are set out especially in fields with a history of the disease. Rotate the following at 7-10 d intervals as long as night temperatures remain warm and there are extended periods of leaf wetness.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Apply the following preventatively prior to the onset of disease. Do not apply chlorothalonil more than 3 times per season.						
M05	chlorothalonil 6F	1.5 to 3.0 pt/A	chlorothalonil	14	12	N
Tank mix the above with one of the following FRAC code 3, 7, or 11 fungicides when conditions favor disease development or when symptoms are present in the field. Rotate fungicides with different modes of action.						
3 + 9	Inspire Super 2.82EW	16.0 to 20.0 fl oz/A	difenoconazole + cyprodinil	7	12	--
3 + 11	Quadris Top 1.67SC	12.0 to 14.0 fl oz/A	difenoconazole + azoxystrobin	7	12	--
7	Endura 70W	6.8 oz/A	boscalid	7	12	--
7	Fontelis 1.67SC	16.0 to 24.0 fl oz/A	penthiopyrad	0	12	L
7 + 9	Luna Tranquility 4.16SC	16.0 to 27.0 fl oz/A	fluopyram + pyrimethanil	7	12	--
7 + 11	Pristine 38WG	10.5 to 18.5 oz/A	boscalid + pyraclostrobin	7	12	--

White Rot (*Sclerotium cepivorum*)

White Rot is severe only on overwintered leeks. Cool, moist soil conditions that are favorable for the growth of leek, garlic and onion are also ideal for white rot. Infection occurs at soil temperatures between 50-75°F (60-65°F optimum). The disease is greatly inhibited above 78°F. Sclerotia can survive for over 20 years, even in the absence of a host plant. In treated fields, do not grow crops other than leek and leafy vegetables during the harvest year, and do not grow leeks, garlic, leafy vegetables, tomatoes, root crops, cereal grains or soybeans the following year.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Apply the following fungicide at 10-14 d intervals (for suppression only):						
3	tebuconazole 3.6F	4.0 to 6.0 fl oz/A	tebuconazole	7	12	N
3 + 7	Luna Experience 3.34SC	8.0 to 12.8 fl oz/A	tebuconazole + fluopyram	7	12	--
9 + 12	Switch 62.5WG	0.5 to 1.0 fl oz/1000 ft row	cyprodinil + fludioxonil	7	12	L

Lettuce, Endive and Escarole

Recommended Varieties

Crop	Type	Color	Variety[1]	Season[2]		Disease Resistance[3]			Environment	
				Sp	LSF	DM	LMV	CR	Heat[4]	Tip[5]
Lettuce	Bibb	Green	Buttercrunch	X						
			Newham	X	X					
	Butterhead	Green	Adriana	X		X	X		X	X
			Harmony	X		X	X			X
			Merkurion	X	X					
			Milagro			X				
			Nancy	X			X			
			Rex[6]	X	X	X			X	X
			Salanova® Green Butter	X	X	X			X	
		Red	Alkindus	X	X	X	X		X	X
			Salanova® Red Butter	X	X	X			X	
			Skyphos	X	X	X	X		X	
	Crisp	Green	Muir	X	X	X	X		X	
			Nevada	X	X				X	X
		Red	Cherokee	X	X	X			X	
			Magenta	X	X	X	X			
	Iceberg	Green	Crispino	X	X					
			Mighty Joe	X					X	
	Leaf	Green	Bergam's Green	X	X			X	X	X
			Green Star	X	X	X			X	X
			Starfighter	X	X	X			X	
			Tropicana	X	X				X	X
			Two Star	X	X				X	X
		Red	New Red Fire	X	X					
	Romaine	Green	Arroyo	X	X	X			X	
			Coastal Star	X				X		
			Green Forest	X				X		X
			Green Towers	X	X					
			Jericho	X	X				X	X
			Monte Carlo	X		X				X
			Salvius	X	X	X		X	X	X
			Sunland	X	X			X	X	
		Red	Pomegranate Crunch		X					
Endive	Endive	Green	Benefine	X						
			Curlesi	X						
			Salad King	X						
Escarole	Escarole	Green	Eros		X					
			Forbes		X					
			Full Heart	X						
			Natacha		X					

[1]**Listed alphabetically within leaf color**.
[2]Sp=Spring, LSF=Late Summer and Fall.
[3]DM=Downy Mildew resistant, LMV=Lettuce Mosaic Virus resistant, CR=Corky Root resistant.
[4]Heat and bolting tolerant.
[5]Leaf tipburn resistant.
[6]Rex Variety: for high tunnel or greenhouse use only.

Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and Chapter B Soil and Nutrient Management. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede the recommendations found below.

Crop		Soil Phosphorus Level				Soil Potassium Level				
		Low	Med	High (Opt)	Very High	Low	Med	High (Opt)	Very High	
	N (lb/A)	P_2O_5 (lb/A)				K_2O (lb/A)				Nutrient Timing and Method
Leaf Lettuce, Endive, or Escarole[1]	100-125	200	150	100	0	200	150	100	0	Total nutrient recommended
	50-75	200	150	100	0	200	150	100	0	Broadcast and disk-in
	25-50	0	0	0	0	0	0	0	0	Sidedress 3-5 weeks after planting
Iceberg Lettuce[1]	60-80	200	150	100	0	200	150	100	0	Total nutrient recommended
	25-50	200	150	100	0	200	150	100	0	Broadcast and disk-in
	25-30	0	0	0	0	0	0	0	0	Sidedress 3-5 weeks after planting

[1]Apply 25-30 lb/A of sulfur (S) for most soils.

Lettuce for Salad Mixes See also section A 3. Specialty Vegetables.

Loose-, red-, and oakleaf, romaine and other lettuces are commonly used in baby or small leaf stages in salad mixes.

Growing Conditions

Lettuce, endive, and escarole are cool-season crops. Properly hardened lettuce transplants can tolerate temperatures as low as 20-25°F (-7 to -4°C). Temperatures above 85°F (29°C) for several days will cause seed stalk formation and bolting in lettuce. Temperatures below 70°F (21°C) during the seedling stage promote premature seed stalk formation in endive and escarole.

Seed Treatment Treat seeds to prevent disease. See Disease Control below.

Seeding and Transplanting

Spring Crop: The early endive and escarole crop is usually grown from transplants shipped into the region. Lettuce transplants are started in frames or greenhouses. Lettuce seed is sown in frames in November, in unheated greenhouses in December, and in heated greenhouses in January and February at the rate of 4-6 oz seed for 1 acre of plants. Plants are ready for field planting in early March.

Direct-seeded lettuce is sown in prepared beds as early in the spring as the ground can be worked. Seeds require light to germinate so should be sown at shallow depth. Some of the seeds should actually be uncovered. Pelleted seed should be watered at night during high-temperature periods (soil temperatures above 80°F/27°C) until germination occurs. The spring lettuce crop can be field-seeded or transplanted through May. In the southern part of the region, planting after April results in seed stalk formation. Only leaf lettuce should be seeded as late as May. Successive plantings of endives can be made through the middle of August.

Seed Priming: Lettuce seeds enter physiological dormancy at temperatures above 85°F (29°C). This can make it difficult to establish a fall crop. Priming seeds in 1% potassium phosphate (K_3PO_4) for 20 hours at 75°F (24°C) prior to sowing will prevent thermo-dormancy. Many vendors offer primed lettuce seeds for fall production.

Fall Lettuce Crop: Seed in the field July 25 to August 10 in PA and other cool areas, and August 5-20 in warmer areas. When transplants are used, planting dates can be delayed 2-3 weeks.

Spacing

Lettuce: Head and Romaine lettuce is planted in rows 2 ft apart with plants 12-15 inches apart in the row. Leaf and Boston type lettuce are planted 3-4 rows per bed with beds spaced 66-72 inches on centers. Space plants 9-12 inches apart in the row. Lettuce for baby greens or salad mixes is direct-seeded in close rows (3-6 inches apart) or broadcast across beds. Coated seed is recommended for precision seeding of heading types. Plant 1 coated seed every 2-3 inches, or 2 seeds spaced 1 inch apart every 12 inches. Direct-seeded plants should be thinned when 2 or 3 true leaves have formed. **Endive and Escarole:** Plant 3-4 rows per bed and space beds 66-72 inches on centers. Space plants 9-15 inches apart in the row.

Irrigation

Lettuce requires frequent irrigation with total seasonal water requirements of 10-12 inches.

Harvest and Post-Harvest Considerations

Lettuce is extremely perishable and needs to be handled delicately and marketed rapidly. Head lettuce is harvested when the heads are of good size (about 2 lb), well-formed and solid. Head lettuce is hand cut and trimmed (leave 3 undamaged wrapper leaves on each head) and placed in containers in the field. It is then vacuum cooled or hydrocooled. Specialty leaf lettuces and other greens for bag mixes are harvested by hand or mechanically. If the harvest is delayed or if the crop is over-mature, a strong bitter taste and toughness develop, and the product becomes unmarketable. Leaf, butterhead and cos/romaine types are cut, trimmed, and bundled before placing in cartons.

Lettuce should be precooled to 34°F (1°C) soon after harvest and stored at 32°F (0°C) and 98-100% relative humidity for retention of quality and shelf life. At 32°F, head lettuce can be held in good condition for 2-3 weeks. Leaf, cos/romaine, and butterhead lettuce have a shorter shelf life. Lettuce is easily damaged by freezing, so all parts of the storage room must be kept above the freezing point (31.7°F, -0.2°C).

Weed Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.

Recommended Herbicides

1. Identify the weeds in each field and select recommended herbicides. More information is available in the "Herbicide Effectiveness on Common Weeds in Vegetables" (Table E-3) in Chapter E Pest Management.

2. Minimize herbicide resistance development. Identify the herbicide mode of action group number and follow recommended good management practices; **bolded group numbers in tables below are herbicides at higher risk for selecting resistant weed populations.** Include non-chemical weed control whenever possible.

1. Soil-Applied (Preplant, Preemergence, or After Transplanting)

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
8	Prefar 4E	5 to 6 qt/A	**bensulide**	5 to 6 lb/A	--	12
-Labeled for preplant or preemergence applications. -Use on mineral soils only. If applied preemergence, irrigate within 36 h of application with ½ inch of water; if not incorporated with rainfall or within 36 h, weed control may be reduced. Provides control/suppression of some annual grass weeds and some broadleaves including pigweeds, purslane, and lambsquarters. **Do not** apply more than 6 qt/A per season.						
3	Kerb 50-W (WP) * Kerb 3.3SC*	2 to 4 lb/A, 1.25 to 5 pt/A	**pronamide**	1 to 2 lb/A 0.5 to 2 lb/A	25 to 55, see label	24
-**Kerb 50-W is labeled for head lettuce, endive, escarole, and radicchio greens.** -**Kerb 3.3SC is labeled for head lettuce, endive, escarole, and radicchio greens** at 1.5 to 5 pt/A; **leaf lettuce** rate is 1.25 to 5 pt/A. -Rate is dependent on weed susceptibility, soil texture, and expect duration of control. -Applications can be made preplant, preemergence, or after emergence. -Kerb needs water after application for optimum performance; 0.5-1 inches of rainfall or 1-2 inches of irrigation is recommended. -Primarily controls annual grasses and certain broadleaf weeds. Kerb will not control emerged weeds. -The required dosage rate is dependent on soil texture, target weed size, and method of irrigation. Refer to label for specific instructions. -**Do not** use more than 1.5 lb ai/A pronamide on val temp, grande verde, and prima verde crisp head lettuce; or on endive (escarole). -**Do not** make more than 1 application of Kerb 50-W per crop. -Kerb SC application can be split so part of the maximum allowable rate can be applied initially and the balance up to 10 days later. -**Do not** apply more than 4 lb/A Kerb 50W or 5 pt/A Kerb SC per acre per crop year. -Crops that are not on the label should not be planted for 3 to 12 months, depending on herbicide rate used and crop.						

2. Postemergence

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
1	Shadow 3EC Select 2EC Select Max 0.97EC	4 to 5.33 fl oz/A 6 to 8 fl oz/A 9 to 16 fl oz/A	**clethodim**	0.07 to 0.125 lb/A	14	24
	Fusilade DX 2EC	8 to 24 fl oz/A	**fluazifop**	0.125 to 0.375 lb/A	45	12
	Poast 1.5EC	1 to 1.5 pt/A	**sethoxydim**	0.2 to 0.28 lb/A	15/30	12
-**Select 2EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). **Select Max**: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution). **Shadow 3EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution) for large or stressed grasses; use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution) when crop safety is a concern.						

2. Postemergence Shadow, Select, Select Max, Fusilade, Poast - continued next page

2. Postemergence Shadow, Select, Select Max, Fusilade, Poast - continued

-**Fusilade DX**: use COC at 1.0% v/v or NIS at 0.25% v/v. **Poast**: Apply with COC at 1.0% v/v.
The use of COC may increase the risk of crop injury when hot or humid conditions prevail.
To reduce the risk of crop injury, omit additives or switch to NIS when grasses are small and soil moisture is adequate.
-Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control.
-Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will **not** be controlled.
-Controls many annual and certain perennial grasses, including annual bluegrass, but Poast is preferred for goosegrass control. For best results, treat annual grasses when they are actively growing and before tillers are present. Control may be reduced if grasses are large or under hot or dry weather conditions.
-Repeated applications may be necessary to control certain perennial weeds. If repeat applications are necessary, allow 14 days between applications. Rainfastness is 1 h.
-**Do not** tank mix with or apply within 2 to 3 days of any other pesticide, unless labeled, as this may increase the risk of crop injury or reduce the control of grasses. **Do not** apply more than 8 fl oz/A of Select 2EC in a single application and **do not** exceed 2 pt/A for the season; **do not** apply more than 16 fl oz/A of Select Max in a single application and **do not** exceed 4 pt/A for the season.
-**Do not** apply more than 5.33 fl oz/A of Shadow 3EC in a single application and **do not** exceed 21.33 fl oz/A for the season.
-**Do not** apply more than 24 fl oz/A of Fusilade DX in a single application and **do not** exceed 3 pt/A per season.
-**Do not** apply more than 1.5 pt/A Poast in a single application and **do not** exceed 3 pt/A for the season.
-**Poast 1.5 EC labeled for leaf and head-type lettuces** (PHI=15 d for leaf types, 30 d for head types).

3. Postharvest

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
22	Gramoxone SL 2.0* Gramoxone SL 3.0*	2.25 to 3 pt/A 1.5 to 2 pt/A	**paraquat**	0.56 to 0.75 lb/A	--	24

-**Supplemental Label in DE for the use of both Gramoxone formulations for postharvest application to desiccate the crop.**
-Apply after the last harvest for bareground or plasticulture. Always include an adjuvant.
-Spray coverage is essential for optimum effectiveness. See the label for additional information and warnings.
-Rainfastness 30 min. A maximum of 2 applications for crop desiccation are allowed.
-***Restricted-use pesticide***. Only certified applicators, who successfully complete the paraquat-specific training, can mix, load, or apply paraquat. Application of paraquat “under the direct supervision” of a certified applicator is no longer allowed. Required training link (*https://campus.extension.org/enrol/index.php?id=2201*); certified applicators must repeat training every three years.

4. Other Labeled Herbicides These products are labeled but limited local data are available; and/or are labeled but not recommended in our region due to potential crop injury concerns.

Group	Product Name (*=Restricted Use)	Active Ingredient
3	Treflan	**trifluralin**
14	Aim	**carfentrazone**
14	Vida	**pyraflufen**

Insect Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F. Recommended Insecticides

Aphids

On fall crops, seedling protection from aphids is important. Spray if the aphid population reaches 1 aphid/seedling or > 4 aphids/plant beyond the seedling stage.

Apply one of the following formulations:

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s) and Crop Restrictions	PHI (d)	REI (h)	Bee TR
1A	Lannate LV*	1.5 to 3.0 pt/A	methomyl (check the label for PHI)	7/10	48	H
1B	Orthene 97	0.5 to 1.0 lb/A	acephate - **only labeled for head lettuce**	21	24	H
1B	Dimethoate 400	0.5 pt/A	dimethoate - **not labeled for head lettuce**	14	48	H
4A	Neonicotinoid insecticides registered for use on Lettuce types: see table at the end of Insect Control.					
4D	Sivanto Prime	21 to 28 fl oz/A	flupyradifurone - **soil**	21	4	M
4D	Sivanto Prime or 200SL	7 to 14 fl oz/A	flupyradifurone - **foliar**	1	4	M
9B	Fulfill 50WDG	2.75 oz/A	pymetrozine	7	12	L
9B	PQZ	2.4 to 3.2 fl oz/A	pyrifluquinazon	1	12	L

Aphids - continued next page

Aphids - continued

9D	Versys	1.5 fl oz/S	afidopyropen	0	12	L
23	Movento	4.0 to 5.0 fl oz/A	spirotetramat	3	24	L
23 + 7C	Senstar	8.0 to 10.0 fl oz/A	spirotetramat + pyriproxyfen	14	24	L
28	Exirel	13.5 to 20.5 fl oz/A	cyantraniliprole	1	12	H
28	Verimark	6.75 to 13.5 fl oz/A	cyantraniliprole	1	4	H
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole - **melon aphid**	1	4	H
28 + 6	Minecto Pro*	10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H
29	Beleaf 50SG	2.0 to 2.8 oz/A	flonicamid	0	12	L

Caterpillar "Worm" Pests Including: Cabbage Loopers (CL), Armyworms, and Corn Earworms (CEW)

Note: Head lettuce seedlings in the 7-18 leaf stage are vulnerable to CEW attack in August and September. Control must be achieved before the center leaves start to form a head (15-18 leaf stage). Apply insecticides every 2-5 days or every 5-10 days according to CEW moth catch and pest management alerts. **Due to resistance development, pyrethroid insecticides (Group 3A) are not recommended for control of beet armyworms or corn earworms.**

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s) and Crop Restrictions**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	1.5 to 3.0 pt/A	methomyl (check the label for PHI)	7/10	48	H
3A	Pyrethroid insecticides registered for use on Lettuce types: see table at the end of Insect Control.					
5	Entrust SC (OMRI)	4.0 to 8.0 fl oz/A	spinosad	1	4	M
5	Radiant SC	5.0 to 10.0 fl oz/A	spinetoram	1	4	M
6	Proclaim 5SG*	2.4 to 4.8 oz/A	emamectin benzoate	7	12	H
11A	Dipel DF, others (OMRI)	0.5 to 2.0 lb/A	*Bacillus thuringiensis kurstaki*	0	4	N
11A	XenTari (OMRI)	0.5 to 2 lb/A	*Bacillus thuringiensis aizawai*	0	4	N
18	Intrepid 2F (early season)	4.0 to 8.0 fl oz/A	methoxyfenozide	1	4	L
18	Intrepid 2F (late season)	8.0 to 10.0 fl oz/A	methoxyfenozide	1	4	L
22	Avaunt, Avaunt eVo	2.5 to 6 oz/A	indoxacarb	3	12	H
28	Coragen 1.67SC Coragen eVo	3.5 to 7.5 fl oz/A 1.2 to 2.5 fl oz/A	chlorantraniliprole - **soil and foliar**	1	4	L
28	Exirel	7 to 17 fl oz/A	cyantraniliprole	1	12	H
28	Verimark	5 to 13.5 fl oz/A	cyantraniliprole - **soil**	1	4	H
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H
28 + 6	Minecto Pro*	5.5 to 10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H

Cutworms

See also section E 3.1. Soil Pests - Detection and Control.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s) and Crop Restrictions**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	1.5 pt/A	methomyl (check the label for PHI)	7/10	48	H
3A	Pyrethroid insecticides registered for use on Lettuce types: see table at the end of Insect Control.					

Leafhoppers

Control of leafhoppers will prevent the spread of lettuce yellows. In the spring, spray when plants are ½ inch tall, and repeat as needed. In the fall, spray seedlings 4-5 times at 5-day intervals.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s) and Crop Restrictions**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	1.5 to 3.0 pt/A	methomyl (check the label for PHI)	7/10	48	H
1B	Orthene 97	0.5 to 1 lb/A	acephate - **head lettuce only**	21	24	H
1B	Dimethoate 400	0.5 pt/A	dimethoate - **leaf lettuce only**	14	48	H
3A	Pyrethroid insecticides registered for use on Lettuce types: see table at the end of Insect Control.					
4A	Neonicotinoid insecticides registered for use on Lettuce types: see table at the end of Insect Control.					
16	Courier SC	9.0 to 13.6 fl oz/A	buprofezin	7	12	L

Leafminers

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s) and Crop Restrictions**	**PHI (d)**	**REI (h)**	**Bee TR**
1B	Dimethoate 400	0.5 pt/A	dimethoate - **not labeled for head lettuce**	14	48	H
3A	Pyrethroid insecticides registered for use on Lettuce types: see table at the end of Insect Control.					
4A	Neonicotinoid insecticides registered for use on Lettuce types: see table at the end of Insect Control.					
5	Entrust SC (OMRI)	6.0 to 10.0 fl oz/A	spinosad	1	4	M
5	Radiant SC	6.0 to 10.0 fl oz/A	spinetoram	1	4	M
6	Agri-Mek SC*	1.75 to 3.5 fl oz/A	abamectin	7	12	H
17	Trigard 75WSP	2.66 oz/A	cyromazine	7	12	H
28	Coragen 1.67SC Coragen eVo	5.0 to 7.5 fl oz/A 1.7 to 2.5 fl oz/A	chlorantraniliprole - **soil and foliar**	1	4	L
28	Exirel	13.5 to 20.5 fl oz/A	cyantraniliprole	1	12	H
28	Verimark	6.75 to 13.5 fl oz/A	cyantraniliprole - **soil**	n/a	4	H
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H
28 + 6	Minecto Pro*	5.5 to 10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H

Tarnished Plant Bugs can cause serious damage to the fall crop; it is usually numerous where weeds abound.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s) and Crop Restrictions**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Sevin XLR Plus	1 to 2 qt/A	carbaryl	14	12	H
3A	Pyrethroid insecticides registered for use on Lettuce types: see table at the end of Insect Control.					
4A	Neonicotinoid insecticides registered for use on Lettuce types: see table at the end of Insect Control.					
29	Beleaf 50SG	2.8 oz/A	flonicamid	0	12	L

Thrips

Some species spread Tomato Spotted Wilt Virus. Scout for thrips and begin treatments when observed.
Do not produce vegetable transplants with bedding plants in the same greenhouse.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s) and Crop Restrictions**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	1.5 to 3.0 pt/A	methomyl (check the label for PHI)	7/10	48	H
3A[1]	Pyrethroid insecticides registered for use on Lettuce types: see table at the end of Insect Control.					
4A[2]	Neonicotinoid insecticides registered for use on Lettuce types: see table at the end of Insect Control.					
5	Entrust SC (OMRI)	6.0 to 10.0 fl oz/A	spinosad	1	4	M
5	Radiant SC	6.0 to 10.0 fl oz/A	spinetoram	1	4	M

[1]Resistance concerns with western flower thrips **[2]Resistance concerns with tobacco thrips**

Group 3A Pyrethroid Insecticides Registered for Use on Lettuce, Endive and Escarole

Apply one of the following formulations (check if the product label lists the insect you intend to spray; not all pyrethroids are labeled for all lettuce types; the label is the law):					
Product Name (*=Restricted Use)	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
Baythroid XL*	0.8 to 3.2 fl oz/A	beta-cyfluthrin †	0	12	H
Brigade 2EC*, others	2.1 to 6.4 fl oz/A	bifenthrin†	7	12	H
Hero*	4.0 to 10.3 fl oz/A	zeta-cypermethrin + bifenthrin† **- head lettuce only**	7	12	H
Mustang Maxx*	2.24 to 4.0 fl oz/A	zeta-cyhalothrin*†	1	12	H
Permethrin 3.2EC*, others	2 to 8 fl oz/A	permethrin†	1	12	H
PyGanic Crop protection EC 5.0 II (OMRI)	4.5 to 15.61 fl oz/A	pyrethrins	0	12	H
Tombstone*	0.8 to 3.2 fl oz/A	cyfluthrin†	0	12	H
Warrior II*	0.96 to 1.92 fl oz/A	lambda-cyhalothrin†	1	24	H
Combo products containing a pyrethroid					
Endigo ZC* and ZCX*	4.0 to 4.5 fl oz/A	lambda-cyhalothrin + thiamethoxam † (Group 4A)	7	24	H
Leverage 360*	3.0 fl oz/A	beta-cyfluthrin + imidacloprid † (Group 4A)	7	12	H
Voliam Flexi	6.0 to 7.0 fl oz/A	thiamethoxam + chlorantraniliprole (Group 28)	7	12	H

†=Not recommended for BAW or CEW

Group 4A Neonicotinoid Insecticides Registered for Use on Lettuce, Endive and Escarole					
Apply one of the following formulations (check if the product label lists the insect you intend to spray; not all neonicotinoids are labeled for all lettuce types; the label is the law):					
Product Name (*=Restricted Use)	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
Admire Pro	4.4 to 10.5 fl oz/A	imidacloprid - **soil**	21	12	H
Admire Pro	1.3 fl oz/A	imidacloprid - **foliar**	7	12	H
Assail 30SG	2.0 to 4.0 oz/A	acetamiprid	7	12	M
Belay 2.13SC	9.0 to 12.0 fl oz/A	clothianidin - **soil**	21	12	H
Belay 2.13SC	3.0 to 4.0 fl oz/A	clothianidin - **foliar**	7	12	H
Actara 25WDG	1.5 to 3.0 oz/A	thiamethoxam	7	12	H
Platinum 75SG	1.66 to 3.67 oz/A	thiamethoxam	30	12	H
Scorpion 35SL	9.0 to 10.5 fl oz/A	dinotefuran - **soil**	21	12	H
Scorpion 35SL	2.0 to 5.25 fl oz/A	dinotefuran - **foliar**	7	12	H
Venom	5.0 to 7.5 oz/A	dinotefuran - **soil**	21	12	H
Venom	1.0 to 3.0 oz/A	dinotefuran – **foliar**	7	12	H
Combo products containing a neonicotinoid					
Endigo ZC* and ZCX*	4.0 to 4.5 fl oz/A	thiamethoxam + lambda-cyhalothrin (Group 3A)	7	24	H
Leverage 360*	3.0 fl oz/A	imidacloprid + beta-cyfluthrin + (Group 3A)	7	12	H

Disease Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.
Recommended Fungicides

Seed Treatment

Dust seed with Thiram 480DP at the rate of 1 level tsp/lb of seed (3.0 oz/100 lb).

Damping-off caused by *Phytophthora*, *Pythium*, and *Rhizoctonia*

An application of mefenoxam or metalaxyl at planting will also help suppress White Rust and Downy Mildew development early in the season. Uniform applied at transplanting or seeding will also help suppress early-season Rhizoctonia root rot and Downy Mildew.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s) Crop Restrictions	PHI (d)	REI (h)	Bee TR
Apply one of the following in a 7-inch band after seeding or transplanting:						
4	Ridomil Gold 4SL	1.0 to 2.0 pt /A	mefenoxam	AP	12	N
4	Ultra Flourish 2E	2.0 to 4.0 pt /A	mefenoxam	AP	48	N
4	MetaStar 2E AG	4.0 to 8.0 pt/A	metalaxyl	AP	48	N
49 + 4	Orondis Gold	13.9 to 27.8 fl oz/A[1]	oxathiapiprolin + mefenoxam	AP	48	--
For Damping-off and Rhizoctonia control:						
4 + 11	Uniform 3.66SE	0.34 fl oz/1000 row	mefenoxam + azoxystrobin	AP	0	N

[1]Can be used in transplant water, see label for instructions

Bacterial and Fungal Diseases

Bottom Rot caused by *Rhizoctonia*

For the spring and fall crops, all fields should receive one of the following fungicide applications one week after transplanting or thinning and 10 and/or 20 days later if conditions warrant and/or cultivation has been done. Uniform (0.34 fl oz 3.66SE/1000 ft row) applied in-furrow at transplanting or seeding for root rot control will also help early-season suppression of Downy Mildew.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s) Crop Restrictions	PHI (d)	REI (h)	Bee TR
4+11	Uniform 3.66SE	0.34 fl oz/1000 ft row	mefenoxam + azoxystrobin	AP	0	N
7	Endura 70WG	8.0 to 11.0 oz/A	boscalid[1] **- not labeled for endive and escarole**	14	12	--
11	azoxystrobin 2.08F	0.40 to 0.80 fl oz/1000 ft row	azoxystrobin	0	4	N

[1]Do not cultivate directly after applying iprodione or Endura (see labels for details).

Corky Root (*Rhizomonas suberifaciens*)

Development of this bacterial disease is favored by continual cropping in the same field. Cultural practices that reduce soil compaction, such as the use of a rye cover crop and high beds, should be considered. Limit irrigation between transplanting or thinning. Warm soil temperatures and high soil N levels may exacerbate disease.

Downy Mildew (*Bremia lactucae*)

Mefenoxam applied for damping-off control at seeding or transplanting will also help in the control of early-season Downy Mildew. Downy Mildew can cause problems during extended periods of cool, wet weather. Fungicide applications should begin and continue as conditions favor disease development.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s) Crop Restrictions	PHI (d)	REI (h)	Bee TR
Rotate one of the following fungicides:						
7 + 11	Merivon 2.09SC	8.0 to 11.0 fl oz/A	fluxapyroxad + pyraclostrobin	1	12	N
11	Reason 500SC	5.5 to 8.2 fl oz/A	fenamidone - **not labeled for endive and escarole**	2	12	--
21	Ranman 400SC	2.75 fl oz/A	cyazofamid	0	12	L
28	Previcur Flex 6F	2.0 pt/A	propamocarb HCl	2	12	N
43	Presidio 4SC	3.0 to 4.0 fl oz/A	fluopicolide	2	12	L
With one of the following fungicides every 7 d as long as weather conditions favor disease development.						
40	Revus 2.08F	8.0 fl oz/A	mandipropamid - **not labeled for escarole**	1	4	--
40	Forum 4.17SC	6.0 fl oz/A	dimethomorph - **not labeled for escarole**	0	12	N
40 + 45	Zampro 525SC	14.0 fl oz/A	dimethomorph + ametoctradin	0	12	--
49 + 40	Orondis Ultra 2.33SC	5.5 to 8.0 fl oz/A	oxathiapiprolin + mandipropamid	1	4	--

Gray Mold (*Botrytis cinera*)

Gray old is most troublesome in transplant greenhouses where air movement is poor and relative humidity high. Avoid overcrowding plants and water early in the day to help reduce leaf wetness overnight. Vent structure as much as possible to reduce relative humidity. See Table E-13 for options for *Botrytis* control in the greenhouse. In the field, rotate between the following fungicides every 7 d as long as conditions are favorable for disease development.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s) Crop Restrictions	PHI (d)	REI (h)	Bee TR
7	Endura 70W	8.0 to 11.0 oz/A	boscalid - **not labeled for endive and escarole**	14	12	--
7 + 11	Merivon 2.09SC	8.0 to 11 fl oz/A	fluxapyroxad + pyraclostrobin	1	12	N
12	Cannonball 50WP	7.0 oz/A	fludioxonil	0	12	L

Leaf Spots caused by *Septoria*, *Anthracnose*, and *Cercospora* spp.

In fields with a history of leaf spot diseases, and when conditions are favorable for disease development, rotate among the following fungicides every 7 d as long as weather conditions favor disease development.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s) Crop Restrictions	PHI (d)	REI (h)	Bee TR
3	Rhyme 2.08SC	5.0 to 7.0 fl oz/A	flutriafol	7	12	--
7	Fontelis 1.67SC	14.0 to 24.0 fl oz/A	penthiopyrad	3	12	L
7 + 11	Merivon 2.09SC	4.0 to 11.0 fl oz/A	fluxapyroxad + pyraclostrobin	1	12	N
11	azoxystrobin 2.08F	6.0 to 15.5 fl oz/A	azoxystrobin	0	4	N

Lettuce Drop (*Sclerotinia*)

The pathogen has a wide host range including allium, brassica, and solanaceous crops. Proper and adequate crop rotations are necessary since the pathogen can survive in soils for many years.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s) Crop Restrictions	PHI (d)	REI (h)	Bee TR
Apply one of the following as a directed spray at transplanting and/or thinning. See labels for restrictions. Rotate between the following fungicides if more than one application is needed.						
2	iprodione 4F[1]	1.5 to 2.0 pt/A	iprodione	14	12	N
7	Endura 70W	8.0 to 11.0 oz/A	boscalid - **not labeled for endive and escarole**	14	12	--
7	Fontelis 1.67SC	16.0 to 24.0 fl oz/A	penthiopyrad	3	12	L

Lettuce Drop (Sclerotinia) - continued next page

Lettuce Drop (Sclerotinia) - continued

7 + 11	Merivon 2.09SC	4.0 to 11.0 fl oz/A	fluxapyroxad + pyraclostrobin	1	12	N
7 + 11	Luna Sensation	7.6 fl oz/A	fluopyram + trifloxystrobin **- lettuce, endive only**	0/20	12	N
7 + 12	Miravis Prime	13.4 fl oz/A	pydiflumetofen + fludioxonil	0	12	--
12	Cannonball 50WP	7.0 oz/A	fludioxonil	0	12	L
P05	Regalia (OMRI)	0.5 to 4.0 qt/A	Extract of *Reynoutria sachalinensis*	0	4	--

Other pre-plant option:
Apply Contans 5.3WG at 2.0 to 4.0 lb/A approximately 3-4 months prior to the anticipated onset of disease to allow the active agent to reduce inoculum levels of sclerotia in the soil. Following application, incorporate to a depth of 1-2 inches but **do not** plow before seeding or transplanting lettuce to avoid untreated sclerotia in lower soil layers from infesting the upper soil layer.

[1]Do not cultivate directly after application (see labels for details).

Viruses

Big-Vein:
Big Vein is favored by cool temperatures (<60°F, 16°C) and high soil moisture conditions. Produce the crop on raised beds and avoid planting in fields with low-lying areas. Soil fumigation is helpful (see section E 1.5. Soil Fumigation).

Lettuce Mosaic Virus:
Use virus-free or Mosaic Tested lettuce seed.

Tomato Spotted Wilt Virus (TSWV):
TSWV is spread from flowering ornamental plants (flowers) to lettuce by thrips. Do not grow any ornamental bedding plants in the same greenhouse as lettuce transplants. Scout and monitor for greenhouse thrips regularly and begin an insecticide control program once observed.

Turnip Mosaic Virus:
Troublesome in late summer and early fall plantings. Control weed hosts around irrigation risers and in border areas.

Yellows:
Control leafhopper vectors with insecticides - see Insect Control section above.

Muskmelons and Mixed Melons

Recommended Varieties

Type	Flesh Color	Variety[1,2]	Days[3]	Rind Description	lb[4]	PM[5]	FW[6]
Muskmelon	Orange	Accolade	74	Oval, medium netting, light sutures	5	1,2	0,1,2
		Aphrodite	80	Light netting, light sutures	7	1	0,1,2
		Astound	75	Oval, fine netting, light sutures	5	1,2	0,1,2
		Athena	79	Oval, medium netting, light sutures	6	1,2	0,1,2
		Atlantis	74	Oval, medium netting, light sutures	7	1,2	0,1,2
		Avatar	72	Oval, medium netting	8	1,2	0,1,2
		Goddess	68	Oval, medium netting, light sutures	5	1,2	0,1,2
		Halona	73	Round, netted, heavy sutures	4	1,2	0,1,2
		Orange Sherbet	80	Oval, medium netted, heavy sutures	7	1	0,1,2
		Rockstar	73	Oval, medium netting, light sutures	6	1,2	0,1,2
		Sarah's Choice	76	Round, netted, no sutures	3	1,2	0,1,2
		Sugar Cube	80	Mini, round, netted, no sutures	2	1,2	0,1,2
		Sugar Rush	75	Oval, netted	4	1,2	0,1,2
		Tirreno	83	Oval, medium netting, green sutures	3	1,2	0,1,2
Canary	White	Camino Europa	84	Oval, yellow, wrinkled, no net	5	1,2	0,1,2
		Halo	75	Oval, yellow, no net	5	1	0,1
		Natal	85	Oval, yellow, wrinkled, no net	5	1,2	0, 1,2
Galia	Green	Diplomat	75	Slight oval, fine net, no sutures	5	1,2	
		Passport	75	Slight oval, fine net, no sutures	6		
		Visa	75	Slight oval, fine net, no sutures	4	1,2	
Honeydew	Light green	Dewlightful	90	Round, white, smooth	7	1,2	
		Earli-Dew	80	Round, white, smooth	3		2
		Summer Dew	88	Round, white, smooth	5	1,2	0,2
	White	Snow Leopard	71	Slight oval, white/green, smooth	2		1
Christmas	Light green	Lambkin	70	Oval, smooth, green/yellow rind	3		

[1]**Listed alphabetically within type**. [2]All varieties are hybrids. [3]Relative days to harvest. [4]lb=average harvest weight (pounds per melon). [5]PM=Powdery Mildew; resistance to PM races as reported from source seed companies. [6]FW=Fusarium Wilt; resistance to FW races as reported from source seed companies.

Melon Descriptions

Ananas	Middle Eastern Melons. Oval shaped with medium-fine netting over pale green to orange rind. Very sweet, aromatic white flesh or orange-pink flesh. Average weight 3-4 pounds.
Canary	Bright yellow rinds and an oblong shape. Inside, the pale, cream-colored flesh is juicy, and the flavor is very mild.
Casaba	Oval shape with a pointy end, wrinkled yellow skin, weighing 4-7 pounds. The pale, almost white flesh is extremely sweet.
Charentais	French melons identifiable by their smooth, gray, or gray-blue rinds with sutures and orange flesh and are small in size.
Christmas	Football shape and weighing upwards of 5 to 8 pounds. They have green mottled rinds and pale orange to light green flesh depending upon the variety. Sweet flesh.
Crenshaw	Casaba cross with a slightly more oblong shape, weighing at least 5 pounds. The slightly wrinkled green rind ripens to yellow. Inside, the flesh is pale peachy orange. It has a strong, spicy aroma.
Crosses	There are a number of crosses, *e.g.*, muskmelon x Galia and Charentais x Muskmelon that produce excellent melons.
Galia	Israeli melons that have netted rinds similar to cantaloupes but paler in color. The sweet pale green to almost white flesh has the consistency of a honeydew with what has been described as a spicy-sweet or banana-like aroma. When ripe, they slip from the vine.
Honeydew	Smooth, white to greenish-white rinds (some may be yellow) and sweet flesh that may be green, white, or orange. Its texture is similar to a cantaloupe, but the flavor more subtle and sweet.
Muskmelon	The familiar American cantaloupes with orange flesh and netted skin. This includes deep sutured round to oval "Superstar" types, Eastern "Athena" types that are oval with slight sutures, and Western shipping types without sutures.
Oriental	Small (weighing a little more than 1 pound), elongated yellow melons with white sutures, and sweet, pale peach to white flesh. Because the seeds are so small and the rind is so thin, the entire melon can be eaten.
Other	Specialty melons that do not fit into the other categories are also available including those categorized as "Gourmet".
Persian	Bigger than cantaloupes, have a dark green rind with light brown netting. As it ripens, the rind turns to light green. Bright pink-orange flesh has a delicate flavor. Unlike most melons in the Reticulatus group, Persian melons do not slip from the vine when mature.
Tuscan	A category of muskmelon that is oblong with deep green sutures and netted straw-colored skin.

Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and Chapter B Soil and Nutrient Management. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede the recommendations found below.

		Soil Phosphorus Level				Soil Potassium Level				
		Low	Med	High (Opt)	Very High	Low	Med	High (Opt)	Very High	
	N (lb/A)	P_2O_5 (lb/A)				K_2O (lb/A)				Nutrient Timing and Method
Musk-melons[1,2]	75-150	150	100	50	0[3]	200	150	100	0[3]	Total nutrient recommended
	25-50	150	100	50	0[3]	200	150	100	0[3]	Broadcast and disk-in or follow fertigation schedule
	25-50	0	0	0	0	0	0	0	0	Sidedress when vines begin to run or follow fertigation schedule
	25-50	0	0	0	0	0	0	0	0	Sidedress prior to first harvest or follow fertigation schedule

For plasticulture, fertilization rates are based on a standard row spacing of 6 ft.

[1]Apply 1-2 lb/A of boron (B) with broadcast fertilizer; see also Table B-7. in Chapter B Soil and Nutrient Management.

[2]Apply 25-30 lb/A of sulfur (S) for most soils.

[3]In VA, crop replacement values of 25 lb/A of P_2O_5 and 50 lb/A of K_2O are recommended on soils testing Very High.

Fertigation Schedule Examples

This table provides examples of fertigation schedules based on two common scenarios – sandy coastal plain soils and heavier upland soils. Modify according to specific soil tests and base fertility.

Fertigation recommendations for 100 lb N and 100 lb K_2O[1,2] For soils with organic matter content less than 2% or coarse texture and low to medium or deficient K								
			Nitrogen			**Potash**		
Preplant (lb/A)[3]			**50**			**100**		
			N	**N**	**N**	**K_2O**	**K_2O**	**K_2O**
Stage and Description	Weeks	Days	lb/day	lb/week	lb/stage	lb/day	lb/week	lb/stage
1 Early vegetative	1-4	1-28	0.9	6.3	25.2	0.9	6.3	25.2
2 Late vegetative	5-7	29-49	1.3	9.1	27.3	1.3	9.1	27.3
3 Flowering and fruiting	8-11	50-77	1.5	10.5	42	1.5	10.5	42
4 Harvest[4]	12-13	78-91	0.7	4.9	9.8	0.7	4.9	9.8
Fertigation recommendations for 60 lb N and 60 lb K_20[1,2] For soils with organic matter content greater than 2% or fine texture and high or optimum K								
			Nitrogen			**Potash**		
Preplant (lb/A)[3]			**40**			**40**		
			N	**N**	**N**	**K_2O**	**K_2O**	**K_2O**
Stage and Description	Weeks	Days	lb/day	lb/week	lb/stage	lb/day	lb/week	lb/stage
1 Early vegetative	1-4	1-28	0.5	3.5	14	0.5	3.5	14
2 Late vegetative	5-7	29-49	0.8	5.6	16.8	0.8	5.6	16.8
3 Flowering and fruiting	8-11	50-77	0.9	6.3	25.2	0.9	6.3	25.2
4 Harvest[4]	12-13	78-91	0.4	2.8	5.6	0.4	2.8	5.6

[1]Rates are based on 7,260 linear bed ft/A (6-ft bed spacing). If beds are closer or wider, fertilizer rates should be adjusted proportionally. Drive rows should not be used in acreage calculations (see section C 3. Fertigation).

[2]Base overall application rate on soil test recommendations.

[3]Applied under plastic mulch to effective bed area using modified broadcast method.

[4]For extended harvest after 10 weeks continue fertigation at this rate.

Plant Tissue Testing

Plant tissue testing can be a valuable tool to assess crop nutrient status during the growing season to aid with in-season fertility programs or to evaluate potential deficiencies or toxicities. Critical muskmelon tissue test values for most recently matured leaves prior to fruit set: N 4-5 %, P 0.4-0.7 %, K 5.0-7.0 %, Ca 3-5%, Mg 0.35-0.45% and S 0.2%. For additional nutrients and other growth stages consult with a tissue testing laboratory or this web link at the University of Florida: *https://edis.ifas.ufl.edu/publication/ep081*.

Seed Treatment

Seed should be treated; check with your seed company and see Disease Control below.

Plant Production, Planting and Spacing

Transplants for early plantings should be grown in pots or cells with at least 2 x 2 inches per plant (50 cell trays). Later plantings can be grown in 72 cell trays. Small cells will restrict root growth and provide less protection to the newly set transplant in colder soils. One ounce of muskmelon seed contains 950-1,250 seeds. Grow at 70-75°F.

Transplant container-grown plants through plastic mulch when soil temperature has reached 60°F (16°C). Temperatures below 50°F (10°C) can stunt plant growth. Direct seeding in plastic mulch or bare ground is also successful. First planting dates vary from May 1 in southern regions to June 5 in northern areas and successive plantings can be made to harvest through early September. Early plantings should be protected from winds with row covers, or rye windbreaks. The recommended spacing for melons is 5-6 ft between rows and 2-3 ft between plants in the row for transplants (space mini melons closer than large melons). Direct seedings should be over-seeded and thinned to a similar population.

Drip/Trickle Fertilization

Before mulching, adjust soil pH to around 6.5, apply enough farm-grade fertilizer to supply 25-50% of N and K_2O requirements and thoroughly incorporate into the soil. At least 50% of N should be in the nitrate (NO_3) form. Apply all P_2O_5 preplant and incorporate into the soil. Apply the balance of N and K_2O through the drip irrigation system throughout the season. The first fertigation application should be within a week after field transplanting or direct seeding.

Manganese Toxicity

This disorder occurs in acid soils (pH < 5.8). Maintain soil pH at 6.5 to avoid toxicity.

Mulching

Plastic mulch laid on moist soil before field plantings conserves moisture, increases soil temperature, and increases early and total yields. Various widths of plastic mulch are available; choose a width that works with your production system and available equipment. Fumigation aids in the control of weeds and soil-borne diseases. Several fumigants can be used on muskmelon depending on what the predominant pests are. Plastic and fumigant should be applied to well-prepared soil 30 days before field planting. Fumigation alone may not provide satisfactory weed control under plastic.

Pollination (see also sections A 12. Pollination and D 6.3.1. Protection of Pollinators).

Honey bees, squash bees, bumble bees and other wild bees are important for pollination and fruit set. Populations of pollinating insects may be adversely affected by insecticides applied to flowers or weeds in bloom. Apply insecticides only in the evening hours or wait until bloom is completed before application. See insecticide tables for relative toxicity of various pesticides for bees and follow all label application restrictions for pollinator protection.

Harvest and Post-Harvest Considerations

Muskmelons should be harvested no sooner than at half-slip and preferably at full-slip for optimum fruit quality. Canary melons and Galia melons also slip, but Honeydews and some specialty melons do not. Pick honeydew melons when the stem end becomes slightly springy, and the skin takes on a creamy yellow appearance. Harvest daily in hot weather. Cooling to remove field heat is desired. Precooling can be done with cold water, cold air, or ice. Hydrocooling is the most efficient method, but room cooling and forced air cooling are also suitable for melons. After precooling, muskmelons should be stored at 36-41°F (2-5°C) and 95% relative humidity. A full-slip melon can be kept about 15 days at this temperature. Honeydews and other non-slip melons should not be stored below 40°F (4°C), as chilling injury will result. They will retain adequate quality for 2-3 weeks at 45-50°F (7-10°C).

Weed Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.

Recommended Herbicides

1. Identify the weeds in each field and select recommended herbicides. More information is available in the "Herbicide Effectiveness on Common Weeds in Vegetables" (Table E-3) in Chapter E Pest Management.

2. Minimize herbicide resistance development. Identify the herbicide mode of action group number and follow recommended good management practices; **bolded group numbers in tables below are herbicides at higher risk for selecting resistant weed populations.** Include non-chemical weed control whenever possible.

Labeled Application Sites for Muskmelons

Herbicide (*=Restricted Use)	HRAC group number	Plastic mulch production					Bareground production		
		Soil-Applied		Postemergence					
		Under Plastic	Row Middles	Over Plastic	Row Middles	Post-Harvest	Soil-applied	POST	Post-harvest
Sandea	2	YES	YES	YES	YES		YES	YES	
Curbit	3		YES				YES		
Prowl H2O	3		YES						
Treflan	3		YES						
Prefar	8	YES	YES				YES		
Command	13		YES				YES		
Strategy	3 + 13		YES				YES		
Poast	1			YES				YES	
Select / Select Max Shadow 3EC	1			YES				YES	
Gramoxone*[1]	22				YES	YES			YES

[1] Special Local Needs Label 24(c), be sure it is registered for the specific state and for the intended use.

1. Pre-Transplant Over Plastic

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
10	Rely 280 2.34L	29 to 43 fl oz/A	**glufosinate**	0.53 to 0.79 lb/A	30	12
-**Supplemental Label expires 12/1/2025 for application over plastic prior to transplanting.** -Ammonium sulfate (AMS) can be used at 1.5 lb/A to 3 lb/A. -Control is best when applied to weeds less than 4 inches, temperatures are above 80, high humidity, and bright sunlight. -Transplants can be injured if they come in contact with herbicide remaining on the plastic. Allow at least 3 days between application and transplanting. At least 0.5 inches of precipitation is needed to wash Rely off the plastic. Do not transplant within 27 days of application if no precipitation occurs. -DO NOT transplant into or within 6 inches of holes in the plastic mulch that were present at time of application. -Two applications can be made prior to transplanting. Do not apply more than 64 fl oz/A prior to transplanting; maximum number of applications is three per season. -Rainfastness is 4 h						
22	Gramoxone SL 2.0* Gramoxone SL 3.0*	2 to 4 pt/A 1.3 to 2.7 pt/A	**paraquat**	0.5 to 1.0 lb/A	--	24
-Gramoxone can be used for preplant weed control over the top of plastic mulch. Sufficient rainfall or sprinkler irrigation is needed to wash off the Gramoxone prior to planting to prevent damage to the crop. -***Restricted-use pesticide***. Only certified applicators, who successfully complete the paraquat-specific training, can mix, load, or apply paraquat. Application of paraquat "under the direct supervision" of a certified applicator is no longer allowed. Required training link (*https://campus.extension.org/enrol/index.php?id=2201*); certified applicators must repeat training every three years. -Do not exceed 8 pt/A per season. -Rainfastness is 30 min.						

2. Soil-Applied

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
2	Sandea 75DF	0.5 to 1 oz/A	**halosulfuron**	0.023 to 0.047 lb/A	57	12
-**Labeled for use on cantaloupes, honeydew melons, and Crenshaw melons.** -**Plasticulture**: can be applied in a band under the plastic, immediately before laying the mulch; delay seeding or transplanting for 7 days after application. Row middles: apply before or after weed emergence; apply as a shielded application to avoid contact with the crop. If weeds have emerged, use a non-ionic surfactant at 0.25% v/v or include a non-selective herbicide. -**Bareground**: apply broadcast after seeding but before crop emergence or no sooner than 7 days before transplanting. -Suppresses or controls yellow nutsedge and certain broadleaf weeds. -Sandea provides both residual and postemergence control of susceptible weed species. Effective postemergence control requires an adjuvant. Sandea is an ALS inhibiting herbicide and resistant weed populations are common in the region. -**Do not** use Group 2 herbicides repeatedly in the same field. -**Do not** apply Sandea to crops treated with a soil applied organophosphate insecticide or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application. -Maximum number of applications per year is 2 and **do not** exceed 2 oz/A during the crop season.						

2. Soil-Applied - continued next page

2. Soil-Applied - continued

3	Curbit 3EC	1 to 3 pt/A	**ethalfluralin**	0.38 to 1.13 lb/A	--	24
-**Plasticulture**: row middles only: apply as a banded spray after crop emergence or after transplanting. **Do not** soil incorporate. -**Bareground**: apply broadcast after direct-seeding but prior to crop emergence; **do not** use on transplanted melons. -Controls annual grasses and certain annual broadleaf weeds, including carpetweed and pigweed sp. Use lower rate for coarse-textured soils or soils with low organic matter. Where overhead irrigation is available, activate Curbit with 0.5 inch of irrigation within 2 days after application; if no irrigation or rainfall occurs within 5 days of application, activity of Curbit can be reduced. -Available as a pre-mix herbicide Strategy. Strategy at 3 pt/A= Curbit at 26 fl oz/A (0.6 lb ai) and Command at 8 fl oz/A (0.188 lb ai) -Maximum applications per season: not specified						
3	Prowl H2O 3.8CS	2.1 pt/A	**pendimethalin**	1 lb/A	35	24
-**Plasticulture**: row middles only: apply as a banded spray before seeded crop has emerged or before transplanting. -**Bareground**: apply with shielded sprayer band between rows, leaving 6 inches of untreated area on both sides of the seeded or transplanted row. Apply before seeded crop emerges or before transplanting. -Where overhead irrigation is available, activate Prowl H2O with 0.5 inch of rainfall or sprinkler irrigation within 48 h of application; if no irrigation or rainfall occurs within 5 days of application, activity of Prowl H2O can be reduced -A second application at the same rate may be applied to row middles as a banded spray postemergence a minimum of 21 days after the first application, but before the vines begin to run. **Do not** apply over the top of the crop, or severe injury may occur. -Maximum number of Prowl H2O applications per season is 2 and **do not** exceed 4.2 pt/A during the crop season.						
3	Treflan 4EC	1 to 2 pt/A	**trifluralin**	0.5 to 1 lb/A	30	12
-**Plasticulture**: row middles only: apply as a directed spray after emergence when plants have reached the 3 to 4 true leaf stage of growth. Not labeled for bareground production. Primarily controls annual grasses with a few broadleaf weeds. -**Do not** use (or reduce the rate) when cold, wet soil conditions are expected, or crop injury may result. -Maximum applications per season: not specified.						
3 + 13	Strategy 2.1SC	1.5 to 6 pt/A	**ethalfluralin *plus* clomazone**	0.39 to 1.58 lb/A	45	24
-**Plasticulture**: row middles application. **Bareground**: apply broadcast just before planting or after planting but before crop emergence. -Strategy is a prepackage mixture of Curbit 3EC and Command 3ME. -Clomazone spray or vapor drift may injure susceptible crops and other vegetation, refer to Command 3ME for comments. -**Do not** apply prior to planting crop. **Do not** soil incorporate. Refer to individual products for comments. -Maximum applications per season: not specified.						
8	Prefar 4E	5 to 6 qt/A	**bensulide**	5 to 6 lb/A	--	12
-**Plasticulture** under plastic: apply in a band under the plastic, immediately before laying the mulch. Allow 7 day before making transplant holes to allow condensation to incorporate the herbicide. Plasticulture: row middles application is labeled. -**Bareground**: apply preemergence or preplant incorporated. -Preemergence applications should be followed by irrigation within 36 h (apply enough water to wet the soil at least 2 to 4 inches deep). Preplant incorporated applications should be incorporated 1 to 2 inches deep (deeper than 2 inches will result in reduced weed control). -Prefar provides control/suppression of some annual grass weeds and some broadleaves including pigweeds, purslane, and lambsquarters. -**Do not** apply more than 6 lb ai/A per season.						
13	Command 3ME	0.4 to 0.67 pt/A	**clomazone**	0.15 to 0.25 lb/A	--	12
-**Plasticulture**: row middles application only. -**Bareground**: apply broadcast just before planting or after planting but before crop emergence. Use the lower rate when used on coarse-textured soils low in organic matter, when weed pressure is light, or to minimize herbicide carryover that could affect subsequent crops. -Controls annual grasses and many broadleaf weeds including common lambsquarters, velvetleaf, spurred anoda, and jimsonweed. Carpetweed, morningglory sp., pigweed sp., and yellow nutsedge will **not** be controlled. Higher rates will improve control (or expand number of species controlled) such as common cocklebur, common ragweed, or jimsonweed (refer to label for specific weeds and rates). -**WARNINGS**: Command spray *or* vapor drift may injure sensitive crops and other vegetation up to several hundred yards from the point of application. **Do not** apply adjacent to sensitive crops (see label) or vegetation, or under unfavorable wind or weather conditions. Command may limit subsequent cropping options, see the label. -Available as a pre-mix herbicide Strategy: Strategy at 3 pt/A= Command at 8 fl oz/A (0.188 lb ai) and Curbit at 26 fl oz/A (0.6 lb ai). -Maximum number of Command applications per year: 1.						

3. Postemergence

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
1	Shadow 3EC Select 2EC Select Max 0.97EC	4 to 5.33 fl oz/A 6 to 8 fl oz/A 9 to 16 fl oz/A	**clethodim**	0.07 to 0.125 lb/A	14	24
	Poast 1.5EC	1 to 1.5 pt/A	**sethoxydim**	0.19 to 0.28 lb/A	3	12
-**Select 2EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). **Select Max**: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution). **Shadow 3EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution) for large or stressed grasses; use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution) when crop safety is a concern. **Poast**: use COC at 1.0% v/v. -**The use of COC may increase the risk of crop injury when hot or humid conditions prevail**. To reduce the risk of crop injury, omit additives or switch to NIS when grasses are small and soil moisture is adequate.						

2. Postemergence Shadow, Select, Select Max, Poast - continued next page

2. Postemergence Shadow, Select, Select Max, Poast - continued

-Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control. -Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will **not** be controlled. -Controls many annual and certain perennial grasses, including annual bluegrass, but Poast is preferred for goosegrass control. For best results, treat annual grasses when they are actively growing and before tillers are present. Control may be reduced if grasses are large or under hot or dry weather conditions. -Repeated applications may be necessary to control certain perennial grasses. If repeat applications are necessary, allow 14 days between applications. -Rainfastness is 1 h. -**Do not** tank mix with or apply within 2 to 3 days of any other pesticide, unless labeled, as this may increase the risk of crop injury or reduce the control of grasses. **Do not** apply more than 8 fl oz/A of Select 2EC in a single application and **do not** exceed 32 fl oz/A for the season; d**o not** apply more than 16 fl oz/A of Select Max in a single application and **do not** exceed 64 fl oz/A for the season. **-Do not** apply more than 5.33 fl oz/A of Shadow 3EC in a single application and **do not** exceed 21.33 fl oz/A for the season. -**Do not** apply more than 1.5 pt/A Poast in a single application and **do not** exceed 3 pt/A for the season.						
2	Sandea 75DF	0.5 to 1 oz/A	**halosulfuron**	0.023 to 0.047 lb/A	57	12
-**Labeled for use on cantaloupes, honeydew melons, and Crenshaw melons.** -**Plasticulture**: broadcast (over the top) or directed to row middles; broadcast for bareground. -**Bareground**: apply Sandea after the crop has at least 3 to 5 true leaves but before first female flowers appear and no sooner than 14 days after transplanting. If weeds have emerged, use a non-ionic surfactant at 0.25% v/v (1 qt/100 gal). -Suppresses or controls yellow nutsedge and certain broadleaf; control of weeds taller than 3 inches may not be adequate. Sandea will not control common lambsquarters or eastern black nightshade if applied postemergence; for row middle application, tank mix with a non-selective herbicide to increase spectrum of control. -Sandea provides both residual and postemergence control of susceptible weed species. Sandea is an ALS inhibiting herbicide and resistant weed populations are common in the region. -**Do not** use Group 2 herbicides repeatedly in the same field. **Do not** apply Sandea to crops treated with a soil applied organophosphate insecticide or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application. -Rainfastness is 4 h. Maximum number of Sandea applications per year is 2 and **do not** exceed 2 oz/A during the crop season						
10	Rely 280 2.34L	29 to 62 fl oz/A	**glufosinate**	0.53 to 1.13 lb/A	30	12
-**Supplemental Label expires 12/1/2025 for hooded spray application between the rows.** If the crop is planted without plastic, do not spray within 6 inches of running vines. **-Do not allow spray to come in contact with crop foliage or damage will occur.** -Ammonium sulfate (AMS) can be used at 1.5 lb/A to 3 lb/A. -Control is best when applied to weeds less than 4 inches, temperatures are above 80, high humidity, and bright sunlight. -Separate sequential applications by at least 14 days. -Do not apply more than 62 fl oz/A in a single application, do not apply more than 87 fl oz/A per season; maximum number of applications is three per season. -Rainfastness is 4 h						
22	Gramoxone SL 2.0* Gramoxone SL 3.0*	1.95 pt/A 1.3 pt/A	**paraquat**	0.49 lb/A	14	24
-**Supplemental Label for the use of both Gramoxone formulations for postemergence weed control in DE, MD, NJ, PA, and VA.** Row middles as a shielded application. -Apply as a directed spray in a minimum of 20 gal/A of spray mix to control emerged weeds between the rows after crop establishment. Include a nonionic surfactant at 0.25% v/v. Use shields or hoods to prevent spray contact with the crop and low spray pressure (maximum of 30 psi) to reduce small droplets that are prone to drift. See the label for additional information and warnings. -Rainfastness is 30 min. A maximum of 3 applications per year are allowed. ***Restricted-use pesticide***. Only certified applicators, who successfully complete the paraquat-specific training, can mix, load, or apply paraquat. Application of paraquat "under the direct supervision" of a certified applicator is no longer allowed. -Required training link (*https://campus.extension.org/enrol/index.php?id=2201*); certified applicators must repeat training every three years.						

4. Postharvest

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
22	Gramoxone SL 2.0* Gramoxone SL 3.0*	2.25 to 3 pt/A 1.5 to 2 pt/A	**paraquat**	0.56 to 0.75 lb/A	14	24
-**Supplemental Label in DE for the use of both Gramoxone formulations for postharvest application to desiccate the crop.** -Apply after the last harvest for bareground or plasticulture. Always include an adjuvant. -Spray coverage is essential for optimum effectiveness. See the label for additional information and warnings. -Rainfastness 30 min. A maximum of 2 applications for crop desiccation are allowed. -***Restricted-use pesticide***. Only certified applicators, who successfully complete the paraquat-specific training, can mix, load, or apply paraquat. Application of paraquat "under the direct supervision" of a certified applicator is no longer allowed. Required training link (*https://campus.extension.org/enrol/index.php?id=2201*); certified applicators must repeat training every three years.						

5. Other Labeled Herbicides

These products are labeled but limited local data are available; and/or are labeled but not recommended in our region due to potential crop injury concerns.

Group	Product Name (*=Restricted Use)	Active Ingredient
2	League	**imazosulfuron**
3	Dacthal	**DCPA**
14	Aim	**carfentrazone**
14	Varsity, others	**flumioxazin**

Insect Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.
Recommended Insecticides

Seed and At-Plant Treatments for Seedcorn Maggot

Farmore DI-400 as a commercially applied seed treatment which contains thiamethoxam (Group 4A).
Verimark (cyantraniprole, Group 28) applied no earlier than 72 hours prior to planting, at 10-13.5 oz/A using in-furrow spray, transplant tray drench, transplant water treatment, hill drench, or surface band.
Note: The use of neonicotinoid insecticides (Group 4A) at planting will help reduce seedcorn maggot damage. See also Maggots in section E 3.1. Soil Pests - Detection and Control.

Aphids Note: Aphids transmit multiple viruses

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	1.5 to 3.0 pt/A	methomyl **- melon aphid only**	1-3	48	H
1B	Dimethoate 400	1.0 pt/A	dimethoate	3	48	H
4A	Neonicotinoid insecticides registered for use on Musk and Mixed Melons: see table at the end of Insect Control.					
4C + 3A	Ridgeback*	5.5 to 13.8 fl oz/A	sulfoxaflor + bifenthrin	3	24	H
4D	Sivanto Prime or 200SL	21.0 to 28.0 fl oz/A	flupyradifurone - **soil/drip**	21	4	M
9B	Fulfill 50WDG	2.75 oz/A	pymetrozine	0	12	L
9B	PQZ	2.4 to 3.2 fl oz/A	pyrifluquinazon	1	12	L
9D	Sefina	3.0 fl oz/A	afidopyropen	0	12	L
21A	Torac	17.0 to 21.0 fl oz/A	tolfenpyrad	1	12	H
28	Exirel	13.5 to 20.5 fl oz/A	cyantraniliprole	1	12	H
28	Verimark	Soil, at planting: 10 to 13.5 fl oz/A Drip chemigation: 10 fl oz/A	cyantraniliprole	1	4	H
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H
28 + 6	Minecto Pro*	10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H
29	Beleaf 50SG	Foliar: 2.0 to 2.8 oz/A Drip: 2.8 to 4.28 oz/A	flonicamid	0	12	L

Armyworms and Cabbage Loopers

Various armyworm species and cabbage loopers can be found feeding on melon leaves. Their damage seldom requires treatment. Defoliation exceeding 25% may justify control measures. Insecticide sprays for cucumber beetles often will control these pests.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	1.5 to 3.0 pt/A	methomyl	1-3	48	H
3A[1]	Pyrethroid insecticides registered for use on Musk and Mixed Melons: see table at the end of Insect Control					
5	Entrust SC (OMRI)	4.0 to 8.0 fl oz/A	spinosad	3	4	M
5	Radiant SC	5.0 to 10.0 fl oz/A	spinetoram	3	4	M
6	Proclaim 5SG*	3.0 to 4.8 oz/A	emamectin benzoate	7	12	H
11A	Dipel DF, others (OMRI)	0.5 to 2.0 lb/A	*Bacillus thuringiensis kurstaki*	0	4	N
11A	XenTari (OMRI)	0.5 to 2.0 lb/A	*Bacillus thuringiensis aizawai*	0	4	N
18	Intrepid 2F	4.0 to 10.0 fl oz/A	methoxyfenozide	3	4	L
22	Avaunt 30WDG, Avaunt eVo	2.5 to 6.0 oz/A	indoxacarb	3	12	H
28	Coragen 1.67SC Coragen eVo	3.5 to 7.5 fl oz/A 1.2 to 2.5 fl oz/A	chlorantraniliprole	1	4	L
28	Exirel	7.0 to 17.0 fl oz/A	cyantraniliprole	1	12	H
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H
28	Verimark	6.75 to 13.5 fl oz/A	cyantraniliprole	1	4	H
28+4A	Voliam Flexi (cabbage looper only)	4.0 to 7.0 oz/A	thiamethoxam + chlorantraniliprole	1	12	H
28 + 6	Minecto Pro*	5.5 to 10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H

[1]Resistance concerns with beet armyworm

Cucumber Beetles

Both striped (*Acalymma vittatum*) and spotted (*Diabrotica undecimpuctata howardii*) cucumber beetles are found in the Mid-Atlantic states. Both species can severely defoliate young seedlings and transmit bacterial wilt pathogens, a disease that most varieties of muskmelons are susceptible to. Cucumber beetles also serve as vectors for certain cucurbit viruses. If that's not enough, cucumber beetles also may feed on fruit causing direct damage. Thus, they are a force to be reckoned with. Control adults before they feed extensively on the cotyledons and first true leaves. Seeds pretreated with a neonicotinoid such as Farmore DI-400 should provide up to 14 days of control of cucumber beetle. If foliar insecticides are used, begin spraying shortly after plant emergence and repeat applications as needed if new beetles continue to invade fields. Treatments may be required until vines begin to run. Reduced susceptibility to pyrethroids has been detected in some striped cucumber beetle populations, such as Delaware. The neonicotinoid Assail is extremely effective on cucumber beetles, while minimizing risks to pollinators. Otherwise, apply one of the following formulations:

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
1A	Lannate LV*	1.5 to 3.0 pt/A	methomyl	1-3	48	H
1A	Sevin XLR Plus	1.0 qt/A	carbaryl	3	12	H
3A	Pyrethroid insecticides registered for use on Musk and Mixed Melons: see table at the end of Insect Control.					
4A	Neonicotinoid insecticides registered for use on Musk and Mixed Melons: see table at the end of Insect Control.					
28	Exirel	20.5 fl oz/A	cyantraniliprole	1	12	H
28	Verimark	Soil, at planting: 13.5 fl oz/A Drip chemigation: 10 fl oz/A	cyantraniliprole	1	4	H
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H

Cutworms See also section E 3.1. Soil Pests - Detection and Control.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV* (variegated cutworm)	1.5 pt/A	methomyl	1	48	H
1A	Lannate LV* (granulate cutworm)	1.5 to 3.0 pt/A	methomyl	1-3	48	H
3A	Pyrethroid insecticides registered for use on Musk and Mixed Melons: see table at the end of Insect Control.					

Leafhoppers High numbers cause leaf yellowing (chlorosis) known as hopper burn, and yield loss.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1B	Dimethoate 400	1.0 pt/A	dimethoate	3	48	H
3A	Pyrethroid insecticides registered for use on Musk and Mixed Melons: see table at the end of Insect Control.					
4A	Neonicotinoid insecticides registered for use on Musk and Mixed Melons: see table at the end of Insect Control.					
4D	Sivanto Prime or 200SL	21.0 to 28.0 fl oz/A	flupyradifurone - **soil/drip**	21	4	M
9B	PQZ	3.2 fl oz/A	pyrifluquinazon	1	12	L
21A	Torac	14.0 to 21.0 fl oz/A	tolfenpyrad	1	12	H

Leafminers

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1B	Dimethoate 400	1.0 pt/A	dimethoate	3	48	H
3A	Pyrethroid insecticides registered for use on Musk and Mixed Melons: see table at the end of Insect Control.					
4A	Neonicotinoid insecticides registered for use on Musk and Mixed Melons: see table at the end of Insect Control.					
5	Entrust SC (OMRI)	6.0 to 8.0 fl oz/A	spinosad	3	4	M
5	Radiant SC	6.0 to 10.0 fl oz/A	spinetoram	3	4	M
6	Agri-Mek SC*	1.75 to 3.5 fl oz/A	abamectin	7	12	H
17	Trigard 75WSP	2.66 oz/A	cyromazine	0	12	H
28	Coragen 1.67SC Coragen eVo	5.0 to 7.5 fl oz/A 1.7 to 2.5 fl oz/A	chlorantraniliprole	1	4	L
28	Exirel	13.5 to 20.5 fl oz/A	cyantraniliprole	1	12	H
28	Verimark	6.75 to 13.5 fl oz/A	cyantraniliprole	1	4	H
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H
28 + 6	Minecto Pro*	5.5 to 10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H

Mites

Infestations generally begin around field margins and grassy areas. **DO NOT** mow or maintain these areas after midsummer since this causes mites into the crop. Localized infestations can be spot treated. Begin treatment when 10-15% of the crown leaves are infested early in the season.

Apply one of the following formulations. Note: Continuous use of carbaryl or pyrethroids may result in mite outbreaks.						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
6	Agri-Mek SC*	1.75 to 3.5 fl oz/A	abamectin	7	12	H
10B	Zeal Miticide	2.0 to 3.0 oz/A	etoxazole	7	12	L
10B	Zeal MVP	23.0 to 34.6 fl oz/A	Etoxazole	7	12	L
20B	Kanemite 15SC	31.0 fl oz/A	acequinocyl	1	12	L
21A	Magister SC	24.0 to 36.0 fl oz/A	fenazaquin	3	12	H
21A	Portal	2.0 pt/A	fenpyroximate	3	12	L
23	Oberon 2SC	7.0 to 8.5 fl oz/A	spiromesifen	7	12	M
28 + 6	Minecto Pro*	5.5 to 10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H
20D	Acramite 50WS	0.75 to 1.0 lb/A	bifenazate	3	12	M
N/A	Sulfur 80WG (OMRI)	5 to 25 lb/A	sulfur	0	24	M

Melonworms and Pickleworms

Apply one of the following formulations. If foliar materials are used, make one treatment prior to fruit set, and then treat weekly. If soil or drip applications are used, check the label for additional instructions.						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	1.5 to 3.0 pt/A	methomyl	1-3	48	H
1A	Sevin XLR Plus	0.5 to 1.0 qt/A	carbaryl	3	12	H
3A	Pyrethroid insecticides registered for use on musk melons: see table at the end of Insect Control.					
5	Entrust SC (OMRI)	4.0 to 8.0 fl oz/A	spinosad	3	4	M
5	Radiant SC	5.0 to 10.0 fl oz/A	spinetoram	3	4	M
6	Proclaim 5SG*	3.0 to 4.8 oz/A	emamectin benzoate	7	12	H
18	Intrepid 2F	4.0 to 10.0 fl oz/A	methoxyfenozide	3	4	L
22	Avaunt 30WDG, Avaunt eVo	2.5 to 6.0 oz/A	indoxacarb	3	12	H
28	Coragen 1.67SC Coragen eVo	2.0 to 7.5 fl oz/A 0.7 to 2.5 fl oz/A	chlorantraniliprole	1	4	L
28	Exirel	7.0 to 13.5 fl oz/A	cyantraniliprole	1	12	H
28	Verimark	5.0 to 10.0 fl oz/A	cyantraniliprole	1	4	H
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H
28+4A	Durivo	10.0 to 13.0 fl oz/A	thiamethoxam + chlorantraniliprole	30	12	H
28+4A	Voliam Flexi	4.0 to 7.0 oz/A	thiamethoxam + chlorantraniliprole	1	12	H
28+6	Minecto Pro*	5.5 to 10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H

Rindworms

For Lepidopteran Rindworms, use one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
3A[1]	Pyrethroid insecticides registered for use on Musk and Mixed Melons: see table at the end of Insect Control.					
5	Entrust SC (OMRI)	4.0 to 8.0 fl oz/A	spinosad	3	4	M
5	Radiant SC	5.0 to 10.0 fl oz/A	spinetoram	3	4	M
6	Proclaim 5SG*	3.0 to 4.8 oz/A	emamectin benzoate	7	12	H
18	Intrepid 2F	4.0 to 10.0 fl oz/A	methoxyfenozide	3	4	L

[1]Resistance concerns with beet armyworm and corn earworm

Thrips

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1B	Dimethoate 400	1.0 pt/A	dimethoate	3	48	H
3A[1]	Pyrethroid insecticides registered for use on Musk and Mixed Melons: see table at the end of Insect Control.					
4A[2]	Neonicotinoid insecticides registered for use on Musk and Mixed Melons: see table at the end of Insect Control.					
5	Entrust SC (OMRI)	6.0 to 8.0 fl oz/A	spinosad	3	4	M

Thrips - continued next page

Thrips - continued

5	Radiant SC	6.0 to 10.0 fl oz/A	spinetoram	3	4	M
21A	Torac	21.0 fl oz/A	tolfenpyrad	1	12	H
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H
29	Beleaf 50SG	Foliar: 2.0 to 2.8 oz/A Drip: 2.8 to 4.28 oz/A	flonicamid	0	12	L

[1]Resistance concerns with western flower thrips [2]Resistance concerns with tobacco thrips

Whiteflies

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
4A	Neonicotinoid insecticides registered for use on Musk and Mixed Melons: see table at the end of Insect Control.					
4C + 3A	Ridgeback*	11.0 to 13.8 fl oz/A	sulfoxaflor + bifenthrin	3	24	H
4D	Sivanto Prime or 200SL	21.0 to 28.0 fl oz/A	flupyradifurone - **soil/drip**	21	4	M
7C	Knack	8.0 to 10.0 fl oz/A	pyriproxyfen	7	12	L
9B	Fulfill 50WDG	2.75 oz/A	pymetrozine	0	12	L
9B	PQZ	2.4 to 3.2 fl oz/A	pyrifluquinazon	1	12	L
9D	Sefina	14.0 fl oz/A	afidopyropen	0	12	L
21A	Portal	2.0 pt/A	fenpyroximate	3	12	L
23	Oberon 2SC	7.0 to 8.5 fl oz/A	spiromesifen	7	12	M
28	Exirel	13.5 to 20.5 fl oz/A	cyantraniliprole	1	12	H
28	Verimark	6.75 to 13.5 fl oz/A	cyantraniliprole	1	4	H
28 + 6	Minecto Pro*	10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H
29	Beleaf 50SG	Foliar: 2.0 to 2.8 oz/A Drip: 2.8 to 4.28 oz/A	flonicamid	0	12	L

Group 3A Pyrethroid Insecticides Registered for Use on Musk and Mixed Melons

Apply one of the following formulations (check if the product label lists the insect you intend to spray; the label is the law):					
Product Name (*=Restricted Use)	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
Asana XL*	5.8 to 9.6 fl oz/A	esfenvalerate	3	12	H
Baythroid XL*	0.8 to 2.8 fl oz/A	beta-cyfluthrin	0	12	H
Brigade 2EC*, others	2.6 to 6.4 fl oz/A	bifenthrin	3	12	H
Danitol 2.4EC*	10.67 to 16.0 fl oz/A	fenpropathrin	7	24	H
Declare*	1.02 to 1.54 fl oz/A	gamma-cyhalothrin	1	24	H
Hero*	4.0 to 10.3 fl oz/A	zeta-cypermethrin + bifenthrin	3	12	H
Lambda-Cy 1EC*, others	2.56 to 3.84 fl oz/A	lambda-cyhalothrin	1	24	H
Mustang Maxx*	1.28 to 4.0 fl oz/A	zeta-cypermethrin	1	12	H
Permethrin 3.2EC*, others	4.0 to 8.0 fl oz/A	permethrin	0	12	H
Tombstone*	0.8 to 2.8 fl oz/A	cyfluthrin	0	12	H
Warrior II*	1.28 to 1.92 fl oz/A	lambda-cyhalothrin	1	24	H
Combo products containing a pyrethroid					
Besiege*	6 .0 to 9.0 fl oz/A	lambda-cyhalothrin + chlorantraniliprole (Group 28)	1	24	H
Endigo ZC* and ZCX*	4.0 to 4.5 fl oz/A	lambda-cyhalothrin + thiamethoxam (Group 4A)	1	24	H
Ridgeback*	5.5 to 13.8 fl oz/A	bifenthrin + sulfoxaflor (Group 4C)	3	24	H
Savoy EC*	6.0 to 12.9 fl oz/A	bifenthrin + acetamiprid (Group 4A)	7	12	H

Group 4A Neonicotinoid Insecticides Registered for Use on Musk and Mixed Melons

Apply one of the following formulations (check if the product label lists the insect you intend to spray; the label is the law):					
Product Name (*=Restricted Use)	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
Admire Pro	7.0 to 10.5 fl oz/A	imidacloprid - **soil**	21	12	H
Assail 30SG	2.5 to 5.3 oz/A	acetamiprid	0	12	M
Actara 25WDG	1.5 to 5.5 oz/A	thiamethoxam	0	12	H
Platinum 75SG	1.66 to 3.67 oz/A	thiamethoxam	30	12	H
Belay 2.13SC	9.0 to 12.0 fl oz/A	clothianidin - **soil/drip**	21	12	H
Belay 2.13SC	3.0 to 4.0 fl oz/A	clothianidin - **foliar** (note: PHI: do not make application after 4th true leaf has unfolded)	see note	12	H

Group 4A Neonicotinoid Insecticides Registered for Use on Musk and Mixed Melons - continued next page

Group 4A Neonicotinoid Insecticides Registered for Use on Musk and Mixed Melons - continued

Scorpion 35SL	9.0 to 10.5 fl oz/A	dinotefuran - **soil/drip**	21	12	H
Scorpion 35SL	2.0 to 7.0 fl oz/A	dinotefuran - **foliar**	1	12	H
Venom 70SG	5.0 to 7.5 oz/A	dinotefuran - **soil/drip**	21	12	H
Venom 70SG	1.0 to 4.0 oz/A	dinotefuran - **foliar**	1	12	H
Combo products containing a neonicotinoid					
Durivo	10.0 to 13.0 fl oz/A	thiamethoxam + chlorantraniliprole (Group 28)	30	12	H
Endigo ZC* and ZCX*	4.0 to 4.5 fl oz/A	thiamethoxam + lambda-cyhalothrin (Group 3A)	1	24	H
Savoy EC*	6 to 12.9 fl oz/A	acetamiprid + bifenthrin (Group 3A)	7	12	H
Voliam Flexi	4.0 to 7.0 oz/A	thiamethoxam + chlorantraniliprole (Group 28)	1	12	H

Disease Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.
Recommended Fungicides

Nematode Control Use fumigants listed in section E 1.5. Soil Fumigation, or one of the nematicides below.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
1A	Vydate L*	1.0 to 2.0 gal/A Incorporate into top 2-4 inches of soil, ***OR*** 2.0 to 4.0 pt/A apply 2 w after planting and repeat 2-3 w later.	oxamyl	1	48	H
7	Velum Prime 4.16SC	6.5 to 6.84 fl oz/A	fluopyram	0	12	--
--	Nimitz 4EC	3.5 to 5.0 pt/A Incorporate or drip-apply 7 d before planting.	fluensulfone	n/a	12	N

Seed Treatment If seed has not been treated with a fungicide and insecticide, use a mixture of Thiram 480DP (4.5 fl oz/100 lb seed) and an approved commercially available insecticide.

Damping-off caused by Phytophthora, Pythium, and Rhizoctonia

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Apply one of the following at-planting (see label for application timing, methods, and restrictions):						
Phytophthora and Pythium Root Rot						
4	Ridomil Gold 4SL	1.0 to 2.0 pt/A	mefenoxam	5	48	N
4	Ultra Flourish 2E	2.0 to 4.0 pt/A	mefenoxam	5	48	N
4	MetaStar 2E AG	4.0 to 8.0 pt/A	metalaxyl	AP	48	N
49 + **4**	Orondis Gold[1]	28.0 to 55.0 fl oz/A	oxathiapiprolin + mefenoxam	AP	48	N
Phytophthora, Pythium, and Rhizoctonia Root Rot						
4 + **11**	Uniform 3.66SE	0.34 fl oz/1000 ft row. Avoid direct seed contact, which may cause delayed emergence.	mefenoxam + azoxystrobin	AP	0	N
Rhizoctonia root rot						
11	azoxystrobin 2.08F	0.40 to 0.80 fl oz/1000 ft row	azoxystrobin	1	4	N
Pythium root rot only						
28	Previcur Flex 6F	1.2 pt/A in transplant water, drip irrigation, or direct spray at base of plant and soil	propamocarb hydrochloride	2	12	N

[1] may cause some yellowing in cucurbit leaves

Bacterial and Fungal Diseases

Alternaria Leaf Blight

Rotate muskmelons with unrelated crops. Begin sprays when vines begin to run, or earlier if symptoms are detected.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Begin sprays when vines begin to run. ALTERNATE one of the following:						
M03	mancozeb 75DF[1]	2.0 to 3.0 lb/A[1]	mancozeb	5	24	N
M05	chlorothalonil 6F	2.0 to 3.0 pt/A	chlorothalonil	0	12	N

Alternaria Leaf Blight - continued next page

Alternaria Leaf Blight - continued

WITH A TANK MIX of one of the following fungicides PLUS chlorothalonil 6F 2.0 to 3.0 pt/A every 14 days. Materials with different modes of action (FRAC codes) should always be alternated.						
7 + **11**	Pristine 38WG[2]	12.5 to 18.5 oz/A	boscalid + pyraclostrobin	0	12	--
3 + 9	Inspire Super 2.82EW	16.0 to 20.0 fl oz/A	difenoconazole + cyprodinil	7	12	--
3 + **11**	Quadris Top 1.67SC[3]	12.0 to 14.0 fl oz/A	difenoconazole + azoxystrobin	1	12	--
7 + 12	Miravis Prime	9.2 to 11.4 fl oz/A	pydiflumetofen + fludioxonil	1	12	--
7 + **11**	Luna Sensation 4.25SC[4]	7.6 fl oz/A	fluopyram + trifloxystrobin	0	12	--
7 + 3	Luna Flex	8.0 fl oz/A	fluopyram + difenoconazole	0	12	--
7 + 3	Luna Experience	8.0 to 17.0 fl oz/A	fluopyram + tebuconazole	7	12	--
3 + 7	Aprovia Top 1.62EC	10.5 to 13.5 fl oz/A	difenoconazole + benzovindiflupyr	0	12	--
7 + **11**	Merivon 2.09SC[2]	4.0 to 5.5 fl oz/A	fluxapyroxad + pyraclostrobin	0	12	N
3 + **11**	Topguard EQ 4.29SC[3,5]	5.0 to 8.0 fl oz/A	flutriafol + azoxystrobin	1	12	--
11	azoxystrobin 2.08F[3,5]	11.0 to 15.5 fl oz/A	azoxystrobin	1	24	N
11	Cabrio 20EG[2]	12.0 to 16.0 oz/A	pyraclostrobin	0	12	N
11	Reason 500SC	5.5 fl oz/A	fenamidone	14	12	--

[1]The varieties ‘Harvest Queen’, ‘Gold Star’, ‘Super Star’, ‘Sweet and Early’, and ‘Saticoy’ are sensitive to mancozeb. [2]Tank mixes of additives, adjuvants, and/or other products may result in crop injury. [3]**Do not apply** near apples. [4]A mild yellowing on leaf margins is sometimes seen following application of Luna Sensation in cucurbits. [5]Do not tank mix with crop oil concentrates, methylated spray oil, or silicon adjuvants. Do not tank mix with Malathion, Thiodan, Lannate, MPede, or Botran.

Angular Leaf Spot and Bacterial Leaf Spot

At first sign of disease, apply the labeled rates of fixed copper plus mancozeb. Some copper-based products are OMRI listed and can be used in organic systems to help suppress Angular leaf spot and other fungal diseases. Repeat every 7 d. Avoid overhead irrigation when symptoms are present and working in field while foliage is wet.

Bacterial Wilt

Controlling striped and spotted cucumber beetles is essential for preventing bacterial wilt. See preceding “Cucumber Beetle” section under Insect Control for specific recommendations. Insecticide applications made at seeding may not prevent beetle damage all season; additional foliar insecticide applications may be necessary.

Downy Mildew

Scout fields for disease incidence beginning in early summer. Strains of Downy Mildew that infect one cucurbit crop may not affect other cucurbit crops. Unnecessary fungicide applications can be avoided by not spraying until disease is predicted in the region on melon or cucumber (check the Cucurbit Downy Mildew Forecasting website at: https://cdm.ipmpipe.org). **Preventative applications are much more effective than applications made after detection.** Materials with different modes of action (FRAC codes) should always be alternated. Tank mix with protectant if not included in the product.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
The following are the most effective products. Sprays should be applied on a 7-day schedule. Under severe disease conditions spray interval may be reduced IF the label allows.						
49 + 40	Orondis Ultra 2.33SC	5.5 to 8.0 fl oz/A	oxathiapiprolin + mandipropamid	0	4	--
21	Ranman 400SC	2.10 to 2.75 fl oz/A (**do not apply with copper**; see label for details)[1]	cyazofamid	0	12	L
Other materials for use in rotation as tank mix partners with a protectant:						
M03+22	Gavel 75DF[2]	1.5 to 2.0 lb/A **contains protectant**	mancozeb + zoxamide	5	48	--
M05+22	Zing! 4.9SC	36 fl oz/A **contains protectant**	chlorothalonil + zoxamide	0	12	N
M05+27	Ariston 42SC	1.9 to 3.0 pt/A **contains protectant**	chlorothalonil + cymoxanil	3	12	--
11 + 27	Tanos 50DF	8.0 oz/A	famoxadone + cymoxanil	3	12	--
27	Curzate 60DF	3.2 to 5.0 oz/A	cymoxanil	3	12	N
28	Previcur Flex 6F	1.2 pt/A	propamocarb hydrochloride	2	12	N
40	Forum 4.17SC	6.0 fl oz/A	dimethomorph	0	12	N
40 + 45	Zampro 525SC	14.0 fl oz/A	dimethomorph + ametoctradin	0	12	--
43	Presidio 4SC	4.0 fl oz/A	fluopicolide	2	12	L
49+M05	Orondis Opti	1.75 to 2.5 pt/A	oxathiapiprolin + chlorothalonil	0	12	--
29	Omega 500F	12.0 to 24.0 fl oz/A	fluazinam	30	12	N
22	Elumin 4SC	8.0 fl oz/A	ethaboxam	2	12	--

[1]Ranman should be tank mixed with an organosilicone surfactant when disease is severe, or a non-ionic surfactant or blend of organosilicone and non-ionic surfactant disease is moderate or light. [2]The varieties ‘Harvest Queen’, ‘Gold Star’, ‘Super Star’, ‘Sweet and Early’, and ‘Saticoy’ are sensitive to mancozeb.

Fusarium Wilt

Rotate to allow 5 years between muskmelon plantings in any given location. Use resistant cultivars, when possible, see table Recommended Varieties. A FIFRA 2(ee) label for chemigation of Rhyme (FRAC code 3) to suppress Fusarium Wilt has been approved in DE, MD, PA, NJ. VA, and WV. See label for details.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Application through drip irrigation or as a post-plant drench followed by two foliar applications may reduce Fusarium Wilt early season:						
3	Proline 480SC[1]	5.7 fl oz/A	prothioconazole	7	12	--
3 + 7	Propulse	13.6 fl oz/A	prothioconazole + fluopyram	7	12	--
7	Velum	4.0 to 6.84 fl oz/A	fluopyram	0	12	--
7 + 12	Miravis Prime	11.4 fl oz/A	pydiflumetofen+ fludioxonil	1	12	--

[1]Note: only one soil application of Proline is allowed per season.

Gummy Stem Blight

In the Mid-Atlantic regions, fungicide that only contain FRAC code 11 components are not recommended. Pristine, which contains both FRAC code 11 and 7 components, should always be tank-mixed with a protectant fungicide to reduce the possibility of resistance development. **When tank-mixing, use at least the minimum labeled rate of each fungicide. Alternate fungicides with different modes of action. Do not apply FRAC code 11 fungicides more than 4 times total per season.** Begin sprays when vines begin to run.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Under LOW DISEASE PRESSURE, apply the following every 7 days:						
M05	chlorothalonil 6F	2.0 to 3.0 pt/A	chlorothalonil	0	12	N
Under HIGH DISEASE PRESSURE, ALTERNATE:						
M05	chlorothalonil 6F	2.0 to 3.0 pt/A[1]	chlorothalonil	0	12	N
WITH A TANK-MIX containing a protectant fungicide (such as chlorothalonil) PLUS one of the following:						
3	Proline 480SC	5.7 fl oz/A	prothioconazole	7	12	--
3	tebuconazole 3.6F[2]	8.0 fl oz/A	tebuconazole	7	12	N
3	Rhyme 2.08SC	5.0 to 7.0 fl oz/A	flutriafol	0	12	--
3 + 9	Inspire Super 2.82EW	16.0 to 20.0 fl oz/A	difenoconazole + cyprodinil	7	12	--
3 + 7	Aprovia Top 1.62EC	10.5 to 13.5 fl oz/A	difenoconazole + benzovindiflupyr	0	12	--
7 + 3	Luna Flex	12.8 to 13.6 fl oz/A	fluopyram + difenoconazole	0	12	--
7 + 3	Luna Experience 3.34SC[4]	8.0 to 17.0 fl oz/A	fluopyram + tebuconazole	7	12	--
7 + **11**	Luna Sensation 4.25SC[4]	7.6 fl oz/A	fluopyram + trifloxystrobin	0	12	--
7 + **11**	Merivon 2.09SC[3]	5.5 fl oz/A	fluxapyroxad + pyraclostrobin	0	12	N
7 + **11**	Pristine 38WG[3]	12.5 to 18.5 oz/A	boscalid + pyraclostrobin	0	12	--
9 + 12	Switch 62.5WG	11.0 to 14.0 oz/A	cyprodinil + fludioxonil	1	12	L
7 + 12	Miravis Prime	9.2 to 11.4 fl oz/A	pydiflumetofen + fludioxonil	1	12	--

[1]Use low rate early in season. [2]Note: reduced sensitivity of the pathogen to tebuconazole has been found in the Southern U.S. [3]Tank mixes of additives, adjuvants, and/or other products may result in crop injury. [4]A mild yellowing on leaf margins is sometimes seen following application of a Luna Experience or Luna Sensation in cucurbits.

Phytophthora Crown and Fruit Rot

Multiple practices should be used to minimize the occurrence of this disease. Grow muskmelons on raised beds and drain fields adequately so that water will not accumulate around the base of the plants. Rotate away from susceptible crops (cucurbits, peppers, lima beans and beans, eggplants, and tomatoes) for as long as possible. Apply pre-plant fumigants to suppress disease. Apply fungicides when conditions are favorable for disease development. Fruit are susceptible at all growth stages and must be protected season-long.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Apply one of the following fungicides and tank mix with fixed copper at labeled rates when conditions favor disease development (for suppression only). Materials with different modes of action (FRAC codes) should always be alternated to reduce the chances for fungicide resistance development:						
49 + 40	Orondis Ultra 2.33SC	5.5 to 8.0 fl oz/A	oxathiapiprolin + mandipropamid	0	4	--
49 + **4**	Orondis Gold	4.8 to 9.6 fl oz/A	oxathiapiprolin + mefenoxam	0	4	--
40	Revus 2.08F	8.0 fl oz/A	mandipropamid	0	4	--
40 + 45	Zampro 525SC	14.0 fl oz/A	dimethomorph + acetoctradin	0	12	--

Phytophthora Crown and Fruit Rot - continued next page

Phytophthora Crown and Fruit Rot - continued

43	Presidio 4SC[1]	4.0 fl oz/A	fluopicolide	2	12	L
M03+22	Gavel 75DF[2]	1.5 to 2.0 lb/A	mancozeb + zoxamide	5	48	--
11 + 27	Tanos 50DF	8.0 to 10.0 oz/A	famoxadone + cymoxanil	3	12	--
21	Ranman 400SC	2.75 fl oz/A (**Do not apply with copper**, see label details)[3]	cyazofamid	0	12	L
40	Forum 4.17SC	6.0 fl oz/A	dimethomorph	0	12	N
49+M05	Orondis Opti	1.75 to 2.5 pt/A	oxathiapiprolin + chlorothalonil	0	12	--
22	Elumin 4SC	8.0 fl oz/A	ethaboxam	2	12	--
M05+22	Zing! 4.9SC	36.0 fl oz/A	chlorothalonil + zoxamide	0	12	N

[1]Presidio may also be applied through the drip irrigation (see supplemental label). [2]The varieties 'Harvest Queen', 'Gold Star', 'Super Star', 'Sweet and Early', and 'Saticoy' are sensitive to mancozeb. [3]Ranman should be tank mixed with an organosilicone surfactant when disease is severe, or a non-ionic surfactant or blend of organosilicone and non-ionic surfactant disease is moderate or light.

Powdery Mildew

Excellent host resistance is available (see table Recommended Varieties). The fungus that causes cucurbit Powdery Mildew has developed resistance to high-risk fungicides. In the Eastern US, resistance to strobilurin (FRAC code 11), SDHI (FRAC code 7), and DMI (FRAC code 3) fungicides has been reported. Proper fungicide resistance management should be followed to help delay the development of resistance and minimize control failures. Materials with different FRAC codes should always be alternated. Powdery Mildew generally occurs from mid-July until the end of the season. Scout fields for the presence of Powdery Mildew. If one lesion is found on the underside of 45 old leaves per acre, begin the following fungicide program:

Code	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
TANK MIX one of these products with a protectant such as chlorothalonil 6F 2.0 to 3.0 pt/A:						
50	Vivando 2.5SC[1]	15.4 fl oz/A	metrafenone	0	12	--
13	Quintec 2.08SC	4.0 to 6.0 fl oz/A	quinoxyfen	3	12	--
3 + 7	Luna Experience 3.34SC[2]	6.0 to 17.0 fl oz/A	tebuconazole + fluopyram	7	12	--
7 + **11**	Luna Sensation 4.25SC[2]	4.0 to 7.6 fl oz/A	fluopyram + trifloxystrobin	0	12	--
AND ALTERNATE with a TANK MIX of one of the following and a protectant such as chlorothalonil 6F 2.0 to 3.0 pt/A:						
3	Proline 480SC	5.7 fl oz/A	prothioconazole	7	12	--
3	Procure 480SC	4.0 to 8.0 fl oz/A	triflumizole	0	12	N
3	Rally 40WSP	2.5 to 5.0 oz/A	myclobutanil	0	24	N
3	tebuconazole 3.6F	4.0 to 6.0 fl oz/A	tebuconazole	7	12	N
3 + 7	Aprovia Top 1.62EC	10.5 to 13.5 fl oz/A	difenoconazole + benzovindiflupyr	0	12	--
3	Rhyme 2.08SC	5.0 to 7.0 fl oz/A	flutriafol	0	12	--
7 + 11	Pristine 38WG[3]	12.5 to 18.5 oz/A	boscalid + pyraclostrobin	0	12	--
3 + 9	Inspire Super 2.82EW	16.0 to 20.0 fl oz/A	difenoconazole + cyprodinil	7	12	--
P05	Regalia (OMRI)	4.0 qt/A	Extract of *Reynoutria sachalinensis*	0	4	--
39	Magister 1.6SC[4]	24.0 to 36.0 fl oz/A	fenazaquin	3	12	H
7 + 12	Miravis Prime	9.2 to 11.4 fl oz/A	pydiflumetofen + fludioxonil	1	12	--
U13	Gatten 5EC	6.0 to 8.0 fl oz/A	flutianil	0	12	--
U06	Torino 0.85SC	3.4 fl oz/A	cyflufenamid	0	4	--

[1]Do not mix Vivando with horticultural oils. [2]A mild yellowing on leaf margins is sometimes seen following application of Luna Experience and Luna Sensation in cucurbits. [3]Tank mixes of additives, adjuvants, and/or other products may result in crop injury. [4]Do not make more than one application per year of Magister.

Scab

The fungus that causes Scab typically occurs during periods of cool, wet weather when temperatures are below normal. Rotate away from fields with a history of Scab for at least 2 years.

Code	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
Begin sprays as true leaves form and repeat every 5-7 days:						
M05	chlorothalonil 6F	2.0 to 3.0 pt/A	chlorothalonil	0	12	N

Viruses

The most prevalent virus in the Mid-Atlantic region is **WMV**, followed by **PRSV**, **ZYMV** and **CMV**. Plant fields as far away from existing cucurbit plantings as possible to help reduce the chances of aphid transmission of viruses from existing fields to new fields.

Okra

Recommended Varieties

Note: Okra is a tropical annual with a wide range of adaptation. However, okra is very sensitive to frost and cold temperatures and should not be planted until the soil has warmed in the spring.

Variety[1]	Hybrid	Height (ft)	Days	Pod Color
Baby Bubba (compact)	Yes	3-4	53	Green
Blondy (Compact)	No	3-4	50	Light Green
Candle Fire	Yes	4	60	Red
Carmine Splendor	Yes	4	51	Red
Clemson Spineless 80	No	6	55	Green
Clemson Spineless 99	No	4	55	Green
Jambalaya	Yes	4	50	Dark Green
Red Burgundy	No	4	55	Red-Burgundy
Red Velvet	No	4-5	55	Red

[1]**Listed alphabetically**.

Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and Chapter B Soil and Nutrient Management. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede the recommendations found below.

Okra is tolerant of a wide range of soil pH values but prefers soil with a pH between 6.0 and 6.8. If the soil pH is below 5.8, the soil should be limed to increase the pH to 6.0 or more. Soil with a pH at or below 5.8 can result in okra with poorly developed pods.

Okra[1,2]		Soil Phosphorus Level				Soil Potassium Level				
		Low	Med	High (Opt)	Very High	Low	Med	High (Opt)	Very High	
	N (lb/A)	P_2O_5 (lb/A)				K_2O (lb/A)				Nutrient Timing and Method
	100-150[1]	150	100	50	0	50	100	50	0	Total nutrient recommended
	50-100	150	100	50	0	150	100	50	0	Broadcast and disk-in
	20-50	0	0	0	0	0	0	0	0	Sidedress or fertigate 3-4 w after planting
	20-50	0	0	0	0	0	0	0	0	Sidedress or fertigate 6-8 w after planting

[1]Apply 1-2 lb/A of boron (B) with broadcast fertilizer; see also Table B-7. in Chapter B Soil and Nutrient Management.
[2]Apply 25-30 lb/A of sulfur (S) for most soils.

Seed Treatment

See Disease Control for seed treatment to prevent disease.

Seeding and Spacing

Field seeding is usually done between May 20 and June 1. Generally, only one planting is made. In northern areas of the region, sow seed in the greenhouse in cell trays in early May and transplant to the field through black plastic mulch on raised beds with drip irrigation in early to mid-June, two rows per bed, 12 inches between plants in the row. For direct seeding, drill seeds ¼-½ inch deep, 2-4 per ft of row (3-7 lb/A). Thin the plants when they are 5 inches tall to 12-15 inches apart in the row. Space the rows 3-3½ ft apart.

Harvest and Post-Harvest Considerations

Okra pods usually reach harvesting maturity 4-6 days after the flowers open. At this stage, the pods are 3-3½ inches long, free of excessive fiber and tender. Pick pods at 2-day intervals by snapping off or clipping the pedicel. Avoid bruising pods during harvest. Gloves should be worn to avoid skin reactions to the fine spines on the fruit. Large and undesirable pods should be removed to keep the plant productive over a longer period. Harvested okra should be kept at 50-55°F (10-13°C) and 85-90% relative humidity. Below 50°F, okra pods are subject to chilling injury.

Weed Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.

Recommended Herbicides

1. Identify the weeds in each field and select recommended herbicides. More information is available in the "Herbicide Effectiveness on Common Weeds in Vegetables" (Table E-3) in Chapter E Pest Management.

2. Minimize herbicide resistance development. Identify the herbicide mode of action group number and follow recommended good management practices; **bolded group numbers in tables below are herbicides at higher risk for selecting resistant weed populations.** Include non-chemical weed control whenever possible.

1. Soil-Applied (Preplant Incorporated or Preemergence)						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient**	**Active Ingredient Rate**	**PHI (d)**	**REI (h)**
3	Treflan 4EC	1 to 2 pt/A	**trifluralin**	0.5 to 0.75 lb/A	--	12
-Incorporate into 2-3 inches of soil within 8 h after application. Primarily controls annual grasses and a few broadleaf weeds. -**Do not** use (or reduce the rate) used when cold, wet soil conditions are expected, or crop injury may result. -Poor incorporation can reduce overall weed control. Maximum application not addressed on label.						
27	Callisto 4SC	6 fl oz/A	**mesotrione**	0.188 lb/A	28	12
-Use as row-middle or hooded post-directed treatment, but not both. -Apply as a band, leaving 1 foot of untreated soil over the seeded row (6" of untreated soil on each side of the row); **do not** apply over the row or severe injury will occur. If replanting, **do not** plant into treated soil. -Callisto controls common lambsquarters, pigweeds, and many other small-seeded annual broadleaf weeds, but Callisto is weak on ragweed and morningglory species. Apply Treflan 4EC between the rows of mulch to control annual grasses. -Crop injury may occur if an organophosphate or carbamate insecticide is applied within 7 days of Callisto. -**Do not** apply more than 1 application of Callisto per crop; **do not** apply more than 6 fl oz/A per year as a banded application.						

2. Postemergence						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient**	**Active Ingredient Rate**	**PHI (d)**	**REI (h)**
1	Select Max 0.97EC	9 to 16 fl oz/A	**clethodim**	0.07 to 0.125 lb/A	3	24
	Poast 1.5EC	1 to 1.5 pt/A	**sethoxydim**	0.2 to 0.3 lb/A	14	12
-**Select Max**: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution); Poast: Use crop oil concentrate at 1.0% v/v (1.0 gal/100 gal of spray solution). Check label for other formulations of clethodim, not all are labeled for okra. -The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant (NIS) when grasses are small and soil moisture is adequate. -Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control. -Yellow nutsedge, wild onion, or broadleaf weeds will **not** be controlled. -Controls many annual and certain perennial grasses, including annual bluegrass. For best results, treat annual grasses when they are actively growing and before tillers are present. Control may be reduced if grasses are large or under hot or dry weather conditions. -Repeated applications may be needed to control certain perennial grasses. If repeat applications are necessary, allow 14 days between applications -**Do not** tank mix with or apply within 2 to 3 days of any other pesticide, unless labeled, as this may increase the risk of crop injury or reduce the control of grasses. -**Do not** apply more than 16 fl oz/A of Select Max in a single application and **do not** exceed 2 qt/A for the season. -**Do not** apply more than 1.5 pt/A Poast in a single application and **do not** exceed 5.5 pt/A for the season.						
22	Gramoxone SL 2.0* Gramoxone SL 3.0*	1.95 pt/A 1.3 pt/A	**paraquat**	0.49 lb/A	21	24
-Row middles as a shielded application. Include a nonionic surfactant at 0.25% v/v. Use shields or hoods to prevent spray contact with the crop and low spray pressure (maximum of 30 psi) to reduce small droplets that are prone to drift. See the label for additional information and warnings. -Rainfastness is 30 min. -A maximum of 3 applications per year are allowed. -***Restricted-use pesticide***. Only certified applicators, who successfully complete the paraquat-specific training, can mix, load, or apply paraquat. Application of paraquat "under the direct supervision" of a certified applicator is no longer allowed. -Required training link (*https://campus.extension.org/enrol/index.php?id=2201*); certified applicators must repeat training every three years.						
27	Callisto 4SC	3.0 fl oz/A	**mesotrione**	0.094 lb/A	28	12
-Use as row-middle or hooded post-directed treatment, but not both. -Apply as a direct spray using a hooded sprayer. Okra must be at least 3 inches tall at time of application. -Use a nonionic surfactant at 0.25% v/v (1 qt/100 gal). -Set spray equipment to minimize the amount of Callisto that comes in contact with okra foliate or crop injury will occur. -Callisto controls common lambsquarters, pigweeds, as well as many other small-seeded annual broadleaf weeds, but Callisto is weak on ragweed and morningglory species. Apply Treflan 4EC between the rows of mulch to control annual grasses. -Crop injury may occur if an organophosphate or carbamate insecticide is applied within 7 days of Callisto. -Rainfastness is 1 h. -**Do not** apply more than 1 application of Callisto per crop; **do not** apply more than 3 fl oz/A per year as a post-directed application.						

3. Postharvest						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient**	**Active Ingredient Rate**	**PHI (d)**	**REI (h)**
22	Gramoxone SL 2.0* Gramoxone SL 3.0*	2.25 to 3 pt/A 1.5 to 2 pt/A	**paraquat**	0.56 to 0.75 lb/A	--	24

-Supplemental Label in DE for the use of both Gramoxone formulations for postharvest application to desiccate the crop.
-Apply after the last harvest for bareground or plasticulture. Always include an adjuvant.
-Spray coverage is essential for optimum effectiveness. See the label for additional information and warnings.
-A maximum of 2 applications for crop desiccation are allowed. -Rainfastness 30 min.
-Restricted-use pesticide. Only certified applicators, who successfully complete the paraquat-specific training, can mix, load, or apply paraquat. Application of paraquat "under the direct supervision" of a certified applicator is no longer allowed.
-Required training link (*https://campus.extension.org/enrol/index.php?id=2201*); certified applicators must repeat training every 3 years.

4. Other Labeled Herbicides These products are labeled but limited local data are available; and/or are labeled but not recommended in our region due to potential crop injury concerns.

Group	Product Name (*=Restricted Use)	Active Ingredient
2	Sandea	**halosulfuron**
5	Caparol	**prometryn**
14	Aim	**carfentrazone**

Insect Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.
Recommended Insecticides

Aphids

Cotton/melon aphids and green peach aphids (GPA) are most common on okra. In the summer, GPA winged females can produce numerous pale yellow or pink colored live young (nymphs). GPA are larger than cotton/melon aphids. Cotton/melon aphids are yellow. Tremendous numbers of aphids can build up on the undersides of leaves and on pods often following pyrethroid insecticide applications. Aphids are sucking insects that excrete a sugary, sticky substance ("honeydew") that can coat fruit and cause growth of black sooty mold fungus. Both honeydew and mold can hurt marketability. Predators and parasitoids (braconid wasps) often can keep aphid populations below damaging levels. Broad-spectrum insecticides, like pyrethroids, destroy these natural enemies. Preserve natural enemies by using selective insecticides whenever possible. Sample plants for aphids as well as the presence of natural enemy species. Spray only when aphid densities appear to be increasing in the absence of predators.

Apply one of the following formulations (note: spray coverage to the underside of the leaf is important):						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1B	Malathion 57 EC	1.5 pt/A	malathion	1	12	H
4A	Admire Pro	7.0 to 14.0 fl oz/A	imidacloprid - **soil**	21	12	H
4A	Admire Pro	1.3 to 2.2 fl oz/A	imidacloprid - **foliar**	0	12	H
4A	Assail 30SG	2.0 to 4.0 oz/A	acetamiprid	7	12	M
4A+3A	Savoy EC*	4.9 to 9.6 fl oz/A	acetamiprid + bifenthrin	7	12	H
4C	Transform WG	0.75 to 1.0 oz/A	sulfoxaflor	1	24	H
4D	Sivanto Prime or 200SL (except green peach aphid)	21.0 to 28.0 fl oz/A	flupyradifurone - **soil**	45	4	M
4D	Sivanto Prime or 200SL	7.0 to 14.0 fl oz/A	flupyradifurone **- foliar**	1	4	M
9B	PQZ	2.4 to 3.2 fl oz/A	pyrifluquinazon	1	12	L
9D	Sefina	3.0 fl oz/A	afidopyropen	0	12	L
21A	Torac	17.0 to 21.0 fl oz/A	tolfenpyrad	1	12	H
23	Movento	4.0 to 5.0 fl oz/A	spirotetramat	1	24	L
23+7C	Senstar	8.0 to 10.0 fl oz/A	spirotetramat + pyriproxyfen	1	24	L
28	Exirel[1] (GPA and potato aphid)	13.5 to 20.5 fl oz/A	cyantraniliprole	1	12	H
28 + 6	Minecto Pro* (GPA and potato aphid)	10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H
29	Beleaf 50SG	2.8 to 4.3 oz/A	flonicamid	0	12	L

[1] For best performance, use an adjuvant

Corn Earworm, Armyworm, European Corn Borer, and Other Lepidopteran “Worm” Pests

Like the related cotton plant, okra may be attacked by several different lepidopteran pests. Corn earworm (CEW) is often the most damaging pest as it typically feeds on pods. The larvae vary in color (yellow, brown, green, or red) but display longitudinal light-colored stripes and black dots from which hair grow. CEW larvae can be distinguished from other larvae due to the presence of hair on their body. Larvae will attack fruit almost immediately following their emergence. Scouting for signs of their presence is necessary. Pheromone traps can also be used to determine periods of moth activity.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Sevin XLR Plus (CEW only)	1.0 to 1.5 qt/A	carbaryl	3	12	H
3A[1]	Pyrethroid insecticides registered for use on Okra: see table at the end of Insect Control.					
5	Entrust SC (OMRI)	3.0 to 8.0 fl oz/A	spinosad	1	4	M
5	Radiant SC	5.0 to 10.0 fl oz/A	spinetoram	1	4	M
6	Proclaim 5SG*	2.4 to 4.8 oz/A	emamectin benzoate	7	12	H
11A	Dipel DF, others (OMRI)	0.5 to 2.0 lb/A	*Bacillus thuringiensis kurstaki*	0	4	N
11A	XenTari (OMRI)	0.5 to 2.0 lb/A	*Bacillus thuringiensis aizawai*	0	4	N
15	Rimon 0.83EC	9.0 to 12.0 fl oz/A	novaluron	1	12	M
22	Avaunt 30WDG	3.5 oz/A	indoxacarb	3	12	H
22	Avaunt eVo	3.5 to 6.0 oz/A	indoxacarb	3	12	H
28	Coragen 1.67SC Coragen eVo	3.5 to 7.5 fl oz/A 1.2 to 2.5 fl oz/A	chlorantraniliprole	1	4	L
28	Exirel	7.0 to 13.5 fl oz/A	cyantraniliprole	1	12	H
28	Verimark	5.0 to 13.5 fl oz/A	cyantraniliprole - **soil**	1	4	H
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H
28 + 6	Minecto Pro*	5.5 to 10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H

[1]Resistance concerns with corn earworm

Japanese beetles

Adult Japanese beetles emerge in June and can cause substantial feeding damage on okra leaves. They skeletonize leaves leaving a lace-like appearance.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1B	Malathion 57 EC	1.5 pt/A	malathion	1	12	H
3A	Pyrethroid insecticides registered for use on Okra: see table at the end of Insect Control.					

Stink Bugs

Multiple species may damage fruit including brown and green stink bugs, and the invasive brown marmorated stink bug (BMSB). Stink bugs have a characteristic shield shape, a triangle on their thorax, are approximately 0.5 inch long and can emit a foul odor when disturbed. BMSB can be distinguished from the native brown stink bug by the white stripes on the antennae. BMSB nymphs have characteristic black and white striped legs and a dark colored or dark and white body, depending on the instar or stage of development. Stink bug eggs are in masses, barrel shaped and cream to greenish colored. Both nymphs and adults remove fluid from the fruit tissue, leaving a conspicuous white “halo” or discoloration on the surface and a raised bump. BMSB feeding injury can be significantly more severe than that of other species. Growers should scout for their presence on plants and initiate weekly spays if observed. **Note:** Brown and brown marmorated stink bugs are less susceptible to pyrethroids than green and southern green stink bugs. Careful pyrethroid selection is advised, consult your local Cooperative Extension Service for recommendations for your area.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
3A	Pyrethroid insecticides registered for use on Okra: see table at the end of Insect Control.					
4A	Admire Pro	1.3 to 2.2 fl oz/A	imidacloprid - **foliar**	0	12	H

Whiteflies

Whiteflies can be found on the underside of leaves where they aggregate in numbers. When disturbed, the white, tiny moth-like adults will fly off but quickly return to the plant. Nymphs and adults feed by removing fluids from plant material, creating stippling, yellowing and distortion of the leaves. Whiteflies also secrete honeydew, leaving a conspicuous sticky, shiny appearance to the plant during times of heavy infestation. (*continued next page*)

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
4A	Admire Pro	7.0 to 14.0 fl oz/A	imidacloprid - **soil**	21	12	H
4A	Admire Pro	1.3 to 2.2 fl oz/A	imidacloprid - **foliar**	0	12	H
4A	Assail 30SG Assail 30SC	2.5 to 4.0 oz/A 1.7 to 3.4 fl oz/A	acetamiprid	7	12	M
4A + 3A	Savoy EC*	6.0 to 9.6 fl oz/A	acetamiprid + bifenthrin	7	12	H
4C	Transform WG	2.0 to 2.25 oz/A	sulfoxaflor	1	24	H
4D	Sivanto Prime or 200SL	21.0 to 28.0 fl oz/A	flupyradifurone - **soil**	45	4	M
4D	Sivanto Prime or 200SL	10.5 to 14.0 fl oz/A	flupyradifurone - **foliar**	1	4	M
7C	Knack	8.0 to 10.0 fl oz/A	pyriproxyfen	1	12	L
9B	PQZ	2.4 to 3.2 fl oz/A	pyrifluquinazon	1	12	L
9D	Sefina	14.0 fl oz/A	afidopyropen	0	12	L
15	Rimon 0.83EC	12.0 fl oz/A	novaluron	1	12	M
16	Courier SC	9.0 to 13.6 fl oz/A	buprofezin	1	12	L
21A	Portal	2.0 pt/A	fenpyroximate	1	12	L
23	Movento	4.0 to 5.0 fl oz/A	spirotetramat	1	24	L
23 + 7 C	Senstar	8.0 to 10.0 fl oz/A	spirotetramat + pyriproxyfen	1	24	L
28 + 6	Minecto Pro*	10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H

Group 3A Pyrethroid Insecticides Registered for Use on Okra					
Apply one of the following formulations (check if the product label lists the insect you intend to spray; the label is the law):					
Product Name (*=Restricted Use)	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
Brigade 2EC*, others	2.1 to 6.4 fl oz/A	bifenthrin	7	12	H
Capture LFR*	3.4 to 8.5 fl oz/A	bifenthrin	7	12	H
Declare*	0.77 to 1.54 fl oz/A	gamma-cyhalothrin	5	24	H
Hero*	4.0 to 13.0 fl oz/A	zeta-cypermethrin + bifenthrin	7	12	H
Mustang Maxx*	2.24 to 4.0 fl oz/A	zeta-cypermethrin	1	12	H
Combo products containing a pyrethroid					
Brigadier*	3.8 to 9.85 fl oz/A	bifenthrin + imidacloprid (Group 4A) - **foliar**	7	12	H
Savoy EC*	4.9 to 9.6 fl oz/A	bifenthrin + acetamiprid (Group 4A)	7	12	H

Disease Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.
Recommended Fungicides

Nematode Control

Okra roots are very susceptible to the damage caused by root knot and sting nematodes. Both fumigant and non-fumigant nematicides can be used to control nematodes (see also sections E 1.5. Soil Fumigation and E 1.6. Nematode Control).

Use the fumigant nematicides listed in section E 1.5. or the non-fumigant nematicide in the table below. Fumigant treatments are most effective in controlling root-knot nematode when residues of the previous crop are either removed or allowed to decay. Consult the label.

Code	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
Incorporate or drip-apply 7 days before planting:						
--	Nimitz 4EC	3.5 to 5.0 pt/A	fluensulfone	n/a	12	N

Seed Treatment

Use Thiram 480DP at 3.0 to 4.0 oz/100 lb of seed (2/3 tsp/lb) *plus* Apron XL (0.32 to 0.64 fl oz/100 lb of seed) for improved germination and stand.

Damping-off caused by *Rhizoctonia*

For control of seedling root rot and basal stem rot apply the following fungicide:

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
11	azoxystrobin 2.08F	0.40 to 0.80 fl oz/1000 row ft	azoxystrobin	0	4	N

Fungal Diseases

Fruit Rot (*Choanephora*)

Choanephora is a fungal pathogen which attacks senescent blossoms and fruit. There are no fungicides labeled for its control. Improving air circulation is the only effective means of reducing the chances for *Choanephora* blossom and fruit rot development. In extreme cases, growers may remove the lower juvenile leaves to improve air circulation.

Fusarium and Verticillium Wilts

These are the major soilborne diseases of okra. Rotate with non-solanaceous crops and avoid planting in fields with a history of either disease. If rotation is not an option, soil fumigation will help reduce soil population of causal agents. Use the fumigants listed in section E 1.5. Soil Fumigation. If fumigation with synthetic chemicals is not possible, raising transplants in beneficial microbes such as TerraGrow inoculated growing mix followed by planting in anaerobically disinfested (ASD) field soil can significantly lower the disease incidence and severity.

Cercospora Leaf Spot and Powdery Mildew

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Rotate the following every 7 d as long as weather conditions favor disease development:						
M01	copper (OMRI)[1]	at labeled rates	copper	0	48	N
M05	chlorothalonil 6F[2]	1.5 pt/A	chlorothalonil	7	12	N
3	tebuconazole 3.6F[3]	4.0 to 6.0 fl oz/A	tebuconazole	4	12	N
11	azoxystrobin 2.08F[4]	6.0 to 15.5 fl oz/A	azoxystrobin	0	4	N

[1]There are several OMRI listed copper-based products; see labels for specifics. Copper applications for bacterial disease control may help suppress some fungal pathogens in organic production systems.
[2] Cercospora and Powdery Mildew.
[3] Cercospora only.
[4] Powdery Mildew only.

Onions

Recommended Bulbing Onion Varieties

Type	Variety[1]	Hybrid	Days[2]	Description[3]	Color	Storage	Method[4]	Size[5]
Long Day (direct-seeded or transplanted in early spring)	Blush	Yes	107	Sweet Spanish	Pink	Medium	TP	L
	Bradley	Yes	118	Storage LD Sp	Yellow	Long	DS, TP	L
	Ebenezer	No	120	Storage LD	Yellow	Long	Sets	M-L
	Redwing	Yes	110	Storage LD Sp	Red	Long	DS, TP	M-L
	Safrane	Yes	106	Storage LD N	Yellow	Long	DS, TP	M
	Sedona	Yes	120	Storage LD Sp	Yellow	Long	DS, TP	L
	Talon	Yes	110	Storage LD Sp	Yellow	Long	DS, TP	L
Intermediate Day (normally early spring transplanted)	Candy	Yes	95	Sweet Spanish	Yellow	Very Short	TP	VL
	Expression	Yes	98	Sweet Spanish	Yellow	Short	TP	L
	Highlander	Yes	90	Sweet Spanish	Yellow	Short/Medium	TP	L
	Great Western	Yes	110	Sweet Spanish	Yellow	Medium	TP	L
	Great White	Yes	103	Sweet Spanish	White	Medium	TP	L
	Sierra Blanca	Yes	100	Sweet Spanish	White	Short	TP	L
	Spanish Medallion	Yes	110	Sweet Spanish	Yellow	Medium	TP	VL
Overwinter (direct-seeded in later summer)	Bridger	Yes	n/a	Storage	Yellow	Medium	DS, TP	M-L
	T-448	Yes	n/a	Storage	Yellow	Medium	DS, TP	L

[1]**Listed alphabetically within type**. [2]Days to maturity; n/a=not available. [3]Storage=long keeping types; LD=Long Day; Sp=Spanish type; N=Northern type; Sweet Spanish=short keeping softer scale sweet types. [4]DS=Direct-Seeded, TP=Transplanted. [5]M=Medium, L=Large, VL=Very Large.

Recommended Green or Bunching Onions (Scallions) Varieties

Variety (listed alpabetically)	Production Method
Evergreen Long White Bunching	Overwinter
Feast	Summer
Green Banner	Fall, Overwinter, Spring, Summer
Ishikura Improved	Summer
Nabechan	Summer
Parade	Summer
Southport White Globe	Overwinter
Tokyo Long White Bunching	Summer
White Sweet Spanish	Spring-Summer

Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and Chapter B Soil and Nutrient Management. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede the recommendations found below.

Onions[1,2]		Soil Phosphorus Level				Soil Potassium Level				
		Low	Med	High (Opt)	Very High	Low	Med	High (Opt)	Very High	
	N (lb/A)	P_2O_5 (lb/A)				K_2O (lb/A)				Nutrient Timing and Method
Bulb Onions	75-100	200	100	50	0[3]	200	100	50	0[3]	Total nutrient recommended
	50-75	200	100	50	0[3]	200	100	50	0[3]	Broadcast and disk-in
	25-50	0	0	0	0	0	0	0	0	Sidedress 4-5 weeks after planting
Green Onions	150-200	200	100	50	0[3]	200	100	50	0[3]	Total nutrient recommended
	50-75	200	100	50	0[3]	200	100	50	0[3]	Broadcast and disk-in
	50	0	0	0	0	0	0	0	0	Sidedress 4-5 weeks after planting
	50	0	0	0	0	0	0	0	0	Sidedress 3-4 weeks before harvest

[1]Apply 1-2 lb/A of boron (B) with broadcast fertilizer; see also Table B-7. in Chapter B Soil and Nutrient Management. [2]For sweet onions avoid sulfur applications. For other onions apply 20-30 lb/A of sulfur (S) for most soils. [3]In VA, crop replacement values of 25 lb/A of P_2O_5 and 25 lb/A of K_2O are recommended on soils testing Very High.

Seed Treatment

Buy commercial fungicide treated seed, if available. See Disease Control below.

Planting and Seeding Dates

For dry bulb onions, sets or seeds can be planted as soon as soil conditions are favorable in the spring; transplants can be planted March 20 to April 1. For bunching onions, seeds can be planted as soon as soil conditions are favorable in the spring; successive plantings can be made through the summer. For PA growers, the Simply Sweet Onion™ branding program is an option. Visit ***https://www.pvga.org/services/pennsylvanias-simply-sweet-onion/*** and/or contact the PA Vegetable Growers Association for more information (717-694-3596 or *pvga@pvga.org*).

Transplant Production

Produce onion transplants in cell trays. For sweet Spanish transplants, the recommended maximum cell size is 338 cells per tray. Grow transplants 10-12 weeks and maintain a plant height of 4 inches by trimming the plants with a sharp clean blade.

Spacing

For dry bulb onions, space rows 24 inches apart. Space 8-9 sets per ft (24 bushels/A). For large Spanish onions, space sets 4-5 inches apart and seeds ½-2 inches in row (2 lb/A using split shoe). For bunching onions, space rows 12-16 inches apart; space seed ½-1½ inches apart (7-10 lb/A). Plant seed ½-¾ inch deep except on muck soils. On muck soils plant seed ½-1 inch deep. Place sets 1-1½ inches deep.

Plasticulture

For sweet Spanish onion, plasticulture has resulted in consistent high quality, large-sized bulb onions. Raised beds (6-8 inches high) are generally placed on 72-78-inch centers (66-inch centers if equipment is adjustable and soil friable). Transplant on 6 x 6 inch spacing with 4 rows across a 28-30-inch-wide raised bed. Two drip irrigation lines are placed in the bed between each of the outer 2 rows of transplants to maintain adequate soil moisture for sizing onion bulbs and producing a sweet taste.

Broadcast 2/3 of the recommended N prior to making raised beds and laying plastic and 1/3 through the drip irrigation system. Apply P and K as well as any magnesium or calcium based on soil test results prior to making the beds with plastic mulch and drip tape. If top growth appears chlorotic (yellow) or stunted, a tissue test analysis is recommended to make corrective measures before onions initiate bulb enlargement. Avoid using sulfur containing fertilizers. While some sulfate is required for optimum plant growth, soil sulfur levels should be less than 20 ppm since high soil sulfur increases the pungency of onion bulbs by increasing pyruvic acid levels.

Onions are shallow-rooted, and unless moisture supply is constant, they bulb early and produce small bulbs. To minimize leaching of nitrogen from the root zone, light, frequent irrigations should be used when onions are small (3 to 5 applications of 1.5-2 inches of water/week are recommended). Soil type does not affect the total amount of water needed but does dictate the frequency of application. Lighter soils need more frequent applications, but less water applied per application. Irrigation should thoroughly wet the soil to a depth of 18 inches. Stop watering after bulbs have reached full size, and tops have begun to fall.

Cultivation For bunching onions, hill 1-2 inches to ensure white bases.

Harvest and Post-Harvest Considerations

Bulb Onions: Start harvesting when at least 50% of tops have fallen. Tops of some Sweet Spanish cultivars may not fall at maturity and bulbs must be checked for desired size before harvesting. Pull bulbs by hand or undercut them without damaging their base. In plasticulture, pull bulbs through existing holes in the plastic. Under dry conditions, lay bulbs on the soil or mulch surface for 3 days. If rain is predicted, cut the tops (leaving 1.5-inch necks; shorter necks increase the risk of disease) and place bulbs in potato burlap bags or bulk bins. Place burlap bags in a greenhouse or high tunnel for 5-7 days; cover burlap with sheets of row cover material to reduce/eliminate sunburn. Place bulk bins in a room with high air flow and controlled heat source (maximum drying temperature 90°F or 32°C). Keep in dryer at moderate heat for at least 48 hours. Check randomly selected onions for dryness of the neck surface paper. For storage of sweet onion (up to 2 months), maintain cool temperatures (38-45°F, 3-7°C), low relative humidity (75-85%) and active air movement.

For storage-type onions, bulbs are undercut, and after an appropriate time, lifted and windrowed for field curing. Rod-weeder diggers and knife undercutters are commonly used. Tops may be left on to prevent sunscald or removed by hand or machine in the windrowing operation. With good air movement and proper placement, onions store best with tops on. However, this may complicate removal from storage and cause extra handling at packing.

Onions should be adequately cured in the field, in open sheds, or by forced air. In the field or in open sheds, this may require 2-4 weeks, depending on the weather. The best skin color develops between 75-90°F (24-32°C) and 60-75% relative humidity. The most common curing method is forced ventilation in storage. Heated air (75-85°F, 24-29°C) is blown through onions at a rate of 2 cubic feet per minute (CFM). Onions are considered cured when the neck is tight, and the outer scales are dry and brittle. This condition is reached after a 3-5% weight loss. If not adequately cured, stored onions are likely to decay.

Onions that are marketed in late spring are often stored refrigerated. Onions should be placed in cold storage immediately after curing. At 32°F (0°C) and with enough air circulation, onions that were cured well will stay dormant and reasonably free from decay for 6-8 months.

Green Onions and Scallions: Harvest should begin when the base is ¼-½ inch in diameter. Semi-bulbing types will be slightly enlarged (up to 1 inch) at the base. Hand pull and bunch with 6-9 onions, or ¼ lb, held together with rubber bands. Pulling is usually done without undercutting and bunching is usually done in the field. Field boxes are moved to packing areas within 2-3 hours after harvesting. It is recommended that bunched green onions are run through a washer/cooler machine with wash water temperatures of 33-35°F (1-2°C). Green tops are usually trimmed to 12 inches. Harvested onions may be bunched in the packing shed. Chilled wash water removes field and ambient heat and then the onions are immediately packed in waxed boxes. Hold green onions at 32°F and 95-100% relative humidity. Green onions are normally marketed promptly but can be stored 3-4 weeks at 32°F if moisture loss is prevented. Crushed ice or packaging in perforated polyethylene film aids in preventing moisture loss.

Weed Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.

Recommended Herbicides

1. Identify the weeds in each field and select recommended herbicides. More information is available in the "Herbicide Effectiveness on Common Weeds in Vegetables" (Table E-3) in Chapter E Pest Management.

2. Minimize herbicide resistance development. Identify the herbicide mode of action group number and follow recommended good management practices; **bolded group numbers in tables below are herbicides at higher risk for selecting resistant weed populations.** Include non-chemical weed control whenever possible.

1.a. Soil-Applied (Preplant Incorporated or Preemergence)

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
3	Dacthal 6F Dacthal W-75	6 to 14 pt/A 6 to 14 lb/A	**DCPA**	4.5 to 10.5 lb/A	--	12
-**Bulb onions and green onions**. Apply at time of seeding or immediately after planting sets. Labeled for applications directly over transplants without crop damage. A second application may be needed for longer season seed onions; but will not control emerged weeds. Primarily controls annual grasses and a few broadleaf weeds, including common purslane. -Results have been most consistent when used in fields with coarse-textured soils low in organic matter, and when the application is followed by rainfall or irrigation. Maximum application not addressed on label.						
3	Prowl H2O 3.8CS	2 pt/A	**pendimethalin**	0.95 lb/A	30	24
-**Labeled for green onions**. Apply at time of seeding or postemergence. Do not apply preemergence to onions planted on mineral soils with less than 3% organic matter or injury may occur. Onion seed must be fully covered by soil, injury may occur if seed is exposed. Prowl H2O can be applied directly over emerged plants with 2 to 3 true leaves without crop damage. -If sequential applications are made, allow 30 days between applications. -Prowl will not control emerged weeds, only provides residual control, controls most annual grasses and certain broadleaf weeds. -**Do not** apply more than 2 pt/A per application; and **do not** apply more than 4 pt/A per season.						
3	Prowl 3.3EC Prowl H2O 3.8CS	4.8 pt/A 4 pt/A	**pendimethalin**	1.9 lb/A	45	24
-**Bulb onions grown on muck soils only.** Apply from preemergence through 9 true leaf stage; crop safety is greater if application is delayed to loop stage. If irrigating, **do not** apply more than 0.5 inches of water until loop stage, **do not** apply more than 0.5 inches of water until loop stage. -Prowl will not control emerged weeds, only provides residual control. Controls most annual grasses and certain broadleaf weeds. -**Do not** apply more than 14.4 pt/A per season of Prowl 3.8EC, or more than 12.6 pt/A per season of Prowl H2O.						
8	Prefar 4E	5 to 6 qt/A	**bensulide**	5 to 6 lb/A	--	12
-**Bulb onions only.** Labeled for preplant incorporated or preemergence applications; **do not** incorporate more than 2 inches deep (1 inch is optimum). If applied preemergence, irrigate within 36 h of application with ½ inch of water; if not incorporated with irrigation or rainfall within 36 h, weed control maybe reduced. -Provides control/suppression of some annual grass weeds and some broadleaves including pigweeds, purslane, and lambsquarters. -**Do not** apply more than 6 lb ai/A per season.						

1.b. Post-Transplant Application / Preemergence Control						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient**	**Active Ingredient Rate**	**PHI (d)**	**REI (h)**
3	Prowl 3.3EC Prowl H2O 3.8CS	1.8 to 3.6 pt/A 1.5 to 3.2 pt/A	**pendimethalin**	0.7 to 1.5 lb/A	45	24
-**Bulb onions only.** Apply directly over emerged onions with 2 to 9 true leaves. If sequential applications are made, allow 30 days between applications. -Prowl will not control emerged weeds, only provides residual control, controls most annual grasses and certain broadleaf weeds. **-Do not** apply more than 3.6 pt/A per season of Prowl 3.8EC, or more than 3.2 pt/A per season of Prowl H2O.						
15	Dual Magnum 7.62E	0.67 to 1.33 pt/A	**s-metolachlor**	0.0.64 to 1.27 lb/A	21/60	24
-**Special Local Needs Label 24(c) for the use of Dual Magnum 7.62E to control weeds in dry bulb onions in NJ and PA and in green onions in NJ (NJ expires 1/28/2027; PA expires 12/31/2027). The use of this product is legal ONLY if a waiver of liability has been completed (see: *https://www.syngenta-us.com/labels/indemnified-label-login*).** -Apply at the 2 true leaf stage; a second application if soil organic matter is greater than 5%. The 2nd application cannot be less than 21 days apart (bulb onions only). Dual Magnum will **not** control emerged weeds. Emerged weeds should be controlled by cultivation, hoeing, or postemergence herbicides prior to Dual Magnum application. -For bulb onions: **do not** make more than 2 applications per crop and **do not** apply more than 1.33 pt/A in a single application or more than 2.6 pt/A per crop; for green onions **do not** apply more than once and **do not** apply more than 1.33 pt/A. -**Do not** harvest bulb onions within 60 days of application or green onions within 21 days of application.						
15	Outlook 6E	10 to 21 fl oz/A	**dimethenamid**	0.47 to 0.98 lb/A	30	12
-**Bulb onions only**. Apply after onions have reached the 2 true-leaf stage. A second application may be needed for longer season seed onions; but will not control emerged weeds. If split applications are made allow at least 14 days between applications. -Application rates vary with soil and organic matter content. See the label for specific instructions. Outlook provides control of many grass species and a few small-seeded broadleaf weeds. **-Do not** apply more than 21 fl oz/A in a single growing season.						

2. Postemergence						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient**	**Active Ingredient Rate**	**PHI (d)**	**REI (h)**
1	Shadow 3EC Select 2EC Select Max 0.97EC	4 to 10.67 fl oz/A 6 to 8 fl oz/A 9 to 32 fl oz/A	**clethodim**	0.07 to 0.24 lb/A	45	24
	Fusilade DX 2EC	8 to 24 fl oz/A	**fluazifop**	0.125 to 0.19 lb/A	45	12
	Poast 1.5EC	1 to 1.5 pt/A	**sethoxydim**	0.2 to 0.3 lb/A	30	12
-Select 2EC/Select Max labeled for **bulb onions only. Shadow 3EC labeled for dry bub at 4 to 10.67 fl oz/A and labeled for green onions at 4 to 5.33 fl oz/A.** -**Select 2EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). **Select Max**: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution). **Shadow 3EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution) for large or stressed grasses; use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution) when crop safety is a concern. **Fusilade DX**: use COC at 1.0% v/v or NIS at 0.25% v/v. **Poast**: use COC at 1.0% v/v. -**The use of COC may increase the risk of crop injury when hot or humid conditions prevail**. To reduce the risk of crop injury, omit additives or switch to NIS when grasses are small and soil moisture is adequate. -Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control. Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will **not** be controlled. Controls many annual and certain perennial grasses, including annual bluegrass, but Poast is preferred for goosegrass control. Control may be reduced if grasses are large or under hot or dry weather conditions. -Repeated applications may be necessary to control certain perennial grasses. If repeated applications are necessary, allow 14 days between applications. -Rainfastness is 1 h. -**Do not** tank mix with or apply within 2 to 3 days of any other pesticide, unless labeled, as this may increase the risk of crop injury or reduce the control of grasses. **Do not** apply more than 8 fl oz/A of Select 2EC in a single application and **do not** exceed 2 applications for the season; **do not** apply more than 32 fl oz/A of Select Max in a single application and **do not** exceed 4 pt/A for the season. -**Shadow 3EC Do not** apply more than 5.33 fl oz/A for **green onion** and do not make more than one application per season; for **dry bulb onions** do no exceed 10.67 fl oz/A in a single application and **do not** exceed 21.33 fl oz/A for the season -**Do not** apply more than 24 fl oz/A of Fusilade DX in a single application and **do not** exceed 3 pt/A per season. -**Do not** apply more than 1.5 pt/A Poast in a single application and **do not** exceed 4.5 pt/A for the season.						
6	Maestro 2E	1 to 1.5 pt/A	**bromoxynil**	0.25 to 0.375 lb/A	60, 112*	24
-B**ulb onions only.** Apply to onions with 2 to 5 true leaves. Apply in a minimum of 50 gals/A. Leaf surface should be dry at time of application. No surfactant or adjuvant is recommended due to risk of crop injury. -Apply to small broadleaf weeds (up to 4-leaf stage, 2 inches in height or 1inch diameter). -Rainfastness is 1 h. **Do not** apply more than 1.5 pt/A during the season. *Do not harvest for 112 days after application on mineral soils or 60 days on muck soils grown in the northeastern US.						

2. Postemergence - continued next page

2. Postemergence - continued

14	Goal 2XL	2 to 4 fl oz/A (NJ) Up to 8 fl oz/A (all other states)	**oxyfluorfen**	0.03 to 0.125 lb/A	45	48
	GoalTender 4F	1 to 2 fl oz/A (NJ) up to 4 fl oz/A (all other states)				
-**Bulb onions only** Apply when onions have a **minimum of 3 true leaves (do not count the flag leaf)** -Multiple treatments of 8 fl oz/A (4 fl oz/A in NJ) can be made up to a maximum of 32 fl oz/A per season. -Goal may cause injury to onion foliage; the injury will appear as necrotic spots on leaves and/or twisted leaves. Heed the following precautions to avoid or minimize injury: Use flat fan nozzles, 20-40 psi and 20-40 gal/A of water. **Do not** tank mix with any other pesticide. **Do not** use surfactant, oil concentrates, or any other additive. **Do not** apply during extended periods of cool, wet, cloudy weather. Control is best if weeks are in the 2 to 4 leaf stage and actively growing. Rainfastness is not specified. -Maximum Goal 2XL application per season 32 fl oz/A. Maximum Goal Tender 4F application per season 16 fl oz/A.						
15	Zidua SC 4.17L	2 to 2.75 fl oz/A	**pyroxasulfone**	0.065 to 0.09 lb/A	60	12
-Apply to onions with 2 to 6 true leaves that have been direct-seeded or transplanted. May result in temporary crop injury. -Zidua controls germinating annual broadleaf and grassy weeds but will **not** control emerged weeds. -**Do no**t use on coarse soil types. -**Do not** apply more than 2.75 fl oz/A during the season. -**Do not** harvest for 60 days after application.						

3. Postharvest

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
22	Gramoxone SL 2.0* Gramoxone SL 3.0*	2.25 to 3 pt/A 1.5 to 2 pt/A	**paraquat**	0.56 to 0.75 lb/A	--	24
-**Supplemental Label in DE for the use of both Gramoxone formulations for postharvest application to desiccate the crop.** -Apply after the last harvest for bareground or plasticulture. Always include an adjuvant. -Spray coverage is essential for optimum effectiveness. See the label for additional information and warnings. -Rainfastness 30 min. A maximum of 2 applications for crop desiccation are allowed. -***Restricted-use pesticide***. Only certified applicators, who successfully complete the paraquat-specific training, can mix, load, or apply paraquat. Application of paraquat "under the direct supervision" of a certified applicator is no longer allowed. Required training link (*https://campus.extension.org/enrol/index.php?id=2201*); certified applicators must repeat training every three years.						

4. Other Labeled Herbicides These products are labeled but limited local data are available; and/or are labeled but not recommended in our region due to potential crop injury concerns.

Group	Product Name (*=Restricted Use)	Active Ingredient
8	Nortron	**ethofumesate** (dry bulb onion)
14	Aim	**carfentrazone**
27	Optogen (use on muck soils only)	**bicyclopyrone**

Insect Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F. Recommended Insecticides

Soil Pests

Onion Maggots

Rotation is extremely important to reduce damage. First-brood adult flies appear in early to mid-May, second brood in July, and third brood in August-September. Flies migrate up to half a mile. Foliar insecticide applications are not likely to control maggot flies as flies spend most of their time outside onion fields. If a spray is applied, apply directly over the row. Soak soil around base of seedlings. Fall maggots are most important because they may end up in stored onions and cause rot. Avoid mechanical injury to bulbs in the field or during harvesting. Crushed onions or culls attract onion maggot flies. Eliminate (bury) culls. Onion seed treated commercially with cyromazine (Trigard ST) is available (pelleted). While only one insecticide is listed other formulations can be used.

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Pre-planting or in-furrow broadcast just before planting, mix into top 3-4 inches of soil:						
1B	Diazinon AG500*	2.0 to 4.0 qt/A	diazinon	60	72	H

Onion Maggots - Post-Planting Spray Treatment on next page

Onion Maggots - continued

Post-Planting Spray Treatment:						
1B	Malathion 57 EC	2.5 pt/A	malathion	3	12	H
3A	Mustang Maxx*	2.2 to 4.0 fl oz/A	zeta-cypermethrin	7	12	H
3A	Permethrin 3.2EC*, others	4.0 to 12.0 fl oz/A	permethrin (also has a repellent effect)	1	12	H
3A	Proaxis*	1.92 to 3.20 fl oz/A	gamma-cyhalothrin **- bulb only**	14	24	H
3A	Warrior II*	0.96 to 1.60 fl oz/A	lambda-cyhalothrin **- bulb only**	14	24	H

Aboveground Pests

Allium Leafminers

This new pest to the Mid-Atlantic area is a long grey-black fly with a distinctive yellow or orange patch on the top of its head, yellow sides, and "knees" (femur-tibia junction), and white halteres (knobs as second pair of wings). The larvae are typical whitish maggots. Leek (*A. porrum*) or scallions (green onions) tends to be the most damaged Allium species or cultivar. Females repeatedly puncture leaves with their ovipositor, resulting in a line of small white dots. Leaves can be wavy, curled, and distorted. The larvae mine leaves and move into bulbs and leaf sheathes where they pupate. Covering plants in April-May, or September-October, during the adult flight, can exclude the pest. Avoid the adult oviposition period by delaying planting. Systemic and contact insecticides can be effective.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
3A	Mustang Maxx*	2.9 to 4.0 fl oz/A	zeta-cypermethrin	7	12	H
3A	Proaxis*	1.92 to 3.2 fl oz/A	gamma-cyhalothrin	14	24	H
3A	Warrior II*	0.96 to 1.60 fl oz/A	lambda-cyhalothrin	14	24	H
4A	Scorpion 35SL	8.75 to 10.5 fl oz/A	dinotefuran - **soil**	21	12	H
4A	Scorpion 35SL	5.25 to 7.0 fl oz/A	dinotefuran - **foliar**	1	12	H
4A	Venom 70SG	5.0 to 6.0 oz/A	dinotefuran - **soil**	21	12	H
4A	Venom 70SG	3.0 to 4.0 oz/A	dinotefuran - **foliar**	1	12	H
5	Entrust SC (OMRI)	3.0 to 6.0 fl oz/A	spinosad	1	4	M
5	Radiant SC	6.0 to 10.0 fl oz/A	spinetoram	1	4	M
17	Trigard 75WSP	2.66 oz/A	cyromazine	0	12	H
28	Exirel	13.5 to 20.5 fl oz/A	cyantraniliprole	1	12	H
28 + 6	Minecto Pro*	7.0 to 10.0 fl oz/A	cyantraniliprole + abamectin	30	12	H

Armyworms (note: uncommon pest of *Allium* crops)

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
3A	Permethrin 3.2EC*	6.0 to 12.0 fl oz/A	permethrin	1	12	H
5	Entrust SC (OMRI)	3.0 to 6.0 fl oz/A	spinosad	1	4	M
5	Radiant SC	5.0 to 10.0 fl oz/A	spinetoram	1	4	M
28	Vantacor	1.2 to 2.5 fl oz/A	chlorantraniliprole	1	4	L

Cutworms See also section E 3.1. Soil Pests - Detection and Control.

Infestations often occur early in the spring and damaging infestations are usually limited to the earliest plantings. Infestations are intermittent and there are no useful methods to predict when and if the pest might occur. Black cutworm moths are attracted to fields containing winter and perennial weeds such as chickweed, purslane, shepherd's purse, and yellow rocket. Moths also are attracted to cereals used as a winter cover crop. The larvae feed just below the soil surface, eventually pulling the above ground portion into the feeding cell. One possible management option includes reducing winter and perennial weeds that serve as oviposition sites.

Apply one of the following formulations, sprays should be directed at the bases of plants.						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	3.0 pt/A	methomyl	7	48	H
3A	Mustang Maxx*	2.24 to 4.0 fl oz/A	zeta-cypermethrin	7	12	H
3A	Proaxis*	1.92 to 3.2 fl oz/A	gamma-cyhalothrin	14	24	H
3A	Warrior II*	0.96 to 1.6 fl oz/A	lambda-cyhalothrin	14	24	H
3A	Permethrin 3.2EC*	4.0 to 12.0 fl oz/A	permethrin	1	12	H

Leafminers (***Liriomyza***) Adult leafminer flies are black and yellow. The female punctures the leaf to feed on plant sap and to lay eggs. Eggs hatch within 2-4 days and the yellow larvae tunnel within the leaf tissue, producing the characteristic “mines” in the leaf. Larvae pupate in the soil or in the leaf axils on plants. Many generations occur each year. Damage caused by leafminers can result in dried out, dead foliage and loss of yield or quality.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
4A	Scorpion 35 SL	8.75 to 10.5 fl oz/A	dinotefuran - **soil**	21	12	H
4A	Scorpion 35 SL	5.25 to 7.0 fl oz/A	dinotefuran - **foliar**	1	12	H
4A	Venom 70SG	5.0 to 6.0 oz/A	dinotefuran - **soil**	21	12	H
4A	Venom 70SG	3.0 to 4.0 oz/A	dinotefuran - **foliar**	1	12	H
5	Entrust SC (OMRI)	3.0 to 6.0 fl oz/A	spinosad	1	4	M
5	Radiant SC	6.0 to 10.0 fl oz/A	spinetoram	1	4	M
17	Trigard 75WSP	2.66 oz/A	cyromazine	60	12	H
28	Exirel	13.5 to 20.5 fl oz/A	cyantraniliprole **- use with adjuvant**	1	12	H
28 + 6	Minecto Pro*	7.0 to 10.0 fl oz/A	cyantraniliprole + abamectin	30	12	H

Thrips

Onion thrips populations frequently increase following adjacent alfalfa or cereal harvest, as adults overwinter in these fields. Thrips pierce plant tissue and remove plant liquids. Immature thrips usually feed on young tissue between the leaf sheaths and stem, adults feed on more mature tissue. Feeding damage on leaves looks like whitish or chlorotic streaks. If feeding is severe, particularly under dry conditions, the tips of leaves become brown. Prolonged feeding reduces bulb size and increases the incidence of leaf and bulb rots. There are 3-5 overlapping generations per season. Effective management relies primarily on foliar insecticide sprays based on some treatment threshold, usually from 2-4 immatures/leaf. High spray pressures and high gallonages are necessary to ensure good contact between the pest and chemical. Twin flat fan nozzles result in greater coverage than single flat fans.

Note: Use of spinosad for leafminer control will suppress thrips population. Other thrips species that are less susceptible to pyrethroids or neonicotinoids may be present besides onion thrips.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	3.0 pt/A	methomyl	7	48	H
3A	Lambda-Cy 1EC*, others	2.56 to 3.84 fl oz/A	lambda-cyhalothrin	14	24	H
3A	Mustang Maxx*	2.88 to 4.0 fl oz/A	zeta-cypermethrin	7	12	H
3A	Permethrin 3.2EC*, others	6.0 to 12.0 fl oz/A	permethrin	1	12	H
3A	Warrior II*	1.28 to 1.92 fl oz/A	lambda-cyhalothrin	14	24	H
4A	Admire Pro	14.0 fl oz/A	imidacloprid - **soil**	21	12	H
4A	Assail 30SG Assail 30SC	5.0 to 8.0 oz/A 4.2 to 6.7 fl oz/A	acetamiprid	7	12	M
4A	Scorpion 35SL	8.75 to 10.5 fl oz/A	dinotefuran - **soil**	21	12	H
4A	Scorpion 35SL	5.25 to 7.0 fl oz/A	dinotefuran - **foliar**	1	12	H
4A	Venom 70SG	5.0 to 6.0 oz/A	dinotefuran - **soil**	21	12	H
4A	Venom 70SG	3.0 to 4.0 oz/A	dinotefuran - **foliar**	1	12	H
5	Entrust SC (OMRI)	3.0 to 6.0 fl oz/A	spinosad	1	4	M
5	Radiant SC	6.0 to 10.0 fl oz/A	spinetoram	1	4	M
6	Agri-Mek SC*	1.75 to 3.5 fl oz/A	abamectin	30	12	H
6 + 28	Minecto Pro*	7.0 to 10.0 fl oz/A	abamectin + cyantraniliprole	30/7 (green)	12	H
21A	Torac	24 fl oz/A	tolfenpyrad	7	12	H
23	Movento (larvae)	5.0 fl oz/A	spirotetramat	3	24	L

Disease Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F. Recommended Fungicides

Seed Treatment Check with your seed company if fungicide treated seed is available. Multiple fungicides are often needed to manage the diversity of soilborne fungi that cause decay.

Damping-off caused by *Pythium* and *Rhizoctonia*

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Pythium Root Rot						
4	Ridomil Gold 4SL[1]	0.5 to 1.0 pt/A	mefenoxam	7	48	N
4	Ultra Flourish 2E[1]	1.0 to 2.0 pt/A	mefenoxam	AP	48	N
Pythium and/or Rhizoctonia Root Rot						
4 + 11	Uniform 3.66SE	0.34 fl oz/1000 ft of row in-furrow (see label), or apply 4.5 fl oz/A to the bed during shaping for transplanted onions	mefenoxam + azoxystrobin	AP	0	N

[1]Applied as a broadcast or banded immediately after seeding the field

Bacterial Diseases

Soft rot, Slippery Skin, Sour Skin and Center Rot

Plant pathogen-free seed and transplants. Rotate to a non-host for 2 or more years and eliminate volunteer onions and weeds. Avoid overhead irrigation, especially with water that may be contaminated with pathogen(s). Minimize injury to maturing or harvested bulbs and consider harvesting early under high disease pressure. Dry mature bulbs as soon as possible after harvest. For sweet onions grown on plastic mulch, consider transplanting them into silver reflective or black biodegradable plastic mulch to reduce the soil temperatures associated with increased losses due to center rot. When conditions are favorable for bacterial diseases, typically warm and wet, initiate a preventative program consisting of fixed copper tank mixed with mancozeb or ManKocide at 2.5 lb/A. There are also several copper-based products that are OMRI listed for use in organic production systems which will help suppress damage caused by bacterial diseases.

Fungal Diseases

Black Mold (*Aspergillus niger*)

This fungus is common in the soil and crop residue and affects numerous vegetables. Manage by promptly and adequately drying bulbs after harvest. Heated air favors disease development. Storing bulbs at low temperature and humidity will help manage black mold. Fields with a history of black mold may benefit from preventative late season applications of azoxystrobin (7-day PHI).

Botrytis Leaf Blight (*Botrytis squamosa*)

The pathogen overwinters in cull piles, on onion debris in the soil, and as sclerotia where related crops were recently grown. Botrytis leaf blight is promoted by moist, cool to mild conditions. Eliminate inoculum sources and rotate 2 or 3 years between onion-related crops. Fungicides can be delayed until there is an average of 1 lesion on 10 leaves.

Apply and alternate between one of the following. Always alternate between fungicides from different FRAC codes to reduce chances for fungicide resistance development.						
Code	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
M05	chlorothalonil 6F	1.0 to 3.0 pt/A	chlorothalonil	7	12	N
2	iprodione 4F	1.5 pt/A	iprodione	7	24	N
3 + 9	Inspire Super 2.82EW	16.0 to 20.0 fl oz/A	difenoconazole + cyprodonil	7	12	--
7	Endura 70W	6.8 oz/A	boscalid	7	12	--
7	Fontelis 1.67SC	16.0 to 24.0 fl oz/A	penthiopyrad	3	12	L
7 + 11	Merivon 2.09SC	8.0 to 11.0 fl oz/A	fluxapyroxad + pyraclostrobin	7	12	N
7 + 11	Pristine 38WG	14.5 to 18.5 oz/A	boscalid + pyraclostrobin	7	12	--
9	Scala 5SC	9.0 oz/A	pyrimethanil	7	12	--
9 + 12	Switch 62.5WG	11.0 to 14.0 oz/A	cyprodinil + fludioxonil	7	12	L
11	azoxystrobin 2.08F	9.0 to 15.5 fl oz/A	azoxystrobin	0	4	N
11+M05	Quadris Opti 5.5SC	1.6 to 3.2 pt/A	azoxystrobin + chlorothalonil	7	12	N
29	Omega 500F	1.0 pt/A	fluazinam	7	48	N

Botrytis Neck Rot (*Botrytis alli*)

Infection is favored by cool, wet conditions and poor drying and curing, and often develops on injured bulbs in storage. Minimize nitrogen late in the season to promote drying of the necks at harvest. Windrow plants to ensure dry tops before topping operation. Apply and alternate between the following. Always alternate fungicides from different FRAC codes to reduce chances for fungicide resistance development. *(continued next page)*

Botrytis Neck Rot (Botrytis alli) - continued

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
2	iprodione 4F[1]	1.5 pt/A	iprodione	7	24	N
7	Endura 70W	6.8 oz/A	boscalid	7	12	--
7 + 11	Merivon 2.09SC	8.0 to 11.0 fl oz/A	fluxapyroxad + pyraclostrobin	7	12	N
9	Scala 5SC	9.0 oz/A	pyrimethanil	7	12	--
29	Omega 500F	1.0 pt/A	fluazinam	7	48	N

[1]Apply at 14-day intervals (for dry bulb onions only)

Downy Mildew (*Peronospora destuctor*) The pathogen can survive as oospores in the soil, or on bulbs, sets and seed. Downy Mildew development is promoted by cool, moist conditions. Management begins with planting pathogen-free seed or sets and crop rotations of at least 3 years without related crops. Be sure to eliminate culls and volunteers from the field. Apply one of the following fungicides and rotate between different FRAC codes.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
M03	mancozeb 75DF	3.0 lb/A	mancozeb	7	24	N
M05	chlorothalonil 6F	1.0 to 3.0 pt/A	chlorothalonil	7	12	N
11	Cabrio 20EG	12.0 oz/A	pyraclostrobin	7	12	N
11	Reason 500SC	5.5 fl oz/A	fenamidone	7	12	--
11+M05	Quadris Opti 5.5SC	1.6 to 3.2 pt/A	azoxystrobin + chlorothalonil	7	12	N
29	Omega 500F	1.0 pt/A	fluazinam	7	48	N
40 + 45	Zampro 525SC	14.0 fl oz/A	dimethomorph + acetoctradin	0	12	--
49+M05	Orondis Opti[1]	1.75 to 2.5 pt/A	oxathiapiprolin + chlorothalonil	7	12	--

[1]Also labeled for Botrytis leaf blight and purple blotch.

Purple Blotch (*Alternaria porri*) and Stemphylium Leaf Blight (*Stemphylium vesicarium*)

The pathogen overwinters in plant residue from onion-related plants. Purple blotch and Stemphylium development are favored by warm, moist conditions. Grow onions in well-drained soil and rotate with non-related crops. Sweet Spanish types are especially susceptible to purple blotch.

Apply and rotate between one of the following every 7 d as long as conditions favor disease development. Rotate fungicides from different FRAC codes to help reduce the development of fungicide resistance.						
Code	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
M05	chlorothalonil 6F (for purple blotch only)	1.0 to 3.0 pt/A	chlorothalonil	7	12	N
2	iprodione 4F[1]	1.5 pt/A	iprodione	7	24	N
3 + 9	Inspire Super 2.82EW	16.0 to 20.0 fl oz/A	difenoconazole + cyprodonil	7	12	--
3 + 11	Quadris Top 1.67SC	12.0 to 14.0 fl oz/A	difenoconazole + azoxystrobin	7	12	--
7	Endura 70W	6.8 oz/A	boscalid	7	12	--
7	Fontelis 1.67SC	16.0 to 24.0 fl oz/A	penthiopyrad	3	12	L
7 + 9	Luna Tranquility 4.16SC	16.0 to 27.0 fl oz/A	fluopyram + pyrimethanil	7	12	--
7 + 11	Merivon 2.09SC	5.5 to 11.0 fl oz/A	fluxapyroxad + pyraclostrobin	7	12	N
7 + 11	Pristine 38WG (apply at 14-d intervals)	10.5 to 18.5 oz/A	boscalid + pyraclostrobin	7	12	--
7 + 12	Miravis Prime	10.3 to 11.4 fl oz /A	pydiflumetofen + fludioxonil	7	12	--
9	Scala 5SC	9.0 oz/A	pyrimethanil	7	12	--
9 + 12	Switch 62.5WG[2]	11.0 to 14.0 oz/A	cyprodinil + fludioxonil	7	12	L
11	azoxystrobin 2.08F	9.0 to 15.5 fl oz/A	azoxystrobin	0	4	N
29	Omega 500F	1.0 pt/A	fluazinam	7	48	N

[1]Apply at high rate and at 14-day intervals (for dry bulb onions only). [2] For Stemphylium leaf blight only.

White Rot (*Sclerotium cepivorum*)

White rot is most limiting in cool, moist soils and most severe on overwintered onions. The sclerotia can be long lived (over 20 years) in the soil in the absence of an Allium host. White rot development is very dependent on soil temperatures with optimum temperatures of 60-65°F (16-18°C).

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Apply in a 4- to 6-inch band over or into the furrow at planting or may also be applied by chemigation:						
3	tebuconazole 3.6F	20.5 fl oz/A	tebuconazole	7	12	N
Two additional foliar applications may be applied (dry bulb onion only):						
3	tebuconazole 3.6F	4.0 to 6.0 fl oz/A	tebuconazole	7	12	N

Parsley

Recommended Varieties[1]

Type	Variety[1]	Type	Variety[1]
Curly Leaf	Banquet (Overwintering)	**Flat Leaf**	Gigante D'Italia (Giant of Italy)
	Darki		Italian Plain Leaf (Dark Green)
	Einfache Schnitt (Overwintering)		Peione
	Forest Green (Semi-curled)		Pinocchio
	Moss Curled II		Plain (Overwintering)
	Wega		

[1]**Listed alphabetically within type**; all varieties are open-pollinated.

Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report, and Chapter B Soil and Nutrient Management in this manual. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede the recommendations found below.

		Soil Phosphorus Level				Soil Potassium Level				
		Low	Med	High (Opt)	Very High	Low	Med	High (Opt)	Very High	
Parsley	**N (lb/A)**	**P_2O_5 (lb/A)**				**K_2O (lb/A)**				**Nutrient Timing and Method**
	150-175	200	150	100	0	200	150	100	0	Total nutrient recommended
	50-75	200	150	100	0	200	150	100	0	Broadcast and disk-in
	25-50	0	0	0	0	0	0	0	0	Sidedress after first cutting
	25-50	0	0	0	0	0	0	0	0	Sidedress after each additional cutting

Seeding and Spacing

Seed is sown 1/3-inch-deep in a well-prepared seedbed as early as the ground can be worked in late February/early March through mid-May for late spring/summer harvest. Later plantings can be sown beginning in mid-July for fall harvest and through mid-August for overwintered production. The spacing between rows is 12-18 inches. Parsley seeds are drilled at a rate of 20-40 lb/A, with plants spaced 1-2 inches apart in each row. Seeds are slow to germinate. If seeds are more than 1 year old, test the germination by sandwiching 10-20 seeds between moist paper towels placed in a resealable plastic bag. Wait a week or two and record the number of germinated seeds. The percent germination equals the number of germinated seeds divided by the total number of seeds multiplied by 100 (germination % = # germinated seed ÷ total # of seed x 100). Increase the sowing rate to compensate for reduced germination.

Overwintered and the earliest spring and later fall plantings benefit from the use of floating row covers and/or low or high tunnels for protection from freezing. Floating row covers can create conditions favorable for bacterial leaf spot infections to start and spread. Removing row covers on warm or windy days to allow excess moisture to evaporate will help reduce the incidence of bacterial leaf diseases.

Harvest and Post-Harvest Considerations

Parsley can be harvested by cutting a few leaves at a time from each plant, or entire plants may be cut or dug with roots attached and bunched for sale. If cut above the crown, plants will regrow for a second cutting. Parsley leaves are commonly grown for fresh markets, but also for dried herb markets where the characteristic flavor and green color can be retained if the leaves are dehydrated. Store fresh parsley at 32°F (0°C) and 95-100% relative humidity. Parsley can keep up to 2-2.5 months at 32°F, but high humidity is essential to prevent desiccation. Do not store with other crops that produce ethylene, as parsley is very sensitive to ethylene. Packaging in perforated polyethylene bags and using top ice are beneficial for longer storage periods. A controlled atmosphere of approximately 10% oxygen and 11% carbon dioxide at moderate temperatures (41-50°F/5-10°C) can help retain green color and salability.

Weed Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.

Recommended Herbicides

1. Identify the weeds in each field and select recommended herbicides. More information is available in the "Herbicide Effectiveness on Common Weeds in Vegetables" (Table E-3) in Chapter E Pest Management.

2. Minimize herbicide resistance development. Identify the herbicide mode of action group number and follow recommended good management practices; **bolded group numbers in tables below are herbicides at higher risk for selecting resistant weed populations.** Include non-chemical weed control whenever possible.

1. Soil-Applied (Preplant Incorporated or Preemergence)

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
5	Caparol 4L	1 pt/A	**prometryn**	0.5 lb/A	30	12
-Apply after seeding, but before crop emergence. Follow with overhead irrigation if rainfall does not occur. Primarily controls annual broadleaf weeds. Annual grasses may only be suppressed. Additional postemergence treatments may be needed for full-season control. -**Do not** use on sand or loamy sand soils, or crop injury may occur. -**Do not** tank mix Caparol with any other pesticide. -**Do not** apply more than 1 pt/A in a single application and maximum Caparol 4L application per season is 3 pt/A.						
7	Lorox 50DF	1 to 3 lb/A	**linuron**	0.5 to 1.5 lb/A	30	24/96
-Apply immediately after seeding. Follow with irrigation if rainfall does not occur. Primarily controls broadleaf weeds. Annual grasses may only be suppressed. -**Do not** apply more than 1.5 lb/A linuron per season. **Do not** apply to parsley through any type of irrigation system. -The restricted-entry interval is extended from 24 to 96 h (4 days) after hand-set irrigation activity.						
8	Prefar 4E	5 to 6 qt/A	**bensulide**	5 to 6 lb/A	--	12
-Labeled for preplant incorporated or preemergence applications; **do not** incorporate more than 2 inches deep (1 inch is optimum). -Use on mineral soils only. If applied preemergence, irrigate within 36 h of application with ½ inch of water; if not incorporated with irrigation or rainfall within 36 h, weed control maybe reduced. -Provides control/suppression of some annual grass weeds and some broadleaves including pigweeds, purslane, and lambsquarters. -**Do not** apply more than 6 lb ai/A per season.						

2. Postemergence

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
1	Shadow 3EC Select 2 EC Select Max 0.97EC	4 to 5.33 fl oz/A 6 to 8 fl oz/A 9 to 16 fl oz/A	**clethodim**	0.07 to 0.125 lb/A	14	24
	Poast 1.5EC	1 to 1.5 pt/A	**sethoxydim**	0.2 to 0.28 lb/A	15	12
-**Select 2EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). **Select Max**: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution). **Shadow 3EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution) for large or stressed grasses; use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution) when crop safety is a concern. **Poast**: use COC at 1.0% v/v. -**The use of COC may increase the risk of crop injury when hot or humid conditions prevail**. To reduce the risk of crop injury, omit additives or switch to NIS when grasses are small and soil moisture is adequate. -Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control. -Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will **not** be controlled. Controls many annual and certain perennial grasses, including annual bluegrass, but Poast is preferred for goosegrass control. For best results, treat annual grasses when they are actively growing and before tillers are present. Control may be reduced if grasses are large or under hot or dry weather conditions. -Repeated applications may be necessary to control certain perennial grasses. If repeated applications are necessary, allow 14 days between applications. -Rainfastness is 1 h. -**Do not** tank mix with or apply within 2 to 3 days of any other pesticide, unless labeled, as this may increase the risk of crop injury or reduce the control of grasses. **Do not** apply more than 8 fl oz/A of Select 2EC in a single application and **do not** exceed 2 pt/A for the season; **do not** apply more than 16 fl oz/A of Select Max in a single application and **do not** exceed 4 pt/A for the season. -**Do not** apply more than 5.33 fl oz/A of Shadow 3EC in a single application and **do not** exceed 21.33 fl oz/A for the season. -**Do not** apply more than 1.5 pt/A Poast in a single application and **do not** exceed 3 pt/A for the season.						
5	Caparol 4L	1 pt/A	**prometryn**	0.5 lb/A	30	12
-Apply after the crop has developed 3 true leaves. Primarily controls seedling annual broadleaf weeds less than 2 inches tall. Annual grasses may only be suppressed. An additional treatment can be applied to regrowth after the first harvest. -**Do not** use on sand or loamy sand soils, or crop injury may occur. **Do not** apply if parsley is under stress. -**Do not** tank mix Caparol with any other pesticide. **Do not** use spray additives such as nonionic surfactant or oil concentrate. -**Do not** apply more than 1 pt/A in a single application and maximum Caparol 4L application per season is 3 pt/A.						

3. Postharvest						
Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
22	Gramoxone SL 2.0* Gramoxone SL 3.0*	2.25 to 3 pt/A 1.5 to 2 pt/A	**paraquat**	0.56 to 0.75 lb/A	--	24

-**Supplemental Label in DE for the use of both Gramoxone formulations for postharvest application to desiccate the crop.**
-Apply after the last harvest for bareground or plasticulture. Always include an adjuvant. -Spray coverage is essential for optimum effectiveness. See the label for additional information and warnings. -Rainfastness 30 min. A maximum of 2 applications for crop desiccation are allowed. ***Restricted-use pesticide***. Only certified applicators, who successfully complete the paraquat-specific training, can mix, load, or apply paraquat. Application of paraquat "under the direct supervision" of a certified applicator is no longer allowed. Required training link (*https://campus.extension.org/enrol/index.php?id=2201*); certified applicators must repeat training every three years.

4. Other Labeled Herbicides These products are labeled but limited local data are available; and/or are labeled but not recommended in our region due to potential crop injury concerns.

Group	Product Name (*=Restricted Use)	Active Ingredient
14	Aim	**carfentrazone**
14	Vida	**pyraflufen**

Insect Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F. Recommended Insecticides

Aphids

Apply one of the following formulations:						
Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
1B	Malathion 57 EC	1.0 to 2.0 pt/A	malathion (2 applications per season, only)	7	24	H
4A	Neonicotinoid insecticides registered for use on Parsley: see table at the end of Insect Control.					
4D	Sivanto Prime	21.0 to 28.0 fl oz/A	flupyradifurone - **soil**	21	12	M
4D	Sivanto Prime	7.0 to 14.0 fl oz/A	flupyradifurone - **foliar**	1	12	M
9B	Fulfill 50WDG	2.75 oz/A	pymetrozine	7	12	L
9B	PQZ	2.4 to 3.2 fl oz/A	pyrifluquinazon	1	12	L
23	Movento	4 to 5 fl oz/A	spirotetramat	3	24	L
23 + 7C	Senstar	8.0 to 10.0 fl oz/A	spirotetramat + pyriproxyfen	14	24	L
28	Exirel	13.5 to 20.5 fl oz/A	cyantraniliprole	1	12	H
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H
28 + 6	Minecto Pro*	10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H
29	Beleaf 50SG	2.0 to 2.8 oz/A	flonicamid	0	12	L
UN	Azatin O, Aza-Direct, Ecozin, Neemix (OMRI)	Refer to individual labels for rates	azadirachtin	0	4	L

Armyworms

Apply one of the following formulations:						
Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
3A	Mustang Maxx*	3.2 to 4.0 fl oz/A	zeta-cypermethrin **- not for beet armyworm**	1	12	H
3A	Tombstone*	2.4 to 3.2 fl oz/A	cyfluthrin **- not for beet armyworm**	0	12	H
3A + 4A	Leverage 360*	3.0 fl oz/A	imidacloprid + beta-cyfluthrin **- not for beet armyworm**	7	12	H
5	Entrust SC (OMRI)	4.0 to 8.0 fl oz/A	spinosad	1	4	M
5	Radiant SC	5.0 to 10.0 fl oz/A	spinetoram	1	4	M
6	Proclaim 5SG*	2.4 to 4.8 oz/A	emamectin benzoate	7	12	H
18	Intrepid 2F (early season)	4.0 to 8.0 fl oz/A	methoxyfenozide	1	4	L
18	Intrepid 2F (late season)	8.0 to 10.0 fl oz/A	methoxyfenozide	1	4	L
28	Coragen 1.67SC Coragen eVo	3.5 to 7.5 fl oz/A 1.2 to 2.5 fl oz/A	chlorantraniliprole	1	4	L

Armyworms - continued next page

Armyworms - continued

28	Exirel	7.0 to 13.5 fl oz/A	cyantraniliprole	1	12	H
28	Verimark	5 to 10 fl oz/A	cyantraniliprole	n/a	4	H
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H
28 + 6	Minecto Pro*	5.5 to 10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H

Carrot Weevils

Weevils can be major parsley pests and are difficult to control. They tend to be more abundant in heavier soil or soil rich in organic matter. Crop rotation at least ¼ mile, row covers, and tillage of previous crop residue are recommended cultural control practices.

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
1B	Malathion 57 EC	1.0 to 2.0 pt/A	malathion	7	24	H
3A	Baythroid XL*	2.4 to 3.2 fl oz/A	beta-cyfluthrin	0	12	H
3A + 4A	Leverage 360*	3.0 fl oz/A	imidacloprid + beta-cyfluthrin	7	12	H

Flea Beetles, Leafhoppers

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Sevin XLR Plus	0.5 to 1 qt/A	carbaryl	14	12	H
3A	Baythroid XL*	2.4 to 3.2 fl oz/A	beta-cyfluthrin	0	12	H
3A	Mustang Maxx*	2.24 to 4.0 fl oz/A	zeta-cypermethrin	1	12	H
3A	Tombstone*	2.4 to 3.2 fl oz/A	cyfluthrin	0	12	H
4A	Neonicotinoid insecticides registered for use on Parsley: see table at the end of Insect Control.					
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H

Tarnished Plant Bugs

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Sevin XLR Plus	1 to 2 qt/A	carbaryl	14	12	H
3A	Baythroid XL*	2.4 to 3.2 fl oz/A	beta-cyfluthrin	0	12	H
3A	Mustang Maxx*	3.2 to 4.0 fl oz/A	zeta-cypermethrin	1	12	H
3A	Tombstone*	2.4 to 3.2 fl oz/A	cyfluthrin	0	12	H
29	Beleaf 50SG	2.0 to 2.8 oz/A	flonicamid	0	12	L

Group 4A Neonicotinoid Insecticides Registered for Use on Parsley

Apply one of the following formulations (check if the product label lists the insect you intend to spray; the label is the law):						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
4A	Actara 25WDG	1.5 to 5.5 oz/A	thiamethoxam	7	12	H
4A	Platinum 75SG	1.6 to 3.67 oz/A	thiamethoxam	30	12	H
4A	Admire Pro	1.2 fl oz/A	imidacloprid - **foliar**	7	12	H
4A	Admire Pro	4.4 to 10.5 fl oz/A	imidacloprid - **soil**	21	12	H
4A	Belay 2.13SC	9.0 to 12.0 fl oz/A	clothianidin - **soil**	21	12	H
4A	Belay 2.13SC	3.0 to 4.0 fl oz/A	clothianidin - **foliar**	7	12	H
4A	Scorpion 35SL	9 to 10.5 fl oz/A	dinotefuran - **soil**	21	12	H
4A	Scorpion 35SL	2 to 5.2 fl oz/A	dinotefuran - **foliar**	7	12	H
4A	Venom 70SG	5 to 7.5 oz/A	dinotefuran - **soil**	21	12	H
4A	Venom 70SG	1.0 to 3.0 oz/A	dinotefuran - **foliar**	1	12	H
Combo products containing a neonicotinoid						
3A + 4A	Leverage 360*	3.0 fl oz/A	imidacloprid + beta-cyfluthrin	7	12	H

Disease Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.

Recommended Fungicides

Nematode Control

Nematode control is essential for satisfactory parsley production, see sections E 1.5. Soil Fumigation and E 1.6. Nematode Control. Before planting, soil should be fumigated with metam-sodium (Vapam HL) according to directions in section E 1.5.

Seed Treatment

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
For Pythium and Phytophthora Control:						
4	Apron XL[1]	0.085 to 0.64 fl oz/100 lb seed	mefenoxam	n/a	n/a	N
For Control of Other Root Rots:						
12	Maxim 4FS[1]	0.08 to 0.16 fl oz/100 lb seed	fludioxonil	n/a	n/a	L

[1]Apron XL and Maxim 4FS can be combined.

Damping-off caused *Pythium* and *Rhizoctonia*

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
For Pythium root rot control, apply as banded spray:						
4	Ridomil Gold 4SL	0.5 to 1.0 pt/A	mefenoxam	AP	48	N
4	MetaStar 2E AG	2.0 to 4.0 pt/A	metalaxyl	AP	48	N
49 + 4	Orondis Gold	13.9 to 27.8 fl oz/A	oxathiapiprolin + mefenoxam	AP	48	--
For Rhizoctonia root rot control, apply as in-furrow application:						
11	azoxystrobin 2.08F	0.40 to 0.80 fl oz/A	azoxystrobin	AP	4	N
For Pythium and Rhizoctonia root rot control apply as banded spray:						
11 + 4	Uniform 3.66SE	0.34 fl oz/1000 ft row	azoxystrobin + mefenoxam	AP	0	N

Bacterial and Fungal Diseases

Bacterial Leaf Blight and Septoria Leaf Spot

To help reduce disease pressure from bacterial and fungal diseases, rotate with non-related crops for at least 2 years. Space successive plantings in the same year as far apart as possible. Heavy winds and rain may damage leaves and predispose leaves to bacterial infections.

Bacterial leaf blight:

Prevention is key. Avoid working in the fields while the foliage is wet to help reduce spread. Scout fields on a regular basis for early symptoms, apply fixed copper at labeled rates with regular maintenance applications for leaf spot diseases and repeat every 7 days. Some copper-based products are OMRI listed and can be used in organic production systems for the suppression of bacterial and some fungal diseases.

Septoria leaf spot:

The disease causes serious problems in fields where parsley has been grown extensively. Grow parsley in fields without a history of the disease. Plant blocks as far apart as possible. **Early detection and prevention are key**. **Scout daily and apply fungicides preventatively** before first leaf spots appear in fields with history of the disease. Early season infections (*i.e.*, prior to first cutting) will severely reduce subsequent harvests.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Rotate one of the following every 7 days:						
3	Rhyme 2.08SC[1]	5.0 to 7.0 fl oz/A	flutriafol	7	12	--
3 + 11	Topguard EQ4.29SC[1,2]	6.0 to 8.0 fl oz/A	flutriafol + azoxystrobin	7	12	--
with one of the following as long as disease is active:						
7	Fontelis 1.67SC[1]	14.0 to 24.0 fl oz/A	penthiopyrad	3	12	L
7 + 11	Merivon 2.09SC[1,2]	4.0 to 11.0 fl oz/A	fluxapyroxad + pyraclostrobin	1	12	N
7 + 12	Miravis Prime[1]	9.2 to 13.4 fl oz/A	pydiflumetofen + fludioxonil	0	12	--
Rotate one of the above FRAC code 3 or 7 fungicides with a FRAC code 11 fungicide where resistance is not present:						
11	azoxystrobin 2.08F[1,2]	6.0 to 15.5 fl oz/A	azoxystrobin	0	4	N
11	Cabrio 20EG[1,2]	12.0 to 16.0 oz/A	pyraclostrobin	0	12	N

(*) See labels for specific crop use. [1] Tank-mixing the above with a fixed copper may also help suppress bacterial infections. [2] Poor control has been noted in areas of southern NJ where FRAC code 11 fungicides have been used extensively to control Septoria leaf spot.

Parsnips

Recommended Varieties

Check with your seed supplier or other growers for recommendations on locally adapted varieties. Any new variety should be tested on a small scale before planting in a large area.

Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and Chapter B Soil and Nutrient Management. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede the recommendations found below.

Parsnips[1,2]		Soil Phosphorus Level				Soil Potassium Level				
		Low	Med	High (Opt)	Very High	Low	Med	High (Opt)	Very High	
	N (lb/A)	P_2O_5 (lb/A)				K_2O (lb/A)				Nutrient Timing and Method
	50-75	150	100	50	0	150	100	50	0	Total nutrient recommended
	25-50	150	100	50	0	150	100	50	0	Broadcast and disk-in
	25-50	0	0	0	0	0	0	0	0	Sidedress 4-5 weeks after planting

[1]Apply 1-2 lb/A of boron (B) with broadcast fertilizer; see also Table B-7. in Chapter B Soil and Nutrient Management.
[2]Apply 20-30 lb/A of sulfur (S) for most soils.

Seeding and Spacing

Seeds germinate slowly. Large growers should purchase primed seed for more even germination. Never use seed that is more than 1 yr. old. In March and April, seed 3-5 lb/A at a depth of 1/4 to 3/8 inch in rows 18-30 inches apart. Adjust the seeder to give 8-10 plants/ft of row. Thin seedlings to 2-4 inches in the row.

Harvest and Post-Harvest Considerations

Parsnips may be dug, topped, and stored at 32°F (0°C). Storage relative humidity must be kept high (90-95%) to prevent wilting; ventilated plastic crate liners help to prevent moisture loss. Parsnips can be stored for up to 6 months. Good market quality is the result of starch changing to sugar which occurs after 2-3 weeks in storage below 35°F (2°C); leaving parsnips in the ground over winter or freezing them is not necessary. If parsnips are left in the ground over winter, remove them before growth starts in the spring.

Weed Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.

Recommended Herbicides

1. Identify the weeds in each field and select recommended herbicides. More information is available in the "Herbicide Effectiveness on Common Weeds in Vegetables" (Table E-3) in Chapter E Pest Management.
2. Minimize herbicide resistance development. Identify the herbicide mode of action group number and follow recommended good management practices; **bolded group numbers in tables below are herbicides at higher risk for selecting resistant weed populations.** Include non-chemical weed control whenever possible.

1. Soil-Applied (Preemergence)						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient**	**Active Ingredient Rate**	**PHI (d)**	**REI (h)**
7	Lorox 50DF Linex 4L	1.5 to 3 lb/A 1.5 to 3 pt/A	**linuron**	0.75 to 1.5 lb/A	--	24
-Apply right after seeding, but before crop emergence. Plant seeds at least 0.5 inch deep. -Primarily controls broadleaf weeds and is weak on grasses. -Use lower rates on coarse-textured soil low in organic matter and higher rates on medium- or fine-textured soils with greater organic matter. -Maximum for Lorox and Linex is one application per season.						

2. Postemergence						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient**	**Active Ingredient Rate**	**PHI (d)**	**REI (h)**
1	Shadow 3EC Select 2EC Select Max 0.97EC	4 to 5.33 fl oz/A 6 to 8 fl oz/A 9 to 16 fl oz/A	**clethodim**	0.07 to 0.125 lb/A	30	24
	Poast 1.5EC	1 to 2.5 pt/A	**sethoxydim**	0.2 to 0.5 lb/A	14	12

-Postemergence as broadcast spray with both plasticulture and bareground
-**Select 2EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution).
-**Select Max**: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution).
-**Shadow 3EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution) for large or stressed grasses; use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution) when crop safety is a concern.
-**Poast**: use COC at 1.0% v/v.
-**The use of COC may increase the risk of crop injury when hot or humid conditions prevail**. To reduce the risk of crop injury, omit additives or switch to NIS when grasses are small and soil moisture is adequate.
-Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control, yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will **not** be controlled. -Controls many annual and certain perennial grasses, including annual bluegrass, but Poast is preferred for goosegrass control. For best results, treat annual grasses when they are actively growing and before tillers are present. Control may be reduced if grasses are large or under hot or dry weather conditions. -Repeated applications may be necessary to control certain perennial **grasses**. If repeat applications are necessary, allow 14 days between applications.
-Rainfastness is 1 h.
-**Do not** tank mix with or apply within 2 to 3 days of any other pesticide, unless labeled, as this may increase the risk of crop injury or reduce the control of grasses.
-**Do not** apply more than 8 fl oz/A of Select 2EC in a single application and **do not** exceed 32 fl oz/A for the season; **do not** apply more than 16 fl oz/A of Select Max in a single application and **do not** exceed 64 fl oz/A for the season.
-**Do not** apply more than 5.33 fl oz/A of Shadow 3EC in a single application and **do not** exceed 21.33 fl oz/A for the season.
-**Do not** apply more than 2.5 pt/A Poast in a single application and **do not** exceed 2.5 pt/A for the season.

3. Other Labeled Herbicides These products are labeled but limited local data are available; and/or are labeled but not recommended in our region due to potential crop injury concerns.		
Group	**Product Name (*=Restricted Use)**	**Active Ingredient**
14	Aim	**carfentrazone**

Insect Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F. Recommended Insecticides

Aphids

Aphids are small soft bodied insects, usually green or yellow. They are found on the underside of leaves and/or on stems. If aphid infestation is heavy, it may cause yellowing or distorted leaves, necrotic spots on leaves and stunted shoots. Aphids secrete a sticky, sugary substance called honeydew which encourages the growth of sooty mold. Plants generally tolerate low to medium levels of infestations.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1B	Malathion 57 EC	1.5 pt/A	malathion	7	24	H
4A	Admire Pro	4.4 to 10.5 fl oz/A	imidacloprid – **soil**	21	12	H
4A	Admire Pro	1.2 fl oz/A	imidacloprid – **foliar**	7	12	H
4A	Actara 25WDG	1.5 to 3.0 oz/A	thiamethoxam	7	12	H
4A	Platinum 75SG	1.7 to 4.0 oz/A	thiamethoxam	7	12	H
4C	Transform WG	0.75 to 1.5 oz/A	sulfoxaflor	7	24	H
4D	Sivanto Prime or 200SL	7.0 to 14.0 fl oz/A	flupyradifurone	7	4	M
28	Exirel	13.5 to 20.5 fl oz/A	cyantraniliprole	1	12	H
28 + 3A	Elevest*	7.7 to 9.6 fl oz/A	chlorantraniliprole + bifenthrin	21	12	H
29	Beleaf 50SG	2.0 to 2.8 oz/A	flonicamid	3	12	L
UN	Azatin O, Aza-Direct, Ecozin, Neemix (OMRI)	Refer to individual labels for rates	azadirachtin	0	4	L

Leafhoppers

Leafhoppers suck sap and plant juices, causing small white spots (stippling) on the upper leaf surface, usually beginning near the midrib. Stippled areas can coalesce into larger whitish blotches on mature leaves. Prolonged feeding causes a drying and yellowing (or browning) of leaf margins, and possibly the whole leaf. In our area leafhoppers only occasionally require treatment. Some leafhopper species cause curling or stunting of terminal leaves and can transmit Aster Yellows, which cause a yellowing of leaves while the veins remain green. Aster Yellows also slows down growth and leaves may be smaller and narrower. The spread of Aster Yellows is worse in a cool, wet summer. Row covers can be used to eliminate leafhoppers. Control weeds such as plantain and dandelion.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Sevin XLR Plus	0.5 to 1.0 qt/A	carbaryl	7	12	H
3A	Fastac CS*	1.8 to 3.8 fl oz/A	alpha cypermethrin	1	12	H
3A	Brigade 2EC*, others	5.12 to 6.4 fl oz/A	bifenthrin	21	12	H
3A	Hero*	4.0 to 10.3 fl oz/A	bifenthrin + zeta cypermethrin	21	12	H
3A	Mustang Maxx*	1.76 to 4.0 fl oz/A	zeta cypermethrin	1	12	H
3A	Delta Gold*	1.5 to 2.4 fl oz/A	deltamethrin	3	12	H
4A	Admire Pro	4.4 to 10.5 fl oz/A	imidacloprid - **soil**	21	12	H
4A	Admire Pro	1.2 to 4.0 fl oz/A	imidacloprid - **foliar**	7	12	H
4A	Actara 25WDG	1.5 to 3.0 oz/A	thiamethoxam	7	12	H
4A	Platinum 75SG	1.7 to 4.0 oz/A	thiamethoxam	7	12	H
4C	Transform WG	1.5 to 2.75 oz/A	sulfoxaflor	7	12	H
4D	Sivanto Prime	7.0 to 14.0 fl oz/A	flupyradifurone - **foliar**	7	4	M

Whiteflies

While whiteflies are not very common pests on parsnips, they can occasionally build their populations up and need treatment. Whiteflies use their piercing, sucking mouthparts to suck sap from phloem tissues in plant stems and leaves. Large populations can cause leaves to turn yellow and die. Whiteflies excrete honeydew, so leaves may be sticky or covered with black sooty mold that grows on the honeydew.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
4A	Admire Pro	4.4 to 10.5 fl oz/A	imidacloprid - **soil**	21	12	H
4A	Admire Pro	1.2 fl oz/A	imidacloprid - **foliar**	7	12	H
4A	Actara 25WDG	3.0 to 4.0 oz/A	thiamethoxam	7	12	H
4A	Platinum 75SG	1.7 to 4.0 oz/A	thiamethoxam	7	12	H
4D	Sivanto Prime or 200SL	10.5 to 14.0 fl oz/A	flupyradifurone	7	4	M
4C	Transform WG	0.75 to 1.5 oz/A	sulfoxaflor	7	24	H
7C	Knack	8.0 to 10.0 fl oz/A	pyriproxyfen	7	12	L
29	Beleaf 50SG	2.8 oz/A	flonicamid	3	12	L

Disease Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F. Recommended Fungicides

Damping-off caused by *Phytophthora* and *Pythium*

Code	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
Apply the following preplant incorporated or as a soil-surface spray after planting:						
4	Ridomil Gold 4SL	1.0 to 2.0 pt/A	mefenoxam	0	48	N
4	Ultra Flourish 2E	2.0 to 4.0 pt/A	mefenoxam	AP	48	N

Leaf Spots (*Alternaria* and *Cercospora*), Rhizoctonia Stem Canker, and Powdery Mildew

Rotate fields to allow at least 2 yr between parsnip plantings. Always plant in well-drained soils with a pH of 7.0. Ridge soil over shoulders to prevent pathogen infection. Begin sprays at the first sign of disease and repeat no more than 3 times at 10-day intervals. **Do not** make more than one consecutive application of a FRAC code 11 fungicide.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Rotate, or tank-mix the following						
M05	chlorothalonil 6F	1.5 to 2.0 pt/A	chlorothalonil	10	12	N
WITH ONE of the following FRAC code 11 fungicides:						
7 + 9	Luna Tranquility 4.16SC	8.0 to 11.2 fl oz/A	fluopyram + pyrimethanil	7	12	--
7 + 11	Luna Sensation 4.25SC	5.0 to 5.8 fl oz/A	fluopyram + trifloxystrobin	7	12	--
7 + 11	Merivon 2.09SC	4.4 to 5.5 fl oz/A[1]	fluxapyroxad + pyraclostrobin	7	12	N
7 + 11	Pristine 38WG	8.0 to 10.5 oz/A	boscalid + pyraclostrobin	0	12	--
11	azoxystrobin 2.08F	9.0 to 15.5 fl oz/A	azoxystrobin	0	12	N
11	Cabrio 20EG	8.0 to 12.0 oz/A	pyraclostrobin	0	12	N
11	Flint Extra 500SC	2.0 to 2.9 fl oz/A	trifloxystrobin (**Do not apply near Concord grapes**, see label)	7	12	N

[1]Use highest rate for Cercospora Leaf Spot

Peas (Succulent)

Recommended Varieties

	Season	Variety[1]	Heat Units	Leaf Type	Reported Disease Reaction[2]
Processing Peas[1]	**First Early**	Jumpstart	1110	Normal	F1
		Strike	1140	Normal	F1
	Early	June	1160	Normal	F1
		Icepack	1170	afila	F1
	Midseason	Dakota	1190	normal	F1, PM
		Topps	1260	normal	F1
		Marias	1290	normal	F1
		Ambler (CS 455 AF)	1300	afila	F1
		Portage	1325	afila	F1
		M-14	1330	normal	F1
		GV 490	1380	normal	PM
		SV0935QF	1390	afila	F1, F2, PM, DM
	Late	Ashton	1480	normal	F1, DM(I)
		Bolero	1480	normal	F1
		Jerome (BSC 712)	1520	afila	
		Hacienda	1520	afila	F1, F2, PM
		SV7688QF	1520	afila	F1, F2, PM
		PLS 196	1550	afila	DM(I)
		Dancer	1580	afila	F1, PM, DM(I)
		Grundy	1595	normal	F1
		Quad	1600	normal	F1, PM
		SV6844QG	1600	afila	F1, F2, PM, DM(I)

[1]**Listed in Heat Units order within season.** Use varieties recommended by processors.
Consult the University of Delaware Extension website for results from recent processing peas variety trials
(*http://extension.udel.edu/ag/vegetable-fruit-resources/vegetable-small-fruits-program/variety-trial-results/*).
[2]Information provided by source seed companies. F1=Resistant to Fusarium Wilt race 1, F2=Resistant to Fusarium Wilt race 2, DM= resistance to Downy Mildew; PM=Resistant to Powdery Mildew, (I) indicates intermediate resistance or tolerance.

	Use	Variety[1]	Days	Height (Inch)[2]	Reported Disease Reaction[3]
Fresh Market Peas[1]	**Shelled**	Bolero	68	30	F1
		Green Arrow	70	30	PM
		Jumpstart	56	22	F1
		Knight	61	19	F, PM
		Lincoln	67	30	F
		Mr. Big	60	30	F1, PM
		PLS 595	72	30	F1, PM(I)
		Progress #9	62	16	
		Strike	49	24	F
		SV0935QF	64	20	F1, F2, PM, DM
	Snow	Avalanche	56	26	F1
		Dwarf Gray Sugar	74	28	
		Frieda Worlds	75	72	
		Green Beauty	60	72	
		Oregon Sugar Pod II	60	28	F1, PM
	Snap	Sugar Ann	55	26	
		Sugar Sprint	55	26	PM
		Super Sugar Snap	58	60	F1, PM

[1]**Listed alphabetically within use**.
[2]Peas that are taller than 24 inches may require trellising.
[3]Information provided by source seed companies: F=general Fusarium Wilt resistant, F1=Resistant to Fusarium Wilt race 1, PM=Powdery Mildew resistant.

Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and Chapter B Soil and Nutrient Management. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede the recommendations found below.

Peas[1]		Soil Phosphorus Level				Soil Potassium Level				
		Low	Med	High (Opt)	Very High	Low	Med	High (Opt)	Very High	
	N (lb/A)	P_2O_5 (lb/A)				K_2O (lb/A)				Nutrient Timing and Method
	40-80	120	80	40	0[2]	120	80	40	0[2]	Total nutrient recommended
	40-80	120	80	40	0[2]	120	80	40	0[2]	Broadcast and disk-in

[1]Apply 20-30 lb/A of sulfur (S) for most soils. [2]In VA, crop replacement values of 20 lb/A of P_2O_5 and 20 lb/A of K_2O are recommended on soils testing Very High.

Seed Treatment

Use seed already treated with an approved treatment or treat seed with a slurry or dust that contains an approved commercial fungicide-insecticide mixture. See the Disease Control section below.

Seeding and Spacing

Peas thrive in cool weather and can tolerate light frost. Planting for processing is based on the heat unit theory. Plant peas between February 25 and April 30 when soil conditions are favorable. For processing peas, drill 250-275 lb/A of seed in rows 6-8 inches apart. For fresh market peas, seed 80-120 lb/A (25 seeds per ft in a band) in 30-36 inch rows. Sow at a depth of no more than 1 inch unless soil is dry. Use press wheel drill or seeder to fix seeds into soil. There is the potential for mid to late summer plantings for fall harvest where local markets exist. Fall plantings usually yield less than spring plantings.

Harvest and Post-Harvest Considerations

Processing peas are mature from May 20 through July 5. Pick shelling types while they are firm, but still succulent. Harvest snow peas before seed swelling becomes too pronounced. Crisp fleshy snap types should be picked when they are round and firm, but still succulent. Peas in pod, shelled peas, and edible pod peas lose part of their sugar content, on which much of their flavor depends, unless they are cooled to near 32°F (0°C) immediately after harvest and maintained at 32°F and 90-95% relative humidity. Forced air cooling is preferred since it does not result in surface moisture formation and minimizes the risk of decay. After precooling, the peas should be packed with crushed ice (top ice) to maintain freshness and turgidity. Top ice provides the desired high humidity to prevent wilting. Temperatures should not exceed 34°F (1°C) when any moisture is present on the surface of the peas or rapid decay and deterioration will occur. Edible pod peas, peas in pod, and shelled peas are only salable for 1-2 weeks even at 32°F unless packed in crushed ice. With top ice, the storage period may be extended by a week.

Pea Shoots

Peas, preferably snap and snow pea varieties, may also be grown for shoots for local markets. Follow the instructions for planting and spacing described above. When plants are 8-12 inches tall, clip off the growing points plus one pair of leaves to encourage branching. These clippings can be used as a first harvest. Keep clipping the top 2-6 inches of each plant after regrowth, every 3-4 weeks. Harvested shoots should include the top pair of small leaves, delicate tendrils and a few larger leaves and blossoms or immature buds. Select undamaged, fresh, crisp and bright green shoots. Harvest a planting until shoots begin to taste bitter. Pea shoots for fall harvest are planted mid to late summer and harvested until a hard freeze. Shoots may also be grown in high tunnels throughout the fall, winter, and early spring. Pea shoots have a short storage life and should be marketed within 2 days after harvest. Rapidly precool shoots to 32°F, and store at 32-34°F (0-1°C) and 98-100% relative humidity. Freezing will damage leaf tissues, so maintain storage temperatures above 28°F (-2°C).

Weed Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.

Recommended Herbicides

1. Identify the weeds in each field and select recommended herbicides. More information is available in the "Herbicide Effectiveness on Common Weeds in Vegetables" (Table E-3) in Chapter E Pest Management.

2. Minimize herbicide resistance development. Identify the herbicide mode of action group number and follow recommended good management practices; **bolded group numbers in tables below are herbicides at higher risk for selecting resistant weed populations.** Include non-chemical weed control whenever possible.

1. Non-Selective or Burndown

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
9	Roundup PowerMax 4.5L “Generic” glyphosate 3L	16 to 32 fl oz/A 24 to 48 fl oz/A	**glyphosate**	0.75 to 1.13 lb acid equivalent/A	--	4
-Apply preplant or preemergence. Some glyphosate formulations may require an adjuvant, refer to label. -Tank mix with appropriate herbicides for residual weed control. Glyphosate controls many perennial weeds as well as annuals if applied when the weed is actively growing and has reached the stage of growth listed on the label. Repeat applications are allowed, with maximum application of 5.3 qt/A per year.						
22	Gramoxone SL 2.0* Gramoxone SL 3.0*	2.5 to 4 pt/A 1.7 to 2.7 pt/A	**paraquat**	0.6 to 1 lb/A	--	24
-Apply preplant or preemergence. Always include an adjuvant (nonionic surfactant or crop oil concentrate). Tank mix with appropriate herbicides for residual weed control. Paraquat may not control established grasses. Spray coverage is essential for optimum control. -Rainfastness 30 min. A maximum of 3 applications per year are allowed. -***Restricted-use pesticide***. Only certified applicators, who successfully complete the paraquat-specific training, can mix, load, or apply paraquat. Application of paraquat “under the direct supervision” of a certified applicator is no longer allowed. Required training link (*https://campus.extension.org/enrol/index.php?id=2201*); certified applicators must repeat training every three years.						

2. Soil-Applied (Preplant Incorporated or Preemergence)

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
2	Pursuit 2L	1.5 to 2 fl oz/A	**imazethapyr**	0.024 to 0.032 lb/A	--	4
-Shallow, thorough incorporation improves consistency of performance when dry weather follows application. -Primarily controls broadleaf weeds. Use in combination with another herbicide to control annual grasses. -In DE, MD, and VA **do not** apply more than 2 fl oz/A to sand or loamy sand soils; other states in the region can use up to 3 fl oz/A. -Pursuit residues persist in the soil after harvest and may affect following crops (check the label). -Maximum number of applications per year: 1.						
13	Command 3ME	1.3 pt/A	**clomazone**	0.5 lb/A	--	12
-Apply to control annual grasses and many broadleaf weeds including common lambsquarters, velvetleaf, spurred anoda, and jimsonweed. Mustards, morningglory species, and pigweed species will **not** be controlled. -Some temporary injury, seen as a partial whitening of leaf and/or stem of the crop, may be observed after seedling emergence. Complete recovery from early injury will occur without affecting yield or delaying maturity. -Rates of 4 to 8 fl oz/A are often used to reduce the risk of injury. -**WARNING**: Command spray or vapor drift may injure sensitive crops and other vegetation up to several hundred yards from the point of application. **Do not** apply adjacent to sensitive crops (see label) or vegetation, or under unfavorable wind or weather conditions. -Herbicide residues may limit subsequent cropping options when Command is used for weed control in peas. See planting restrictions on the label. -Maximum number of applications per season: 1.						
15	Dual Magnum 7.62E	0.5 to 1 pt/A	**s-metolachlor**	0.48 to 0.96 lb/A	60	24
-Primarily controls annual grasses, suppresses yellow nutsedge, and suppresses or controls certain annual broadleaf weeds including pigweed and nightshade species. Common lambsquarters and common ragweed will **not** be controlled. -Recommended rates may be lower than the labeled rate to reduce the risk of crop injury. The use of less than 1 pt/A of Dual Magnum may reduce the duration or level of control of some weeds. Cold wet weather after application increases the risk of crop injury, which may delay maturity. Use the minimum recommended rate or choose another herbicide when cold wet weather is anticipated. -Other generic versions of metolachlor and s-metolachlor may be available and may or may not be labeled for use in the crop. -Maximum number of applications per season: 1.						

3. Postemergence

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
1	Shadow 3EC Select 2EC Select Max 0.97EC	4 to 5.33 fl oz/A 6 to 8 fl oz/A 9 to 16 fl oz/A	**clethodim**	0.07 to 0.125 lb/A	21	12
	Assure II/Targa 0.88EC	6 to 12 fl oz/A	**quizalofop-P-ethyl**	0.04 to 0.08 lb/A	15	12
	Poast 1.5EC	1 to 2.5 pt/A	**sethoxydim**	0.2 to 0.4 lb/A	15	12
-**Select 2EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). **Select Max**: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution). **Shadow 3EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution)						

3. Postemergence Shadow, Select, Select Max, Assure, Targa, Poast - continued next page

3. Postemergence Shadow, Select, Select Max, Assure, Targa, Poast - continued

for large or stressed grasses, use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution) when crop safety is a concern. **Assure II/Targa**: use COC at 1% v/v. **Poast**: use COC at 1% v/v. -The use of COC may increase the risk of crop injury under hot or humid conditions. To reduce this risk, omit additives or switch to NIS when grasses are small and soil moisture is adequate. The addition of nitrogen is not recommended. -Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control. -Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will **not** be controlled. Controls many annual and certain perennial grasses, including annual bluegrass, but Poast is preferred for goosegrass control. For best results, treat annual grasses when they are actively growing and before tillers are present. Control may be reduced if grasses are large or under hot or dry weather conditions. -Repeated applications may be necessary to control certain perennial grasses. If repeat applications are necessary, allow 14 days between applications. -**Do not apply during bloom stage of the peas.** -Rainfastness is 1 h. -**Do not** tank mix with or apply within 2 to 3 days of any other pesticide, unless labeled, as this may increase the risk of crop injury or reduce the control of grasses. -**Do not** apply more than 8 fl oz/A of Select 2EC in a single application and **do not** exceed 2 pt/A for the season; **do not** apply more than 16 fl oz/A of Select Max in a single application and **do not** exceed 4 pt/A for the season. -**Do not** apply more than 5.33 fl oz/A of Shadow 3EC in a single application and **do not** make more than one application per season. -**Do not** exceed more than 14 fl oz/A Assure/Targa for the season. -**Do not** apply more than 2.5 pt/A Poast in a single application and **do not** exceed 4 pt/A for the season. -**Do not** exceed more than 14 fl oz/A Assure II/Targa for the season.						
2	Pursuit 2L	1.5 to 3 fl oz/A	**imazethapyr**	0.024 to 0.048 lb/A	--	4
-Apply early postemergence to control annual broadleaf weeds and some grasses when the crop is at least 3-inches tall (after 1-true leaf stage) but before 5 nodes before flowering. Add nonionic surfactant to be 0.25% of the spray solution (1 qt/100 gal of spray). -Pursuit can delay maturity if growing conditions are less than favorable at time of application. -Rainfastness is 1 h. -**Do not** apply more than 1 application per growing season.						
2	Raptor 1L Beyond Xtra 1L	3 fl oz/A	**imazamox**	0.023 lb/A	--	4
-Apply to control annual broadleaf weeds and some grasses when the crop is at least 3-inches tall but before 5 nodes before flowering. -Add nonionic surfactant to be 0.25% of the spray solution (1 qt/100 gal of spray); **do not** use nitrogen fertilizer in spray solution. -In DE and MD, Basagran must always be added to the spray mixture to reduce crop injury; mix 6 to 16 fl oz/A of bentazon (Basagran) to reduce the expression of injury symptoms or use. -**Varisto 4.18L** which is a prepackaged mixture of Raptor plus Basagran; 21 fl oz/A of Varisto = 4 fl oz/A of Raptor and 21 fl oz/A of Basagran 4L -The use of trifluralin (*e.g.*, Treflan) before Raptor application may increase the possibility and severity of crop injury. -Use Raptor only if good agronomic practices have been used to establish and maintain the crop. -Rainfastness is 1 h. -**Do not** apply more than 3 fl oz/A per year and more than 1 application per growing season.						
4	Thistrol 2L	2 to 6 pt/A	**MCPB**	0.5 to 1.5 lb/A	--	24
-Apply postemergence to control certain annual broadleaf weeds (*e.g.*, lambsquarters, pigweed, smartweed, morningglory) and Canada thistle when the crop is from shoot emergence to 3-leaf nodes before flowering. Typical application is from 6 to 12 nodes. -Tank mix with Basagran to broaden weed control spectrum. See label for additional guidelines. -**Do not** spray peas under moisture stress and when air temperatures exceed 90F. Temporary twisting may occur on some pea varieties.						
6	Basagran 4L Basagran 5L	1 to 2 pt/A 0.8 to 1.6 pt/A	**bentazon**	0.5 to 1 lb/A	30	12
-Apply after peas have more than 3 pairs of leaves. -**Do not** add oil concentrate. Ground application in a minimum of 20 gal/A is preferred. For broadleaf weed control only. See label for weed size for effective control. Rainfastness is 4 h.						

4. Postharvest

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
22	Gramoxone SL 2.0* Gramoxone SL 3.0*	2.5 pt/A 1.7 pt/A	**paraquat**	0.6 lb/A	--	24
-**Supplemental Label in DE for the use of both Gramoxone formulations for postharvest application to desiccate the crop.** -Apply after the last harvest. Always include an adjuvant. Spray coverage is essential for optimum effectiveness. See the label for additional information and warnings. -Rainfastness 30 min. A maximum of 2 applications for crop desiccation are allowed. -***Restricted-use pesticide***. Only certified applicators, who successfully complete the paraquat-specific training, can mix, load, or apply paraquat. Application of paraquat "under the direct supervision" of a certified applicator is no longer allowed. Required training link (*https://campus.extension.org/enrol/index.php?id=2201*); certified applicators must repeat training every three years.						

5. Other Labeled Herbicides These products are labeled but limited local data are available; and/or are labeled but not recommended in our region due to potential crop injury concerns.		
Group	**Product Name (*=Restricted Use)**	**Active Ingredient**
3	Prowl 3.3 EC / Prowl H2O	**pendimethalin**
3	Treflan	**trifluralin**
7	Lorox	**linuron**
14	Aim	**carfentrazone**
14	Sharpen	**saflufenacil**
14	Sulfentrazone	**sulfentrazone**

Insect Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.

Recommended Insecticides

Soil Pests

Seed Maggots

Seedcorn maggot is active about one to two weeks earlier than onion or cabbage maggot. Overwintered fly peak fly activity can be predicted with a degree day model using a base temperature of 39°F and peak emergence around 360GDD. First generation peak activity is harder to predict. Look for maggots and feeding tunnels inside seeds or stems to help distinguish seed maggot damage from that of wireworm feeding or damping off. In fields with a history of seed maggots, wait until soil conditions favor crop emergence and growth to help seeds and seedlings avoid or quickly recover from injury. When possible, incorporate cover crops, manure, or compost no less than 3 weeks before seeding. Rescue treatments are not effective. If there is enough damage to warrant replanting, wait until larvae are pupating so they will not damage new seeds.
Commercially applied seed treatments only: thiamethoxam (Cruiser 5FS).

Above-ground Pests

Armyworms and Other "Worm" or Caterpillar Pests

Armyworms often feed in groups on leaves and also attack pods. An action threshold of 30 larvae per 3 ft of row or about 20% defoliation is often used pre-pod. The late season worm complex may include other worm species. **Note that some localized corn earworm, fall armyworm, and soybean looper populations have developed resistance to pyrethroids (Group 3A), and that these insecticides should be used with caution and rotated to other insecticide classes within a season.**

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	.75 to 3 pt/A	methomyl	see label	48	H
3A	Asana XL*	2.9 to 9.6 fl oz/A	esfenvalerate	3	12	H
3A	Baythroid XL*	1.6 to 2.1 fl oz/A	beta-cyfluthrin	3	12	H
3A	Brigade 2EC*, others	2.1 to 6.4 fl oz/A	bifenthrin	3	12	H
3A	Declare*	1.02 to 1.54 fl oz/A	gamma-cyhalothrin	7	24	H
3A	Hero*	4.0 to 10.3 fl oz/A	zeta-cypermethrin + bifenthrin	3	12	H
3A	Lambda-Cy 1EC*, others	1.92 to 3.84 fl oz/A	lambda-cyhalothrin	7	24	H
3A	Mustang Maxx*	1.28 to 4.0 fl oz/A	zeta-cypermethrin	1	12	H
3A+4A	Brigadier*	5.6 fl oz/A	bifenthrin + imidacloprid - **foliar**	7	12	H
3A+28	Besiege*	5.0 to 10.0 fl oz/A	lambda-cyhalothrin + chlorantraniliprole	7	24	H
3A+28	Elevest*	5.6 to 9.6 fl oz/A	bifenthrin + chlorantraniliprole	3	12	H
5	Blackhawk 36WG	1.7 to 3.3 oz/A	spinosad	3	4	M
5	Radiant SC	3.0 to 8.0 fl oz/A	spinetoram	3	4	M
18	Intrepid 2F	4.0 to 16.0 fl oz/A	methoxyfenozide	7	4	L
28	Coragen 1.67SC Coragen eVo	5.0 to 7.5 fl oz/A 1.7 to 2.5 fl oz/A	chlorantraniliprole - **at planting**	1	4	L
28	Coragen 1.67SC Coragen eVo	3.5 to 7.5 fl oz/A 1.2 to 2.5 fl oz/A	chlorantraniliprole - **foliar**	1	4	L

Armyworms and Other "Worm" or Caterpillar Pests - continued next page

Armyworms and Other "Worm" or Caterpillar Pests continued

28	Exirel	10.0 to 20.5 fl oz/A	cyantraniliprole **(CEW/ECB only)**	1	12	H
28	Vantacor	1.7 to 2.5 fl oz/A	chlorantraniliprole - **soil**	1	4	L
28	Vantacor	1.2 to 2.5 fl oz/A	chlorantraniliprole - **foliar**	1	4	L
28	Verimark	6.75 to 13.5 fl oz	cyantraniliprole **(FAW only) - soil**	n/a	4	H

Cutworms

See also section E 3.1. Soil Pests - Detection and Control.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Sevin XLR Plus	1.0 to 1.5 qt/A	carbaryl	3	12	H
1B	Diazinon AG500*[1]	2.0 to 4.0 qt/A	diazinon	45	72	H
3A	Asana XL*	5.8 to 9.6 fl oz/A	esfenvalerate	3	12	H
3A	Baythroid XL*	0.8 to 1.6 fl oz/A	beta-cyfluthrin	3	12	H
3A	Brigade 2EC*, others	2.1 to 6.4 fl oz/A	bifenthrin	3	12	H
3A	Hero*	4.0 to 10.3 fl oz/A	zeta-cypermethrin + bifenthrin	3	12	H
3A	Lambda-Cy 1EC*, others	1.92 to 3.2 fl oz/A	lambda-cyhalothrin	7	24	H
3A	Mustang Maxx*	1.28 to 4.0 fl oz/A	zeta-cypermethrin	1	12	H
3A	Warrior II*	0.96 to 1.6 fl oz/A	lambda-cyhalothrin	7	24	H
3A+4A	Brigadier*	5.6 fl oz/A	bifenthrin + imidacloprid - **foliar**	7	12	H
3A+28	Besiege*	5.0 to 8.0 fl oz/A	lambda-cyhalothrin + chlorantraniliprole	7	24	H
3A+28	Elevest*	4.8 to 9.6 fl oz/A	bifenthrin + chlorantraniliprole	3	12	H

[1]Broadcast just before planting and immediately incorporate into soil

Pea Aphids

The pea aphid is light green with unusually long legs and cornicles. Treat when there are 5-10 aphids per plant or 50 or more aphids per sweep in a 15-inch sweep net.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	1.5 to 3.0 pt/A	methomyl	see label	48	H
1B	Dimethoate 400	0.32 pt/A	dimethoate	0[1]	48	H
3A	Asana XL*	5.8 fl oz to 9.6 fl oz/A	esfenvalerate	3	12	H
3A	Warrior II*	1.28 to 1.92 fl oz/A	lambda-cyhalothrin	7	24	H
3A+4A	Brigadier*	3.8 to 5.6 fl oz/A	bifenthrin + imidacloprid - **foliar**	7	12	H
4A	Admire Pro	7.0 to 10.5 fl oz/A	imidacloprid - **soil**	21	12	H
4A	Admire Pro	1.2 fl oz/A	imidacloprid - **foliar**	7	12	H
4A	Assail 30SG Assail 30SC	2.5 to 5.3 oz/A 2.1 to 4.5 fl oz/A	acetamiprid	7	12	M
4D	Sivanto Prime or 200SL	7.0 to 14.0 fl oz/A	flupyradifurone	7	4	M
7C+23	Senstar	8.0 to 10.0 fl oz/A	spirotetramat + pyriproxifen	7	24	L
23	Movento	4.0 to 5.0 fl oz/A	spirotetramat	1	24	L
23	Movento HL	2.0 to 2.5 fl oz/A	spirotetramat	1	24	L
29	Beleaf 50SG	2.8 oz/A	flonicamid	7	12	L

[1]Mechanical Harvest only

Stink Bugs

Note: Brown and brown marmorated stink bugs are less susceptible to pyrethroids than green and southern green stink bugs. Careful pyrethroid selection is advised, consult your local Cooperative Extension Service for recommendations for your area.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
3A	Warrior II*	1.28 to 1.92 fl oz/A	lambda-cyhalothrin	7	24	H
3A	Baythroid XL*	1.6 to 2.1 fl oz/A	beta-cyfluthrin	3	12	H
3A	Brigade 2EC*, others	2.1 to 6.4 fl oz/A	bifenthrin	3	12	H
3A	Hero*	4.0 to 10.3 fl oz/A	zeta-cypermethrin + bifenthrin	3	12	H

Stink Bugs - continued next page

Stink Bugs - continued

3A	Lambda-Cy 1EC*, others	2.56 to 3.84 fl oz/A	lambda-cyhalothrin	7	24	H
3A	Mustang Maxx*	3.2 to 4.0 fl oz/A	zeta-cypermethrin	1	12	H
3A	Warrior II*	0.96 to 1.6 fl oz/A	lambda-cyhalothrin	7	24	H
3A+28	Besiege*	6.0 to 10.0 fl oz/A	lambda-cyhalothrin + chlorantraniliprole	7	24	H
3A+28	Elevest*	5.6 to 9.6 fl oz/A	bifenthrin + chlorantraniliprole	3	12	H

Disease Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.
Recommended Fungicides

Seed Treatment

Use seed already treated with an approved seed treatment or treat seed with a slurry or dust that contains an approved commercial fungicide-insecticide mixture. Use seed treated with:

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
For Rhizoctonia and Fusarium Control:						
12	Maxim 4FS	0.08 to 0.16 fl oz/100 lb seed	fludioxonil	--	12	L
For Pythium Control:						
4	Apron XL	0.16 to 0.64 fl oz/100 lb seed	mefenoxam	--	48	N
4	Allegiance FL	0.75 fl oz/100 lb seed	metalaxyl	--	24	N

Damping-off caused *Pythium* and *Rhizoctonia*

Rotate and allow 4 to 5 years between plantings. Do not double crop with another legume of any type.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Apply one of the following according to the label:						
Pythium root rot only:						
4	Ridomil Gold 4SL	0.5 to 1.0 pt/A	mefenoxam	--	48	N
4	Ultra Flourish 2E	1.0 to 2.0 pt/A	mefenoxam	AP	48	N
4	MetaStar 2E AG	2.0 to 4.0 pt/A	metalaxyl	--	48	N
For Pythium and/or Rhizoctonia root rots:						
4 + 11	Uniform 3.66SE	0.34 fl oz/1000 ft of row in-furrow, see label	mefenoxam + azoxystrobin	AP	0	N
Rhizoctonia root rot only:						
11	azoxystrobin 2.08F	0.40 to 0.80 fl oz/1000 row ft	azoxystrobin	0	4	N

Bacterial and Fungal Diseases

Ascochyta Blight

Ascochyta Blight is favored by long periods of leaf wetness and heavy growth of vines that creates a moist environment under the pea vine canopy. Plant fungicide treated seed. Deeply incorporate crop debris immediately after harvest before the fungus can be dispersed by wind or rain. Scout on a regular basis; the disease can develop and spread rapidly. In fields with a history of Ascochyta Blight apply one of the following fungicides preventatively and rotate between fungicides every 7 days as long as conditions favor disease development.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
7	Endura 70W	8.0 to 11.0 oz/A	boscalid	7	12	--
7 + 11	Priaxor 4.17SC[1]	4.0 to 8.0 fl oz/A	fluxapyroxad + pyraclostrobin	7	12	N
11	azoxystrobin 2.08F	6.0 to 15.5 fl oz/A	azoxystrobin	0	4	N
11	Headline 2.09EC	6.0 to 9.0 fl oz/A	pyraclostrobin	7	12	N

[1]Also effective for Powdery Mildew.

Bacterial Blight

The pathogen can be seedborne so source high quality seed. Avoid walking or moving equipment through fields when vines are wet, as this will spread the disease. Copper-based fungicides may provide some suppression.

Downy Mildew (*Peronospora viciae*)

Management strategies include planting recommended resistant cultivars, crop rotations of 3 years or more, and effective seed treatments (*e.g.*, Allegiance FL or Apron XL) prior to seeding. Avoid planting in fields that had peas the previous year because the pathogen can overwinter on old debris. Downy Mildew development is favored by prolonged cool, wet weather conditions.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
7 + 11	Priaxor 4.17SC	4.0 to 8.0 fl oz/A	fluxapyroxad + pyraclostrobin	7	12	N

Fusarium Wilt

Use resistant cultivars if available. Plant as early as possible to minimize crop growth when soil temperatures are ideal for Fusarium Wilt development (68 to 72°F).

Powdery Mildew

Powdery Mildew is favored by warm, dry days and cool nights that lead to dew formation. Disease severity is usually highest in late summer. Fall plantings are most susceptible. If available plant resistant or less susceptible cultivars. At first appearance of symptoms, apply one of the following and rotate between different fungicides as long as conditions favor disease development.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
M02	sulfur (OMRI)[1]	3.0 to 10.0 lb/A	sulfur	--	24	N
7	Endura 70W	8.0 to 11.0 oz/A	boscalid	7	12	--
3 + 7	Aprovia Top 1.62EC	10.5 to 11.0 fl oz/A	difenoconazole + benzovindiflupyr	14	12	--
7 + 11	Priaxor 4.17SC[2]	4.0 to 8.0 fl oz/A	fluxapyroxad + pyraclostrobin	7	12	N

[1]Some sulfur-based products are OMRI listed for use in organic production systems.
[2]Also effective for Ascochyta Blight.

White Mold (*Sclerotinia*)/Gray Mold (*Botrytis*)

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Preplant. Apply 3 to 4 months prior to planting to reduce levels of sclerotia inoculum in the soil. Incorporate to a depth of 1-2 inches. Do not plow before seeding peas to avoid moving untreated sclerotia from lower to upper soil layers. See label for more detailed instructions.						
44	Contans 5.3WG (OMRI)[1]	1.0 to 4.0 lb/A	*Coniothyrium minitans*	0	4	N
At the beginning of flowering or prior to onset of disease apply:						
7	Endura 70W[2]	8.0 to 11.0 oz/A	boscalid	7	12	--
7	Fontelis 1.67SC	16.0 to 30.0 fl oz/A	penthiopyrad	0	12	L
7 + 11	Priaxor 4.17SC	6.0 to 8.0 fl oz/A (suppression only)	fluxapyroxad + pyraclostrobin	7	12	N

[1]Only effective for White Mold
[2]Apply at 7 to 10 d interval, maximum 2 applications per growing season.

Viruses

Use resistant varieties when possible and manage aphid populations.

Peppers

Recommended Varieties

Variety (all hybrids)[1]		Color[2]	Disease Resistance[3]							
			BLSR	CMV	PVY	PHY	TEV	TM	TMV	TSWV
Bell Type	Aristotle	G/R	1-3			T		R		
	Delirio	G/O							R	R
	Early Sunsation	G/Y	0-3, 7, 8							
	Flavorburst	G/Y								
	Intruder	G/R	1-3			T	R		R	
	Mercer	G/R	0-3, 7, 8			T			R	
	Nitro S-10	G/R	0-10			T			R	T
	Red Knight	G/R	1-3		R					
	Revolution	G/R	1-3, 5	T		T				
	Shogun S-10	G/R	0-10						R	T
	Turnpike	G/R	0-5, 7-9			T				
	1819	G/R	1-5			T				
	3964	G/R	0-4, 7-9							
	9325	G/R	0-10							
Cherry Type	Fireball (hot)	G/R								
Sweet Frying Type	Aruba	LG				T				
	Biscayne	LY								
	Carmen	G/R								
	Key West	LG/R	1-3							
Hot Type	Charger (Anaheim)	G/DR								I
	Compadre (Jalapeno)	G/R								
	El Jefe (Jalapeno)	G/R	0-3, 7, 8		R		T			
	Mesilla (Cayenne)	G/R			R		R		R	
	Mucho Nacho (Jalapeno)	G/R			T		T			
	Numex Joe E. Parker (Anaheim)	G/R								
	Rayo (Jalapeno, processing)	G/R	1-3							
Non-Hot Type	Felicity (Jalapeno)	G/R								
	Pace 105 (Jalapeno, processing)	G/R								
Banana Pepper	Doblon	Y/R							R	R
	Inferno (hot)	Y/R								
	Pagaent	Y/R	1-3							
	Sopron	Y/R	1-3							
	Sweet Savannah	Y/R								

[1]**Listed alphabetically within type**.
[2]G/O=Green to Orange, G/R=Green to Red, G/DR=Green to Dark Red, G/Y=Green to Yellow, LG=Light Green, LG/R=Light Green to Red, LY=Light Yellow, Y/R Yellow to Red.
[3]Information provided by seed companies, T=tolerant and R=resistant.
BLSR=Bacterial Leaf Spot Resistance (races listed), CMV=Cucumber Mosaic Virus, PHY=*Phytophthora capsici*, PVY=Potato Virus Y, TEV=Tobacco Etch Virus, TM=Tobamovirus, TMV=Tobacco Mosaic Virus, TSWV=Tomato Spotted Wilt Virus.

F. Peppers

Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and Chapter B Soil and Nutrient Management. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede the recommendations found below.

		Soil Phosphorus Level				Soil Potassium Level				
		Low	Med	High (Opt)	Very High	Low	Med	High (Opt)	Very High	
	N (lb/A)	P_2O_5 (lb/A)				K_2O (lb/A)				Nutrient Timing and Method
Peppers[1,2]	100-180[3]	200	150	100	0[4]	200	150	100	0[4]	Total nutrient recommended
	50	200	150	100	0[4]	200	150	100	0[4]	Broadcast and disk-in or follow fertigation schedule
	50	0	0	0	0	0	0	0	0	Sidedress after first fruit set or follow fertigation schedule
	25-30	0	0	0	0	0	0	0	0	Sidedress later in season if needed or follow fertigation schedule

[1]Apply 1 lb/A of boron (B) with broadcast fertilizer; see also Table B-7. in Chapter B Soil and Nutrient Management. [2]Apply 20-30 lb/A of sulfur (S) for most soils. [3]If crop is mulched with plastic but not drip/trickle fertilized, broadcast 150 lb/A of N with P and K fertilizer. [4]In VA, crop replacement values of 50 lb/A of P_2O_5 and 50 lb/A of K_2O are recommended on soils testing Very High.

Fertigation Schedule Examples

This table provides examples of fertigation schedules based on two common scenarios – sandy coastal plain soils and heavier upland soils. Modify according to specific soil tests and base fertility.

Fertigation recommendations for 75 lb N and 125 lb K_2O[1,2] For soils with organic matter content less than 2% or coarse texture and low to medium or deficient K								
			Nitrogen			**Potash**		
Preplant (lb/A)[3]			**50**			**100**		
			N	**N**	**N**	**K_2O**	**K_2O**	**K_2O**
Stage and Description	Weeks	Days	lb/day	lb/week	lb/stage	lb/day	lb/week	lb/stage
1 Early vegetative	1-2	1-14	0.5	3.5	7	0.5	3.5	7
2 Late vegetative	3-4	15-28	0.7	4.9	9.8	0.7	4.9	9.8
3 Early Flowering	5-6	29-42	1.0	7	14	1	7	14
4 Fruit Development	7-8	43-56	1.5	10.5	21	1.5	10.5	21
5 Harvest Period[4]	9-14	56-98	1.8	12.6	75.6	1.8	12.6	75.6
Fertigation recommendations for 75 lb N and 75 lb K20[1,2] For soils with organic matter content greater than 2% or fine texture and high or optimum K								
			Nitrogen			**Potash**		
Preplant (lb/A)[3]			**50**			**50**		
			N	**N**	**N**	**K_2O**	**K_2O**	**K_2O**
Stage and Description	Weeks	Days	lb/day	lb/week	lb/stage	lb/day	lb/week	lb/stage
1 Early vegetative	1-2	1-14	0.25	1.75	3.5	0.25	1.75	3.5
2 Late vegetative	3-4	15-28	0.35	2.45	4.9	0.35	2.45	4.9
3 Early Flowering	5-6	29-42	0.5	3.5	7	0.5	3.5	7
4 Fruit Development	7-8	43-56	0.75	5.25	10.5	0.75	5.25	10.5
5 Harvest Period[4]	9-14	56-98	1.25	7.7	46.2	1.1	7.7	46.2

[1]Based on 7,260 linear bed ft/A (6 ft bed spacing). If beds have a different width, adjust fertilizer rates. Drive rows should not be used in acreage calculations (see section C 3. Fertigation). [2]Base overall application rate on soil tests. [3]Applied under plastic mulch to effective bed area using modified broadcast method. [4]For extended harvest after 10 w continue fertigation at this rate.

Plant Tissue Testing

Plant tissue testing can be a valuable tool to assess crop nutrient status during the growing season to aid with in-season fertility programs or to evaluate potential deficiencies or toxicities. Critical bell pepper tissue test values for most recently matured leaves prior to fruit set: N 3-5 %, P 0.3-0.5 %, K 2.5-5 %, Ca 0.9-1.5%, Mg 0.3-0.5% and S 0.3-0.6 %. For additional nutrients and other growth stages consult with a tissue testing laboratory or this web link at the University of Florida: *https://edis.ifas.ufl.edu/publication/ep081*.

Seed Treatment

Check with your seed company if the seed is hot water-treated. Purchase hot water treated seed if possible or request hot water seed treatment - see also Disease Control below.

Transplant Production

Sow seeds in the greenhouse 6-8 weeks before field planting. Seven ounces of seed are necessary to produce 10,000 plants per acre. Optimum temperature for germination is 85°F. Seed in 72-200 cell trays, depending on desired earliness and greenhouse space. Larger cell sizes are easier to maintain and result in better transplants but are more expensive to produce.

Planting and Spacing

Pepper is a warm-season crop that grows best at temperatures between 70-75°F. Peppers are sensitive to temperature extremes. Poor fruit set and blossom drop can be expected when night temperatures drop below 60°F or day temperatures rise above 85°F. Transplant into the field May 1-30 for summer harvest. In Southern New Jersey, transplants can be set until July 1. In VA and warm areas, transplant July 25 to August 1 for fall harvest. Space rows 4-5 feet apart. Set plants 12-18 inches apart in single or double rows. Select fields with good drainage. Plant on raised beds to aid in disease management. To minimize sunscald when growing peppers on sandy soils and on plastic mulch without drip irrigation, plant varieties that have excellent fruit cover from foliage.

Drip/Trickle Fertilization

Before mulching, adjust soil pH to approximately 6.5 and then apply enough fertilizer to supply 25-50% of total crop N and K_2O requirements and thoroughly incorporate into the soil. Apply all P_2O_5 preplant and incorporate into the soil. Apply the balance of N and K_2O through the drip irrigation system throughout the season. On soils testing low and low to medium in boron, also include 0.25 lb/A of actual boron in each soluble fertilizer application.

The first soluble fertilizer application should be applied through the trickle irrigation system within 1 week after field transplanting peppers. The same rate of soluble fertilizer should be applied about every 3 weeks during the growing season for a total of 6 applications through the trickle irrigation system. The soluble fertilizer may be delivered in 12 equally timed applications provided the soluble nutrients are applied at half the above suggested rates per application so that the total seasonal rates of N, P_2O_5, and K_2O and B are the same. The number of fertilizer applications can be reduced for late plantings and in areas where the growing season is short. These rates were developed on sandy loam soils with a cation exchange capacity (CEC) of 3--5. If your soil has a lower CEC, you may wish to increase the total seasonal soluble fertilizer nutrient rates by at least one-third. On very coarse, very low CEC soils, it may be profitable to increase the total seasonal soluble fertilizer nutrient rates by two-thirds over the first suggestion. On the heavier textured soils with higher CEC, you may wish to decrease the total seasonal soluble fertilizer nutrients by one-half. Review the tables above for suggested application rates and timing.

Mulching

The use of black plastic mulch with drip irrigation and double rows can greatly increase yields and percentage of large fruit. Use opaque, white plastic when planting in the summer for fall harvest. Plant double rows 12-15 inches apart with plants staggered 12-18 inches apart in each of the double rows. Use 5-ft wide plastic for double rows and 4-ft wide plastic for single row peppers. Do not use plastic mulch without trickle irrigation on coarse or sandy soils.

Staking

Staking peppers helps protect fruit from sunburn by holding the plants in an upright position. Use 2-2½ ft long by 1¼ x 1½-inch Honduran pine stakes (half-length tomato stakes). Drive stakes 6-8 inches into the soil every 4-5 ft in the plant row. Tie plants with polyethylene string that is used for staked tomatoes. Tie the first string 7-9 inches above the soil when plants are 10-12 inches tall or at first fruit set. For single row peppers, run the string on one side of the row, looping and tightening string around each stake for about 100 ft. Then run the string back on the opposite side of the plant row using the same procedure. Allow 3-4 ft untied breaks every 100 ft to make harvesting easier. For double rows of peppers, use one row of stakes in each row of peppers. Tie each row separately as described above for single row peppers.

A second tie should be made at 6 to 8 inches above the first string and before peppers enlarge and fall over the first string. Use the same procedure described above. An alternate method for applying the second string in single and double rows is to run a single string in the center of the plant canopy of each row, allowing the branches to grow up through the string and be caught and supported by the string.

Consider the cost of staking versus reduction in losses and increases in quality and price received. The higher price offered for red peppers increases the potential for profit when staking for the red compared to the green market.

Production under Protective Structures

Pepper plants can be classified by their growth habit as determine and indeterminate. The traditional open field pepper plants are determinate, decreasing their vegetative growth as flowering begins. Indeterminate cultivars are more common for production under greenhouses and high tunnels, as their vegetative growth does not slow down as the plant produces flowers and fruits. These systems allowed for a more specialized treatment of the plants, where stem and leaf pruning are common, usually leading to better fruit quality although overall production costs also tend to increase. Pepper plants produced under protective structures usually demand a high investment in labor, as many practices cannot be mechanized. Additionally, in some cases many plant disorders manifest earlier if the system is not professionally managed. Many insect and disease complexes tend to differ from the open field. More research is required to prepare a production management guide for peppers under protective structures in the Mid-Atlantic region.

Physiological Disorders

Blossom End Rot:

This physiological disorder is caused by reduced Calcium (Ca) uptake and movement into fruit at low soil moisture. To control blossom end rot, maintain proper soil Ca, nutrient balance, and uniform, favorable soil moisture. This is especially important when cropping in raised beds for Phytophthora control, because soil in raised beds will dry more quickly than in flat bed culture.

Skin separation or "silvering" of bell pepper fruit:

Skin separation or "silvering" in bell pepper fruit reduces aesthetic fruit quality. Research in NJ has shown that phytophthora-tolerant bell pepper cultivars (such as 'Paladin' and 'Aristotle') are more prone to the development of "silvering" than phytophthora-susceptible varieties.

Sunscald:

To reduce sunscald, select varieties with good foliage cover. Maintain vigorous vegetative growth by following the recommended fertilizer (especially N) program and timely irrigation. Harvest carefully to avoid damaging stems, branches, and foliage.

Stip:

In late summer and fall when temperatures drop into the 40's, pepper Stip disorder can be a problem in bell peppers causing them to be unmarketable. It is particularly a problem on peppers taken to ripe stage such as red bells but can also be an issue on green immature fruit. It causes gray, brown, black, or green spots that are slightly sunken and are ¼ inch or smaller in diameter. Pepper varieties vary considerably in their susceptibility to Stip. Reduce N fertilization in late plantings to reduce Stip and avoid Stip susceptible varieties for fall production.

Harvest and Post-Harvest Considerations

Harvest green fruit once they have reached full size and the walls are firm. Harvest every 7-14 days to achieve maximum yields. Harvest red, yellow, or orange peppers after they turn color. Colored pepper production requires 2-4 weeks of additional growing time. Increased attention to insects and diseases is required to produce mature, colored fruit. Harvest hot peppers after they reach full size and the walls are firm for green fruit, and after they have turned color for colored fruit.

Peppers are picked by hand using a upward snap and pull motion with part of the stem (peduncle) and fruit cap (calyx) adhering to the fruit; branches of the plant are usually brittle and can break easily if pulled too hard. Hot peppers generally detach from the plant much more easily than sweet peppers and plants are less brittle.

Keep harvested peppers out of direct sunlight to avoid water loss, sunscald, and heat damage. Peppers can be bruised when washed after harvest. If peppers are washed in a dump tank, wash water temperature should be up to 10°F warmer than the peppers. Cold water creates a partial vacuum that draws some water (and potentially bacteria) into the fruit, leading to premature breakdown. Chlorinated water or another labeled surface disinfectant should be used in the wash water. Only first-quality peppers should be packed. Peppers should be selected for uniform maturity, color, shape, and size and for freedom from defects. Any pepper showing signs of sunscald, mechanical or insect damage, or disease should be discarded. Most bell peppers are packed in 1⅑-bushel corrugated cartons that hold 28 to 30 pounds of peppers. Some are packed in 1¼-bushel cartons holding 35 pounds. Peppers can be cooled with room cooling, forced air cooling, forced air with evaporative cooling, or vacuum cooling.

Optimal conditions for storing peppers are 45-50°F with relative humidity of 85-95%. Chilling injury occurs at temperatures below 45°F, and damage may occur even below 50°F depending on variety and other factors. Bell peppers may be stored 2--3 weeks if handled properly. Dried hot peppers are stored at 32-38°F.

Weed Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.

Recommended Herbicides

1. Identify the weeds in each field and select recommended herbicides. More information is available in the "Herbicide Effectiveness on Common Weeds in Vegetables" (Table E-3) in Chapter E Pest Management.

2. Minimize herbicide resistance development. Identify the herbicide mode of action group number and follow recommended good management practices; **bolded group numbers in tables below are herbicides at higher risk for selecting resistant weed populations.** Include non-chemical weed control whenever possible.

Labeled Application Sites for Peppers

Herbicide (*=Restricted Use)	HRAC group number	Plastic mulch production					Bareground production		
		Soil-Applied		Postemergence					
		Under Plastic	Row Middles	Over Plastic	Row Middles	Post-Harvest	Soil-applied	POST	Post-harvest
League	2		YES		YES		directed[2]		
Sandea	2		YES		YES		directed[2]		
Prowl H2O	3		YES				YES[3]		
Treflan	3						YES[3]		
Prefar	8	YES	YES				YES		
Command	13	YES	YES				YES		
Dual[1]	15	YES	YES				YES[3]		
Devrinol	15	YES	YES				YES		
Select / Select Max Shadow 3EC	1			YES				YES	
Poast	1			YES				YES	
Gramoxone*[1]	22				YES	YES	YES[4]		YES
Rely 280	10				YES				

[1] Special Local Needs Label 24(c), be sure it is registered for the specific state and for the intended use.
[2] League and Sandea are labeled for bareground only if the spray is directed to the row middles.
[3] Transplants only.
[4] Gramoxone can be applied early preplant, or after planting but before crop emergence.

1. Pre-Transplant Over Plastic

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
10	Rely 280 2.34L	29 to 43 fl oz/A	**glufosinate**	0.53 to 0.79 lb/A	30	12
-Supplemental Label expires 12/1/2025 for application over plastic prior to transplanting. -Ammonium sulfate (AMS) can be used at 1.5 lb/A to 3 lb/A. -Control is best when applied to weeds less than 4 inches, temperatures are above 80, high humidity, and bright sunlight. -Transplants can be injured if they come in contact with herbicide remaining on the plastic. Allow at least 3 days between application and transplanting. At least 0.5 inches of precipitation is needed to wash Rely off the plastic. Do not transplant within 27 days of application if no precipitation occurs. -DO NOT transplant into or within 6 inches of holes in the plastic mulch that were present at time of application. -Two applications can be made prior to transplanting. -Do not apply more than 64 fl oz/A prior to transplanting; maximum number of applications is three per season. -Rainfastness is 4 h						
22	Gramoxone SL 2.0* Gramoxone SL 3.0*	2 to 4 pt/A 1.3 to 2.7 pt/A	**paraquat**	0.5 to 1.0 lb/A	30	24
-Gramoxone can be used for preplant weed control over the top of plastic mulch. Sufficient rainfall or sprinkler irrigation is needed to wash off the Gramoxone prior to planting to prevent damage to the crop. -***Restricted-use pesticide***. Only certified applicators, who successfully complete the paraquat-specific training, can mix, load, or apply paraquat. Application of paraquat "under the direct supervision" of a certified applicator is no longer allowed. Required training link (*https://campus.extension.org/enrol/index.php?id=2201*); certified applicators must repeat training every three years. -Do not exceed 8 pt/A per season. -Rainfastness is 30 min.						

<table>
<tr><td colspan="7">2. Soil Applied</td></tr>
<tr><th>Group</th><th>Product Name (*=Restricted Use)</th><th>Product Rate</th><th>Active Ingredient</th><th>Active Ingredient Rate</th><th>PHI (d)</th><th>REI (h)</th></tr>
<tr><td>2</td><td>League 75WDG</td><td>4 to 6.4 oz/A</td><td>imazosulfuron</td><td>0.19 to 0.3 lb/A</td><td>21</td><td>12</td></tr>
<tr><td colspan="7">-Can be used on bell and non-bell peppers. -Plasticulture: row middles only; apply after peppers are well established and at least 10 inches tall. -Bareground: apply between rows of direct-seeded or transplants only after peppers are well established and at least 10 inches tall; spray should be directed at base of the stem and not contact the plant higher than 2 inches from soil surface. Do not apply as broadcast application.
-For control of emerged weeds be sure to include appropriate adjuvant (see label).
-Movement of soil may reduce residual control. -Avoid rainfall or overhead irrigation (0.5 to 1 inch) within 12 hours of application. However, rainfall or irrigation within 5 days of application is needed to activate League.
-League controls a limited number of species including common purslane and hairy galinsoga.
-League is an ALS inhibiting herbicide and resistant weed populations are common in the region.
-Do not use Group 2 herbicides repeatedly in the same field.
-Do not apply League to crops treated with a soil applied organophosphate insecticide, or 21 days before a foliar applied organophosphate insecticide or 7 days after an organophosphate application.
-Maximum League applications per year is 1 and do not exceed 6.4 oz/A during the crop season.</td></tr>
<tr><td>2</td><td>Sandea 75DF</td><td>0.5 to 1 oz/A</td><td>halosulfuron</td><td>0.023 to 0.047 lb/A</td><td>30</td><td>12</td></tr>
<tr><td colspan="7">-Plasticulture: row middles only; apply as shield application after crop has been planted.
-Bareground: apply between rows of direct-seeded or transplants; Do not apply as broadcast application; avoid contact of the herbicide with the planted crop
-Suppresses or controls yellow nutsedge and certain broadleaf weeds. Sandea provides both residual and postemergence control of susceptible weed species. Effective postemergence control requires an adjuvant. -Sandea is an ALS inhibiting herbicide and resistant weed populations are common in the region.
-Do not use Group 2 herbicides repeatedly in the same field. -Do not apply Sandea to crops treated with a soil applied organophosphate insecticide or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application. -Maximum Sandea applications per year is 2 and do not exceed 2 oz/A during the crop season.</td></tr>
<tr><td>3</td><td>Prowl H2O 3.8CS</td><td>1 to 3 pt/A</td><td>pendimethalin</td><td>0.48 to 1.42 lb/A</td><td>70</td><td>24</td></tr>
<tr><td colspan="7">-Plasticulture: recommended for row middles only. Labeled for under plastic, but no local data or experience with this application.
-Bareground: broadcast preplant or preplant incorporated before transplanting; not labeled for direct-seeded crop.
-Avoid root contact with Prowl-treated soil when placing transplants into furrow or hole or injury may occur.
-Prowl labeled for directed application to transplanted or established direct-seeded peppers; avoid contact with leaves or stems.
-Prowl will not control emerged weeds, only provides residual control; row middle applications may be made with Gramoxone using shielded sprayers. -Use the lower rate on coarse-textured or sandy soils. Activate with ½ inch of rainfall or sprinkler irrigation within 48 h of application to control most annual grasses and certain broadleaf weeds.
-Maximum Prowl H2O application per season is 3 pt/A.</td></tr>
<tr><td>3</td><td>Treflan 4E</td><td>1 to 2 pt/A</td><td>trifluralin</td><td>0.5 to 1 lb/A</td><td>--</td><td>12</td></tr>
<tr><td colspan="7">-Labeled for transplanted peppers only; not labeled for seeded peppers.
-Apply preplant incorporated. Incorporate 2 to 3 inches of the soil within 8 h of application.
-Slight stunting may occur if the weather is cool and damp at time of transplanting.
-Maximum application per season: not specified.</td></tr>
<tr><td>8</td><td>Prefar 4E</td><td>5 to 6 qt/A</td><td>bensulide</td><td>5 to 6 lb/A</td><td>--</td><td>12</td></tr>
<tr><td colspan="7">-Plasticulture under plastic: apply in a band under the plastic, immediately before laying the mulch. Allow 7 day before making transplant holes to allow condensation to incorporate the herbicide. Plasticulture: row middles application is labeled.
-Bareground: apply preemergence or preplant incorporated.
-Do not incorporate more than 2 inches deep (1 inch is optimum).
-If applied preemergence, irrigate within 36 h of application with ½ inch of water; if not incorporated with irrigation or rainfall within 36 h, weed control maybe reduced.
-Provides control/suppression of some annual grass weeds and some broadleaves including pigweeds, purslane, and lambsquarters.</td></tr>
<tr><td>13</td><td>Command 3ME</td><td>0.66 to 1.33 pt/A</td><td>clomazone</td><td>0.25 to 0.50 lb/A</td><td>--</td><td>12</td></tr>
<tr><td colspan="7">-Plasticulture: under plastic: apply in a band under the plastic, immediately before laying the mulch. Plasticulture: row middles application is labeled. -Bareground: apply preemergence for seeded peppers or before transplanting (do not apply over emerged plants).
-Use the lower rate on coarse-textured soils low in organic matter, when weed pressure is light, or to minimize herbicide carryover that could affect subsequent crops. Use higher rates on fine-textured soils or soils with high organic matter, or to improve control of certain weeds, including common cocklebur (refer to label for specific weeds and rates).
-Do not use on banana peppers.
-Broad-spectrum herbicide that will control annual grasses and many broadleaf weeds, except pigweed sp., carpetweed, morningglory sp., and yellow nutsedge; combine with Devrinol or Dual Magnum (transplants only) to improve the control.
-WARNINGS: Command spray or vapor drift may injure sensitive crops and other vegetation up to several hundred yards from the point of application. Do not apply adjacent to sensitive crops (see label) or vegetation, or under unfavorable wind or weather conditions. Command may limit subsequent cropping options, see the label. -Maximum Command applications per season: 1.</td></tr>
</table>

1. Soil Applied - continued next page

1. Soil Applied - continued

15	Devrinol 2-XT 2EC Devrinol DF-XT 50DF	2 to 4 qt/A 2 to 4 lb/A	**napropamide**	1.0-2 lb/A	--	24
-**Plasticulture**: under plastic is labeled for seeded or transplanted peppers; apply in a band under the plastic, immediately before laying mulch. Use lower rate on coarse textured or sandy soil. Condensation that forms on the underside of the mulch will activate the herbicide. Plasticulture: row middles application is labeled. -**Bareground**: apply as broadcast, preemergence treatment for seeded and transplanted peppers. Rainfall or irrigation within 24 h after application improves performance (½ inch sprinkler irrigation). -Annual grasses and certain annual broadleaf weeds will be suppressed or controlled. -May reduce stand and yield of fall planted small grain crop. Moldboard plowing will reduce the risk of injury. -Maximum Devrinol application per season: 4 qt/A (2-XT) or 4 lb/A (DF-XT).						
15	Dual Magnum 7.62EC	0.5 to 1.33 pt/A	***s*-metolachlor**	0.48 to 1.27 lb/A	60	24
-**Special Local Needs Label 24(c) for DE and NJ (expires in DE 12/31/2028, NJ 1/28/2027)** for use in transplanted bell and non-bell peppers (except tabasco peppers). -**Special Local Needs Label 24(c) for PA for bell peppers ONLY (expires 12/31/2027) and maximum rate of 1 pt/A.** -**The use of Dual Magnum is legal ONLY if a waiver of liability has been completed (see: *https://www.syngenta-us.com/labels/indemnified-label-login*).** -**Plasticulture**: under plastic is labeled for seeded or transplanted peppers; apply in a band under the plastic, immediately before laying mulch. Use lower rate on coarse textured or sandy soil. Condensation that forms on the underside of the mulch will activate the herbicide. Plasticulture: row middles application is labeled. -**Bareground**: apply as broadcast, preemergence treatment for transplanted bell and non-bell peppers, do **not** use on seeded peppers; **do not** incorporate. **For NJ only** can be applied as post-directed spray to soil surface after the plants have recovered from transplant shock. Dual will not control emerged weeds. -Maximum Dual Magnum applications per season: 1.						

3. Postemergence

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
1	Shadow 3EC Select 2EC Select Max 0.97EC	4 to 5.33 fl oz/A 6 to 8 fl oz/A 9 to 16 fl oz/A	**clethodim**	0.07 to 0.125 lb/A	20	24
	Poast 1.5EC	1 to 1.5 pt/A	**sethoxydim**	0.2 to 0.28 lb/A	7	12
-**Select 2EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). **Select Max**: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution). **Shadow 3EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution) for large or stressed grasses; use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution) when crop safety is a concern. **Poast**: use COC at 1.0% v/v -**The use of COC may increase the risk of crop injury when hot or humid conditions prevail**. To reduce the risk of crop injury, omit additives or switch to NIS when grasses are small and soil moisture is adequate. -Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control. -Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will **not** be controlled. -Controls many annual and certain perennial grasses, including annual bluegrass, but Poast is preferred for goosegrass control. For best results, treat annual grasses when they are actively growing. Control may be reduced if grasses are large or under hot or dry weather conditions. -Repeated applications may be necessary to control certain perennial grasses. If repeat applications are necessary, allow 14 days between applications. -Rainfastness is 1 h. -**Do not** tank mix with or apply within 2 to 3 days of any other pesticide unless labeled, as this may increase the risk of crop injury or reduce the control of grasses. **Do not** apply more than 8 fl oz/A of Select 2EC in a single application and **do not** exceed 2 pt/A for the season; **do not** apply more than 16 fl oz/A of Select Max in a single application and **do not** exceed 4 pt/A for the season. -**Do not** apply more than 5.33 fl oz/A of Shadow 3EC in a single application and **do not** exceed 21.33 fl oz/A for the season. -**Do not** apply more than 1.5 pt/A Poast 1.5EC in a single application and **do not** exceed 4.5 pt/A for the season.						
10	Rely 280 2.34L	29 to 62 fl oz/A	**glufosinate**	0.53 to 1.13 lb/A	30	12
-**Supplemental Label expires 12/1/2025 for hooded spray application between the rows.** -Ammonium sulfate (AMS) can be used at 1.5 lb/A to 3 lb/A. -Do not allow spray to come in contact with crop foliage or damage will occur. -Separate sequential applications by at least 14 days. -Control is best when applied to weeds less than 4 inches, temperatures are above 80, high humidity, and bright sunlight. -Do not apply more than 62 fl oz/A in a single application, do not apply more than 87 fl oz/A per season; maximum number of applications is three per season. -Rainfastness is 4 h.						
22	Gramoxone SL 2.0* Gramoxone SL 3.0*	2 pt/A 1.3 pt/A	**paraquat**	0.5 lb/A	--	24
-Gramoxone can be applied before or after seeding to control emerged broadleaf weeds and grass seedlings. -For use in plasticulture: row middles as a shielded application. -Include a nonionic surfactant at 0.25% v/v. **Do not** allow spray to contact crop foliage as injury may result. Use flaps that drag along the edge of plastic mulch and use low spray pressure (maximum of 30 psi) to reduce small droplets that are prone to drift. -See the label for additional information and warnings. Rainfastness is 30 min. A maximum of 3 applications per year are allowed. ***-Restricted-use pesticide***. Only certified applicators, who successfully complete the paraquat-specific training, can mix, load, or apply paraquat. Application of paraquat "under the direct supervision" of a certified applicator is no longer allowed. Required training link (*https://campus.extension.org/enrol/index.php?id=2201*); certified applicators must repeat training every three years.						

4. Postharvest						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient**	**Active Ingredient Rate**	**PHI (d)**	**REI (h)**
22	Gramoxone SL 2.0* Gramoxone SL 3.0*	2.25 to 3 pt/A 1.5 to 2 pt/A	**paraquat**	0.56 to 0.75 lb/A	--	24

-**Supplemental Label in DE for the use of both Gramoxone formulations for postharvest application to desiccate the crop.**
-Apply after the last harvest for bareground or plasticulture. Always include an adjuvant. -Spray coverage is essential for optimum effectiveness. See the label for additional information and warnings. -Rainfastness 30 min. A maximum of 2 applications for crop desiccation are allowed.
-***Restricted-use pesticide***. Only certified applicators, who successfully complete the paraquat-specific training, can mix, load, or apply paraquat. Application of paraquat "under the direct supervision" of a certified applicator is no longer allowed. Required training link (*https://campus.extension.org/enrol/index.php?id=2201*); certified applicators must repeat training every three years.

5. Other Labeled Herbicides These products are labeled but limited local data are available; and/or are labeled but not recommended in our region due to potential crop injury concerns.

Group	Product Name (*=Restricted Use)	Active Ingredient
14	Aim	**carfentrazone**
14	Vida	**pyraflufen**

Insect Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.

Recommended Insecticides

Aphids

Green peach aphid is the most common aphid on peppers. Females produce numerous pale yellow or pink-colored nymphs. Large numbers can build up on the undersides of leaves, often following pyrethroid insecticide applications. Aphids are sucking insects that excrete a sugary, sticky substance (honeydew) that coats fruit and causes growth of black sooty mold fungus. Both honeydew and mold can hurt marketability. Natural enemies can keep aphid populations below damaging levels; use selective insecticides whenever possible. Treat if you have an average of 10 aphids per leaf before fruit set, and 5 per leaf after fruit set. When plants are small, silver reflective plastic mulch can significantly reduce the number of aphids landing on the crop.

Apply one of the following formulations:
Note: Spray coverage to the underside of the leaf is important; add a spreader-sticker to foliar sprays.

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
1A	Lannate LV*	1.5 to 3.0 pt/A	methomyl	3	48	H
1A	Vydate L*	2.0 pt/A	oxamyl - **foliar**	7	48	H
1B	Dimethoate 400	0.5 to 0.6 pt/A	dimethoate	0[1]	48	H
1B	Malathion 57 EC	1.25 to 1.5 pt/A	malathion	3	12	H
1B	Orthene 97	0.5 to 1.0 lb/A (bell)	acephate	7	24	H
1B	Orthene 97	0.5 lb/A (non-bell)	acephate	7	24	H
4A	Neonicotinoid insecticides registered for use on Peppers: see table at the end of Insect Control.					
4C	Transform WG	0.75 to 1.0 oz/A	sulfoxaflor	1	24	H
4C + 3A	Ridgeback*	4.5 to 13.8 fl oz/A	sulfoxaflor + bifenthrin	7	24	H
4D	Sivanto Prime or 200SL	21 to 28 fl oz/A	flupyradifurone - **soil**	45	4	M
4D	Sivanto Prime or 200SL	7.0 to 14.0 fl oz/A	flupyradifurone - **foliar**	1	4	M
7C + 23	Senstar	8.0 to 10.0 fl oz/A	pyriproxyfen + spirotetramat	1	24	L
9B	Fulfill	2.75 oz/A	pymetrozine	0	12	L
9B	PQZ	2.4 to 3.2 fl oz/A	pyrifluquinazon	1	12	L
9D	Sefina	3.0 fl oz/A	afidopyropen	0	12	L
21A	Torac	17.0 to 21.0 fl oz/A	tolfenpyrad	1	12	H
23	Movento	4.0 to 5.0 fl oz/A	spirotetramat	1	24	L
28	Exirel	13.5 to 20.5 fl oz/A	cyantraniliprole - **foliar**	1	12	H
28	Verimark	6.75 to 13.5 fl oz/A	cyantraniliprole	1	4	H
28 + 6	Minecto Pro*	10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H
29	Beleaf 50 SG	2.8 to 4.28 oz/A	flonicamid	0	12	L
n/a	Grandevo CG (OMRI)	2 to 3 lb/A	*Chromobacterium subtsugae*	0	4	M

[1]Mechanical Harvest only

Caterpillar "Worm" Pests Including: Corn Earworms (CEW), European Corn Borers (ECB), Beet Armyworms (BAW), Cabbage Loopers (CL), Hornworms, and Other Armyworms Peppers may be attacked by various lepidopteran pest species. For decades, ECB was the most important of these in the Mid-Atlantic Region requiring intense (weekly) control measures throughout the fruiting period of peppers. However, since the mid-2000s, ECB populations and damage to peppers have declined significantly. Today, a mix of any of the species listed above can occur in peppers and sometimes require control. Local pheromone or blacklight traps are effective for monitoring key moth pest populations. Consult your Extension Agent or IPM alerts for information about trap catches. Also, visually inspecting plants and fruit or beat sheeting can help determine the presence or absence of lepidopteran pests. There is no reliable economic threshold. Note that not all lepidopteran pest species are listed on all of the insecticide labels below, but, unless noted, these products have activity on all caterpillars. **Pyrethroid (Group 3A) resistance is common in BAW and CEW.** So, caution should be used when using that class of insecticide. Also, multiple applications of pyrethroids may lead to aphid outbreaks on peppers. Rotating insecticide classes within a season is strongly recommended.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	1.5 to 3.0 pt/A	methomyl	3	48	H
1A	Sevin XLR Plus (ECB, FAW)	1.0 to 2.0 qt/A	carbaryl	3	12	H
1B	Orthene 97 (not for CEW)	0.5 to 1.0 lb/A (bell)	acephate	7	24	H
1B	Orthene 97 (not for CEW)	0.5 lb/A (non-bell)	acephate	7	24	H
3A	Pyrethroid insecticides registered for use on Peppers: see table at the end of Insect Control. **Not recommended for BAW**					
5	Entrust SC (OMRI)	3.0 to 8.0 fl oz/A	spinosad	1	4	M
5	Radiant SC	5.0 to 10.0 fl oz/A	spinetoram	1	4	M
6	Proclaim 5SG*	2.4 to 4.8 oz/A	emamectin benzoate	7	12	H
11A	XenTari (OMRI)	0.5 to 2.0 lb/A	*Bacillus thuringiensis aizawai*	0	4	N
11A	Dipel DF, others (OMRI)	0.5 to 2.0 lb/A	*Bacillus thuringiensis kurstaki*	0	4	N
15	Rimon 0.83EC	9.0 to 12.0 fl oz/A	novaluron	1	12	M
18	Confirm 2F	6.0 to 16.0 fl oz/A	tebufenozide	7	4	M
18	Intrepid 2F	4.0 to 16.0 fl oz/A	methoxyfenozide	1	4	L
22	Avaunt 30WDG, Avaunt eVo	3.5 oz/A	indoxacarb - **bell pepper only**	3	12	H
28	Coragen 1.67SC Coragen eVo	3.5 to 7.5 fl oz/A 1.2 to 2.5 fl oz/A	chlorantraniliprole	1	4	L
28	Exirel	7.0 to 13.5 fl oz/A	cyantraniliprole	1	12	H
28	Verimark	5.0 to 10.0 fl oz/A	cyantraniliprole	1	4	H
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H
28 + 4A	Durivo	10.0 to 13.0 fl oz/A	thiamethoxam + chlorantraniliprole	30	12	H
28 + 4A	Voliam Flexi	4.0 to 7.0 oz/A	thiamethoxam + chlorantraniliprole	1	12	H
28 + 6	Minecto Pro*	5.5 to 10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H
32	Spear-Lep (tank mix with Bt)	1.0 to 2.0 pt/A	GS-omega/kappa-Hxtx-Hv1a	0	4	L
n/a	Grandevo CG (OMRI)	1 to 2 lb/A	*Chromobacterium subtsugae*	0	4	M

Cutworms

See also section E 3.1. Soil Pests - Detection and Control. Cutworms are not a major pest of peppers but are occasionally encountered. They can feed on the lower smaller leaves but typically create the most damage by clipping small transplants off at the soil level. Cutworms feed at night and hide in the top layer of the soil near the plant roots during the day. Scout seedlings for presence of clipped seedlings.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Sevin XLR Plus	2.0 qt/A	carbaryl	3	12	H
3A	**Preplant:** Pyrethroid insecticides registered for use on Peppers: see table at the end of Insect Control.					

Flea Beetles

Flea beetles can occasionally damage young pepper seedlings. Tobacco and eggplant flea beetle damage consists of foliage feeding resembling tiny shotgun holes, primarily on young transplants. Control of flea beetles is suggested before plants reach 25% defoliation. Once plants have five leaves, they can tolerate several beetles per plant without damage. *(continued next page)*

Flea Beetles - continued

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Sevin XLR Plus	0.5 to 1.0 qt/A	carbaryl	3	12	H
3A	Pyrethroid insecticides registered for use on Peppers: see table at the end of Insect Control.					
4A	Neonicotinoid insecticides registered for use on Peppers: see table at the end of Insect Control.					
21A	Torac	17.0 to 21.0 fl oz/A	tolfenpyrad	1	12	H
28	Verimark	6.75 to 13.5 fl oz/A	cyantraniliprole	1	4	H

Leafminers

Leafminers exhibit several generations per year, but they are considered minor pests of peppers. Adult flies penetrate the leaf surface to deposit a single egg. Larvae emerge and form galleries or tunnels during their feeding process. These tunnels can be observed as white, serpentine mines on the leaves. Excessive damage on small transplants can lead to leaf drop and plant death.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Vydate L*	2.0 pt/A	oxamyl - **foliar and soil injection**	7	48	H
1B	Dimethoate 400	0.5 to 0.6 pt/A	dimethoate	0[1]	48	H
3A	Pyrethroid insecticides registered for use on Peppers: see table at the end of Insect Control.					
4A	Neonicotinoid insecticides registered for use on Peppers: see table at the end of Insect Control.					
5	Entrust SC (OMRI)	10.0 fl oz/A	spinosad	1	4	M
5	Radiant SC	6.0 to 10.0 fl oz/A	spinetoram	1	4	M
6	Agri-Mek SC*	1.75 to 3.5 fl oz/A	abamectin	7	12	H
15	Rimon 0.83EC	12.0 fl oz/A	novaluron	1	12	M
17	Trigard 75WSP	2.66 oz/A	cyromazine	0	12	H
28	Coragen 1.67SC Coragen eVo	5.0 to 7.5 fl oz/A 1.7 to 2.5 fl oz/A	chlorantraniliprole - **soil and foliar**	1	4	L
28	Exirel	13.5 to 20.5 fl oz/A	cyantraniliprole	1	12	H
28	Verimark	6.75 to 13.5 fl oz/A	cyantraniliprole	[1]	4	H
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H
28 + 6	Minecto Pro*	5.5 to 10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H

[1]Mechanical Harvest only

Mites

Two-spotted spider mites (TSSM) are the most common mites found on peppers, although broad mites are also a sporadic pest. TSSM are tiny (1/60-1/80 inch), yellowish in color with 2 dark spots on each side of their body. Their damage is most often the first indicator of their presence on pepper plants. They feed by removing fluids from plant tissue leading to lighter colored or white areas described as stippling. Extensive feeding can lead to reduced photosynthesis, reduced vigor, and potential death of plants. TSSM most often occur on the undersides of leaves. They reproduce very quickly and once a heavy population is reached; webbing can be observed on plants. Mites are flared by hot, dry conditions, particularly in July and August, and using broad-spectrum insecticides like organophosphates, carbamates or pyrethroids killing predators, or by frequent applications of fungicides. The use of a spreader sticker is recommended with foliar applications to increase coverage and control of these tiny arthropods. There are some label restrictions on the types of spreader-stickers that can be used with certain products, so take care to read your label.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
6	Agri-Mek SC*	1.75 to 3.5 fl oz/A	abamectin	7	12	H
6 + 28	Minecto Pro*	5.5 to 10.0 fl oz/A	abamectin + cyantraniliprole	7	12	H
10A	Onager 1EC	12 to 24 fl oz/A	hexythiazox	1	12	N
10B	Zeal Miticide	2.0 to 3.0 oz/A	etoxazole	7	12	L
20B	Kanemite 15SC	31 fl oz/A	acequinocyl	1	12	L
21A	Magister SC	24.0 to 36.0 fl oz/A	fenazaquin	3	12	H
21A	Portal	2.0 pt/A	fenpyroximate	1	12	L
21A	Torac (broad mite only)	14.0 to 21.0 fl oz/A	tolfenpyrad	1	12	H

Mites - continued next page

Mites - continued

23	Oberon 2SC	7.0 to 8.5 fl oz/A	spiromesifen	1	12	M
23	Movento (broad mite only)	4.0 to 5.0 fl oz/A	spirotetramat	1		L
20D	Acramite 50WS	0.75 to 1.0 lb/A	bifenazate	3	12	M
UN	Sulfur 80 WDG (OMRI) (broad mite only)	3.0 to 10.0 lb/A	sulfur	0	24	M

Pepper Maggots (PM)

Horsenettle and ground cherries are primary hosts of the pepper maggot. Adult flies are active all summer and deposit eggs in the tissue of young pepper fruit by piercing it with their ovipositor. PM strongly prefer cherry peppers and other round fruit. Maggots feed on the developing seeds and internal tissue of the fruit then exit the fruit leaving a large hole that is highly susceptible to pathogens and rot. Sanitation and rotation is important as adult flies are attracted to rotting fruit. Yellow sticky traps baited with a 30% liquid ammonia and installed in trees surrounding fields can indicate the presence of adult flies. Planting cherry peppers can alert growers of PM's presence. Sprays should be initiated one week following detection of the first flies; 2-3 sprays may be necessary.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1B	Dimethoate 400	0.50 to 0.6 pt/A	dimethoate	0[1]	48	H
1B	Malathion 57 EC	2.5 pt/A	malathion	3	12	H
3A	Pyrethroid insecticides registered for use on Peppers: see table at the end of Insect Control.					
4A	Neonicotinoid insecticides registered for use on Peppers: see table at the end of Insect Control.					

[1]Mechanical Harvest only **Note:** Use of acephate in bell peppers will reduce pepper maggot infestations.

Pepper Weevils (PW)

Adults are small beetles with a long snout. PW do not overwinter in our area, but is a sporadic pest occasionally imported on transplants or fruit from the South. PW require a constant pepper host throughout the year and can therefore not survive north of South Carolina. **The materials listed here are effective for adult weevil control but are ineffective in controlling the larvae.**

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Vydate L*	2.0 pt/A	oxamyl - **foliar**	7	48	H
3A	Pyrethroid insecticides registered for use on Peppers: see table at the end of Insect Control.					
4A	Neonicotinoid insecticides registered for use on Peppers: see table at the end of Insect Control.					
15	Rimon 0.83EC	9.0 to 12.0 fl oz/A	novaluron	1	12	M
21A	Torac	17.0 to 21.0 fl oz/A	tolfenpyrad	1	12	H
28	Exirel	13.5 to 20.5 fl oz/A	cyantraniliprole	1	12	H
28	Harvanta 50SL	16.4 fl oz/A	cyclaniliprole	1	4	H

Stink Bugs

Brown, green, and the invasive brown marmorated stink bugs (BMSB) may attack pepper fruit. Stink bugs have a characteristic shield shape, a triangle on their thorax, are approximately 0.5 inch long and can emit a foul odor when disturbed. BMSB have white stripes on their antennae; nymphs have a dark colored or dark and white body, depending on the instar or stage of development, and have characteristic black and white striped legs. Stink bug eggs are in masses, barrel shaped and cream to greenish colored. Both nymphs and adults feed on fruit and leave a conspicuous white "halo" or discoloration on the surface. Feeding injury from BMSB can be significantly more severe than that from other species. Growers should scout for stink bugs and initiate weekly sprays if observed.

Note: Brown and brown marmorated stink bugs are less susceptible to pyrethroids than green and southern green stink bugs. Careful pyrethroid selection is advised, consult your local Cooperative Extension Service for recommendations for your area.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	1.5 to 3.0 pt/A	methomyl	3	48	H
3A	Pyrethroid insecticides registered for use on Peppers: see table at the end of Insect Control.					
4A	Neonicotinoid insecticides registered for use on Peppers: see table at the end of Insect Control.					

Thrips

Several species can be present; tobacco, flower, and Western flower thrips are the most common. Thrips fly in from surrounding crops or weeds and feed on the foliage, flowers, and fruit. Larvae and adults cause damage by removing fluids from tissues. Adults can also damage fruit by leaving oviposition marks forming a small indent. Resulting damage from feeding leaves silvery or gray areas on fruit. Leaf distortion can also occur. More importantly, several species of thrips are vectors of Tomato Spotted Wilt Virus (TSWV), an important and untreatable disease (once acquired) of tomato, tobacco, and pepper crops. Thrips control is critical for reducing TSWV. Scout for thrips and begin treatments when observed. Do not produce transplants with bedding plants in the same greenhouse.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Vydate L*	2.0 to 4.0 pt/A	oxamyl - **foliar**	7	48	H
3A[1]	Pyrethroid insecticides registered for use on Peppers: see table at the end of Insect Control.					
4A[2]	Neonicotinoid insecticides registered for use on Peppers: see table at the end of Insect Control.					
5	Entrust SC (OMRI)	4.0 to 8.0 fl oz/A	spinosad	1	4	M
5	Radiant SC	6.0 to 10.0 fl oz/A	spinetoram	1	4	M
15	Rimon 0.83EC	12.0 fl oz/A	novaluron	1	12	M
21A	Torac	21.0 fl oz/A	tolfenpyrad	1	12	H
29	Beleaf 50SG	2.8 to 4.28 oz/A	flonicamid - **soil**	0	12	L
n/a	Requiem EC	2.0 to 3.0 qt/A	*Chenopodium* extract	0	4	L

[1]Resistance concerns with western flower thrips [2]Resistance concerns with tobacco thrips

Whiteflies

Usually an infrequent late season pest. However, if they become a more frequent problem then avoid the use of broad-spectrum pesticides early in the season. Check field margins for whiteflies; these areas are usually infested first. Allow beneficials an opportunity to control light whitefly infestations. If higher populations are present at the field margins than the field centers, then treat only the field margins.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
4A	Neonicotinoid insecticides registered for use on Pepper: see table at the end of Insect Control.					
4C	Transform WG	2.0 to 2.25 oz/A	sulfoxaflor	1	24	H
4C + 3A	Ridgeback*	4.5 to 13.8 fl oz/A	sulfoxaflor + bifenthrin	7	24	H
4D	Sivanto Prime or 200SL	21.0 to 28.0 fl oz/A	flupyradifurone - **soil**	45	4	M
4D	Sivanto Prime or 200SL	10.5 to 14.0 fl oz/A	flupyradifurone - **foliar**	1	4	M
7C	Knack	8.0 to 10.0 fl oz/A	pyriproxyfen	1	12	L
9B	Fulfill 50WDG	2.75 oz/A	pymetrozine	0	12	L
9B	PQZ	2.4 to 3.2 fl oz/A	pyrifluquinazon	1	12	L
9D	Sefina	14.0 fl oz/A	afidopyropen	0	12	L
16	Courier SC	9.0 to 13.6 fl oz/A	buprofezin	1	12	L
23	Movento	4.0 to 5.0 fl oz/A	spirotetramat	1	24	L
23	Oberon 2SC	7.0 to 8.5 fl oz/A	spiromesifen	1	12	M
23+7C	Senstar	8.0 to 10.0 fl oz/A	spirotetramat + pyriproxyfen	1	24	L
28 + 6	Minecto Pro*	10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H
n/a	Requiem EC	2.0 to 3.0 qt/A	*Chenopodium* extract	0	4	L

Group 3A Pyrethroid Insecticides Registered for Use on Peppers

Note, resistance concerns with this class of insecticide with western flower thrips, BAW, and CEW.

Apply one of the following formulations (check if the product label lists the insect you intend to spray; the label is the law):					
Product Name (*=Restricted Use)	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
Asana XL*	5.8 to 9.6 fl oz/A	esfenvalerate	7	12	H
Baythroid XL*	1.6 to 2.8 fl oz/A	beta-cyfluthrin	7	12	H
Brigade 2EC*, others	2.1 to 6.4 fl oz/A	bifenthrin	7	12	H
Capture LFR*	3.4 to 6.8 fl oz/A	bifenthrin	7	12	H
Danitol 2.4EC*	10.67 fl oz/A	fenpropathrin	3	24	H

Group 3A Pyrethroid Insecticides Registered for Use on Peppers - continued next page

Group 3A Pyrethroid Insecticides Registered for Use on Peppers - continued

Declare*	0.77 to 1.54 fl oz/A	gamma-cyhalothrin	5	24	H
Hero*	4.0 to 10.3 fl oz/A	zeta-cypermethrin + bifenthrin	7	12	H
Lambda-Cy 1EC*, others	1.92 to 3.84 fl oz/A	lambda-cyhalothrin	5	24	H
Mustang Maxx*	2.24 to 4.0 fl oz/A	zeta-cypermethrin	1	12	H
Permethrin 3.2EC*, others	4.0 to 8.0 fl oz/A	permethrin	3	12	H
Tombstone*	1.6 to 2.8 fl oz/A	cyfluthrin	7	12	H
Warrior II*	0.96 to 1.92 fl oz/A	lambda-cyhalothrin	5	24	H
Combo products containing a pyrethroid					
Besiege*	5.0 to 9.0 fl oz/A	lambda-cyhalothrin + chlorantraniliprole (Group 28)	5	24	H
Brigadier*	3.8 to 9.85 fl oz/A	bifenthrin + imidacloprid (Group 4A) - **foliar**	7	12	H
Endigo ZC* and ZCX*	4.0 to 4.5 fl oz/A	lambda-cyhalothrin + thiamethoxam (Group 4A)	5	24	H
Leverage 360*	3.8 to 4.1 fl oz/A	beta-cyfluthrin + imidacloprid (Group 4A)	7	12	H
Ridgeback*	4.5 to 13.8 fl oz/A	bifenthrin + sulfoxaflor (Group 4C)	7	24	H
Savoy EC*	4.9 to 12.9 fl oz/A	bifenthrin + acetamiprid (Group 4A)	7	12	H

Group 4A Neonicotinoid Insecticides Registered for Use on Peppers

Apply one of the following formulations (check if the product label lists the insect you intend to spray; the label is the law):

Product Name (*=Restricted Use)	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
Admire Pro	7.0 to 14.0 fl oz/A	imidacloprid - **soil**	21	12	H
Admire Pro	1.3 to 2.2 fl oz/A	imidacloprid - **foliar**	0	12	H
Assail 30SG	2.0 to 4.0 oz/A	acetamiprid	7	12	M
Belay 2.13SC	9.0 to 12.0 fl oz/A	clothianidin - **soil**	7	12	H
Belay 2.13SC	3.0 to 4.0 fl oz/A	clothianidin - **foliar**	1	12	H
Actara 25WDG	2.0 to 5.5 oz/A	thiamethoxam - **foliar**	0	12	H
Platinum 75SG	1.66 to 3.67 oz/A	thiamethoxam - **soil**	30	12	H
Scorpion 35SL	9.0 to 10.5 fl oz/A	dinotefuran - **soil**	21	12	H
Scorpion 35SL	2.0 to 7.0 fl oz/A	dinotefuran - **foliar**	1	12	H
Venom 70SG	5.0 to 7.5 oz/A	dinotefuran - **soil**	21	12	H
Venom 70SG	1.0 to 4.0 oz/A	dinotefuran - **foliar**	1	12	H
Combo products containing a neonicotinoid					
Brigadier*	5.1 to 9.85 fl oz/A	imidacloprid + bifenthrin (Group 3A) - **foliar**	7	12	H
Durivo	10.0 to 13.0 fl oz/A	thiamethoxam + chlorantraniliprole (Group 28)	30	12	H
Endigo ZC* and ZCX*	4.0 to 4.5 fl oz/A	thiamethoxam + lambda-cyhalothrin (Group 3A)	5	24	H
Leverage 360*	3.8 to 4.1 fl oz/A	imidacloprid + beta-cyfluthrin (Group 3A)	7	12	H
Savoy EC*	6.0 to 12.9 fl oz/A	acetamiprid + bifenthrin (Group 3A)	7	12	H
Voliam Flexi	4.0 to 7.0 oz/A	thiamethoxam + chlorantraniliprole (Group 28)	1	12	H

Disease Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F. Recommended Fungicides

<u>Nematodes</u> See sections E 1.5. Soil Fumigation and E 1.6. Nematode Control for listed fumigants or use nematicides listed below. Consult the label.

Code	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Vydate L*	see label	oxamyl	7	48	H
--	Nimitz 4EC	3.5 to 5.0 pt/A	fluensulfone	n/a	12	N

Seed Treatment: Reducing Bacterial Leaf Spot

Purchase hot water treated seed if possible or request hot water seed treatment. Heat treatment of seeds is a nonchemical alternative to conventional chlorine treatments that only kill pathogens on the surface of the seed coat. Heat treatment has the additional benefit of killing pathogens within the seed coat and is particularly useful for crops that are prone to seed-borne bacterial infections such as pepper and tomato. Seed heat treatment follows a strict time and temperature protocol and is best done with thermostatically controlled water baths. Two baths are required: one for pre-heating, and a second for the effective (pathogen killing) temperature. For pepper seed, the initial pre-heating is at 100°F (38°C) for 10 minutes, followed by the effective temperature of 125°F (52°C) for 30 minutes. Immediately after removal from the second bath, seeds should be rinsed with cool water to stop the heating process. After that, seeds should be dried on a screen or paper. Pelleted seed is not recommended for heat treatment. Only use heat treatment on seed that will be used during the current production season. Following heat or chlorine treatment, dust the dried seed with Captan 50WP or Thiram 480DP at 1 level tsp/lb of seed (3.0 oz/100 lb). Both for Bacterial leaf spot and Phytophthora, it is important to use resistant varieties on farms or fields with a history of the disease.

Damping-off caused by *Phytophthora*, *Pythium* and *Rhizoctonia*

Use new planting mix. Soilless mixes containing microorganisms that help suppress damping-off fungi should be considered. Transplants that have been in flats for extended periods of time and/or are slow to establish after setting are prone to Rhizoctonia root rot while wet soils favor Pythium root rot.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
In transplant water (see label for application methods and restrictions):						
Pythium root rot[1]						
21	Ranman 400SC	2.75 fl oz/A[1]	cyazofamid	AP	12	L
28	Previcur Flex 6F	1.2 pt/A[1]	propamocarb hydrochloride	AP	12	N
4 + 49	Orondis Gold	28.0 to 55.0 fl oz/A[1]	mefenoxam + oxathiapiprolin	AP	48	N
Phytophthora, Pythium, and Rhizoctonia root rot						
4 + 11	Uniform 3.66SE	0.34 fl oz/1000 ft row. Avoid direct seed contact, which may cause delayed emergence.	mefenoxam + azoxystrobin	AP	0	N
Rhizoctonia root and stem rot						
11	azoxystrobin 2.08F	0.40 to 0.80 fl oz/1000 ft row	azoxystrobin	AP	4	N

[1] Ranman, Previcur Flex, and Orondis Gold can be used in transplant water. See labels for rates and restrictions.

Bacterial and Fungal Diseases

Anthracnose Fruit Rot

Anthracnose 'hot spots' typically develop in fields with prior history of the disease, especially in fields where peppers or tomatoes have been grown extensively. Heavy winds and rain help spread spores. Excessive fertilization may create dense canopies, which help create microclimates conducive for fruit infection and reduced fungicide control. Scout regularly as fruit begin to develop. Use adequate water when spraying to ensure good penetration into canopy. Apply preventative applications starting at bloom, especially in fields with a history of the disease. Removing infected fruit from heavily infested areas of fields have been shown to reduce inoculum levels and help reduce spread of the disease if done early.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Beginning at flowering, on a 7 day schedule, apply one of the following:						
M03	mancozeb 75DF	1.5 to 3.0 lb/A	mancozeb	7	24	N
M05	chlorothalonil 6F	1.5 pt/A	chlorothalonil	3	12	N
Tank mix one of the above WITH ONE of the following fungicides and rotate:						
3 + 7	Aprovia Top 1.62EC	10.5 to 13.5 fl oz/A	difenoconazole + benzovindiflupyr	0	12	--
3 + 11	Topguard EQ4.29SC	4.0 to 8.0 fl oz/A	flutriafol + azoxystrobin	0	12	--
3 + 11	Quadris Top 1.67SC	8.0 to 14.0 fl oz/A	difenoconazole + azoxystrobin	0	12	--
7 + 11	Priaxor 4.17SC	4.0 to 8.0 fl oz/A	fluxapyroxad + pyraclostrobin	7	12	N
11	Cabrio 20EG	8.0 to 12.0 oz/A	pyraclostrobin	0	12	N
11	azoxystrobin 2.08F	6.2 to 15.5 fl oz/A	azoxystrobin	0	4	N
NOTE: DO NOT make more than 2 consecutive applications of any FRAC code 11 fungicide.						

Bacterial Leaf Spot (BLS)

The best method for limiting loss due to BLS is to plant X10R cultivars. Races 1 to 10 have been identified in areas of the region. Several new bell pepper cultivars have resistance to some or all races (X10R) of the pathogen (see table Recommended Varieties). In fields with a history of BLS, only plant cultivars that are X10R. When producing transplants, be sure to use seed treated with hot water (described above) or Clorox. Purchase heat-treated seed or disease-free transplants. Prior to transplanting, apply Agri-Mycin 17 (FRAC code 25, streptomycin) sprays when the first true leaves appear and continue every 4 to 5 days until transplanting (1.0 lb/100 gal, 1.25 tsp/gal, REI 12 h). Streptomycin cannot be applied after transplanting. Copper resistance has been detected in areas of the Mid-Atlantic region.

Losses may be reduced by maintaining a high level of fertility, which will stimulate additional leaf formation and help replace leaves lost due to BLS. However, sufficient restraint with fertilization must be done to ensure that plants do not become overly vegetative, or fruit set may be severely reduced. Where disease is present or anticipated, do not work in fields when plant surfaces are wet. Disk fields as soon as possible after the growing season is finished. This will hasten breakdown of the crop debris that is harboring the bacteria and minimize overwintering of the bacteria in the field.

Field sprays to help reduce spread: If growing susceptible varieties or varieties showing symptoms of the disease, apply a fixed copper + mancozeb at labeled rates. If necessary, begin preventative fungicide applications shortly after transplanting and repeat every 7 to 10 days, especially if symptoms of BLS are present during transplant production.

Code	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
Tank mix the following beginning shortly after transplanting and repeat every 7 days:						
M01	copper (OMRI)[1,2,3]	1.0 lb ai/A	copper	0	see label	N
M03	mancozeb 75DF	1.5 lb/A	mancozeb	5	12/24	N
The following is a <u>plant defense activator</u> and preventative applications should begin prior to the onset of symptoms.						
P01	Actigard 50WG[4]	0.33 to 0.75 oz/A (see label)	acibenzolar-S-methyl	14	12	N

[1]Copper-based OMRI listed products for suppression of BLS are available; see labels for rates. [2]Copper can be tank mixed with mancozeb to also help reduce Anthracnose Fruit Rot. [3]Copper resistance has been detected in the Mid-Atlantic region. [4] Improper use may cause stunting, see label for rates and specifics

Bacterial Soft Rot in Harvested Fruit

During periods of humid weather, the stem ends of harvested peppers may turn brown due to bacterial soft rot. If necessary, pack peppers without washing to minimize soft rot. If peppers must be washed, maintain 25 ppm of chlorine in the water (1 tbs Clorox/8 gal water). Avoid washing peppers with water more than 10°F (6°C) cooler than the fruit temperature to prevent movement of bacteria into the stem end of the fruit.

Phytophthora Blight

Plant loss can be severe in all pepper types. Phytophthora blight typically develops in low-lying areas after rain and can spread quickly. Planting on a ridge or raised, dome-shaped bed will help provide better soil drainage. Use a minimum 3-year crop rotation with crops other than peppers, cucurbits, lima beans, snap beans, eggplants, or tomatoes. In fields with low-lying or wet areas, plant only Phytophthora-tolerant or -resistant cultivars. In heavily infested fields with a known history of Phytophthora blight, plant only resistant or tolerant cultivars to help reduce plant losses. **If mefenoxam-insensitivity is known, plant only resistant or tolerant cultivars. Do not use mefenoxam or metalaxyl where insensitivity is present.**

Code	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**		**REI (h)**	**Bee TR**
	For control of the <u>CROWN ROT</u> phase of Phytophthora Blight, apply one of the following at transplanting and 30 days later.						
4	MetaStar 2E AG	4.0 to 8.0 pt/A[1]	metalaxyl	7		12	N
4	Ridomil Gold 4SL	1.0 pt/A[1]	mefenoxam	--		--	N
4	Ultra Flourish 2E	1.0 qt/A[1]	mefenoxam	--		--	N
21	Ranman 400SC	2.75 fl oz/A[2,3]	cyazofamid	0		12	L
43	Presidio 4SC	3.0 to 4.0 fl oz/A[3]	fluopicolide	2		12	L
49 + **4**	Orondis Gold	See labels[1,2,4]	oxathiapiprolin + mefenoxam	0		4	--
	For prevention of the <u>AERIAL STEM AND FRUIT ROT</u> phase of Phytophthora Blight, tank mix one of the following with fixed copper and rotate different modes of action.						
21	Ranman 400SC	2.75 fl oz/A	cyazofamid	0		12	L
40	Forum 4.17SC	6.0 fl oz/A	dimethomorph	4		12	N
40	Revus 2.08F	8.0 fl oz/A	mandipropamid	1		12	--
40 + 45	Zampro 525SC	14.0 fl oz/A	dimethomorph + ametoctradin	4		12	--
43	Presidio 4SC	3.0 to 4.0 fl oz/A	fluopicolide	2		12	L
49 + **4**	Orondis Gold	See label[2,4]	oxathiapiprolin + mefenoxam	0		4	--

[1]Apply at transplanting and 30 d later. [2]May also be applied via transplant water (see label for restrictions). [3]Apply Presidio or Ranman via drip between mefenoxam/metalaxyl applications. [4]If applying through drip, **do not apply as foliar application**, see label for restrictions.

Southern Blight (*Sclerotium rolfsii)*

High soil moisture and temperature favor disease development. Long crop rotations with corn and small grains help reduce disease incidence. Additionally, use the following in the transplant water. Consult label before use.

In Transplant Water						
Code	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
11	azoxystrobin 2.08F	15.5 fl oz/A as a directed spray	azoxystrobin	0	4	N
14	Terraclor 75WP	3.0 lb/100 gal of water, apply 0.5 pt/plant	pentachloronitrobenzene (PCNB)	AP	12	H

Verticillium Wilt

This soil-borne fungus can infect many crops including eggplant, tomato, pepper, potato, and strawberries and can survive in the soil for many years. A long, proper crop rotation is necessary to reduce losses. DO NOT grow tomato, potato, strawberries, or eggplant in rotation or consecutively in the same field and never plant other solanaceous crops, such as eggplants or tomatoes, between pepper plantings.

Viruses

Cooler than normal temperatures in the early season often result in virus-like Mosaic symptoms and distorted appearances in actively growing young transplants. In past instances, entire fields or blocks looked symptomatic. Early season transplants will grow out of problems over time as temperatures rise.

Aphid-transmitted viruses: **Alfalfa Mosaic Virus, Cucumber Mosaic Virus, Potato Virus X, Potato Virus Y, and Tobacco Etch Virus.**

Cucumber Mosaic Virus has caused problems in peppers in the Mid-Atlantic region the past few growing seasons. Infected fruit may develop small, irregular brown spots that run parallel on fruit. Young leaves may develop Mosaic symptoms. The identification of pepper viruses with laboratory tests can be difficult. Importantly, pepper virus will not be properly controlled with insecticide applications, but symptom expression can be delayed through their use. Since aphids transmit the virus, growers may wish to use yellow trap pans containing water to determine when mass flights of aphids occur. Repeated applications of a contact aphicide at those times are most beneficial.

Thrips-transmitted viruses: Tomato Spotted Wilt Virus (TSWV) and Impatiens Necrotic Spot Virus (INSV).

Resistant varieties should be used, especially in VA. TSWV can be severe on peppers during both greenhouse transplant and field production of the crop. INSV causes similar symptoms as TSWV, however, the virus is not as severe and does not limit production to the same extent. Both viruses are transmitted by a number of thrips species (*e.g.*, Western flower thrips) during the entire thrips life cycle. **DO NOT GROW ornamental bedding plants in the same greenhouse as pepper transplants, as thrips are known to transmit the virus from infected ornamental plants. Do not purchase or import transplants from southern states.** Monitor greenhouses and scout fields regularly for thrips. When thrips are observed in the field, treat with an insecticide, and rogue out any plant showing TSWV symptoms.

Mechanically transmitted viruses: Tobacco Mosaic Virus (TMV).

Use resistant varieties.

Potatoes

Recommended Varieties

When selecting varieties, consider market preferences, variety adaptation to local conditions, specific field problems and the susceptibility-tolerance to stress disorders. Use certified, disease-free “seed” (tuber or cut piece used for planting) of good quality from reputable source to maximize yield and quality. Depending on variety, production area and market, the crop take 90 to 160 days to mature and harvest.

Maturity Group	Varieties[1,2]	Table Stock[3]	Chipping[3]	Yield[3]	Spacing (in.)
Early	Andover	+++	+++	+	9-10
	Dark Red Norland D	++	No	+	8-10
	Envol	+++	No	++	8-10
	Michigan Purple (purple skin)	++	No	++	8-10
	Superior (S resistant, VW susceptible)	+++	+	++	8-12
	Vivaldi (yellow flesh)	+++	No	++	8-10
Midseason	Atlantic[4]	No	+++	+++	7- 9
	Chieftain (red skin)	++	No	++	7- 9
	Dakota Crisp	++	+++	+++	8-10
	Electra (pale yellow flesh) (S resistant)	++	No	+++	9-10
	Eva	++	++	++	8-10
	Harley Blackwell	++	+++	++	9-12
	King Harry (for organic production)	++	--	++	8-10
	Kueka Gold (pale yellow flesh)	++	+	+++	9-10
	NorDonna (red skin)	++	No	++	9-12
	Norkotah Russet	++	No	+	9-12
	Peter Wilcox (purple skin/yellow flesh)	++	No	++	8-10
	Purple Majesty (purple skin/purple flesh)	++	++	++	9-12
	Reba[5]	+++	++	++	7- 9
	Sebec	+	+++	++	8-10
	Yukon Gold[5] (yellow flesh)	+++	No	++	8-10
Late	Gold Rush	+++	No	++	8-10
	Katahdin (LR resistant)	++	No	+++	8-10
	Kennebec (VW susceptible, LB tolerant) (not for eastern VA)	++	No	+++	7-10
	Lehigh (yellow flesh)	+++	++	+++	8-10
	Marcy	++	+++	+++	7- 9
	Snowden (for chips only)	No	+++	++	8-10

[1]**Listed alphabetically within maturity group**. [2]LR=Leaf Roll, LB=Leaf Blight, S=Scab, VW=Verticillium Wilt. [3]+=fair, ++= good, +++= excellent. [4]Tubers are extremely susceptible to internal necrosis and hollow heart. [5]Tubers are susceptible to hollow heart during cool growing seasons. Apply one-third of the N at planting and sidedress the remainder when plants are 4-6 inches tall to help reduce hollow heart.

Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and Chapter B Soil and Nutrient Management. Your state’s soil test report recommendations and/or your farm’s nutrient management plan supersede the recommendations found below.

		Soil Phosphorus Level				Soil Potassium Level				
		Low	Med	High (Opt)	Very High	Low	Med	High (Opt)	Very High	
	N (lb/A)	P_2O_5 (lb/A)				K_2O (lb/A)				Nutrient Timing and Method
Potatoes[1,2]	150-180[3]	200	150	100	0[4]	300	200	100	0[4]	Total nutrient recommended
	50	200	150	100	0[4]	300	200	100	0[4]	Broadcast and disk-in
	100	0	0	0	0	0	0	0	0	Sidedress 4-5 weeks after planting
	0-30[3]	0	0	0	0	0	0	0	0	Adjust rate based on petiole nitrate testing at flowering

[1]Apply 1 lb/A of boron (B) with broadcast fertilizer; see also Table B-7. in Chapter B Soil and Nutrient Management. [2]Apply 20 to 30 lb/A of sulfur (S) for most soils. [3]For high yielding crop systems (>250 cwt/A), an extra split N application at flowering may be useful. [4] In VA, crop replacement values of 50 lb/A of P_2O_5 and 50 lb/A of K_2O are recommended on soils testing Very High; additionally total nitrogen should be maintained under 150 lb/A.

Plant Tissue Testing

Plant tissue testing can be a valuable tool to assess crop nutrient status during the growing season to aid with in-season fertility programs or to evaluate potential deficiencies or toxicities. Critical potato tissue test values for most recently matured leaves at first flower are: N 3-4 %, P 0.2-0.5 %, K 3-5 %, Ca 0.6-2 %, Mg 0.25-0.6% and S 0.2-0.5 %. For additional nutrients and other growth stages consult with a tissue testing laboratory or this web link at the University of Florida: *https://edis.ifas.ufl.edu/publication/ep081*.

Site Selection, Soil Preparation and Fertilization

The best soils are well-drained, deep, well aerated, sandy, and sandy loam soils high in organic matter (especially muck soils). Avoid heavy soils and soils that adhere to tubers. Ideally, the planting site should have a low to moderate slope to avoid water accumulation near the plants. Use crop rotation to decrease the incidence of soil-borne diseases. Avoid fields that have had potatoes in the past 2 years, and those with high nematode populations. Test the soil for nematodes and fertility. Soil compaction reduces the available space for water and oxygen, resulting in a substantial reduction of potato yield. Avoid field operations when the soil is too wet. Vary the depth of tillage from year to year to reduce the chances of developing a hard pan. Incorporate green manure crops and deep-rooted cover crops to help increase soil organic matter, improve soil drainage, and return considerable amounts of crop residue to the soil. Optimum soil pH is 5.5 to 6.5. All P and K can be applied before planting. Split the recommended N (See table: Recommended Nutrients Based on Soil Tests above).

Seed-Piece Treatment Use certified seed. See Disease Control below.

Planting and Spacing

The recommended planting dates are March 10 to April 5 in MD and coastal VA, March 20 to April 15 in DE, March 20 to April 25 in NJ, and March 25 to June 5 in PA. Space seed 7 to 12 inches apart in 34 or 36-inch rows. Use close spacing for large seed pieces and wider spacing for whole (B-size) seed. Use close spacing for potatoes that are to be marketed in 5 and 10-pound consumer packs, and for ‘Katahdin’ and ‘Kennebec’, which tend to produce few oversized tubers.

Irrigation

Soil moisture and irrigation management are key for the success of the crop (see Chapter C Irrigation Management). Shortage of water may reduce tuber size and increase deformation, but water excess may promote late blight and other soil-borne diseases. Overhead irrigation in combination with crop evapotranspiration estimations can be used to supply the crop irrigation requirements. The critical stage for irrigating potatoes is in early tuber formation and tuber bulking. Potatoes are extremely sensitive to both excessive and deficient water applications. An effective potato irrigation plan requires regular monitoring of the soil water content and an irrigation schedule based on quantitative measurements. Plant available soil water should be maintained above 65% to avoid yield and quality losses. The optimum range for planting is about 70-80%. Soils that are too wet may slow down soil warming and delay sprout development and emergence early in the season. Cool, wet soils can increase seed decay. Available soil water should be allowed to decrease to 60-65% at vine kill. Dry soils during vine kill will increase the chances of developing stem-end discoloration.

Harvest and Storage Considerations

Monitor environmental conditions prior to harvest to determine potential incidence of a disorder associated with adverse conditions (see Common Physiological Disorders below). Pre-harvest conditioning in potato is critical to set the skin and facilitate harvest. In early harvests, vine killing can hasten or improve skin set on relatively immature potatoes, thus reducing tuber damage during harvest, grading, packing, and shipping. Tubers stop growing after vine killing and proper skin set improves shelf life, promotes retention of potato quality during transport, and improves eye appeal. Chemical vine killing is the most common method (see Vine Killing below), but mechanical vine killing (mowing) is also used. Vines of potatoes going into storage should be completely dead at least 14-21 days before harvest. Use potato chain diggers or other means of bulk-harvest with appropriate design to reduce bruises. After harvest, healing of cuts and bruises is most rapid at 50-60°F (10-16°C) tuber temperature and 90-95% relative humidity without water condensation. This temperature should be maintained for 2-3 weeks at the beginning of the storage period. The temperature should then be lowered to 40°F (4°C) for table stock or seed potatoes.

Potatoes for processing are stored at 45-50°F (7-10°C). If a rot-producing agent such as field frost, late blight, or soft rot is present, the curing period should be eliminated, air flow increased, and the temperature lowered to 45°F (7°C) as soon as possible. Monitor the storage daily and, if the rot continues, sell the crop immediately.

Common Physiological Disorders

Disorders that are associated with adverse environmental conditions or cultural practices are listed below.

Disorder	Primary Cause	Occurrence	Market Effect
Blackheart	low oxygen, wet soil	bulking, storage	quality, poor processing
Brown center and hollow heart	rapid growth after stress	early to mid-bulking	quality, poor processing
Chaining	hot soil	mid-bulking	yield (size)
Chilling, Freezing	low temperature	harvest, storage	quality, yield prone to rots
Deformation	growth stops and go	bulking	quality
Greening	Light	bulking, storage	quality
Growth crack	wet/dry soil	bulking	quality
Heat necrosis	heat, acid soil (low Ca)	harvest	quality, yield, poor processing
Heat and hair sprouting	hot soil	late bulking, early storage	quality, yield, poor processing
Internal sprouting	piling, sprout inhibition	storage	quality, poor seed
Jelly End, Glassy End	fast vine death, low moisture	harvest	poor processing
Swollen lenticel	wet soil	bulking, harvest	storage rots
Vascular discoloration	fast vine death, low moisture	harvest	poor processing

Air Pollution

Symptoms appear as tiny spots of brown tissue on the upper surface of leaves and a bronzing of the lower surfaces. Some varieties (*e.g.*, Snowden) are particularly sensitive.

Vine Killing

Vine desiccation facilitates harvesting by reducing potato and weed foliage, and to set the skin when done 2 to 3 weeks before harvest. Decisions as to when to kill the vines are based on market, demand for a given size, and the need for non-skinned tubers.

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
10	Rely 280 2.34L, Scout 2.34L, Interline 2.34L	21 fl oz/A	**glufosinate**	0.38 lb/A	9	12
-Apply at the beginning of natural vine senescence in a single application. Cover vines thoroughly. -**Do not** apply to potatoes grown for seed. **Do not** plant treated areas with wheat, barley, and other small grains until 30 or more days after application. Refer to label for rotational restrictions. The presence of heavy or dense vines may require an application of another desiccation product (*i.e.*, Reglone). Rainfastness is 4 h. **Do not** apply more than 1 application per harvest.						
22	Reglone 2SL	1 to 2 pt/A	**diquat**	0.25 to 0.5 lb/A	7	24
-Add a non-ionic surfactant 0.5% v/v (2 qt/100 gal). Ground application in a minimum of 20 gal/A of water. -**Do not** apply to drought stressed potatoes. If a second application is necessary, allow at least 5 days between applications. -Rainfastness is 30 min. Maximum application of Reglone per season is 4 pt/A						

Other Labeled Products These products are labeled but limited local data is available; and/or are labeled but not recommended in our region due to potential crop injury concerns.

Group	Product Name (*=Restricted Use)	Active Ingredient
14	Aim	**carfentrazone**
14	Vida	**pyraflufen**
22	Generic paraquat*	**paraquat**
--	Defol 5	**sodium chlorate**

Sprout Inhibitors

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
--	Sprout Nip 3EC	Apply at 1% emulsion	**chlorpropham**	0.01 lb ai/1100 lb potatoes	--	--
-Refer to label for respirator and other PPE requirements. **Do not** use on seed potatoes. -Use to treat potatoes after storage and washing; use only after bruises and cuts have healed (normally a minimum of 2 weeks) -Use at 1% emulsion by diluting 1 gal of Sprout Nip 3EC to 35 gal of water. -Apply at a rate of 1 qt of 1% emulsion per 20 bags of potatoes (100 lb/bag). Only one application is allowed. -Spray uniformly across rollers moving the potatoes.						
--	MH-30	5 lb/A	**maleic hydrazide**	0.01 lb ai/1100 lb potatoes	--	12
-Apply in minimum of 30 gallons of water per acre. Apply 2 to 3 weeks past full bloom. Applying too early will result in undersized tubers.						

Weed Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.

Recommended Herbicides

1. Identify the weeds in each field and select recommended herbicides. More information is available in the "Herbicide Effectiveness on Common Weeds in Vegetables" (Table E-3) in Chapter E Pest Management.

2. Minimize herbicide resistance development. Identify the herbicide mode of action group number and follow recommended good management practices; **bolded group numbers in tables below are herbicides at higher risk for selecting resistant weed populations.** Include non-chemical weed control whenever possible.

<table>
<tr><th colspan="7">1. Non-Selective or Burndown</th></tr>
<tr><th>Group</th><th>Product Name
(*=Restricted Use)</th><th>Product Rate</th><th>Active Ingredient</th><th>Active Ingredient Rate</th><th>PHI
(d)</th><th>REI
(h)</th></tr>
<tr><td>9</td><td>Roundup PowerMax 4.5L
"Generic" glyphosate 3L</td><td>16 to 32 fl oz/A
24 to 48 fl oz/A</td><td>glyphosate</td><td>0.75 to 1.10 lb acid equivalent/A</td><td>--</td><td>4</td></tr>
<tr><td colspan="7">-Apply prior to planting. Some glyphosate formulations may require an adjuvant, refer to label.
-Glyphosate controls many perennial weeds as well as annuals if applied when the weed is actively growing and has reached the stage of growth listed on the label. Repeat applications are allowed, with maximum application of 5.3 qt/A per year.</td></tr>
<tr><td>22</td><td>Gramoxone SL 2.0*
Gramoxone SL 3.0*</td><td>1 to 2 pt/A
0.7 to 1.3 pt/A</td><td>paraquat</td><td>0.25 to 0.5 lb/A</td><td>--</td><td>24</td></tr>
<tr><td colspan="7">-Apply up to ground cracking, before potato has emerged. Always include an adjuvant (nonionic surfactant or crop oil concentrate).
-Tank mix with appropriate herbicides for residual weed control. Paraquat may not control established grasses. Spray coverage is essential for optimum control. -Rainfastness 30 min. -A maximum of 3 applications per year are allowed.
-Restricted-use pesticide. Only certified applicators, who successfully complete the paraquat-specific training, can mix, load, or apply paraquat. Application of paraquat "under the direct supervision" of a certified applicator is no longer allowed. Required training link (https://campus.extension.org/enrol/index.php?id=2201); certified applicators must repeat training every three years.</td></tr>
</table>

<table>
<tr><th colspan="7">2. Soil-Applied (Preemergence/Drag-Off)</th></tr>
<tr><th>Group</th><th>Product Name
(*=Restricted Use)</th><th>Product Rate</th><th>Active Ingredient</th><th>Active Ingredient Rate</th><th>PHI
(d)</th><th>REI
(h)</th></tr>
<tr><td>2</td><td>Matrix 25DF or
Solida 25DF</td><td>1.0 to 1.5 oz/A</td><td>rimsulfuron</td><td>0.0156 to 0.023 lb/A</td><td>60</td><td>4</td></tr>
<tr><td colspan="7">-Apply immediately after hilling or drag-off. -Apply with nonionic surfactant at 0.25% v/v (1.0 qt/100 gal of spray solution) if weeds are emerged at the time of application. -Controls many weeds including foxtail species, pigweed species, wild mustard, and wild radish. Suppresses common lambsquarters, common ragweed, jimsonweed, morningglory species, and yellow nutsedge. Tank mix with other residual products to improve spectrum of weed control. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. -Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled.
-Repeated applications may be needed to control certain perennial grasses.
-Temporary chlorosis may occur to potatoes under stress from drought, cold temperatures, high temperatures, or extreme temperature variations.
-Do not tank mix with or apply within 1 week before or after any pesticide unless labeled. The risk of crop injury may be increased, or reduced control of grasses may result. Matrix is an ALS inhibiting herbicide and resistant weed populations are common in the region. Do not use Group 2 herbicides repeatedly in the same field. -Maximum for Matrix: 2.5 oz/A per year.</td></tr>
<tr><td>3</td><td>Prowl H2O 3.8CS
Prowl 3.3 EC</td><td>1.5 to 3.0 pt/A
1.8 to 3.6 pt/A</td><td>pendimethalin</td><td>0.71 to 1.43 lb/A</td><td>--</td><td>24</td></tr>
<tr><td colspan="7">-Apply preemergence after planting, but before potatoes and weeds emerge, or after drag-off.
-Activity of Prowl H2O is improved by incorporation. Apply preemergence incorporated after planting but before potatoes and weeds emerge. Where drag-off is practiced, apply and incorporate before, at, or after drag-off, but before potatoes and weeds emerge.
-Ensure incorporation equipment does not damage seed pieces or elongating sprouts.
-Prowl H2O controls certain broadleaf weeds and annual grasses. Does not control yellow nutsedge.
-Use lower rates on coarse-textured soils with < 3% organic matter and higher rates on medium- and fine-textured soil with > 3% organic matter. Tank mix with appropriate postemergence herbicides if weeds are emerged at time of application. Tank mix with other residual herbicides such as Lorox or Metribuzin to improve broadleaf control.
-Application to 'White Rose' variety during or followed by cool and/or wet conditions may result in crop injury.
-A maximum of 1 application per season is allowed.</td></tr>
<tr><td>3</td><td>Sonalan HFP 3EC</td><td>1.3 to 2.67 pt/A</td><td>ethalfluralin</td><td>0.49 to 1.0 lb/A</td><td>--</td><td>24</td></tr>
<tr><td colspan="7">-Apply after planting but before potato emergence.
-Use lower rates on coarse-textured soils and higher rates on medium- and fine-textured soil. -Must be incorporated for maximum effectiveness. Rainfall or irrigation (0.5 to 1 inch) is sufficient for incorporation. If rainfall or irrigation does not occur within 2 days of application, mechanical incorporation in the top 2 to 3 inches of soil is recommended. Ensure incorporation equipment does not</td></tr>
</table>

2. Soil-Applied (Preemergence/Drag-Off) Sonalan - continued next page

2. Soil-Applied (Preemergence/Drag-Off) Sonalan - continued

Group	Product Name	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
damage seed pieces or elongating sprouts. -Sonalan controls certain broadleaf weeds and annual grasses. Does not control yellow nutsedge, and only provides suppression of eastern black nightshade. -Maximum application is 2.67 pt/A/season.						
5	Metribuzin 75DF Metribuzin 4L	0.33 to 0.66 lb/A 0.5 to 1 pt/A	**metribuzin**	0.25 to 0.5 lb/A	60	12
-Apply just prior to emergence or after drag-off. Metribuzin primarily controls broadleaf weeds and is weak on grasses. -Tank mix with Dual Magnum or Prowl H2O or use in addition to Eptam for preemergence annual grass control. -Pre-mixes of Dual Magnum and metribuzin are sold under the trade names Boundary and Moccasin MTZ. -Metribuzin has some postemergence activity. To get consistent control, apply metribuzin before weeds are 1 inch tall. -Tank mix with appropriate postemergence herbicides if weeds are emerged at time of application. -Preemergence application to 'Atlantic' and 'Norland' or to any early maturing, smooth, white- or red-skinned potato varieties, may cause crop injury, especially under adverse weather conditions and when higher labeled rates are used. -'Atlantic', 'Bellchip', 'Centennial', 'Chipbell', and 'Shepody' are sensitive to metribuzin and may be injured by preemergence applications under adverse weather conditions on coarse soils, under high soil pH, with higher rates, and with mechanical incorporation. -Maximum for metribuzin 75DF: May be applied once preemergence and once postemergence. **Do not** exceed 1.33 lb/A per season of metribuzin 75DF or 2 pt/A of metribuzin 4L.						
7	Lorox 50DF Linex 4L	0.8 to 2.0 lb/A 0.75 to 2 pt/A	**linuron**	0.4 to 1.0 lb/A	--	24
-Apply just prior to emergence or after drag-off. -Primarily controls broadleaf weeds and is weak on grasses. Tank mix with Dual Magnum for preemergence annual grass control. -Use lower rates on coarse-textured soil low in organic matter and higher rates on medium- or fine-textured soils with greater organic matter. Linuron has some postemergence activity. To get consistent control, apply just before or when weed seedlings emerge. If weeds are emerged add a nonionic surfactant at 0.5% v/v (2 qt/100 gal spray solution). -Maximum for Lorox: 3 lb/A per year. Maximum for Linex: 3 pt/A per year.						
8	Eptam 7E	3.4 to 5.1 pt/A	**EPTC**	3.0 to 4.5 lb/A	30	12
-Apply at one of the following timings: 1) just before planting and disking. For plantings before April 1, Eptam may reduce early vigor and yields slightly; 2) just after drag-off and incorporate with 1 or 2 cultivations by a spike-tooth harrow or similar piece of equipment; and 3) just before first or second cultivation. -Eptam controls annual grasses, yellow nutsedge, and a few broadleaf weeds. Tank mix with Lorox or metribuzin to improve broadleaf weed control. Maximum for Eptam: 14 pt/A per season.						
14	Reflex 2SL	0.75 to 1.0 pt/A	**fomesafen**	0.188 to 0.25 lb/A	70	24
-Apply after planting but before potato emergence. **Do not** apply preplant incorporated nor apply to emerged potatoes or severe injury will occur. Reflex primarily controls broadleaf weeds and is weak on grasses. -Tank mix with Dual Magnum, Prowl H2O, or use in addition to Eptam for preemergence annual grass control. The Reflex rate labeled for potato is lower than for other crops due to crop safety concerns. -Reflex has postemergence activity. To get consistent control, apply before weeds reach 4 inches. -Potato varieties vary in response to Reflex. Determine crop tolerance before using. -Maximum for Reflex 2SL: 1 pt/A per season on potatoes. Maximum fomesafen for all crops: NJ and most of PA 0.313 lb ai/A in alternate years; DE, MD, VA, and parts of PA 0.375 lb ai/A in alternate years.						
15	Dual Magnum 7.62E	1.0 to 2.0 pt/A	***s*-metolachlor**	0.96 to 1.91 lb/A	60	24
-Apply preplant incorporated, postplant incorporated up to drag-off, preemergence, delayed preemergence, or after drag-off prior to emergence of potatoes and weeds. If incorporate, use appropriate equipment to evenly distribute the herbicide into the top 2 to 3 inches of soil. Ensure incorporation equipment does not damage seed pieces or elongating sprouts. -Dual Magnum controls most annual grasses (except Texas panicum), small seeded broadleaf weeds, and suppresses yellow nutsedge. -Tank mix with Lorox or metribuzin for additional broadleaf weed control. -Pre-mixes of Dual Magnum and metribuzin are sold under the trade name Boundary or Moccasin MTZ. -If cool, wet soil conditions occur after application, *s*-metolachlor may delay maturity and/or reduce yield of 'Superior' and other early maturing potato varieties. **Do not** use on muck or peat soils. **Do not** apply both a preemergence and an incorporated treatment. -Maximum for Dual Magnum: 3.6 pt/A per crop season.						
15	Outlook 6E	12 to 21 fl oz/A	**dimethenamid**	0.56 to 0.98 lb/A	40	12
-Apply preemergence after planting or dragoff, but before potatoes and weeds emerge. -Apply as a single application. -Application under cold conditions may cause delayed emergence or early season stunting. -Outlook controls annual grasses and broadleaves such as pigweed, lambsquarters, nightshade, common ragweed etc. Suppresses yellow nutsedge. -Use lower rates on coarse-textured soils with < 3% organic matter and higher rates on medium- and fine-textured soil with > 3% organic matter. Tank mix with appropriate postemergence herbicides if weeds are emerged at time of application. Tank mix with other residual herbicides such as Lorox or Metribuzin to improve broadleaf control.						

3. Postemergence

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
1	Shadow 3EC Select 2EC Select Max 0.97EC	4 to 10.67 fl oz/A 6 to 8 fl oz/A 9 to 32 fl oz/A	**clethodim**	0.07 to 0.242 lb/A	30	24
	Poast 1.5EC	1.0 to 2.5 pt/A	**sethoxydim**	0.2 to 0.47 lb/A	30	12

3. Postemergence (Shadow, Select, Select Max, Poast) - continued next page

3. Postemergence (Shadow, Select, Select Max, Poast) - continued

-**Select 2EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). **Select Max**: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution). **Shadow 3EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution) for large or stressed grasses; use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution) when crop safety is a concern. **Poast**: use COC at 1.0% v/v.
-**The use of COC may increase the risk of crop injury when hot or humid conditions prevail**. To reduce the risk of crop injury, omit additives or switch to NIS when grasses are small and soil moisture is adequate.
-Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control.
-Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will **not** be controlled. Controls many annual and certain perennial grasses, including annual bluegrass, but Poast is preferred for goosegrass control. For best results, treat annual grasses when they are actively growing and before tillers are present. Control may be reduced if grasses are large or under hot or dry weather conditions.
-Repeated applications may be necessary to control certain perennial grasses. If repeat applications are necessary, allow 14 days between applications. Rainfastness is 1 h.
-**Do not** tank mix with or apply within 2 to 3 days of any other pesticide, unless labeled, as this may increase the risk of crop injury or reduce the control of grasses.
-**Do not** apply more than 8 fl oz/A of Select in a single application and **do not** exceed 2 pt/A for the season; **do not** apply more than 32 fl oz/A of Select Max in a single application and **do not** exceed 4 pt/A for the season.
-**Do not** apply more than 10.67 fl oz/A of Shadow 3EC in a single application and **do not** exceed 21.33 fl oz/A for the season
-**Do not** apply more than 2.5 pt/A Poast in a single application and **do not** exceed 5 pt/A for the season.

2	Matrix 25DF or Solida 25DF	1.0 to 1.5 oz/A	**rimsulfuron**	0.0156 to 0.023 lb/A	60	4

-Apply early postemergence; typically weeds at 1 inch tall or less; crop stage is not defined on label.
-Apply with nonionic surfactant at 0.25% v/v (1.0 qt/100 gal of spray solution).
-Controls many small weeds including foxtail species, pigweed species, wild mustard, and wild radish. Suppresses common lambsquarters, common ragweed, jimsonweed, morningglory species, and yellow nutsedge.
-Temporary chlorosis may occur to potatoes under stress from drought, cold or high temperatures, or extreme temperature variations.
-Matrix provides both residual and postemergence control of susceptible weed species. Matrix is an ALS inhibiting herbicide and resistant weed populations are common in the region. **Do not** use Group 2 herbicides repeatedly in the same field.
-Rainfastness is 4 h.
-Maximum for Matrix: 2.5 oz/A per year.

5	Metribuzin 75DF Metribuzin 4L	0.33 to 0.66 lb/A 0.5 to 1 pt/A	**metribuzin**	0.25 to 0.50 lb/A	60	12

-Apply just prior to emergence or after drag-off. Metribuzin primarily controls broadleaf weeds and is weak on grasses.
-Tank mix with Dual Magnum or Prowl H2O or use in addition to Eptam for preemergence annual grass control.
-Metribuzin has some postemergence activity. To get consistent control, apply metribuzin before weeds are 1 inch tall.
-Tank mix with appropriate postemergence herbicides if weeds are emerged at time of application.
-Postemergence application can used only on russet or white-skinned varieties that are not early maturing. **Do not** use on red-skinned or early maturing, smooth, white-skinned varieties.
-Potato varieties vary in sensitivity to metribuzin. Determine tolerance on a trial basis before using on field scale. 'Atlantic', 'Bellchip', 'Centennial', 'Chipbell', and 'Shepody' are sensitive to metribuzin. Avoid postemergence applications to these varieties.
-Apply only if there have been at least three successive sunny days prior to application. May cause some chlorosis or minor necrosis.
-Maximum for metribuzin 75DF: 0.66 lb/A postemergence or metribuzin 4L: 1 pt/A. May be applied once preemergence and once postemergence. -**Do not** exceed 1.33 lb/A per season of metribuzin 75DF or 2 pt/A per season of metribuzin 4L. -Rainfastness is 6 h.

4. Other Labeled Herbicides These products are labeled but limited local data are available; and/or are labeled but not recommended in our region due to potential crop injury concerns.

Group	Product Name (*=Restricted Use)	Active Ingredient
2	League	**imazosulfuron**
3	Treflan	**trifluralin**
14	Chateau	**flumioxazin**
15	Zidua SC	**pyroxasulfone**

Insect Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F. Recommended Insecticides

Soil Pests

Wireworms

See also section E 3.1. Soil Pests - Detection and Control.

(continued next page)

Wireworms - continued

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
Preplant Application: Broadcast and incorporate just before planting.						
1B	Mocap EC*	2/3 to 1.0 gal/A (broadcast), 4.4 fl oz/1000 row ft (banded)	ethoprop	AP	48	H
3A	Brigade 2EC*, others	9.6 to 19.2 fl oz/A	bifenthrin	21	12	H
3A	Capture LFR*	12.75 to 25.5 fl oz/A	bifenthrin	n/a	12	H
Planting Application						
1B	Mocap EC*	2/3 to 1.0 gal/A (broadcast), 4.4 fl oz/1000 row ft (banded)	ethoprop	AP	48	H
1B	Thimet 20G*	Light or sandy soil: 8.5-11.3 oz/1000 ft Heavy or clay soil: 13-17.3 oz/1000 ft	phorate	90	48	H
2B	Regent 4SC*	2.9 to 3.2 fl oz/A (see label for rate based on row spacing)	fipronil	90	0	H
3A	Brigade 2EC*, others	9.6 to 19.2 fl oz/A	bifenthrin	21	12	H
3A	Capture LFR*	12.75 to 25.5 fl oz/A	bifenthrin	n/a	12	H
3A	Ethos XB*	12.75 to 25.5 fl oz/A	bifenthrin + *Bacillus amyloliquefaciens*	n/a	12	H
3A+4A	Brigadier*	16.0 to 25.6 fl oz/A	bifenthrin +imidacloprid	21	12	H
30	Nurizma	0.08 to 0.16 fl oz/ 1000 row ft	broflanilide	AP	12	H
Lay-by Application						
1B	Thimet 20G*	8.5 to 11.3 oz/1000 ft	phorate	90	48	H
3A	Brigade 2EC*, others	3.2 to 9.6 fl oz/A	bifenthrin	21	12	H
3A	Capture LFR*	12.75 to 25.5 fl oz/A	bifenthrin	n/a	12	H
3A	Ethos XB*	12.75 to 25.5 fl oz/A	bifenthrin + *Bacillus amyloliquefaciens*	n/a	12	H
Systemic Foliar Application at Flowering						
23	Movento	4.0 to 5.0 fl oz/A	spirotetramat	7	24	L
23	Movento HC	2.0 to 2.5 fl oz/A	spirotetramat	7	24	L

Above-ground Pests

Aphids

Insecticide treatments are recommended when aphid counts exceed 2 per leaf prior to bloom, 4 per leaf during bloom, and 10 per leaf within 2 weeks of vine kill. Apply one of the following formulations:

Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	1.5 to 3.0 pt/A	methomyl	6	48	H
1B	Dimethoate 400	0.5 to 1.0 pt/A	dimethoate	0	48	H
3A	Pyrethroid insecticides registered for use on Potatoes: see table at the end of Insect Control.					
4A	Neonicotinoid insecticides registered for use on Potatoes: see table at the end of Insect Control.					
4D	Sivanto Prime or 200SL	7.0 to 14.0 fl oz/A	flupyradifurone – **foliar**	7	4	M
4C	Transform WG	0.75 to 1.5 oz/A	sulfoxaflor	7	24	H
4C + 3A	Ridgeback*	4.5 to 13.8 fl oz/A	sulfoxaflor + bifenthrin	21	24	H
7C + 23	Senstar (broad mite only)	8.0 to 10.0 fl oz/A	pyriproxyfen + spirotetramat	7	24	L
9B	Fulfill 50WDG	2.75 to 5.5 oz/A	pymetrozine	14	12	L
21A	Torac	14.0 to 2.01 fl oz/A	tolfenpyrad	21	12	H
23	Movento	4.0 to 5.0 fl oz/A	spirotetramat	7	24	L
23	Movento HC	2.0 to 2.5 fl oz/A	spirotetramat	7	24	L
28 + 6	Minecto Pro*	10.0 fl oz/A	cyantraniliprole + abamectin	14	12	H
29	Beleaf 50SG	2.0 to 2.8 oz/A	flonicamid	7	12	L

Colorado Potato Beetles (CPB) – Preplant or Planting Application

Pesticide Resistance Management:

Do not rely exclusively on the neonicotinoid class of insecticides (Class 4: Actara, Assail, Cruiser, Gaucho, imidacloprid, Leverage 360, Platinum, Scorpion, or Venom) for CPB control. It is important to use all available effective pest management strategies, including crop rotation, pest scouting, treatment thresholds, and alternative (different class) insecticides, such as abamectin (Agri-Mek), Blackhawk, Coragen, Entrust, Radiant, Rimon, Verimark, Voliam Xpress, or Vydate.

For rotated fields adjacent to CBP overwintering sites or to previous year's potato fields, most of the colonizing adults can be killed by treating only a strip of rows along the field edge where the invasion front is expected. Fields should still be monitored for beetles and other insect pests throughout the season.

DO NOT use foliar applications of any neonicotinoid insecticide (clothianidin, imidacloprid, thiamethoxam, dinotefuron, acetamiprid) in fields previously treated with seed-treatment or at-planting neonicotinoids.

Apply one of the following formulations. PREPLANT OR PLANTING APPLICATION						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
4A	Neonicotinoid insecticides registered for use on Potatoes: see table at the end of Insect Control.					
28	Verimark	6.75 to 13.5 fl oz/A	cyantraniliprole	AP	4	H

Colorado Potato Beetles - Postemergence Application

Rotation to non-solanaceous crops (crops other than potato, tomato, eggplant, and pepper) is extremely important in reducing CPB problems. Avoid applying late-season sprays to prevent the buildup of insecticide-resistant beetles.

Beginning at plant emergence, sample fields weekly for CPB to determine the need to spray. Select at least 10 sites per field along a V- or W-shaped path throughout the field. At each site, select 1 stem from each of 5 adjacent plants and count and record all adults, large larvae (larger than half-grown), and small larvae (smaller than half-grown). If more than 50 adults or 75 large larvae or 200 small larvae are counted per 50 stems, treatment is recommended. Yield loss because of CPB feeding depends on the age of the potato plant. 'Superior' variety (short season) cannot compensate for early season defoliation by overwintered beetles, but during the last 30 days of the season, 'Superior' can withstand up to 50% defoliation without yield loss.

Note: Several of these insecticides may no longer be effective in certain areas due to CPB resistance. Check with your county Extension agent for most effective control.

Apply one of the following formulations. POSTEMERGENCE APPLICATION						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1B	Imidan 70W	1.33 lb/A	phosmet	7	120	H
3A	Pyrethroid insecticides registered for use on Potatoes: see table at the end of Insect Control.					
4A	Neonicotinoid insecticides registered for use on Potatoes: see table at the end of Insect Control.					
4D	Sivanto Prime or 200SL	10.5 to 14.0 fl oz/A	flupyradifurone	7	4	M
5	Blackhawk 36WG	1.7 to 3.3 oz/A	spinosad	7	4	M
5	Radiant SC	4.5 to 8.0 fl oz/A	spinetoram	7	4	M
6	Agri-Mek SC*	1.75 to 3.5 fl oz/A	abamectin	14	12	H
11A	Trident (OMRI)	3.0 to 6.0 qt/A	*Bacillus thuringiensis tenebrionis*	0	4	L
15	Rimon 0.83EC	6.0 to 12.0 fl oz/A	novaluron	14	12	M
17	Trigard 75WSP	2.66 to 5.32 oz/A	cyromazine	17	12	H
21A	Torac	14 to 21 fl oz/A	tolfenpyrad	21	12	H
22	Avaunt 30WDG, Avaunt eVo	3.5 to 6.0 oz/A	indoxacarb	7	12	H
28	Coragen 1.67SC Coragen eVo	3.5 to 5 fl oz/A 1.2 to 2.5 fl oz/A	chlorantraniliprole - **foliar**	14	4	L
28	Exirel	5.0 to 13.5 fl oz/A	cyantraniliprole	7	12	H
28	Vantacor	1.2 to 2.5 fl oz/A	chlorantraniliprole - **foliar**	14	4	L
28 + 3	Elevest*	5.6 to 9.8 fl oz/A	bifenthrin + chlorantraniliprole	21	12	H
28 + 6	Minecto Pro*	5.5 to 10.0 fl oz/A	cyantraniliprole + abamectin	14	12	H
UN	Azatin O, Aza-Direct, Ecozin, Neemix (OMRI)	Refer to individual labels for rates	azadirachtin	0	4	L
UN+3A	Azera (OMRI)	2.0 to 35 pt/A	azadirachtin + pyrethrins	0	12	H

Cutworms
See also section E 3.1. Soil Pests - Detection and Control.

Present during July and August. Especially troublesome to tubers where soil cracking occurs. Variegated cutworms feed on lower leaves and petioles, and protective sprays should be applied if numbers exceed 6 worms per plant or foliar loss is more than 10%. Black cutworms are largely underground feeders but will occasionally feed on leaves.

Apply one of the following formulations. Note: No materials are effective if larvae do not feed above ground (foliar and systemic insecticides are ineffective). Several spray applications may be required for control.

Cutworms - continued

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
1A	Lannate LV*	1.5 pt/A	methomyl	6	48	H
1A	Sevin XLR Plus	1.0 to 2.0 qt/A	carbaryl	7	12	H
3A	Pyrethroid insecticides registered for use on Potatoes: see table at the end of Insect Control.					

European Corn Borers (ECB)

Proper timing of ECB sprays is critical. Apply the first spray when 10% of the stems have entry holes in fresh market varieties or 25% in processing varieties. Make 2 to 3 applications on a 5-10-day schedule. Consult your county Extension agent and/or area pest management newsletter.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
3A	Pyrethroid insecticides registered for use on Potatoes: see table at the end of Insect Control.					
4A	Neonicotinoid insecticides registered for use on Potatoes: see table at the end of Insect Control.					
5	Blackhawk 36WG	1.7 to 3.3 oz/A	spinosad	7	4	M
5	Radiant SC	6.0 to 8.0 fl oz/A	spinetoram	7	4	M
15	Rimon 0.83EC	6.0 to 12.0 fl oz/A	novaluron	14	12	M
22	Avaunt 30WDG, Avaunt eVo	3.5 to 6.0 oz/A	indoxacarb	7	12	H
28	Coragen 1.67SC Coragen eVo	3.5 to 7.5 fl oz/A 1.2 to 2.5 fl oz/A	chlorantraniliprole - **foliar**	14	4	L
28	Exirel	7.0 to 13.5 fl oz/A	cyantraniliprole	7	12	H
28	Verimark	10.0 to 13.5 fl oz/A	cyantraniliprole	AP	4	H
28	Vantacor	1.2 to 2.5 fl oz/A	chlorantraniliprole - **foliar**	14	4	L
28 + 3	Elevest*	5.6 to 9.8 fl oz/A	bifenthrin + chlorantraniliprole	21	12	H
28 + 6	Minecto Pro*	5.5 to 10.0 fl oz/A	cyantraniliprole + abamectin	14	12	H

Flea Beetles

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	1.5 pt/A	methomyl	6	48	H
1B	Imidan 70W	1.33 lb/A	phosmet	7	120	H
3A	Pyrethroid insecticides registered for use on Potatoes: see table at the end of Insect Control.					
4A	Neonicotinoid insecticides registered for use on Potatoes: see table at the end of Insect Control.					

Potato Leafhoppers

Monitor fields for the buildup of leafhoppers from early June until early August. Treatment is suggested if leafhopper counts exceed 1 adult per sweep or 1 nymph per 10 leaves.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	1.5 to 3.0 pt/A	methomyl	6	48	H
1A	Sevin XLR Plus	0.5 to 1 qt/A	carbaryl	7	12	H
1B	Dimethoate 400	0.5 to 1.0 pt/A	dimethoate	0	48	H
1B	Imidan 70W	1.33 lb/A	phosmet	7	120	H
3A	Pyrethroid insecticides registered for use on Potatoes: see table at the end of Insect Control.					
4A	Neonicotinoid insecticides registered for use on Potatoes: see table at the end of Insect Control.					
4C	Transform WG	1.5 to 2.75 oz/A	sulfoxaflor	7	24	H
4D	Sivanto Prime or 200SL	7 to 10.5 fl oz/A	flupyradifurone	7	4	M
21A	Portal	2.0 pt/A	fenpyroximate	7	12	L
21A	Torac	14 to 21 fl oz/A	olfenpyrad	21	12	H

Potato Tuberworms

Treat for tuberworms when foliage injury is first noted; 4 to 5 applications at 7 to 14 day intervals may be needed. Tuberworms are primarily a problem on the fall crop. Because moths are actively flying at dusk, sprays are most effective when applied early evening. *(continued next page)*

Potato Tuberworms - continued

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	1.5 to 3.0 pt/A	methomyl	6	48	H
3A	Pyrethroid insecticides registered for use on Potatoes: see table at the end of Insect Control.					
4A	Neonicotinoid insecticides registered for use on Potatoes: see table at the end of Insect Control.					
15	Rimon 0.83EC	6.0 to 12.0 fl oz/A	novaluron	14	12	M
28	Coragen 1.67SC Coragen eVo	3.5 to 7.5 fl oz/A 1.2 to 2.5 fl oz/A	chlorantraniliprole - **foliar**	14	4	L
28	Vantacor	1.2 to 2.5 fl oz/A	chlorantraniliprole - **foliar**	14	4	L
28 + 3	Elevest*	5.6 to 9.8 fl oz/A	bifenthrin + chlorantraniliprole	21	12	H
28 + 6	Minecto Pro*	5.5 to 10.0 fl oz/A	cyantraniliprole + abamectin	14	12	H

Group 3A Pyrethroid Insecticides Registered for Use on Potatoes

Apply one of the following formulations (check if the product label lists the insect you intend to spray; the label is the law):					
Product Name (*=Restricted Use)	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
Asana XL*	2.9 to 9.6 fl oz/A	esfenvalerate	7	12	H
Baythroid XL*	0.8 to 2.8 fl oz/A	beta-cyfluthrin	0	12	H
Brigade 2EC*, others	2.1 to 19.2 fl oz/A	bifenthrin	21	12	H
Hero*	2.6 to 10.3 fl oz/A	zeta-cypermethrin + bifenthrin	21	12	H
Lambda-Cy 1EC*, others	1.92 to 3.84 fl oz/A	lambda-cyhalothrin	7	24	H
Mustang Maxx*	1.28 to 4.0 fl oz/A	zeta-cypermethrin	1	12	H
Permethrin 3.2EC*, others	4.0 to 8.0 fl oz/A	permethrin	14	12	H
Tombstone*	0.8 to 2.8 fl oz/A	cyfluthrin	0	12	H
Warrior II*	0.96 to 1.92 fl oz/A	lambda-cyhalothrin	7	24	H
Combo products containing a pyrethroid					
Besiege*	5.0 to 9.0 fl oz/A	lambda-cyhalothrin + chlorantraniliprole (Group 28)	14	24	H
Brigadier*	16.0 to 25.6 fl oz/A	bifenthrin + imidacloprid (Group 4A) - **soil**	21	12	H
Brigadier*	3.8 to 6.14 fl oz/A	bifenthrin + imidacloprid (Group 4A) - **foliar**	21	12	H
Elevest*	3.9 to 9.6 fl oz/A	bifenthrin + chlorantraniliprole (Group 28)	21	12	H
Endigo ZC*	3.5 to 4.5 fl oz/A	lambda-cyhalothrin + thiamethoxam (Group 4A)	14	24	H
Endigo ZCX*	3.0 to 3.5 fl oz/A	lambda-cyhalothrin + thiamethoxam (Group 4A)	14	24	H
Ethos XB*	12.75 to 25.5 fl oz/A	bifenthrin + *Bacillus amyloliquefaciens* - **soil**	n/a	12	H
Leverage 360*	2.8 fl oz/A	beta-cyfluthrin + imidacloprid (Group 4A)	7	12	H
Ridgeback*	4.5 to 13.8 fl oz/A	bifenthrin + sulfoxaflor (Group 4C)	21	24	H
Savoy EC*	3.6 to 9.6 fl oz/A	bifenthrin + acetamiprid (Group 4A)	21	12	H

Group 4A Neonicotinoid Insecticides Registered for Use on Potatoes

Apply one of the following formulations (check if the product label lists the insect you intend to spray; the label is the law):					
Product Name (*=Restricted Use)	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
Admire Pro	5.7 to 8.7 fl oz/A	imidacloprid - **soil**	AP	12	H
Admire Pro	1.3 fl oz/A	imidacloprid - **foliar**	7	12	H
Assail 30SG	1.5 to 4.0 oz/A	acetamiprid	7	12	M
Belay	9.0 to 12.0 fl oz/A	chlothianidin - **soil**	AP	12	H
Belay	2.0 to 3.0 fl oz/A	chlothianidin - **foliar**	14	12	H
Actara 25WDG	1.5 to 3.0 oz/A	thiamethoxam	14	12	H
Platinum 75SG	1.66 to 2.67 oz/A	thiamethoxam	AP	12	H
Scorpion 35SL	11.5 to 13.25 fl oz/A	dinotefuran - **soil**	AP	12	H
Scorpion 35SL	2.0 to 2.75 fl oz/A	dinotefuran - **foliar**	7	12	H
Venom 70SG	6.5 to 7.5 oz/A	dinotefuran - **soil**	AP	12	H
Venom 70SG	1.0 to 1.5 oz/A	dinotefuran - **foliar**	7	12	H
Combo products containing a neonicotinoid					
Brigadier*	16.0 to 25.6 fl oz/A	imidacloprid + bifenthrin (Group 3A) - **soil**	21	12	H
Brigadier*	3.8 to 6.14 fl oz/A	imidacloprid + bifenthrin (Group 3A) - **foliar**	21	12	H
Endigo ZC*	3.5 to 4.5 fl oz/A	thiamethoxam + lambda-cyhalothrin (Group 3A)	14	24	H
Endigo ZCX*	3.0 to 3.5 fl oz/A	thiamethoxam + lambda-cyhalothrin (Group 3A)	14	24	H

Group 4A Neonicotinoid Insecticides Registered for Use on Potatoes - continued next page

Group 4A Neonicotinoid Insecticides Registered for Use on Potatoes - continued

Leverage 360*	2.8 fl oz/A	imidacloprid + beta-cyfluthrin (Group 3A)	7	12	H
Savoy EC*	3.6 to 9.6 fl oz/A	acetamiprid + bifenthrin (Group 3A)	21	12	H
Voliam Flexi	4.0 oz/A	thiamethoxam + chlorantraniliprole (Group 28)	14	12	H

Disease Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.

Recommended Fungicides

Nematodes

See sections E 1.5. Soil Fumigation and E 1.6. Nematode Control (including "Nonchemical Management of Nematodes" - certain mustard green cover crops planted in the fall and incorporated prior to planting may offer nematode suppression). Use fumigants listed in section E 1.5., or one of the following:

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
1A	Vydate CL-V 3.77L*	34.0 to 68.0 fl oz/A in at least 20 gal/A pre-plant in-furrow treatment. See label.	oxamyl	AP	48	H
1B	Mocap 6F*	4.4 fl oz/1000 ft row in 12-inch band over the row at planting. See label.	ethoprop	AP	48	H
7	Velum Prime 4.16SC	6.5 to 6.84 fl oz/A, see label	fluopyram	7	12	--

Seed-Piece Treatment

Use certified seed. Keep seed at 65-70°F (18-21°C) for 2-3 weeks before planting to encourage rapid emergence. Plant seed pieces immediately after cutting or store under conditions suitable for rapid healing of the cut surfaces (60-70°F, 16-21°C plus high humidity). Dust seed pieces with fungicides immediately after cutting. Some fungicide seed-piece treatments are formulated with fir or alder bark. Bark formulations have been effective treatments.

Apply one of the following formulations:						
Code	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
For *Fusarium* spp.:						
M04	Captan 7.5D	1.0 lb/cwt	captan	--	--	N
For *Fusarium* spp. and *Rhizoctonia* spp.:						
7 + M03	MonCoat MZ 7.5D[1]	0.75 to 1.0 lb/cwt	flutolanil + mancozeb	--	--	N
12+M03	Maxim MZ[1]	0.5 lb/cwt	fludioxonil + mancozeb	--	--	L

[1]Seed-piece fungicides that contain Early Blight Disease Control (EBDC) fungicides or cymoxanil also provide protection against seedborne late blight infections.

Bacterial and Fungal Diseases

Bacterial Soft Rot

Prevent wounding and make certain the tubers are dry before packing. Free chlorine wash maintained at 25 ppm chlorine or use of a fresh chlorine rinse maintained at 50 ppm chlorine may help reduce soft rot.

Common Scab

Potato scab is caused by a soil-inhabiting fungus (*Streptomyces scabies*). The disease is suppressed in acid soils and the optimum soil pH for growing scab susceptible varieties is about 5.0 to 5.2. Scab resistant varieties may be grown at pH 5.5 to 6.2. If lime is needed, apply after potato harvest and before subsequent crops grown in rotation. Plant scab-free seed potatoes. Use resistant varieties and rotate with small grains, corn, or alfalfa. Avoid rotations using red clover. Maintain adequate soil moisture during and after tuber set. Avoid heavy application of manures.

Dickeya dianthicola and *Pectobacterium* spp.

In 2015, *Dickeya dianthicola* was introduced to the Mid-Atlantic region. *Dickeya* and related *Pectobacterium* species are transmitted via infested seed pieces and is thought to have limited or no survival ability in our soils. Growers should purchase certified seed that has been properly inspected and determined free of these pathogens. Growers are reminded to practice sound sanitation practices when handling seed pieces (particularly those not tested for *Dickeya* or *Pectobacterium*) to prevent contamination of other potato seed lots.

Early Blight

Begin preventative sprays and continue every 7-10 d according to a disease forecasting system where available. If late blight is a threat, then begin sprays when plants are 8 inches tall.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Rotate and TANK-MIX one of the following protectant fungicides:						
M03	mancozeb 75DF	1.5 to 2.0 lb/A	mancozeb	0	12	N
M03	Polyram 80DF	2.0 lb/A	metiram	14	24	N
M05	chlorothalonil 6F	1.0 to 1.5 pt/A	chlorothalonil	0	12	N
M05+22	Zing! 4.9SC	32.0 to 34.0 fl oz/A	chlorothalonil + zoxamide	7	12	N
30	Super Tin 4L*	3.0 to 6.0 fl oz/A	triphenyltin hydroxide	7	48	--
WITH one of the following pre-mix fungicides:						
49+M05	Orondis Opti	1.75 to 2.5 pt/A	oxathiapiprolin + chlorothalonil	7	12	--
M05+11	Quadris Opti 5.5SC	1.6 pt/A	chlorothalonil + azoxystrobin	14	12	N
3 + 11	Quadris Top 1.67SC	8.0 to 14.0 fl oz/A	difenoconazole + azoxystrobin	0	12	--
3 + 40	Revus Top 4.16SC	5.5 to 7.0 fl oz/A	difenoconazole + mandipropamid	1	12	M
7 + 3	Luna Pro 3.34SC	10.0 fl oz	fluopyram + prothioconazole	14	12	--
7 + 9	Luna Tranquility 4.16SC	8.0 to 11.2 fl oz/A	fluopyram + pyrimethanil	7	12	--
7 + 11	Priaxor 4.17SC	4.0 to 8.0 fl oz/A	fluxapyroxad + pyraclostrobin	7	12	N
11 + 27	Tanos 50DF	6.0 oz/A	famoxadone + cymoxanil	3	12	--
OR tank mix a protectant fungicide with one of the following single-active ingredient fungicides:						
3	Quash 50WDG	2.5 to 4.0 oz/A	metconazole	1	12	--
7	Endura 70W	2.5 to 4.5 oz/A	boscalid	0	12	--
11	azoxystrobin 2.08F	6.0 to 15.5 fl oz/A	azoxystrobin	0	4	N
11	Flint Extra 500SC	3.0 to 3.8 fl oz/A	trifloxystrobin (**Do not apply near Concord grapes**, see label)	7	12	N
11	Headline 2.09EC	6.0 to 9.0 fl oz/A	pyraclostrobin	3	12	N
11	Reason 500SC	5.5 to 8.2 fl oz/A	fenamidone	14	12	--

Late Blight

Begin fungicide applications when plants are 6 inches tall and repeat every 7 d or apply fungicides according to a disease forecasting system such as BLITECAST or WISDOM. Monitor for progress of the disease by following local Extension reports or visiting the following website (*http://www.usablight.org/*). When a field contains new late blight infections and harvest is near, vines should be destroyed immediately to help prevent tuber infection.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
One of the following protective fungicides should be applied early in the season PRIOR to occurrence of any disease in the region:						
M03	mancozeb 75DF[1]	1.5 to 2.0 lb/A[1]	mancozeb	0	12	N
M03	Polyram 80DF[1]	2.0 lb/A[1]	metiram	14	24	N
M03+22	Gavel 75DF	1.5 to2.0 lb/A	mancozeb + zoxamide	5	48	--
M05	chlorothalonil 6F	1.0 to 1.5 pt/A	chlorothalonil	0	12	N
M05+22	Zing! 4.9SC	34.0 fl oz/A	chlorothalonil + zoxamide	7	12	N
Once late blight is detected in your area, rotate and tank mix one of the following fungicides with a protectant fungicide listed above. Apply on a 7-day schedule as long as conditions are favorable for disease development.						
3 + 40	Revus Top 4.16SC	5.5 to 7.0 fl oz/A	difenoconazole + mandipropamid	1	12	M
11+ 27	Tanos 50DF	6.0 to 8.0 oz/A	famoxadone + cymoxanil	3	12	--
21	Ranman 400SC	1.40 to 2.75 fl oz/A	cyazofamid	0	12	L
27	Curzate 60DF	3.2 oz/A	cymoxanil	3	12	N
28	Previcur Flex 6F	1.2 pt/A	propamocarb HCl	5	12	N
29	Omega 500F	5.5 fl oz/A	fluazinam	14	48	N
30	Super Tin 4L*	3.0 to 6.0 fl oz/A	triphenyltin hydroxide	7	48	--
40	Forum 4.17SC	4.0 to 6.0 fl oz/A	dimethomorph	4	12	N
45 + 40	Zampro	11.0 to 14.0 fl oz/A	ametoctradin + dimethomorph	4	12	--
49+M05	Orondis Opti	1.75 to 2.5 pt/A	oxathiapiprolin + chlorothalonil	7	12	--
49 + 40	Orondis Ultra 2.33SC	5.5 to 8.0 fl oz/A	oxathiapiprolin + mandipropamid	14	4	--

[1]**DO NOT** apply more than a combined total of 15.0 lb/A of mancozeb 75DF or Polyram 80DF per crop

Leak (*Pythium*) and Pink Rot (*Phytophthora*)

Leak usually enters the tubers through bruises occurring in conjunction with the harvesting of immature tubers during hot weather. Pink Rot generally occurs in poorly drained areas. Rotate field out of potatoes for at least 2 yr.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Apply one of the following fungicides in a 6-8 inch band directly over the seed-piece prior to row closure:						
4	Ridomil Gold 4SL	0.42 fl oz/1000 ft row	mefenoxam	AP	48	N
4	Ultra Flourish 2E	0.84 fl oz/1000 ft row	mefenoxam	AP	48	N
21	Ranman 400SC	0.42 fl oz/1000 ft row (see label)	cyazofamid	AP	12	L
22	Elumin	8 fl oz/A (see label)	ethaboxam	AP	12	--
49 + 4	Orondis Gold	27.8 fl oz/A	oxathiapiprolin + mefenoxam	AP	48	--
33	Phostrol	3.75 to 10.0 fl oz/A (see label)	Mono- and dibasic sodium, potassium, and ammonium salts of phosphorous acid	AP	4	--
As an alternative, apply one of the following fungicides with as much water as possible for ground applications and a minimum of 5 gal/A for aerial applications. Apply at flowering and 14 d later. If the field has a history of Pink Rot or leak a third application might be warranted 14 d after that. Be sure to get some coverage of the soil surrounding plants for root uptake to occur.						
4 + M01	Ridomil Gold Copper 65WP	2.0 lb/A	mefenoxam + copper	14	48	N
4 + M03	Ridomil Gold MZ 68WP	2.5 lb/A	mefenoxam + mancozeb	14	48	N
4 + M05	Ridomil Gold Bravo 76WP	2.0 lb/A	mefenoxam + chlorothalonil	14	48	N

Rhizoctonia stem canker and black scurf

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Apply one of the following formulations as an in-furrow spray at planting:						
7	Moncot 70DF	0.79 to 1.18 oz/1000 ft row	flutolanil	AP	12	N
7 + 11	Elatus 45WG	0.34 to 0.50 oz/1000 ft row	benzovindiflupyr + azoxystrobin	AP	12	N
11	azoxystrobin 2.08F	0.4 to 0.6 fl oz/1000 ft row	azoxystrobin	AP	4	N
11	Aftershock	0.16 to 0.24 fl oz/1000 ft row	fluoxastrobin	AP	7	--

Verticillium Wilt

Select fields with a low incidence of wilt. Use resistant varieties where possible. Do not plant tomato, eggplant, or pepper in rotation with potato. The use of Sudangrass in rotation with potato may reduce nematode levels. The use of Mocap will reduce lesion nematode levels in the soil, resulting in less Verticillium Wilt.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Apply one of the following through center pivot irrigation in the fall to fallow fields for suppression of Verticillium and lesion nematode:						
--	K-Pam HL*	30 to 60 gal/A	potassium N-methyldithiocarbamate	AP	48	N
--	Vapam HL*	37.5 to 70 gal/A	metam-sodium	AP	48	N

White Mold

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Apply one of the following immediately prior to row closing and repeat 28 d later with a different FRAC code:						
1	Topsin M WSB	1.0 to 1.5 lb/A	thiophanate-methyl	14	12	N
2	iprodione 4F	2.0 pt/A	iprodione	14	24	N
7	Endura 70W	5.5 to 10.0 oz/A	boscalid	0	12	--
29	Omega 500F	5.5 to 8.0 fl oz/A	fluazinam	14	48	N

Viruses

Numerous seed-borne viruses can occur in potato including potato leafroll, potato virus S, potato virus M, and several strains of potato virus Y. There has been an increase in occurrence of the potato virus YN strain in the region. Control these seed borne viruses by obtaining virus-free certified or foundation seed.

Pumpkins and Winter Squash

Recommended Varieties

Varieties are listed by maturity within each type, earliest first (*=hybrid varieties).
Disease resistance or tolerance in parentheses:
BRT=Black Rot tolerant,
FR=*Fusarium* Wilt Resistant,
PMR=Powdery Mildew Resistant,
PMT=Powdery Mildew Tolerant,
PR=*Phytophthora* Resistant,
ZYMVR=Zucchini Yellow Mosaic Virus Resistant.

Pumpkins

Pumpkins, Less than 1 pound	WeeeeeOne* (PMR)	**Pumpkins 10 to 20 pounds**	Carbonado Gold* (PMT)
	Jill Be Little* (PMR)		Hermes* (PMT)
	Wee-B-Little*		Orange Sunrise* (PMT)
	Casperita		Secretariat* (PMR)
			HSC151 (edible seeds)
Pumpkins 1 to 3 pounds	Jack Sprat* (PMT)	**Pumpkins More than 20 pounds**	Cronos* (PMT)
	Baby Bear*		Kratos* (PMT)
	Little Giant* (PMT)		Gladiator* (PMT)
	Touch of Autumn* (PMT)		Aladdin* (PMT)
Pumpkins 2 to 6 pounds	Prankster* (PMT)		Gold Medal*
	Cannonball* (hard shell)		Rhea* (PMT)
	Iron Man* (FR, PR, PMT) (hard shell)		Solid Gold*
	Field Trip*(PMT)		Captain Jack*
	Orange Smoothie* (hard shell)	**Pumpkins More than 50 pounds**	Atlantic Giant
	Hybrid Pam*		Prizewinner
	Fall Splendor Plus*(PMT)	**Pumpkins, Ornamental**	Knucklehead*
	Mystic Plus* (PMT) (5-6 lb, plant at closer spacing to reduce size)		Goosebumps II*
	Small Sugar (BRT)	**Pumpkins, Processing**	Neck Pumpkin Types
	Naked Bear (ornamental, edible seeds)		Autumn Buckskin*
			Dickenson Field Types

Winter Squash

Winter Squash Acorn Type	Table Ace*	**Winter Squash Hubbard Type**	Green Hubbard
	Taybelle* (semi bush, PMT)		Golden Hubbard
	Table Gold		New England Blue Hubbard
	Table Star* (PMT)		Blue Ballet
	Autumn Delight* (PMT)		Other Hubbard Types
	Celebration* (PMT, specialty)		Boston Marrow Types
Winter Squash Butternut Type	Early Butternut*	**Spaghetti Squash**	Pinnacle
	Prism* (restricted vine)		Primavera*
	Metro* (restricted vine, PMR)		Vegetable Spaghetti
	Quantum*	**Processing Squash**	Atlas*
	Waltham Butternut		Genesis*
Winter Squash Buttercup Type	Sunshine*(orange)		Other Butternut Types
	Buttercup		
	Sweet Mama*		
	Bonbon*		

Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and Chapter B Soil and Nutrient Management. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede the recommendations found below.

Pumpkins and Winter Squash[1]		Soil Phosphorus Level				Soil Potassium Level				
		Low	Med	High (Opt)	Very High	Low	Med	High (Opt)	Very High	
	N (lb/A)	P_2O_5 (lb/A)				K_2O (lb/A)				Nutrient Timing and Method
	50-100	150	100	50	0[2]	200	150	100	0[2]	Total nutrient recommended
	25-50	150	100	50	0[2]	200	150	100	0[2]	Broadcast and disk-in
	25-50	0	0	0	0	0	0	0	0	Sidedress when vines start to run

For crops grown on plastic mulch, fertilization rates are based on a standard row spacing of 6 ft. [1]Apply 20-30 lb/A of sulfur (S) for most soils. [2]In VA, crop replacement values of 25 lb/A of P_2O_5 and 50 lb/A of K_2O are recommended on soils testing Very High.

Seed Treatment

Check if seed has been treated with an insecticide and fungicide. See Disease Control below.

Planting and Spacing

Seed or transplant in the field between June 15 and July 5 in cooler areas, and between May 15 and July 15 in warmer, southern areas. Base plant spacing on vine habit and average fruit size of the variety. **Note**. Fruit size may be decreased at closer spacings.

Small vine/bush with fruit less than 8 lb: Rows 5-6 ft apart with 2 ft between plants in the row.
Large/medium vine with fruit 8-15 lb: Rows 6-7.5 ft apart with 3-4 ft between plants in the row.
Large vine with fruit 12 to 25 lb: Rows 7.5-9 ft apart with 4 ft between plants in the row.
Large vine with fruit over 30 lb: Rows 10-12 ft apart with 5-6 ft between plants in the row.

Conservation Tillage (No-Till) Pumpkins

Seed or transplanted no-till pumpkins planted into small grain cover crop or stubble, hairy vetch, or fallow ground has produced commercially acceptable yields. A cover crop on the soil surface will reduce dirty pumpkins at harvest, provide some weed suppression, and minimize fruit rot by creating a barrier between pumpkins and the soil. Since cultivation is not an option in a no-till planting system and few postemergence herbicides are available to control escaped weeds, choose fields carefully for no-till production. The performance of residual preemergence herbicides depends on rainfall or overhead irrigation for activation. Moisture for activation is more critical in no-till fields consisting of a trash or straw layer. Postemergence control of grasses can be accomplished with Poast or Select. Sandea is labeled for postemergence control of yellow nutsedge and certain annual broadleaf weeds. Sandea can cause pumpkin stunting, see comments section below for more information. Sandea is an ALS inhibitor (Group 2) and is at high risk for weed resistance development. **Not recommended in NJ due to the high risk of weed resistance development and the lack of postemergence control options for certain pigweed species, common lambsquarters, annual morningglory, Eastern black nightshade, or any ALS resistant weed.**

Cover Crop Establishment and Weed Management

Preplant field considerations.

The best chance of success with no-till requires a thick mat of residue on the soil surface. While small grain stubble can be used, often there will not be sufficient surface cover and weeds can become a problem later in the season. The other requirement for success is control of weeds, particularly perennials, in the summer before pumpkins are to be grown.

The most commonly used no-till method is to seed fields in the fall with winter cereal rye at 2.5-3.5 bu/A. Use higher rates when seeding later in the fall. Hairy vetch can be mixed with rye to provide some nitrogen for the pumpkins but be sure to seed earlier in the fall (3-4 weeks before the average frost date) to allow the vetch to become established. Adjust soil pH before the cover crop is seeded as tillage will not be performed before pumpkin planting. Application of P and K before seeding the cover crop is optional, depending on soil test results. When using rye alone, plan to apply 25 lb N/A in the early spring to increase tillering and rye growth prior to termination.

Soil moisture prior to planting is a critical factor for successful establishment of pumpkins. The living cover crop may remove soil moisture and prevent pumpkin germination and growth. If irrigation is not available, kill the cover crop 10-14 days prior to planting in order to conserve moisture for seeding or transplanting. If rainfall is excessive, the cover crop may remove water to facilitate timely planting. Irrigation will eliminate the concerns about soil moisture for pumpkin seeding and germination.

Termination of the Cover Crop

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
9	Roundup PowerMax 4.5L "Generic" glyphosate 3L	16 to 32 fl oz/A 24 to 48 fl oz/A	**glyphosate**	0.75 to 1.13 lb acid equivalent/A	--	4
-Allow at least 5-7 days between application and planting. -Some glyphosate formulations may require an adjuvant, refer to the label. -Glyphosate is not very effective for control of legumes (hairy vetch or crimson clover); glyphosate is preferred for the control of grass cover crops. -Glyphosate-resistant horseweed is widespread in the region and will **not** be controlled with glyphosate. -Repeat applications are allowed, with maximum application of 5.3 qt/A per year.						
22	**Gramoxone SL 2.0***	2.4 to 4 pt/A	**paraquat**	0.6 to 1 lb/A	--	24
-Apply before planting, a second application maybe required for complete control. -Always include an adjuvant (nonionic surfactant or crop oil concentrate). -Tank mix with appropriate herbicides for residual weed control; see Weed Control For Seeding Into Soil Without Plastic Mulch. -Paraquat may not control established grasses. Spray coverage is essential for optimum control. -See the label for additional information and warnings. Rainfastness is 30 min. A maximum of 3 applications per year are allowed. -***Restricted-use pesticide***. Only certified applicators, who successfully complete the paraquat-specific training, can mix, load, or apply paraquat. Application of paraquat "under the direct supervision" of a certified applicator is no longer allowed. Required training link (*https://campus.extension.org/enrol/index.php?id=2201*); certified applicators must repeat training every three years.						

Pumpkin Planting

See the herbicide recommendations for pumpkins for further discussion. Use "no-till" corn planters equipped with coulters to cut through straw or cover crop stems killed by contact herbicides. Planters with finger pickup or air/vacuum units function well for seeding pumpkins. Plate planters may damage seed and should be evaluated carefully before use. Cole plate planters are satisfactory. A disk coulter on the seeding unit is essential to cut through the vetch or straw stems. Mount a 3-inch wide waffle coulter ahead of pot-transplanters to provide effective penetration of the cover crop and plant placement.

Fertility

Hairy vetch will normally supply all the N requirements for pumpkins. However, if N deficiency symptoms appear before fruit production, topdress with 20-30 lb N/A. P and K amendments can be applied (based on soil tests) to the soil surface before planting cover crop or before planting pumpkins. When planting pumpkins into non-legume cover crops for grain stubble, apply the recommended P, K, lime, and other nutrients based on soil tests before planting. N rate recommendations may need to be increased based on fertilizer source, fertilizer application method, crop residue amount, and amount of time in a conservation tillage (no-till) production system. See section A 6. Conservation Tillage Crop Production.

Pollination (see also sections A 12. Pollination and D 6.3.1. Protection of Pollinators).

Honey bees, squash bees, bumble bees and other wild bees are important for proper set and pollination. Populations of pollinating insects may be adversely affected by insecticides applied to flowers or weeds in bloom. Apply insecticides only in the evening hours or wait until bloom is completed before application. Check the pesticide tables below for relative toxicity to bees.

Harvest and Post-Harvest Considerations

Disease-free fruit following a regular fungicide program during crop production will minimize post-harvest fruit rots. Harvest when fruits are mature and prior to frost. Use care in handling fruit to prevent wounds. **Wounding can negate benefits from a season-long fungicide program.** Cure fruit after harvest at temperatures between 80 and 85°F (27-29°C) with a relative humidity of 75-80% for approximately 10 days. Temperatures below 50°F (10°C) cause chilling injury.

The hard-shelled squashes, such as Butternut, Delicious, Spaghetti, and the Hubbard types, can be stored at 55°F (13°C) and 50-70% relative humidity. Acorn squash will store for 5-8 weeks; pumpkins for 2-3 months and other hard-shelled squashes will store for 3 months except Hubbard types that may hold for 5-6 months. Remove squash from the field before they have chilling injury and do not allow fruits to be exposed to extended periods below 50°F (10°C). Handle fruits carefully to eliminate bruising or damage and remove stems from squash like butternuts that can damage adjacent fruit. Store winter squash in a cool, dry, well-ventilated area. The longer keeping winter squash types can be kept in saleable condition through late winter into spring (3-6 months). Research has not documented any benefit to post-harvest fruit fungicide dips.

Weed Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.

Recommended Herbicides

1. Identify the weeds in each field and select recommended herbicides. More information is available in the "Herbicide Effectiveness on Common Weeds in Vegetables" (Table E-3) in Chapter E Pest Management.

2. Minimize herbicide resistance development. Identify the herbicide mode of action group number and follow recommended good management practices; **bolded group numbers in tables below are herbicides at higher risk for selecting resistant weed populations.** Include non-chemical weed control whenever possible.

Labeled Application Sites for Pumpkins

Herbicide (*=Restricted Use)	**HRAC group number**	**Plastic mulch production**					**Bareground production**		
		Soil-Applied		Postemergence					
		Under Plastic	Row Middles	Over Plastic	Row Middles	Post-Harvest	Soil-applied	POST	Post-harvest
Sandea	2		YES		YES		YES	YES	
Curbit	3		YES				YES		
Prefar	8	YES	YES				YES		
Command	13		YES				YES		
Strategy			YES				YES		
Reflex[1]	14		YES				YES[2]		
Dual	15		YES				YES[2]		
Select / Select Max Shadow 3EC	1			YES				YES	
Poast	1			YES				YES	
Gramoxone*[1]	22				YES	YES	YES[3]		YES

[1] Special Local Needs Label 24(c), be sure it is registered for the specific state and for the intended use. [2] Dual and Reflex are labeled for bareground only if the spray is directed to the row middles. [3] Apply preplant or after seeding but before crop emergence.

1. Soil Applied

Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient**	**Active Ingredient Rate**	**PHI (d)**	**REI (h)**
2	Sandea 75DF	0.5 to 1 oz/A	**halosulfuron**	0.023 to 0.047 lb/A	30	12
-**Plasticulture** row middles application only: apply before or after weed emergence; apply as a shielded application to avoid contact with the crop. If weeds have emerged, use a non-ionic surfactant at 0.25% v/v or include a non-selective herbicide. -**Bareground**: apply broadcast after seeding but before crop emergence or no sooner than 7 days before transplanting. -Suppresses or controls yellow nutsedge and certain broadleaf weeds. Sandea provides both residual and postemergence control of susceptible weed species. Effective postemergence control requires an adjuvant. -Sandea is an ALS inhibiting herbicide and resistant weed populations are common in the region. **Do not** use Group 2 herbicides repeatedly in the same field. -**Do not** apply Sandea to crops treated with a soil applied organophosphate insecticide or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application. -Maximum number of Sandea applications per year is 2 and **do not** exceed 2 oz/A during the crop season.						
3	Curbit 3EC	1 to 3 pt/A	**ethalfluralin**	0.38 to 1.13 lb/A	--	24
-**Plasticulture**: row middles only: apply as a banded spray after crop emergence or transplanting. **Do not** soil incorporate. -**Bareground**: apply broadcast after direct-seeding but prior to crop emergence; **do not** use on transplanted pumpkins. -Controls annual grasses and certain annual broadleaf weeds, including carpetweed and pigweed sp. -Use lower rate for coarse-textured soils or soils with low organic matter. -Where overhead irrigation is available, activate Curbit with 0.5 inch of irrigation within 2 days after application; if no irrigation or rainfall occurs within 5 days of application, activity of Curbit can be reduced. -Available as a pre-mix herbicide Strategy. Strategy at 3 pt/A= Curbit at 26 fl oz/A (0.6 lb ai) and Command at 8 fl oz/A (0.188 lb ai) -Maximum applications per season: not specified						

1. Soil Applied - continued next page

1. Soil Applied - continued

3 + 13	Strategy 2.1SC	1.5 to 6 pt/A	**ethalfluralin *plus* clomazone**	0.39 to 1.58 lb/A	45	24
-**Plasticulture**: row middles application only. -**Bareground**: apply broadcast just before planting or after planting but before crop emergence. -Strategy is a prepackage mixture of Curbit 3EC and Command 3ME. Refer to individual products for comments. -Clomazone spray or vapor drift may injure susceptible crops and other vegetation, refer to Command 3ME for comments. -**Do not** apply prior to planting the crop. **Do not** soil incorporate. -Certain crop varieties may have the potential for injury or loss with this product. Consult qualified crop advisors for information pertaining to varieties in your area. -Maximum applications per season: not specified.						
8	Prefar 4E	5 to 6 qt/A	**bensulide**	5 to 6 lb/A	--	12
-**Plasticulture**: under plastic: apply in a band under the plastic, immediately before laying the mulch. Allow 7 days before making transplant holes to allow condensation to incorporate the herbicide. Plasticulture: row middles application is labeled. -**Bareground**: apply preemergence or preplant incorporated. -Preemergence applications should be followed by irrigation within 36 h (apply enough water to wet the soil at least 2 to 4 inches deep). Preplant incorporated applications should be incorporated 1 to 2 inches deep (deeper than 2 inches will result in reduced weed control). -Provides control/suppression of some annual grass weeds and some broadleaves including pigweeds, purslane, and lambsquarters. -**Do not** apply within 45 days of harvesting squash. -**Do not** apply more than 6 lb ai/A per season.						
13	Command 3ME Up-Stage 3CS	0.67 to 2 pt/A 0.67 pt/A	**clomazone**	0.25 to 0.75 lb/A 0.25 lb/A	45	12
-**Command is labeled for winter squash and processing pumpkins; not labeled for jack-o-lantern pumpkins. Up-Stage is labeled for all pumpkin types.** -**Plasticulture**: row middles application only. -**Bareground**: apply broadcast just before planting but before crop emergence, or just before transplanting. Use the lower rate when used on coarse-textured soils low in organic matter, when weed pressure is light, or to minimize herbicide carryover that could affect subsequent crops. -Controls annual grasses and many broadleaf weeds including common lambsquarters, velvetleaf, spurred anoda, and jimsonweed. Carpetweed, morningglory sp., pigweed sp., and yellow nutsedge will **not** be controlled. Higher rates will improve control (or expand number of species controlled) such as common cocklebur, common ragweed, or jimsonweed (refer to label for specific weeds and rates). -**WARNINGS**: Command spray *or* vapor drift may injure sensitive crops and other vegetation up to several hundred yards from the point of application. **Do not** apply adjacent to sensitive crops (see label) or vegetation, or under unfavorable wind or weather conditions. Command may limit subsequent cropping options, see the label. -Available as a pre-mix herbicide Strategy: Strategy at 3 pt/A= Command at 8 fl oz/A (0.188 lb ai) and Curbit at 26 fl oz/A (0.6 lb ai) -Maximum number of Command applications per year: 1.						
14	Reflex 2SL	8 to 10 fl oz/A	**fomesafen**	0.13 to 0.38 lb/A	32	24
-For pumpkins ONLY. **-Special Local Needs Label 24(c) for the use of Reflex 2SL to control weeds in pumpkins in DE and NJ and pending in PA (expires 12/31/2025 in DE and 12/31/2027 in NJ). The use of this product is legal ONLY if a waiver of liability has been completed (see: *https://www.syngenta-us.com/labels/indemnified-label-login*).** -Rates differ by States, soil types, and planting method. Rates as low as 10 fl oz/A can cause injury on coarse-textured soils. -**Plasticulture**: row middles application only, apply prior to transplanting. -**Bareground**: apply broadcast within 24 h after direct-seeding and follow with 0.2 to 0.5 inches of overhead irrigation at least 36 h before pumpkin begin to crack through the soil. For transplants, apply Reflex and then irrigate with 0.2 to 0.5 inches of water and then transplant. **Do not** prepare transplant holes until after Reflex application and irrigation. -Foliar application of Reflex will severely damage or kill pumpkin. The potential of crop injury is greater on lighter textured soils combined with intensive irrigation programs or high amounts of rainfall, therefore, adjust rates accordingly. -Reflex provides both residual and postemergence control of susceptible weed species. Effective postemergence control requires an adjuvant. **Pumpkin varieties may vary in their response to Reflex**. Treat small acreages first to determine tolerance, especially when applying to a new variety. -Reflex rates lower than 16 fl oz/A may not provide full-season control and should be used with other herbicides and/or other methods of weed control. -Consider rotational crops when applying fomesafen. If the crop is replanted, **do not** re-apply Reflex. Refer to 24(c) label for specifics on rotational restrictions. -Maximum for Reflex application is 24 fl oz/A **IN ALTERNATE YEARS.**						
15	Dual Magnum 7.62E	1 to 1.33 pt/A	**s-metolachlor**	0.95 to 1.27 lb/A	30	24
-**For pumpkins ONLY. Plasticulture**: row middles application only. -**Bareground**: apply as an inter-row or inter-hill spray, leaving 1 ft of untreated area over the row. -**Do not** use as an over the top application. **Do not** soil incorporate. -Suppresses or controls annual grasses, yellow nutsedge, and certain annual broadleaf weeds including nightshade species. -Dual Magnum will not control emerged weeds. Cultivate and/or hoe or tank mix with Gramoxone to control emerged weeds before treatment. -Use the lower rate on fields with coarse-textured soils low in organic matter. Use the higher rates on fields with fine-textured soil and those with high organic matter. Maximum applications per season: not specified.						

<table>
<tr><th colspan="7">2. Postemergence</th></tr>
<tr><th>Group</th><th>Product Name
(*=Restricted Use)</th><th>Product Rate</th><th>Active Ingredient</th><th>Active Ingredient Rate</th><th>PHI
(d)</th><th>REI
(h)</th></tr>
<tr><td>1</td><td>Shadow 3EC
Select 2EC
Select Max 0.97EC</td><td>4 to 5.33 fl oz/A
6 to 8 fl oz/A
9 to 16 fl oz/A</td><td>clethodim</td><td>0.07 to 0.125 lb/A</td><td>14</td><td>24</td></tr>
<tr><td></td><td>Poast 1.5EC</td><td>1 to 1.5 pt/A</td><td>sethoxydim</td><td>0.19 to 0.28 lb/A</td><td>14</td><td>12</td></tr>
<tr><td colspan="7">-Select 2EC: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). Select Max: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution). Shadow 3EC: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution) for large or stressed grasses; use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution) when crop safety is a concern. Poast: use COC at 1.0% v/v.
-The use of COC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to NIS when grasses are small and soil moisture is adequate.
-Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control.
-Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will not be controlled.
-Controls many annual and certain perennial grasses, including annual bluegrass, but Poast is preferred for goosegrass control. For best results, treat annual grasses when they are actively growing and before tillers are present. Control may be reduced if grasses are large or under hot or dry weather conditions.
-Repeated applications may be necessary to control certain perennial grasses. If repeat applications are necessary, allow 14 days between applications.
-Rainfastness is 1 h.
-Do not tank mix with or apply within 2 to 3 days of any other pesticide, unless labeled, as this may increase the risk of crop injury or reduce the control of grasses. Do not apply more than 8 fl oz/A of Select 2EC in a single application and do not exceed 32 fl oz/A for the season; do not apply more than 16 fl oz/A of Select Max in a single application and do not exceed 64 fl oz/A for the season.
-Do not apply more than 5.33 fl oz/A of Shadow 3EC in a single application and do not exceed 21.33 fl oz/A for the season.
-Do not apply more than 1.5 pt/A Poast in a single application and do not exceed 3 pt/A for the season.</td></tr>
<tr><td>2</td><td>Sandea 75DF</td><td>0.5 to 1 oz/A</td><td>halosulfuron</td><td>0.023 to 0.047 lb/A</td><td>30</td><td>12</td></tr>
<tr><td colspan="7">-Plasticulture: row middles application only.
-Bareground: broadcast for bareground. Apply Sandea after the crop has at least 3 to 5 true leaves but before first female flowers appear and no sooner than 14 days after transplanting. If weeds have emerged, use a non-ionic surfactant at 0.25% v/v (1 qt/100 gal).
-Suppresses or controls yellow nutsedge and certain broadleaf; control of weeds taller than 3 inches may not be adequate. Sandea will not control common lambsquarters or eastern black nightshade if applied postemergence; for row middle application, tank mix with a non-selective herbicide to increase spectrum of control.
-Sandea provides both residual and postemergence control of susceptible weed species. -Sandea is an ALS inhibiting herbicide and resistant weed populations are common in the region. Do not use Group 2 herbicides repeatedly in the same field.
-Do not apply Sandea to crops treated with a soil applied organophosphate insecticide or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application.
-Rainfastness is 4 h. Maximum number of Sandea applications per year is 2 and do not exceed 2 oz/A during the crop season</td></tr>
<tr><td>22</td><td>Gramoxone SL 2.0*
Gramoxone SL 3.0*</td><td>1.95 pt/A
1.3 pt/A</td><td>paraquat</td><td>0.49 lb/A</td><td>14</td><td>24</td></tr>
<tr><td colspan="7">-Supplemental Label for the use of Gramoxone 2SL or 3SL for postemergence weed control in DE, MD, NJ, PA, and VA. Row middles as a shielded application. Apply as a directed spray in a minimum of 20 gal spray mix/A to control emerged weeds between the rows after crop establishment. Include a nonionic surfactant at 0.25% v/v.
-Use shields or hoods to prevent spray contact with the crop and low spray pressure (maximum of 30 psi) to reduce small droplets that are prone to drift. See the label for additional information and warnings.
-Rainfastness is 30 min. A maximum of 3 applications per year are allowed.
-Restricted-use pesticide. Only certified applicators, who successfully complete the paraquat-specific training, can mix, load, or apply paraquat. Application of paraquat "under the direct supervision" of a certified applicator is no longer allowed. Required training link (https://campus.extension.org/enrol/index.php?id=2201); certified applicators must repeat training every three years.</td></tr>
</table>

<table>
<tr><th colspan="7">3. Postharvest</th></tr>
<tr><th>Group</th><th>Product Name
(*=Restricted Use)</th><th>Product Rate</th><th>Active Ingredient</th><th>Active Ingredient Rate</th><th>PHI
(d)</th><th>REI
(h)</th></tr>
<tr><td>22</td><td>Gramoxone SL 2.0*
Gramoxone SL 3.0*</td><td>2.25 to 3 pt/A
1.5 to 2 pt/A</td><td>paraquat</td><td>0.56 to 0.75 lb/A</td><td>--</td><td>24</td></tr>
<tr><td colspan="7">-Supplemental Label in DE for the use of both Gramoxone formulations for postharvest application to desiccate the crop.
-For bareground or plasticulture, apply after the last harvest. -Always include an adjuvant. Spray coverage is essential for optimum effectiveness. -See the label for additional information and warnings. -Rainfastness 30 min. A maximum of 2 applications for crop desiccation are allowed.
-Restricted-use pesticide. Only certified applicators, who successfully complete the paraquat-specific training, can mix, load, or apply paraquat. Application of paraquat "under the direct supervision" of a certified applicator is no longer allowed. Required training link (https://campus.extension.org/enrol/index.php?id=2201); certified applicators must repeat training every three years.</td></tr>
</table>

4. Other Labeled Herbicides These products are labeled but limited local data are available; and/or are labeled but not recommended in our region due to potential crop injury concerns.		
Group	**Product Name (*=Restricted Use)**	**Active Ingredient**
14	Aim	**carfentrazone**
14	Valkos 51 WDG	**flumioxazin**
14	Vida	**pyraflufen**

Insect Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.

Recommended Insecticides

Seed and At-Plant Treatments for Seedcorn Maggot

Farmore DI-400 as a commercially applied seed treatment which contains thiamethoxam (Group 4A).
Verimark (cyantraniliprole, Group 28) applied no earlier than 72 hours prior to planting, at 10-13.5 oz/A using in-furrow spray, transplant tray drench, transplant water treatment, hill drench, or surface band.
Note: The use of neonicotinoid insecticides (Group 4A) at planting may help reduce seedcorn maggot populations. See also Maggots in section E 3.1. Soil Pests - Detection and Control.

Aphids Note: Aphids transmit Mosaic Virus.

Apply one of the following formulations: **Note: Thorough spray coverage beneath leaves is important. Treat seedlings every 5-7 days, or as needed.**						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
4A	Neonicotinoid insecticides registered for use on Pumpkins and Winter Squash: see table at the end of Insect Control.					
4C + 3A	Ridgeback*	5.5 to 13.8 fl oz/A	sulfoxaflor + bifenthrin	3	24	H
4D	Sivanto Prime or 200SL	10.5 to 14.0 fl oz/A	flupyradifurone - **foliar**	1	4	M
4D	Sivanto Prime or 200SL	21.0 to 28.0 fl oz/A	flupyradifurone - **soil**	21	4	M
9B	Fulfill	2.75 oz/A	pymetrozine	0	12	L
9B	PQZ	2.4 to 3.2 fl oz/A	pyrifluquinazon	1	12	L
9D	Sefina	3.0 fl oz/A	afidopyropen	0	12	L
21A	Torac	17.0 to 21.0 fl oz/A	tolfenpyrad	1	12	H
28	Exirel	13.5 to 20.5 fl oz/A	cyantraniliprole	1	12	H
28	Verimark	Soil, at planting: 10 to 13.5 fl oz/A Drip chemigation: 6.75 to 10 fl oz/A	cyantraniliprole	1	4	H
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H
28 + 6	Minecto Pro*	10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H
29	Beleaf 50SG	Foliar: 2.0 to 2.8 oz/A Drip: 2.8 to 4.28 oz/A	flonicamid	0	12	M

Armyworms and Cabbage Loopers

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
3A	Pyrethroid insecticides registered for use on Pumpkins and Winter Squash: see table at the end of Insect Control.					
5	Entrust SC (OMRI)	4.0 to 8.0 fl oz/A	spinosad	3	4	M
5	Radiant SC	5.0 to 10.0 fl oz/A	spinetoram	3	4	M
6	Proclaim*	3.0 to 4.8 oz/A	emamectin benzoate	7	12	H
11A	Dipel DF, others (OMRI)	0.5 to 2.0 lb/A	*Bacillus thuringiensis kurstaki*	0	4	N
11A	XenTari (OMRI)	0.5 to 2.0 lb/A	*Bacillus thuringiensis aizawai*	0	4	N
18	Intrepid 2F	4.0 to 10.0 fl oz/A	methoxyfenozide	3	4	L
22	Avaunt 30WDG, Avaunt eVo	2.5 to 6.0 oz/A	indoxacarb	3	12	H
28	Coragen 1.67SC Coragen eVo	3.5 to 7.5 fl oz/A 1.2 to 2.5 fl oz/A	chlorantraniliprole - **soil and foliar**	1	4	L
28	Exirel (armyworms)	7.0 to 13.5 fl oz/A	cyantraniliprole	1	12	H
28	Exirel (cabbage loopers)	10.0 to 17.0 fl oz/A	cyantraniliprole	1	12	H
28	Verimark	6.75 to 13.5 fl oz/A	cyantraniliprole - **soil**	1	4	H
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H
28 + 4A	Voliam Flexi (cabbage looper only)	4.0 to 7.0 oz/A	thiamethoxam + chlorantraniliprole	1	12	H
28 + 6	Minecto Pro*	5.5 to 10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H

Cucumber Beetles

Young plants need to be protected from cucumber beetle feeding as the beetles can transmit the causal agent of bacterial wilt. Cucumber beetles also cause direct damage to pumpkin and winter squash rinds. Management of adult cucumber beetles early in the season may help reduce damage to rinds later in the season. Seeds pretreated with a neonicotinoid seed treatment such as Farmore DI400 should provide up to 14 days of control of cucumber beetle. **Note:** Some populations in Delaware may exhibit reduced pyrethroid susceptibility. Otherwise, apply one of the following formulations:

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
1A	Sevin XLR Plus	1.0 qt/A	carbaryl	3	12	H
3A	Pyrethroid insecticides registered for use on Pumpkins and Winter Squash: see table at the end of Insect Control.					
4A	Neonicotinoid insecticides registered for use on Pumpkins and Winter Squash: see table at the end of Insect Control.					
28	Verimark	Soil, at planting: 13.5 fl oz/A Drip chemigation: 10 fl oz/A	cyantraniliprole	1	4	H
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H

Cutworms See also section E 3.1. Soil Pests - Detection and Control.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
3A	Pyrethroid insecticides registered for use on Pumpkins and Winter Squash: see table at the end of Insect Control.					

Leafminers

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
3A	Pyrethroid insecticides registered for use on Pumpkins and Winter Squash: see table at the end of Insect Control.					
4A	Neonicotinoid insecticides registered for use on Pumpkins and Winter Squash: see table at the end of Insect Control.					
5	Entrust SC (OMRI)	6.0 to 8.0 fl oz/A	spinosad	3	4	M
5	Radiant SC	6.0 to 10.0 fl oz/A	spinetoram	3	4	M
6	Agri-Mek SC*	1.75 to 3.5 fl oz/A	abamectin	7	12	H
17	Trigard	2.66 oz/A	cyromazine	0	12	H
28	Coragen 1.67SC Coragen eVo	5.0 to 7.5 fl oz/A 1.7 to 2.5 fl oz/A	chlorantraniliprole - **soil and foliar - larvae**	1	4	L
28	Exirel	13.5 to 20.5 fl oz/A	cyantraniliprole	1	12	H
28	Verimark	6.75 to 13.5 fl oz/A	cyantraniliprole - **soil**	1	4	H
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H
28 + 6	Minecto Pro*	5.5 to 10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H

Melonworms and Pickleworms

Apply one of the following formulations. When using foliar materials make one treatment prior to fruit set, and then treat weekly. For soil or drip applications check the label for instructions on treatment frequency.						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Sevin XLR Plus	0.5 to 1.0 qt/A	carbaryl	3	12	H
3A	Pyrethroid insecticides registered for use on Pumpkins and Winter Squash: see table at the end of Insect Control.					
5	Entrust SC (OMRI)	4.0 to 8.0 fl oz/A	spinosad	3	4	M
5	Radiant SC	5.0 to 10.0 fl oz/A	spinetoram	3	4	M
6	Proclaim*	3.0 to 4.8 oz/A	emamectin benzoate	7	12	H
18	Intrepid 2F	4.0 to 10.0 fl oz/A	methoxyfenozide	3	4	L
22	Avaunt 30WDG, Avaunt eVo	2.5 to 6.0 oz/A	indoxacarb	3	12	H
28	Coragen 1.67SC Coragen eVo	2.0 to 3.5 fl oz/A 0.7 to 1.2 fl oz/A	chlorantraniliprole - **melonworms**	1	4	L
28	Coragen 1.67SC Coragen eVo	3.5 to 7.5 fl oz/A 1.2 to 2.5 fl oz/A	chlorantraniliprole **- pickleworms**	1	4	L
28	Exirel	7.0 to 13.5 fl oz/A	cyantraniliprole	1	12	H
28	Verimark	5.0 to 10.0 fl oz/A	cyantraniliprole - **soil**	1	4	H
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H
28 + 4A	Durivo	10.0 to 13.0 fl oz/A	thiamethoxam + chlorantraniliprole	30	12	H
28 + 4A	Voliam Flexi	4.0 to 7.0 oz/A	thiamethoxam + chlorantraniliprole	1	12	H
28 + 6	Minecto Pro*	5.5 to 10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H

Mites Mite infestations generally begin around field margins and grassy areas. **DO NOT** mow or maintain these areas after midsummer to prevent mites from moving into the crop. Localized infestations can be spot-treated. Begin treatment when 10-15% of the crown leaves are infested early in the season.

Apply one of the following formulations. Note: Continuous use of carbaryl or pyrethroids may result in mite outbreaks. Addition of crop oils or organosilicon spray additives will increase miticide effectiveness.						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
6	Agri-Mek SC*	1.75 to 3.5 fl oz/A	abamectin	7	12	H
10B	Zeal Miticide	2.0 to 3.0 oz/A	etoxazole	7	12	L
20B	Kanemite 15SC	31.0 fl oz/A	acequinocyl	1	12	L
21A	Magister SC	24.0 to 36.0 fl oz/A	fenazaquin	3	12	H
23	Oberon 2SC	7.0 to 8.5 fl oz/A	spiromesifen	7	12	M
28 + 6	Minecto Pro*	5.5 to 10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H
20D	Acramite 50WS	0.75 to 1.0 lb/A	bifenazate	3	12	M
N/A	Sulfur 80WG (OMRI)	5 to 25 lb/A	sulfur	0	24	M

Rindworms In addition to the above specified Lepidopteran pests, various species feed on rinds, including, but not limited to corn earworm, leafrollers, webworms, and beet armyworm. Proper pest identification is important because not all species that cause rind feeding damage are susceptible to pyrethroids.

For Lepidopteran Rindworms, apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
3A[1]	Pyrethroid insecticides registered for use on Pumpkins and Winter Squash: see table at the end of Insect Control.					
5	Entrust SC (OMRI)	4.0 to 8.0 fl oz/A	spinosad	3	4	M
5	Radiant SC	5.0 to 10.0 fl oz/A	spinetoram	3	4	M
6	Proclaim 5SG*	3.0 to 4.8 oz/A	emamectin benzoate	7	12	H
18	Intrepid 2F	4.0 to 10.0 fl oz/A	methoxyfenozide	3	4	L

[1]Resistance concerns with corn earworm and beet armyworm

Squash Bugs

Begin treatments if more than one egg mass per plant is present. Sprays should target nymphal stages.

Apply one of the following formulations: Note: Under-leaf spray coverage is essential.						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Sevin XLR Plus	1.0 qt/A	carbaryl	3	12	H
3A	Pyrethroid insecticides registered for use on Pumpkins and Winter Squash: see table at the end of Insect Control.					
4A	Neonicotinoid insecticides registered for use on Pumpkins and Winter Squash: see table at the end of Insect Control.					
4D	Sivanto Prime or 200SL	10.5 to 14.0 fl oz/A	flupyradifurone – **foliar**	1	4	M

Squash Vine Borers When vines begin to run, apply to bases of plants 4 times at 7-day intervals. Pheromone traps for squash vine borer are commercially available. These traps can be used to indicate when moth activity begins. Note: Use of spinosad or spinetoram for Cabbage Looper control will reduce squash vine borer populations.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
3A	Pyrethroid insecticides registered for use on Pumpkins and Winter Squash: see table at the end of Insect Control.					

Thrips

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
3A[1]	Pyrethroid insecticides registered for use on Pumpkins and Winter Squash: see table at the end of Insect Control.					
4A[2]	Neonicotinoid insecticides registered for use on Pumpkins and Winter Squash: see table at the end of Insect Control.					
5	Entrust SC (OMRI)	6.0 to 8.0 fl oz/A	spinosad	3	4	M
5	Radiant SC	6.0 to 10.0 fl oz/A	spinetoram	3	4	M
21A	Torac	21.0 fl oz/A	tolfenpyrad	1	12	H
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H
29	Beleaf 50SG	Foliar: 2.0 to 2.8 oz/A Drip: 2.8 to 4.28 oz/A	flonicamid	0	12	M

[1]Resistance concerns with western flower thrips **[2]Resistance concerns with tobacco thrips**

Whiteflies

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
4A	Neonicotinoid insecticides registered for use on Pumpkins and Winter Squash: see table at the end of Insect Control.					
4D	Sivanto Prime or 200SL	7.0 to 14.0 fl oz/A	flupyradifurone - **foliar**	1	4	M
7C	Knack	8.0 to 10.0 fl oz/A	pyriproxyfen	7	12	L
9B	Fulfill	2.75 oz/A	pymetrozine	0	12	L
9B	PQZ	2.4 to 3.2 fl oz/A	pyrifluquinazon	1	12	L
9D	Sefina	14.0 fl oz/A	afidopyropen	0	12	L
23	Oberon 2SC	7.0 to 8.5 fl oz/A	spiromesifen	7	12	M
28	Exirel	13.5 to 20.5 fl oz/A	cyantraniliprole	1	12	H
28	Verimark	6.75 to 13.5 fl oz/A	cyantraniliprole - **soil**	1	4	H
28 + 6	Minecto Pro*	10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H
29	Beleaf 50SG	Foliar: 2.8 oz/A Drip: 2.8 to 4.28 oz/A	flonicamid	0	12	M

Group 3A Pyrethroid Insecticides Registered for Use on Pumpkins and Winter Squash

Apply one of the following formulations (check if the product label lists the insect you intend to spray; the label is the law):					
Product Name (*=Restricted Use)	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
Asana XL*	5.8 to 9.6 fl oz/A	esfenvalerate	3	12	H
Baythroid XL*	0.8 to 2.8 fl oz/A	beta-cyfluthrin	0	12	H
Brigade 2EC*, others	2.6 to 6.4 fl oz/A	bifenthrin	3	12	H
Danitol 2.4EC*	10.67 to 16.0 fl oz/A	fenpropathrin	7	24	H
Declare*	1.02 to 1.54 fl oz/A	gamma-cyhalothrin	1	24	H
Hero*	4.0 to 10.3 fl oz/A	zeta-cypermethrin + bifenthrin	3	12	H
Lambda-Cy 1EC*, others	2.56 to 3.84 fl oz/A	lambda-cyhalothrin	1	24	H
Mustang Maxx*	1.28 to 4.0 fl oz/A	zeta-cypermethrin	1	12	H
Permethrin*, others	4.0 to 8.0 fl oz/A	permethrin	0	12	H
Tombstone*	0.8 to 2.8 fl oz/A	cyfluthrin	0	12	H
Warrior II*	1.28 to 1.92 fl oz/A	lambda-cyhalothrin	1	24	H
Combo products containing a pyrethroid					
Besiege*	6.0 to 9.0 fl oz/A	lambda-cyhalothrin + chlorantraniliprole (Group 28)	1	24	H
Endigo ZC and ZCX*	4.0 to 4.5 fl oz/A	lambda-cyhalothrin + thiamethoxam (Group 4A)	1	24	H
Ridgeback*	5.5 to 13.8 fl oz/A	bifenthrin + sulfoxaflor (Group 4C)	3	24	H
Savoy EC*	6.0 to 12.9 fl oz/A	bifenthrin + acetamiprid (Group 4A)	7	12	H

Group 4A Neonicotinoid Insecticides Registered for Use on Pumpkins and Winter Squash

Apply one of the following formulations (check if the product label lists the insect you intend to spray; the label is the law):					
Product Name (*=Restricted Use)	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
Admire Pro	7.0 to 10.5 fl oz/A	imidacloprid - **soil**	21	12	H
Assail 30SG	2.5 to 5.3 oz/A	acetamiprid	0	12	M
Belay	9 .0 to 12.0 fl oz/A	clothianidin - **soil/drip**	21	12	H
Belay	3.0 to 4.0 fl oz/A	clothianidin - **foliar** (PHI note: do not make application after 4th true leaf has unfolded)	see note	12	H
Actara	1.5 to 5.5 oz/A	thiamethoxam	0	12	H
Platinum 75SG	1.66 to 3.67 oz/A	thiamethoxam	30	12	H
Scorpion 35SL	9.0 to 10.5 fl oz/A	dinotefuran - **soil/drip**	21	12	H
Scorpion 35SL	2.0 to 7.0 fl oz/A	dinotefuran - **foliar**	1	12	H
Venom 70SG	5.0 to 7.5 oz/A	dinotefuran - **soil/drip**	21	12	H
Venom 70SG	1.0 to 4.0 oz/A	dinotefuran - **foliar**	1	12	H
Combo products containing a neonicotinoid					
Durivo	10.0 to 13.0 fl oz/A	thiamethoxam + chlorantraniliprole (Group 28)	30	12	H
Endigo ZC* and ZCX*	4.0 to 4.5 fl oz/A	thiamethoxam + lambda-cyhalothrin (Group 3A)	1	24	H
Savoy EC*	6.0 to 12.9 fl oz/A	acetamiprid + bifenthrin (Group 3A)	7	12	H
Voliam Flexi	4.0 to 7.0 oz/A	thiamethoxam + chlorantraniliprole (Group 28)	1	12	H

Disease Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.

Recommended Fungicides

Nematodes See also sections E 1.5. Soil Fumigation and E 1.6. Nematode Control. Use fumigants listed in section E 1.5., or nematicides listed below. Consult the label.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
1A	Vydate L*	1.0 to 2.0 gal/A incorporate into top 2-4 inches of soil, *OR* 2.0 to 4.0 pt/A apply 2 w after planting and repeat 2-3 w later.	oxamyl	1	48	H
7	Velum Prime 4.16SC	6.5 to 6.84 fl oz/A	fluopyram	0	12	--
--	Nimitz 4EC	3.5 to 5.0 pt/A incorporate or drip-apply 7 d before planting	fluensulfone	n/a	12	N

Seed Treatment

Check with your seed company if seed has been treated with an insecticide and fungicide. If it has not been treated, use a mixture of Thiram 480DP (4.5 fl oz/100 lb seed) and an approved commercially available insecticide.

Damping-off caused by *Phytophthora*, *Pythium*, and *Rhizoctonia*

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Apply one of the following at-planting (see label for application timing, methods, and restrictions):						
Phytophthora and Pythium Root Rot						
4	Ridomil Gold 4SL	1.0 to 2.0 pt/A	mefenoxam	5	48	N
4	Ultra Flourish 2E	2.0 to 4.0 pt/A	mefenoxam	5	48	N
4	MetaStar 2E AG	4.0 to 8.0 pt/A	metalaxyl	AP	48	N
49 + **4**	Orondis Gold[1]	28.0 to 55.0 fl oz/A	oxathiapiprolin + mefenoxam	AP	48	N
Phytophthora, Pythium, and Rhizoctonia Root Rot						
4 + 11	Uniform 3.66SE	0.34 fl oz/1000 ft row. Avoid direct seed contact, which may cause delayed emergence.	mefenoxam + azoxystrobin	AP	0	N
Rhizoctonia root rot						
11	azoxystrobin 2.08F	0.40 to 0.80 fl oz/1000 ft row	azoxystrobin	1	4	N
Pythium root rot only						
28	Previcur Flex 6F	1.2 pt/A in transplant water, drip irrigation, or direct spray at base of plant and soil	propamocarb hydrochloride	2	12	N

[1] may cause some yellowing in cucurbit leaves

Bacterial and Fungal Diseases

Angular Leaf Spot/Bacterial Leaf Spot

Both diseases can produce foliar symptoms that are often overlooked. Early detection is important since control of the foliar phase can reduce infections in developing fruit. Infected fruit will become unmarketable. Both diseases are seedborne and can survive on infested debris for at least one year or until the debris decomposes. Rotate away from fields with a history of bacterial problems. Incorporate the following into a standard disease management program when leaf spot is first detected and repeat every 7 to 10 days: fixed copper at labeled rates plus mancozeb.

Anthracnose - see Gummy Stem Blight (Black Rot) and Anthracnose below.

Bacterial Wilt

Controlling striped and spotted cucumber beetles is essential for preventing bacterial wilt. See "Cucumber Beetles" in the Cucumber Insect Control section for specific recommendations. Insecticide applications made at planting may not prevent beetle damage season-long; additional foliar insecticide applications may be necessary.

Choanophora Fruit Rot

This disease occurs during warm wet weather and develops predominantly on flowers or fruit near the ground. Management is difficult because disease development is rapid and weather dependent. Fungicide sprays are not effective because flowers, which open daily, must be protected immediately. Practices that reduce soil moisture or reduce flower-soil contact, such as raised beds and plastic mulch, may be beneficial.

Downy Mildew

Scout fields for disease incidence on a regular basis. Begin targeted sprays when Downy Mildew is predicted for the region. For current status of the disease, check the Cucurbit Downy Mildew Forecasting website at *https://cdm.ipmpipe.org*. Strains of Downy Mildew that infect one cucurbit crop may not affect pumpkin or winter squash. Unnecessary fungicide application can be avoided by not spraying until disease is predicted in the region on watermelon. Preventative applications are much more effective than applications made after disease is detected. Materials with different modes of action (FRAC codes) should always be alternated to reduce the chances for fungicide resistance development.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Sprays should be applied on a 7-d schedule when disease is forecast or present in the region. Under severe disease conditions and conducive weather, spray interval may be reduced IF the label allows. TANK-MIX one of these products WITH a protectant fungicide such as chlorothalonil 6F or Gavel 75DF:						
49 + 40	Orondis Ultra 2.33SC	5.5 to 8.0 fl oz/A	oxathiapiprolin + mandipropamid	0	4	--
49+M05	Orondis Opti	1.75 to 2.5 pt/A	oxathiapiprolin + chlorothalonil	0	12	--
21	Ranman 400SC	2.10 to 2.75 fl oz/A (**do not apply with copper**; see label for details)[1]	cyazofamid	0	12	L
Other materials for use in rotations as tank mix partners with a protectant:						
43	Presidio 4SC	3.0 to 4.0 fl oz/A	fluopicolide	2	12	L
28	Previcur Flex 6F	1.2 pt/A	propamocarb hydrochloride	2	12	N
40 + 45	Zampro 525SC	14.0 fl oz/A	dimethomorph + ametoctradin	0	12	--
22	Elumin 4SC	8.0 fl oz/A	ethaboxam	2	12	--
M03+22	Gavel 75DF	1.5 to 2.0 lb/A **contains protectant**	mancozeb + zoxamide	5	48	--
M05+22	Zing! 4.9SC	36 fl oz/A **contains protectant**	chlorothalonil + zoxamide	0	12	N
M05+27	Ariston 42SC	1.9 to 3.0 pt/A **contains protectant**	chlorothalonil + cymoxanil	3	12	--
11 + 27	Tanos 50DF	8.0 oz/A	famoxadone + cymoxanil	3	12	--
27	Curzate 60DF	3.2 to 5.0 oz/A	cymoxanil	3	12	N
29	Omega 500F	12.0 to 24.0 fl oz/A	fluazinam	7	12	N
40	Forum 4.17SC	6.0 fl oz/A	dimethomorph	0	12	N

[1]Ranman should be tank mixed with an organosilicone surfactant when disease is severe, or a non-ionic surfactant or blend of organosilicone and non-ionic surfactant disease is moderate or light.

Fusarium Fruit Rot

This disease is especially destructive in fields where pumpkins are grown every year. Once the pathogen is established in a field, loss can be significant. Fruit Rot is caused by several Fusarium spp., and fungicide applications are not effective. Hard rind cultivars are less susceptible to Fusarium Fruit Rot than other cultivars. Production of pumpkin on a no-till cover crop mulch layer such as winter rye plus hairy vetch has been shown to help reduce disease incidence. Greater disease reductions will occur when the mulch layer is thicker.

Gummy Stem Blight (Black Rot) and Anthracnose

Rotate crops to allow at least 2 years between cucurbit plantings. Pumpkin cv. ‘Small Sugar’ appears to be the least affected by Black Rot.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Fungicides with a high-risk for resistance development, such as FRAC code 11 fungicides (Cabrio, Pristine and Quadris), should be tank-mixed with a protectant fungicide. Use at least the minimum labeled rate of each fungicide in the tank-mix. Do not apply FRAC code 11 fungicides more than 4 times total per season. If resistance to FRAC code 11 fungicides exists in the area, use fungicides from a different FRAC code. Begin the following fungicide program when fruit start to form. **Tank mix:**						
M05	chlorothalonil 6F	2.0 to 3.0 pt/A (use low rate early in season)	chlorothalonil	0	12	N
WITH one of the following and rotate between fungicides in different FRAC codes:						
3	tebuconazole 3.6F	8.0 fl oz/A	tebuconazole	7	12	N
3	Proline 480SC	5.7 fl oz/A	prothioconazole	7	12	--
3	Rhyme 2.08SC	5.0 to 7.0 fl oz/A	flutriafol	0	12	--
3 + 9	Inspire Super 2.82EW	16.0 to 20.0 fl oz/A	difenoconazole + cyprodinil	7	12	--
3 + 7	Luna Experience 3.34SC[1]	10.0 to 17.0 fl oz/A	tebuconazole + fluopyram	7	12	--
7 + 12	Miravis Prime	9.2 to 11.4 fl oz/A	pydiflumetofen + fludioxonil	1	12	--

Gummy Stem Blight (Black Rot) and Anthracnose - continued next page

Gummy Stem Blight (Black Rot) and Anthracnose - continued

9 + 12	Switch 62.5WG	11.0 to 14.0 oz/A	cyprodinil + fludioxonil	1	12	L
3 + 7	Aprovia Top 1.62EC	10.5 to 13.5 fl oz/A	difenoconazole + benzovindiflupyr	0	12	--
7 + **11**	Merivon 2.09SC[2]	5.5 fl oz/A	fluxapyroxad + pyraclostrobin	0	12	N
7 + **11**	Pristine 38WG[2]	12.5 to 18.5 oz/A	boscalid + pyraclostrobin	0	12	--
Maintain fungicide schedule until harvest (see "Harvest and Post-Harvest Considerations" section above). Fungicide application for Black Rot control will help maintain "handles" on the fruit. Harvest carefully because wounding can negate benefits from a season-long fungicide program.						

[1]A mild yellowing on leaf margins is sometimes seen following application of Luna Experience in cucurbits. [2]Tank mixes of additives, adjuvants, and/or other products may result in crop injury.

Phytophthora Crown and Fruit Rot

Multiple practices should be used to minimize the occurrence of this disease. Rotate away from susceptible crops (such as peppers, eggplants, tomatoes, lima and snap beans, and other cucurbits) for as long as possible. Pre-plant fumigants will also suppress disease. Fields should be adequately drained to ensure that water does not accumulate around the base of the plant. Once the canopy closes, subsoil between the rows to allow for faster drainage following rainfall. Materials with different modes of action (*i.e.*, FRAC codes) should always be alternated to reduce the chances for fungicide resistance development. Apply fungicides when conditions are favorable for disease development. Fruit are susceptible at all growth stages and must be protected season-long.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Apply one of the following formulations pre-plant for early season control:						
4	MetaStar 2E AG	4.0 to 8.0 pt/A	metalaxyl	AP	48	N
4	Ridomil Gold 4SL	1.0 to 2.0 pt/A	mefenoxam	5	48	N
4	Ultra Flourish 2E	2.0 to 4.0 pt/A	mefenoxam	5	48	N
4 + 11	Uniform 3.66SE	0.34 fl oz/1000 ft row	mefenoxam + azoxystrobin	AP	0	N
28	Previcur Flex 6F	1.2 pt/A in transplant water, drip irrigation, or spray directed to the base of the plants and soil.	propamocarb hydrochloride	2	12	N
49 + **4**	Orondis Gold[1]	28.0 to 55.0 fl oz/A	oxathiapiprolin + mefenoxam	5	48	--
Apply one of the following fungicides and tank mix with fixed copper at labeled rates when conditions favor disease development (for suppression only):						
49 + 40	Orondis Ultra 2.33SC	5.5 to 8.0 fl oz/A	oxathiapiprolin + mandipropamid	0	4	--
49+M05	Orondis Opti	1.75 to 2.5 pt/A	oxathiapiprolin + chlorothalonil	0	12	--
21	Ranman 400SC	2.75 fl oz/A (**do not apply with copper**; see label for details)[2]	cyazofamid	0	12	L
40 + 45	Zampro 525SC	14.0 fl oz/A	dimethomorph + ametoctradin	0	12	--
22	Elumin 4SC	8 fl oz/A	ethaboxam	2	12	--
40	Revus 2.08F	8.0 fl oz/A	mandipropamid	0	4	--
40	Forum 4.17SC	6.0 fl oz/A	dimethomorph	0	12	N
43	Presidio 4SC[3]	4.0 fl oz/A	fluopicolide	2	12	L
M05+22	Zing! 4.9SC	36 fl oz/A	chlorothalonil + zoxamide	0	12	N

[1]Do not follow soil applications of Orondis Gold with foliar applications of oxathiapiprolin-containing products. [2]Ranman should be tank mixed with an organosilicone surfactant when disease is severe, or a non-ionic surfactant or blend of organosilicone and non-ionic surfactant disease is moderate or light. [3]Presidio may also be applied through the drip irrigation (see supplemental label). Soil drench followed by drip application has given good results in some trials on crown rot caused by *Phytophthora capsici*.

Plectosporium Blight (Microdochium blight)

Research has shown that no-till pumpkin production may reduce disease. Rotate with crops other than cucurbits. It is important to achieve maximum foliage coverage with each fungicide application. Scout fields regularly.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Once symptoms appear on petioles or as fruit begins to form, apply one of the following and repeat every 7-10 days:						
M05	chlorothalonil 6F	2.0 to 3.0 pt/A	chlorothalonil	0	12	N
3 + 11	Quadris Top 1.67SC[1]	12.0 to 14.0 fl oz/A	difenoconazole + azoxystrobin	1	12	--
7 +11	Pristine 38WG[2]	18.5 oz/A	boscalid + pyraclostrobin	0	12	--
A spray schedule that alternates Cabrio 20EG or Flint Extra 500SC with chlorothalonil will also provide control. Note: do not apply Flint Extra 500SC near Concord grapes, see label.						

[1]**Do not apply near apples**, see label. [2]Tank mixes of additives, adjuvants, and/or other products may result in crop injury.

Powdery Mildew

Some varieties have resistance or tolerance to Powdery Mildew and should be used if possible (see table Recommended Varieties above). The fungus that causes cucurbit Powdery Mildew has developed resistance to high-risk fungicides. In the Eastern US, resistance to strobilurin (FRAC code 11) and DMI (FRAC code 3) fungicides has been reported. Proper fungicide resistance management should be followed to help delay the development of resistance and minimize control failures.

Powdery Mildew generally occurs from mid-July until the end of the season. Development on tolerant varieties will vary from year to year. Planting tolerant varieties will help delay the development of Powdery Mildew and improve the performance of fungicides. If Powdery Mildew has become well established in the mid- to late part of the season, only apply protectant fungicides such as chlorothalonil or sulfur. Make first application when Powdery Mildew is observed in the area or is detected by scouting (one lesion on the underside of 45 old leaves per acre).

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
TANK MIX one of these products with a protectant such as chlorothalonil 6F 2.0 to 3.0 pt/A:						
50	Vivando 2.5SC[1]	15.4 fl oz/A	metrafenone	0	12	--
3 + 7	Luna Experience 3.34SC[2]	6.0 to 17.0 fl oz/A	tebuconazole + fluopyram	7	12	--
13	Quintec 2.08SC	4.0 to 6.0 fl oz/A	quinoxyfen	3	12	--
AND ALTERNATE with fungicides from different FRAC codes with a protectant such as chlorothalonil 6F 2.0 to 3.0 pt/A:						
3	tebuconazole 3.6F	4.0 to 6.0 fl oz/A	tebuconazole	7	12	N
3	Procure 480SC	4.0 to 8.0 fl oz/A	triflumizole	0	12	N
3	Proline 480SC	5.7 fl oz/A	prothioconazole	7	12	--
3	Rally 40WSP	2.5 to 5.0 oz/A	myclobutanil	0	24	N
3	Rhyme 2.08SC	5.0 to 7.0 fl oz/A	flutriafol	0	12	--
3 + 9	Inspire Super 2.82EW	16.0 to 20.0 fl oz/A	difenoconazole + cyprodinil	7	12	--
3 + 7	Aprovia Top 1.62EC	10.5 to 13.5 fl oz/A	difenoconazole + benzovindiflupyr	0	12	--
7 + **11**	Pristine 38WG[3]	12.5 to 18.5 oz/A	boscalid + pyraclostrobin	0	12	--
39	Magister 1.6SC[4]	24.0 to 36.0 fl oz/A	fenazaquin	3	12	H
7 + 12	Miravis Prime	9.2 to 11/4 fl oz/A	pydiflumetofen + fludioxonil	1	12	--
P05	Regalia (OMRI)	4.0 qt/A	Extract of *Reynoutria sachalinensis*	0	4	--
OR WITH (Note: Sulfur may injure plants, especially at high temperatures. Certain varieties can be more sensitive. Consult the label for precautions).						
M02	Micronized Wettable Sulfur 80W[5]	4.0 lb/A	sulfur	--	24	N
U06	Torino 0.85SC	3.4 fl oz/A	cyflufenamid	0	4	--

[1]Do not mix Vivando with horticultural oils. [2]A mild yellowing on leaf margins is sometimes seen following application of Luna Experience in cucurbits. [3]Tank mixes of additives, adjuvants, and/or other products may result in crop injury. [4]Do not make more than one application per year of Magister. [5]Do not apply when temperature exceeds 90°F or to varieties susceptible to sulfur injury.

Scab

Select scab-resistant varieties. The fungus that causes scab typically occurs during periods of cool, wet weather when temperatures are below normal. Rotate away from fields with a history of scab for at least 2 years.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Begin sprays as true leaves form and repeat every 5 to 7 days:						
M05	chlorothalonil 6F	2.0 to 3.0 pt/A	chlorothalonil	0	12	N

Viruses (WMV, PRSV, ZYMV, and CMV)

The most prevalent virus in the Mid-Atlantic region is WMV, followed by PRSV, ZYMV, and CMV. An easy method for mitigating potential losses are to plant varieties with resistance packages to multiple viruses whenever possible. Plant fields as far away from existing cucurbit plantings as possible to help reduce aphid transmission of viruses.

Radishes, Rutabagas and Turnips

Radishes are a quick-growing, cool-season crop, that develops its best quality (small tops and well-shaped roots) when grown at 50-65°F in medium to short day lengths. Crops must be grown rapidly (23-28 days) with adequate soil moisture. When growth is checked, the radish becomes hot, tough, and pithy. Long days (15 hours) and warm temperatures induce seed-stalk formation.
Rutabagas and Turnips are cool-season crops that develop their best root growth at 40-60°F. They can be grown in spring or fall. Rutabagas require 90 days to mature so it is not practical to grow a spring crop in Southern New Jersey, Delaware, Maryland, or Virginia. Early maturing turnip varieties can be harvested in 40 days, but late maturing varieties in 75 days. As biennial plants, both rutabagas and turnips will be induced to flower after exposure to cool temperatures in spring planted crops or if fall crops are left to regrow over winter. Seed stalk formation will stop root development rendering them unsalable.

Recommended Varieties[1]

Radish (Red Globe; White Interior)	Cherriette[2]
	Crunchy Royale[2]
	Red Satin[2]
	Cherry Belle
	Fireball[2]
	Champion
Daikon/Specialty Radish	Watermelon (white flesh, red interior, globe)
	Shumkyo Semi Long (red flesh, white interior, elongated)
	White icicle (white flesh, white interior, elongated)
	Eastern Egg (multi-color)
	Minowase Summer Cross #3 (Daikon)
	Redmoon (red interior)
	Bluemoon (blue interior)
	French Breakfast (red top, white interior, elongated)
	Black Spanish Round (dark flesh, white interior, large globe)
	April Cross* (Daikon)
Rutabaga	Laurentian
	American Purple Top
Turnip White	Tokyo Cross[2]
	White Lady[2]
	Tokyo Silky[2]
	Hakurei[2]
	Polar[2]
Turnip Purple	Purple Prince[2]
	Purple Top White Globe (MR[3])
	Royal Crown[2]

[1]**Varieties within type listed earliest to latest according to vendors:**
Radish 18-45 days; Daikon/Specialty Radish 24-80 days; Rutabaga 90-100 days; Turnip 35-75 days.
[2]F1 hybrid variety. [3]MR = Mosaic Resistant (vendor information).

Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and Chapter B Soil and Nutrient Management. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede the recommendations found below.

Radishes Rutabagas and Turnips[1,2]		Soil Phosphorus Level				Soil Potassium Level				
		Low	Med	High (Opt)	Very High	Low	Med	High (Opt)	Very High	
	N (lb/A)	P_2O_5 (lb/A)				K_2O (lb/A)				Nutrient Timing and Method
	50	150	100	50	0	150	100	50	0	Total nutrient recommended
	50	150	100	50	0	150	100	50	0	Broadcast and disk-in

[1]Apply 1-2 lb/A of boron (B) with broadcast fertilizer; see also Table B-7. in Chapter B Soil and Nutrient Management.
[2]Apply 20-30 lb/A of sulfur (S) for most soils.

Seed Treatment - See also Disease Control below

Purchase hot water treated seed or request hot water seed treatment, if possible (check with your seed company).

Spacing and Seeding

Radishes: Seed as early in the spring as soil can be worked, then at 8-10 day intervals through September.
Seed 10-15 lb/A in rows 8-15 inches apart with 12-15 plants/ft in the row.
Rutabagas: Seed in early spring for the early summer crop and at least 90 days before the fall early freeze date. Seed 1½-2 lb/A, ¼ inch deep, in rows 30-36 inches apart. Thin plants to 4-8 inches apart in the row when plants are 2-3 inches tall.
Turnips: Seed as early in the spring as soil can be worked or at least 70 days before the fall early freeze date. Seed 1-2 lb/A, ⅛-¼ inch deep, in rows 14-18 inches apart. Plants should be 2-3 inches apart in the row. Seed can also be broadcast at the rate of 2.5 lb/A.

Harvest and Post-Harvest Considerations

Radishes: Bunched with tops or bagged without tops are the two ways radishes are sold. Bunching is most common in this region. Plants are pulled and gathered with rubber bands or twist ties.
Shelf life is 10-14 days. Store at 32°F and 95-100% relative humidity after washing to remove any soil on roots.
Rutabagas: Pull and trim tops in the field. Bruised, damaged, or diseased rutabagas will not store well. Wash rutabagas in clean water, spray-rinse with clean water, then dry as rapidly as possible before waxing for shipping. For short term storage the root does not need to be waxed. Waxed rutabagas can be stored 4-6 months at 32°F and 95-100% relative humidity.
Turnips: The crop is dug mechanically or by hand and either bunched or topped. Turnips can be stored over 4-5 months at 32°F and at 95% relative humidity.

Weed Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.

Recommended Herbicides

1. Identify the weeds in each field and select recommended herbicides. More information is available in the "Herbicide Effectiveness on Common Weeds in Vegetables" (Table E-3) in Chapter E Pest Management.
2. Minimize herbicide resistance development. Identify the herbicide mode of action group number and follow recommended good management practices; **bolded group numbers in tables below are herbicides at higher risk for selecting resistant weed populations.** Include non-chemical weed control whenever possible.

1. Soil-Applied (Preplant Incorporated or Preemergence)

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
3	Dacthal 6F Dacthal W-75	6 to 14 pt/A 6 to 14 lb/A	**DCPA**	4.5 to 10.5 lb/A	25	12

-**For turnips only**. Turnips: apply preplant incorporated or preemergence in turnips; **do not** incorporate deeper than 2 inches.
-**Do not** apply preplant incorporated for radishes. Emerged weeds should be cultivated or weeded prior to application.
-Primarily controls annual grasses and a few broadleaf weeds, including common purslane.
-Results have been most consistent when used in fields with coarse-textured soils low in organic matter, and when the application is followed by rainfall or irrigation. Maximum application not addressed on label.

2. Postemergence

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
1	Shadow 3EC Select 2EC Select Max 0.97EC	4 to 5.33 fl oz/A 6 to 8 fl oz/A 9 to 16 fl oz/A	**clethodim**	0.07 to 0.125 lb/A	15/ 30	24
	Poast 1.5EC	1 to 2.5 pt/A	**sethoxydim**	0.2 to 0.5 lb/A	14	12

-**Select 2EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). **Select Max**: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution). **Shadow 3EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution) for large or stressed grasses; use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution) when crop safety is a concern.

2. Postemergence Shadow, Select, Select Max, Poast - continued next page

2. Postemergence Shadow, Select, Select Max, Poast - continued

Poast: Apply with COC at 1.0% v/v. -**The use of COC may increase the risk of crop injury when hot or humid conditions prevail**. To reduce the risk of crop injury, omit additives or switch to NIS when grasses are small and soil moisture is adequate. -Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control. -Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will **not** be controlled. -Controls many annual and certain perennial grasses, including annual bluegrass, but Poast is preferred for goosegrass control. -For best results, treat annual grasses when they are actively growing and before tillers are present. Control may be reduced if grasses are large or under hot or dry weather conditions. Repeated applications may be necessary to control certain perennial grasses. If repeat applications are necessary, allow 14 days between applications. Rainfastness is 1 h. -**Do not** tank mix with or apply within 2 to 3 days of any other pesticide, unless labeled, as this may increase the risk of crop injury or reduce the control of grasses. -**Do not** apply more than 8 fl oz/A of Select 2EC in a single application and **do not** exceed 1 pt/A for the season, **do not** apply more than 16 fl oz/A of Select Max in a single application and **do not** exceed 32 oz/A (radish) or 64 oz/A (rutabagas, turnips) for the season. - **Do not** apply more than 5.33 fl oz/A of Shadow 3EC in a single application and **do not** exceed 10.67 fl oz/A for the season for radish or 21.33 fl oz/A for rutabagas and turnips. -**Do not** apply more than 2.5 pt/A Poast in a single application and **do not** exceed 2.5 pt/A for the season. -**Do not** harvest radish within 15 days of application and rutabagas and turnips within 30 days of Select or Shadow application.						
4	Stinger 3SL	5.3 to 8 fl oz/A	**clopyralid**	0.125 to 0.188 lb/A	15/30	12
-**Turnip roots and tops only.** Other clopyralid formulations may not be labeled (read the label). -Apply in a single application to control certain annual and perennial broadleaf weeds. -Common annuals controlled include galinsoga, ragweed species, common cocklebur, groundsel, pineappleweed, clover, and vetch. Perennials controlled include Canada thistle, goldenrod species, aster species, and mugwort (wild chrysanthemum). -Stinger is very effective on small seedling annual and emerging perennial weeds less than 2-4 inches tall but is less effective and takes longer to work when weeds are larger. -Use 5.3 fl oz/A to control annual weeds less than 2 inches tall. Increase the rate to 5.3 to 8 fl oz/A to control larger annual weeds. Apply 8 fl oz/A to suppress or control perennial weeds. -Spray additives are not needed or required by the label and are not recommended. -Rainfastness is 6 h. -Maximum Stinger application per year: 8 fl oz/A; do not apply more than one application per crop per year. -PHI is 15 d for turnip tops and 30 d for turnip roots. -Observe follow-crop restrictions, or injury may occur from herbicide carryover.						

3. Other Labeled Herbicides These products are labeled but limited local data are available; and/or are labeled but not recommended in our region due to potential crop injury concerns.		
Group	**Product Name (*=Restricted Use)**	**Active Ingredient**
3	Treflan	**trifluralin**
14	Aim	**carfentrazone**

Insect Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.

Recommended Insecticides

<u>Soil Pests</u>

Cabbage Maggots

Cabbage maggots overwinter as pupae. Overwintered adults (flies) emerge when yellow rocket (mustard) first blooms, then begin laying eggs on roots or soil near roots. All brassica crops are affected. Eggs hatch within 3-7 days. Young plants may become severely stunted or die. Larvae or tunnels in harvest bulbs may be evident from later infestations. This pest has 3-4 generations per growing season, although the first generation is often the most economically damaging. The last larval generation is in October, particularly in warmer years. Treatments for cabbage maggot must be done preventively, as once damage is evident, loss of plants is unavoidable. Barriers, such as row covers, may be useful in excluding flies from smaller plantings. Prompt and complete destruction of crop residue is helpful. Chemical treatments should be applied preplant, or at planting, depending on the product used.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s) and Crop Restrictions**	**PHI (d)**	**REI (h)**	**Bee TR**
1B	Diazinon AG500*	2.0 to 4.0 qt/A	diazinon - **rutabaga only, preplant broad-cast, incorporate immediately to 4" depth**	AP	96	H
28	Verimark	10.0 to 13.5 fl oz/A	cyantraniliprole - **suppression only**	AP	4	H

Cutworms See also section E 3.1. Soil Pests - Detection and Control.

Cutworms are moth larvae (caterpillars) that feed on roots and stems. Cutworms chew through stems at or near the soil line, causing young plants to topple over. Cutworms may also feed on the subterranean portion of bulb crops like radish, turnips, and rutabagas. Larvae are typically active at night and spend most of this stage belowground.

Cutworms are favored by less disturbed soils and debris covered soil surfaces. Conventional tillage and crop debris incorporation helps reduce populations. Several species in NJ can injure young plants. There are usually two generations per season. If cutworm damage is anticipated, it is best to treat preventively with insecticide.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s) and Crop Restrictions**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Sevin XLR Plus	1.0 to 2.0 qt/A	carbaryl	7	12	H
3A	Baythroid XL*	1.6 to 2.8 fl oz/A	beta-cyfluthrin - **radish only**	0	12	H
3A	Tombstone*	1.6 to 2.8 fl oz/A	cyfluthrin **- radish only**	0	12	H
3A	Brigade 2EC*, others	5.12 to 6.4 fl oz/A	bifenthrin	21	12	H
3A	Hero*	2.6 to 6.1 fl oz/A	zeta-cypermethrin + bifenthrin - **rutabaga and turnip only**	21	12	H
3A + 4A	Leverage 360*	2.4 to 2.8 fl oz/A	imidacloprid + beta-cyfluthrin - **radish only**	7	12	H
28	Exirel	10.0 to 20.5 fl oz/A	cyantraniliprole	1	12	H

Above-ground Pests

Aphids

To prevent flare-ups, avoid overuse of synthetic pyrethroid (3A) insecticides for control of other pests.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s) and Crop Restrictions**	**PHI (d)**	**REI (h)**	**Bee TR**
1B	Malathion 57 EC	1.0 to 1.6 pt/A - radish, rutabaga 1.0 to 2.0 pt/A - turnip	malathion	7 1	12	H
3A+4A	Leverage 360*	2.4 to 2.8 fl oz/A	imidacloprid + beta-cyfluthrin-**radish only**	7	12	H
4A	Actara 25WDG	1.5 to 3.0 oz/A	thiamethoxam	7	12	H
4A	Platinum 75SG	1.70 to 2.17 oz/A- radish 1.70 to 4.01 oz/A- rutabaga, turnip	thiamethoxam	AP	12	H
4A	Admire Pro	1.2 fl oz/A	imidacloprid - **foliar**	7	12	H
4A	Admire Pro	4.4 to 10.5 fl oz/A	imidacloprid - **soil**			
4D	Sivanto Prime	7.0 to 14.0 fl oz/A	flupyradifurone - **foliar**	7	4	M
28	Exirel	13.5 to 20.5 fl oz/A	cyantraniliprole	1	12	H
29	Beleaf	2.0 to 2.8 fl oz/A	flonicamid	3	12	L

Caterpillar "Worm" Pests Including Cabbage Loopers, Diamondback Moths, Imported Cabbageworms, Cross-striped Cabbageworms, Cabbage Webworms, and Armyworms

Due to resistance development, pyrethroid insecticides are not recommended for control of Diamondback Moth or Beet Armyworm. Other insecticides may no longer be effective in certain areas due to Diamondback Moth resistance; consult your Extension Office. Rotation of insecticides with different modes of action is recommended to reduce resistance development. Under-leaf spray coverage is essential for effective control particularly with *Bacillus thuringiensis* and contact materials. With boom-type rigs, apply spray with at least 3 nozzles per row, one directed downward, and one directed toward each side. Evaluate effectiveness when considering further treatment.

Apply one of the following formulations: **Note: not all materials are labeled for all crops, insects or application methods, check the label for directions!**						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s) and Crop Restrictions**	**PHI (d)**	**REI (h)**	**Bee TR**
1B	Malathion 57 EC	1.0 to 1.6 pt/A (radish and rutabaga) 1.0 to 2.0 pt/A (turnip)	malathion	see label	12	H
3A	Asana XL*	5.8 to 9.6 fl oz/A	esfenvalerate - **turnip: imported cabbageworm only**	7	12	H
3A	Brigade 2EC*, others	5.12 to 6.4 fl oz/A	bifenthrin	21	12	H
5	Entrust SC (OMRI)	3.0 to 6.0 fl oz/A	spinosad	3	4	M
5	Blackhawk	1.7 to 3.3 fl oz/A	spinosad	3	4	M
5	Radiant SC	6.0 to 8.0 fl oz/A	spinetoram	3	4	M
11A	XenTari (OMRI)	0.5 to 2.0 lb/A	*Bacillus thuringiensis aizawai*	0	4	N
18	Intrepid 2F	4.0 to 10.0 fl oz/A	methoxyfenozide	1	4	L
18 + 5	Intrepid Edge	4.5 to 12.0 fl oz/A	methoxyfenozide + spinetoram	7	4	M
28	Vantacor	1.2 to 2.5 fl oz/A	chlorantraniliprole - **foliar**	1	4	L
28	Exirel	10.0 to 20.5 fl oz/A	cyantraniliprole	1	12	H
28 + 3A	Elevest*	7.7 to 9.6 fl oz/A	chlorantraniliprole + bifenthrin	21	12	H

Flea Beetles Crop rotation, management of wild hosts (wild mustard, rocket etc.) and prompt destruction of crop residue are helpful in population suppression. Sequential plantings of host crops can result in population build-up.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s) and Crop Restrictions**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Sevin XLR Plus	0.5 to 1.0 qt/A	carbaryl	7	12	H
3A	Asana XL*	5.8 to 9.6 fl oz/A	esfenvalerate - **radish and turnip only**	7	12	H
3A	Baythroid XL*	1.6 to 2.8 fl oz/A	beta-cyfluthrin	0	12	H
3A	Tombstone*	1.6 to 2.8 fl oz/A	cyfluthrin	0	12	H
3A	Hero*	2.6 to 6.1 fl oz/A	zeta-cypermethrin + bifenthrin - **rutabaga and turnip only**	21	12	H
3A + 4A	Leverage 360*	2.4 to 2.8 fl oz/A	imidacloprid + beta-cyfluthrin - **radish only**	7	12	H
4A	Admire Pro	4.4 to 10.5 fl oz/A	imidacloprid - **soil**	21	12	H
4A	Admire Pro	1.2 fl oz/A	imidacloprid - **foliar**	7	12	H
4A	Actara 25WDG	1.5 to 3.0 oz/A	thiamethoxam	7	12	H
4A	Platinum 75SG	1.7 to 2.17 oz/A 1.7 to 4.01 oz/A	thiamethoxam - **radish** thiamethoxam - **rutabaga, turnip**	AP	12	H
5	Entrust SC (OMRI)	3 to 6 fl oz/A	spinosad	3	4	M
5	Blackhawk	1.7 to 3.3 fl oz/A	spinosad	3	4	M
28	Exirel	13.5 to 20.5 fl oz/A	cyantraniliprole	1	12	H
28 + 3A	Elevest*	7.7 to 9.6 fl oz/A	chlorantraniliprole + bifenthrin	21	12	H

Leafminers

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s) and Crop Restrictions**	**PHI (d)**	**REI (h)**	**Bee TR**
1B	Dimethoate 400	0.5 pt/A	dimethoate - **turnip only**	14	48	H
5	Entrust SC (OMRI)	3 to 6 fl oz/A	spinosad	3	4	M
5	Blackhawk	1.7 to 3.3 fl oz/A	spinosad	3	4	M
5	Radiant SC	6.0 to 8.0 fl oz/A	spinetoram	3	4	M
28	Exirel	13.5 to 20.5 fl oz/A	cyantraniliprole	1	12	H

Disease Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.
Recommended Fungicides

Seed Treatment Options

Heat treatment is a non-chemical alternative to conventional chlorine treatments that only kill pathogens on the surface of the seed coat. Heat treatment has the additional benefit of killing pathogens within the seed coat and is particularly useful for crops that are prone to seed-borne bacterial infections. Seed heat treatment follows a strict time and temperature protocol and is best done with thermostatically controlled water baths. Two baths are required: one for pre-heating, and a second for the effective (pathogen killing) temperature. The initial pre-heating is at 100ºF (37ºC) for 10 minutes. In the second bath, soak radish seed at 122°F (50°C) for 15 minutes. Immediately after removal from the second bath, rinse seeds with cool water. Dry seeds on a screen or paper. Pelleted seed is not recommended for heat treatment. Only treat seed that will be used during the current production season.

An alternative to hot water is to use 1 part Alcide (sodium chlorite), 1 part lactic acid, and 18 parts water as a seed soak. Treat seed for 1-2 minutes with constant agitation and rinse for 5 minutes in running water. Following either treatment above, dust dried seed with Captan 50WP or Thiram 480DP at 1 level tsp/lb of seed (3 oz/100 lb).

Seed Treatment Prior to Seeding

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
For Pythium and Phytophthora Root Rot control use a seed treatment such as:						
4	Apron XL	0.085 to 0.64 fl oz/100 lb seed	mefenoxam	--	--	N
For control of other root rots apply:						
12	Maxim 4FS	0.08 to 0.16 fl oz/100 lb seed	fludioxonil	--	--	L
Note: Apron XL and Maxim 4FS can be combined.						

Damping-off caused by *Pythium* and *Rhizoctonia*

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
For Pythium root rot control apply as banded spray:						
4	MetaStar 2E AG[1]	2.0 to 4.0 pt/A	metalaxyl	AP	48	N
4	Ridomil Gold 4SL[1]	0.5 to 1.0 pt/A	mefenoxam	AP	48	N
43	Presidio 4SC[1]	3.0 to 4.0 fl oz/A	fluopicolide	AP	48	L
For Rhizoctonia root rot control apply as in-furrow application:						
11	azoxystrobin 2.08F	0.40 to 0.80 fl oz/A (see label)	azoxystrobin	0	4	N
For Pythium and Rhizoctonia root rot control apply as banded spray:						
4 + 11	Uniform 3.66SE[1]	0.34 fl oz/1000 ft. row[2]	mefenoxam + azoxystrobin	AP	0	N

[1]Applications at seeding will also help control Downy Mildew. [2] See label for restrictions

Bacterial and Fungal Diseases

Alternaria, Blackleg and Black Rot Alternaria, Blackleg and Black Rot can survive on infested debris and seed. Purchase certified or treated seed. Use hot water seed treatment to help reduce seed-borne infections (see above). Thoroughly disc or plow under plant debris after harvest. Eliminate cruciferous weeds which can act as hosts and rotate with non-cruciferous crops.

Clubroot Radishes are susceptible, whereas turnips are resistant. Use of irrigation water containing fungus spores is the principal way of spreading the pathogen. If clubroot occurs, clean and disinfest any equipment to be used in other fields. Adjust soil pH with hydrated lime to as close to 7.0 as possible. Improve drainage and use raised beds.

Downy Mildew

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Apply the following when weather conditions favor disease development and/or disease is first noticed:[1,2]						
M01	copper (OMRI)[1]	at labeled rates	copper	0	48	N
21	Ranman 400SC	2.75 fl oz/A (turnip greens only)	cyazofamid	0	12	L

[1]Some copper -based products are OMRI listed for organic production and may help suppress some fungal pathogens in these crops.
[2]Uniform, Presidio, mefenoxam, or metalaxyl applications for root rot control at seeding will also help control Downy Mildew.

Leaf Spots (caused by *Cercospora* or *Alternaria*) and Powdery Mildew Long periods of wet weather and driving rains which promote soil splashing are conducive for development. Thoroughly disc or plow under plant debris after harvest. Eliminate cruciferous weeds which can act as hosts and rotate with non-cruciferous crops.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Apply and rotate the following preventatively and/or when conditions favor development:						
3	Tilt 3.6EC[1]	3.0 to 4.0 fl oz/A	propiconazole	14	12	N
7	Fontelis	16.0 to 30.0 fl oz/A	penthiopyrad	0	12	L
7 + 9	Luna Tranquility 4.16SC	8.0 to 11.2 fl oz/A	fluopyram + pyrimethanil	7	12	--
7 + 11	Merivon 2.09SC	4.0 to 5.5 fl oz/A	fluxapyroxad + pyraclostrobin	0	12	N
7 + 12	Miravis Prime	6.8 fl oz/A	pydiflumetofen + fludioxonil	7	12	--
Rotate with one of the following FRAC code 11 fungicides:						
11	azoxystrobin 2.08F	6.0 to 15.5 fl oz/A plus fixed copper at labeled rates	azoxystrobin	0	4	N
11	Cabrio 20EG	8.0 to 12.0 oz/A plus fixed copper at labeled rates	pyraclostrobin	0	12	N

[1]For Cercospora leaf spot only.

Scab Scab is more severe under dry soil conditions, high soil pH, and low level of Mg. Heavy irrigation in the first two weeks after emergence and the application of S to reduce soil pH will assist in disease control.

White Rust

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
When weather conditions favor disease development or at the first sign of disease in field, apply one of the following:						
11	azoxystrobin 2.08F	6.0 to 15.5 fl oz/A	azoxystrobin	0	4	N
11	Cabrio 20EG	8.0 to 16.0 oz/A	pyraclostrobin	0	12	N

Spinach

Recommended Varieties

Type	Variety[1]
Fall (Summer Planted)	Kolibri* (Semi-savoy; DM resistance races 1-9, 12-15, tolerance 10-11)
	Kookaburra* (Savoy; DM resistance races 1-13)
	Persius* (Smooth, DM resistance races 1, 3, 5, 8, 9, 11, 12, 14, 16)
	SV 2146 VB* (Semi-savoy, DM resistance races 1-14, 16, 19)
	Regiment (Semi-savoy; DM resistance races 1-7, 11)
	Space (Smooth, DM resistance races 1-3, 5, 6, 8, 9, 11, 12, 14, 16, 19)
Summer (Spring Planted)	Corvair* (DM resistance races 1-11)
	Kookaburra* (Semi-savoy; DM resistance races 1-13)
	Marabu* (Smooth; DM resistance races 1-10, 15)
	SV2146VB* (Semi-savoy, DM resistance races 1-14, 16, 19)
	SV2157VB* (Savoy; DM resistance races 1-13)
"Baby" Leaf Type	C2-606* (Smooth: slow bolting: DM resistance races 1-9, 11-16, 18, 19)
	Finwhale RZ* (Smooth: DM resistance races 1-15, 17)
	Marabu* (Smooth; DM resistance races 1-10,15)
	Seaside* (Smooth; DM resistance races 1-11)
	Sunangel RZ* (Semi-savoy; DM resistance races 1-9, 11-19

[1]**Listed alphabetically within type**. *F1 hybrid variety. Downy Mildew (DM) resistance/tolerances (according to vendors) and specialty characters in parentheses. Processors generally specify preferred varieties for contracted plantings.

Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and Chapter B Soil and Nutrient Management. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede the recommendations found below.

Spinach[1]		Soil Phosphorus Level				Soil Potassium Level				
		Low	Med	High (Opt)	Very High	Low	Med	High (Opt)	Very High	
	N (lb/A)	P_2O_5 (lb/A)				K_2O (lb/A)				Nutrient Timing and Method
Spring or Fall	100-230	200	150	100	0[2]	200	150	100	0[2]	Total nutrient recommended
	50-75	200	150	100	0[2]	200	150	100	0[2]	Broadcast and disk-in
	25-40	0	0	0	0	0	0	0	0	Sidedress or topdress
	40-60	0	0	0	0	0	0	0	0	Topdress after each cutting
Overwinter	100-190	200	150	100	0[2]	200	150	100	0[2]	Total nutrient recommended
	20-30	200	150	100	0[2]	200	150	100	0[2]	Broadcast and disk-in at fall planting
	50-80	0	0	0	0	0	0	0	0	Topdress in late February when crop begins to grow
	30-40	0	0	0	0	0	0	0	0	Topdress in March
	40-60	0	0	0	0	0	0	0	0	Topdress for second cutting

[1]Apply 20-30 lb/A of sulfur (S) for most soils. [2]In VA, crop replacement values of 50 lb/A of P_2O_5 and 50 lb/A of K_2O are recommended on soils testing Very High.

Seed Treatment

Use treated seed. See Disease Control below for more information.

Seeding

Dates: *Spring*: March 12 to April 20 (harvest May 20 to June 7). *Fall*: August 10-31 (harvest September 25 to October 10). *Overwinter*: October 1-15 (harvest in the spring). **Rates:** *Not clipped*: 10-14 lb/A. *Clipped*: 18-25 lb/A. **Spacing:** *Processing*: rows on 12-inch centers. *Market:* rows on 12-inch centers. Planted on 6- and 8-row beds.

Pre-harvest

FOR FALL HARVEST ONLY. Apply 6.0 to 8.0 g/A (active ingredient) gibberellic acid to improve harvesting efficiency of semi-upright varieties and to increase yield under cool growing conditions. For best response, apply when daytime temperatures are 40-70°F (4-21°C) and when early morning dew is present on the crop. Apply by ground equipment in 20-50 gal of water/A, 12-18 days before each harvest. Wait until some regrowth has occurred before applying gibberellic acid to promote growth of a second or third cutting.

Harvest and Post-Harvest Considerations

For processing spinach, harvest plants before they are too large (or begin to bolt in spring plantings), usually when 16-17 inches tall. A second cut is made often in summer planted for fall harvest after suitable regrowth. The first cut is made 6-7 inches above the ground to eliminate as much stem, petiole, and older leaves as possible for the whole leaf pack. Prior to the second cutting, small disks can be used to cut away yellow or old leaves and to remove some soil away from the crown to facilitate harvest. Depending on temperature and plant density, 3-4 weeks between the first and second cutting are needed to obtain adequate regrowth.

For fresh market spinach, plants should be dry prior to harvest to prevent petiole breakage. When harvesting by hand, cut leaves above the crown or soil line and bunch. Exclude yellow leaves and leaves that are dirty with soil. Bunched spinach must be handled very carefully to avoid breakage of plants or bunches during bunching, washing, and packaging. Spinach for bag mixes is usually hand harvested, but mechanical harvesters for this purpose are now available. Walk-behind harvesters are also available for smaller acreage growers.

Store spinach at 32°F (0°C) and 95-100% relative humidity. Spinach is very perishable and can be stored for only 10-14 days. Crushed ice should be used for rapid cooling and for removing the heat of respiration. Top ice, hydro-cooling and vacuum cooling are other satisfactory cooling methods.

Most spinach for fresh market is prepackaged in perforated plastic bags to reduce moisture loss and physical injury. Controlled atmospheres with 10-40% carbon dioxide and 10% oxygen retard yellowing and extend shelf life. Special guidance for handling cut spinach, particularly for the bagged salad market, has been developed due to elevated food safety concerns.

Weed Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.

Recommended Herbicides

1. Identify the weeds in each field and select recommended herbicides. More information is available in the "Herbicide Effectiveness on Common Weeds in Vegetables" (Table E-3) in Chapter E Pest Management.
2. Minimize herbicide resistance development. Identify the herbicide mode of action group number and follow recommended good management practices; **bolded group numbers in tables below are herbicides at higher risk for selecting resistant weed populations.** Include non-chemical weed control whenever possible.

1. Soil-Applied

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
8	Ro-Neet 6E	4 pt/A	**cycloate**	3 lb/A	--	48
-Preplant incorporated treatments; apply before seeding and incorporate into soil 2-3 inches, and incorporation should occur within a few hours of application. Delay planting 7-10 days may help reduce potential injury. -Labeled for only specific states including DE, MD, NJ, PA, and VA (WV not included on label) -Ro-Neet provides residual control for a short period of time (about 3 weeks). Only 1 application is allowed per crop cycle						
15	Dual Magnum 7.62E	0.33 to 0.67 pt/A	**s-metolachlor**	0.32 to 0.63 lb/A	50	24
-**Special Local Needs Label 24(c) for the use of Dual Magnum 7.62E to control weeds in spinach in DE, NJ, and PA (expires DE 12/31/2028; NJ 1/28/2027; PA 12/31/2027). The use of Dual Magnum 7.62E is legal ONLY if a waiver of liability has been completed (see: *https://www.syngenta-us.com/labels/indemnified-label-login*).** -Apply as a preemergence treatment, **do not** incorporate. -Primarily controls annual grasses and certain broadleaf weeds. Dual will not control emerged weeds. -Note that the Dual rate labeled for spinach is lower than other crops; Dual will only provide a few weeks of control for select species at this low rate. Ratings in Table E-3 are based on higher use rates. -Apply to spinach accurately with a well calibrated sprayer. The margin of crop safety for Dual Magnum on spinach is narrow; rates higher than recommended for the soil type may result in crop injury. -Only 1 application per same season is allowed.						

2. Postemergence

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
1	Shadow 3EC Select 2EC Select Max 0.97EC	4 to 5.33 fl oz/A 6 to 8 fl oz/A 9 to 16 fl oz/A	**clethodim**	0.07 to 0.125 lb/A	14	24
	Poast 1.5EC	1 to 1.5 pt/A	**sethoxydim**	0.2 to 0.3 lb/A	15	12

2. Postemergence Shadow, Select, Select Max, Poast - continued next page

2. Postemergence Shadow, Select, Select Max, Poast - continued

-**Select 2EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). **Select Max**: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution). **Shadow 3EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution) for large or stressed grasses; use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution) when crop safety is a concern. -**Poast**: use COC at 1.0% v/v. -**The use of COC may increase the risk of crop injury when hot or humid conditions prevail**. To reduce the risk of crop injury, omit additives or switch to NIS when grasses are small and soil moisture is adequate. -Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control. -Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will **not** be controlled. -Controls many annual and certain perennial grasses, including annual bluegrass, but Poast is preferred for goosegrass control. For best results, treat annual grasses when they are actively growing and before tillers are present. Control may be reduced if grasses are large or under hot or dry weather conditions. -Repeated applications may be necessary to control certain perennial grasses. If repeat applications are necessary, allow 14 days between applications. -**Do not** tank mix with or apply within 2 to 3 days of any other pesticide, unless labeled, as this may increase the risk of crop injury or reduce the control of grasses. -Rainfastness is 1 h. -**Do not** apply more than 8 fl oz/A of Select 2EC in a single application and **do not** exceed 2 pt/A for the season; **do not** apply more than 16 fl oz/A of Select Max in a single application and **do not** exceed 4 pt/A for the season. -**Do not** apply more than 5.33 fl oz/A of Shadow 3EC in a single application and **do not** exceed 21.33 fl oz/A for the season. -**Do not** apply more than 1.5 pt/A Poast in a single application and **do not** exceed 3.5 pt/A for the season.						
4	Stinger 3SL / Spur 3SL	4 to 8 fl oz/A	**clopyralid**	0.094 to 0.188 lb/A	21	12
-Apply to spinach in the 2 to 5-leaf stage -Stinger will control common cocklebur, groundsel, jimsonweed, prickly lettuce, pineappleweed, common ragweed, and legumes. -Some leaf curling may occur; as well as noticeably more upright leaf development, but does not affect yield or maturity -Use 2 4.0 fl oz/A to control annual weeds less than 2 inches tall; increase the rate to 4.0 to 8.0 fl oz/A to control larger annual weeds. -Spray additives are not needed or required by the label and are not recommended. -Observe crop rotation restrictions or injury may occur from herbicide carryover. -Rainfastness is 6 h. Maximum use rate is 8 fl oz/A per season.						
5	Spin-Aid 1.3EC*	3 to 6 pt/A	**phenmedipham**	0.5 to 1 lb/A	21	12
-**Labeled for processing spinach only.** -Apply to spinach at the 4-true leaf stage or larger; spinach plants less than 4 to 6 true leaf may be injured from Spin-Aid -**Do not** apply if temperatures are over 75 F in order to reduce risk of crop injury. -**Do not** spray if dew is present on leaves. -For best results spray when weeds are at the 2 true leaf stage. The use of an 8002 flat fan nozzle or a comparable nozzle is suggested. -Rainfastness is 6 h. Split applications of Spin-Aid is allowed, but total rate of Spin-Aid rate is 6 pt/A per season.						

3. Postharvest

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
22	Gramoxone SL 2.0* Gramoxone SL 3.0*	2.25 to 3 pt/A 1.5 to 2 pt/A	**paraquat**	0.56 to 0.75 lb/A	--	24
-**Supplemental Label in DE for the use of both Gramoxone formulations for postharvest application to desiccate the crop.** -Apply after the last harvest. Always include an adjuvant. -Spray coverage is essential for optimum effectiveness. See the label for additional information and warnings. -Rainfastness 30 min. A maximum of 2 applications for crop desiccation are allowed. -***Restricted-use pesticide***. Only certified applicators, who successfully complete the paraquat-specific training, can mix, load, or apply paraquat. Application of paraquat "under the direct supervision" of a certified applicator is no longer allowed. Required training link (*https://campus.extension.org/enrol/index.php?id=2201*); certified applicators must repeat training every three years.						

Insect Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.
Recommended Insecticides

Aphids Green peach aphid is the most common aphid on spinach. Populations can remain on spinach throughout the winter and their presence can be a contamination concern for leafy crops. Females fly to plants and produce numerous pale yellow or pink-colored young (nymphs). Large numbers of aphids can build up on the undersides of leaves, often following pyrethroid insecticide applications. Aphids are sucking insects and excrete a sugary, sticky substance (honeydew). Preserve natural enemies by using selective insecticides whenever possible. Spray coverage to the underside of the leaf is important; add a spreader-sticker to foliar sprays. Foxglove aphids may be more difficult to control with group 4A insecticides.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
4A	Neonicotinoid insecticides registered for use on Spinach: see table at the end of Insect Control.					

Aphids - continued next page

Aphids - continued

4D	Sivanto Prime or 200SL	21 to 28 fl oz/A	flupyradifurone - **soil**	21	4	M
4D	Sivanto Prime or 200SL	7 to 14 fl oz/A	flupyradifurone - **foliar**	1	4	M
9B	Fulfill 50WDG	2.75 oz/A	pymetrozine	7	12	L
9B	PQZ	2.4 to 3.2 fl oz/A	pyrifluquinazon	1	12	L
9D	Versys	1.5 fl oz/A	afidopyropen	0	12	L
21A[1]	Torac	17.0 to 21.0 fl oz/A	tolfenpyrad	1	12	H
23	Movento	4.0 to 5.0 fl oz/A	spirotetramat	3	24	L
23 + 7C	Senstar	8.0 to 10.0 fl oz/A	spirotetramat + pyriproxyfen	14	24	L
28	Exirel	13.5 to 20.5 fl oz/A	cyantraniliprole	1	12	H
28	Verimark	6.75 to 13.5 fl oz/A	cyantraniliprole	n/a	4	H
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H
29	Beleaf 50SG	2.0 to 2.8 oz/A	flonicamid	0	12	L

[1]Aerial application with spray plane not allowed.

Cutworms See also section E 3.1. Soil Pests - Detection and Control.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	1.5 pt/A	methomyl	7	48	H
1B	Diazinon AG500*	2.0 to 4.0 qt/A	diazinon	AP	72	H
3A	Baythroid XL*	0.8 to 1.6 fl oz/A	beta-cyfluthrin	0	12	H
3A	Mustang Maxx*	2.24 to 4.00 fl oz/A	zeta-cypermethrin	1	12	H
3A	Tombstone*	0.8 to 1.6 fl oz/A	cyfluthrin	0	12	H

Leafminers

Serpentine leafminers can cause direct damage to spinach leaves affecting marketability.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
4A	Neonicotinoid insecticides registered for use on Spinach: see table at the end of Insect Control.					
5	Entrust SC (OMRI)	6.0 to 10.0 fl oz/A	spinosad	1	4	M
5	Radiant SC	6.0 to 10.0 fl oz/A	spinetoram	1	4	M
6	Agri-Mek SC*	1.75 to 3.5 fl oz/A	abamectin	7	12	H
17	Trigard 75WSP	2.66 oz/A	cyromazine	7	12	H
28	Coragen 1.67SC Coragen eVo	5.0 to 7.5 fl oz/A 1.7 to 2.5 fl oz/A	chlorantraniliprole	1	4	L
28	Exirel	13.5 to 20.5 fl oz/A	cyantraniliprole	1	12	H
28	Verimark	6.75 to 13.5 fl oz/A	cyantraniliprole	n/a	4	H
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H

Non-Lepidopteran Chewing Pests Including: Flea Beetles and Grasshoppers

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Sevin XLR Plus	0.5 to 1.0 qt/A	carbaryl	14	12	H
3A	Baythroid XL*	2.4 to 3.2 fl oz/A	beta-cyfluthrin	0	12	H
3A	Fastac CS*	2.2 to 3.8 fl oz/A	alpha-cypermethrin	1	12	H
3A	Mustang Maxx*	2.2 to 4.0 fl oz/A	zeta-cypermethrin	1	12	H
3A	Tombstone*	2.4 to 3.2 fl oz/A	cyfluthrin	0	12	H
3A + 4A	Leverage 360*	3.0 fl oz/A	imidacloprid + beta-cyfluthrin	7	12	H
4A	Neonicotinoid insecticides registered for use on Spinach: see table at the end of Insect Control.					
28	Harvanta 50SL (FB only)	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H

Spider Mites

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
6	Agri-Mek SC*	1.75 to 3.5 fl oz/A	abamectin	7	12	H

"Worm Pests" Including: Beet Armyworms (BAW), Cabbage Loopers (CL), Webworm, and Hawaiian Beet Webworm (HBW) Caterpillars can cause direct feeding damage thus there is low tolerance for their presence. **Note:** pyrethroid insecticides (Group 3A, in bold-face type) are not recommended for control of BAW or HBW due to resistance issues.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	1.5 to 3 pt/A	methomyl - see label for PHI	label	48	H
3A	Baythroid XL* (CL only)	1.6 to 2.4 fl oz/A	**beta-cyfluthrin - not recommended for BAW or HBW**	0	12	H
3A	Tombstone* (CL only)	1.6 to 2.4 fl oz/A	**cyfluthrin - not recommended for BAW or HBW**	0	12	H
5	Entrust SC (OMRI)	4.0 to 8.0 fl oz/A	spinosad	1	4	M
5	Radiant SC	5.0 to 10.0 fl oz/A	spinetoram	1	4	M
6	Proclaim 5SG*	3.2 to 4.8 oz/A	emamectin benzoate	7	12	H
11A	Dipel DF, others (OMRI)	0.5 to 2.0 lb/A	*Bacillus thuringiensis kurstaki*	0	4	N
11A	XenTari (OMRI)	0.5 to 2.0 lb/A	*Bacillus thuringiensis aizawai*	0	4	N
18	Intrepid 2F	4.0 to 10.0 fl oz/A	methoxyfenozide	1	4	L
22	Avaunt 30WDG, Avaunt eVo	3.5 oz/A	indoxacarb	3	12	H
28	Coragen 1.67SC Coragen eVo	3.5 to 7.5 fl oz/A 1.2 to 2.5 fl oz/A	chlorantraniliprole	1	4	L
28	Exirel	10.0 to 17.0 fl oz/A	cyantraniliprole	1	12	H
28	Verimark	6.75 to 13.5 fl oz/A	cyantraniliprole	1	4	H
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H
28+4A	Voliam Flexi	4.0 to 7.0 oz/A	chlorantraniliprole + thiamethoxam	7	12	H

Group 4A Neonicotinoid Insecticides Registered for Use on Spinach

Apply one of the following formulations (check if the product label lists the insect you intend to spray; the label is the law):					
Product Name (*=Restricted Use)	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
Admire Pro	1.3 fl oz/A	imidacloprid - **foliar**	7	12	H
Admire Pro	4.4 to 12.5 fl oz/A	imidacloprid - **soil**	21	12	H
Assail 30SG	2.0 to 4.0 oz/A	acetamiprid	7	12	M
Assail 30SC	1.7 to 3.4 fl oz/A	acetamiprid	7	12	M
Belay 2.13SC	9.0 to 12.0 fl oz/A	clothianidin - **soil**	21	12	H
Belay 2.13SC	3.0 to 4.0 fl oz/A	clothianidin - **foliar**	7	12	H
Scorpion 35SL	9.0 to 10.5 fl oz/A	dinotefuran - **soil**	21	12	H
Scorpion 35SL	2.00 to 5.25 fl oz/A	dinotefuran - **foliar**	7	12	H
Venom 70SG	5.0 to 7.5 oz/A	dinotefuran – **soil**	21	12	H
Venom 70SG	1.0 to 3.0 oz/A	dinotefuran - **foliar**	7	12	H
Actara 25WDG	1.5 to 3.0 oz/A	thiamethoxam	7	12	H
Platinum 75SG	1.66 to 3.67 oz/A	thiamethoxam	30	12	H
Combo products containing a neonicotinoid					
Durivo	10.0 to 13.0 fl oz/A	thiamethoxam + chlorantraniliprole (Group 28) - **soil**	30	12	H
Leverage 360*	3.0 fl oz/A	imidacloprid + beta-cyfluthrin (Group 3A)	7	12	H
Voliam Flexi	4.0 to 7.0 oz/A	thiamethoxam + chlorantraniliprole (Group 28)	7	12	H

Disease Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.
Recommended Fungicides

Seed Treatment

Code	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
For Rhizoctonia and Fusarium Control:						
12	Maxim 4FS	0.08 to 0.16 fl oz/100 lb seed	fludioxonil	n/a	n/a	L
For Pythium Control:						
4	Apron XL	0.16 to 0.64 fl oz/100 lb seed	mefenoxam	n/a	n/a	N

Damping-off caused *Pythium* and *Rhizoctonia*

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Apply one of the following pre-plant incorporated or as a soil surface spray after planting:						
For Pythium root rot control						
4	Ridomil Gold 4SL	1.0 to 2.0 pt/A	mefenoxam	21	48	N
4	Ultra Flourish 2E	2.0 to 4.0 pt/A	mefenoxam	21	48	N
4	MetaStar 2E AG	4.0 to 8.0 pt/A	metalaxyl	21	48	N
49 + 4	Orondis Gold	4.8 to 9.6 fl oz/A	oxathiapiprolin + mefenoxam	1	4	--
For Pythium and Rhizoctonia root rot control						
4 + 11	Uniform 3.66SE	0.34 fl oz/1000 ft row	mefenoxam + azoxystrobin	--	0	N
Application of mefenoxam or metalaxyl at planting will also help control early-season White Rust infections in spinach.						

Bacterial and Fungal Diseases

Downy Mildew (Blue Mold) and White Rust

Use resistant varieties (see Recommended Varieties Table). Rotate away from spinach for at least 2 years. Do not plant spring crop near overwintered fields. The use of mefenoxam or metalaxyl at planting for damping-off control will provide early season control. Fungicides containing copper may cause phytotoxicity.

Shank application: mefenoxam (0.25 pt/A Ridomil Gold 4SL or 0.5 pt/A Ultra Flourish 2E) or metalaxyl (1.0 pt/A MetaStar 2E AG) may be shanked in 21 days after planting or after first cutting. A second shanked application may be made 21 days later or after the second cutting.

Foliage Application: Beginning 2-3 weeks after emergence (or prior to symptom development), rotate one of the following fungicides on a 7 to 10-day schedule (do not apply if temperature is 90°F/32°C or above):

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Beginning 2-3 weeks after emergence (or prior to symptom development), rotate the following fungicides on a 7 to 10-day schedule as long as weather conditions favor disease development:						
Apply one of the following FRAC code 11 fungicides[1]:						
11	Reason 500SC	5.5 to 8.2 fl oz/A	fenamidone	2	12	--
11 + 27	Tanos 50DF	8.0 to 10.0 oz/A	famoxadone + cymoxanil	1	12	--
and rotate with one of the following fungicides:						
21	Ranman 400SC	2.75 fl oz/A	cyazofamid	0	12	L
40	Revus 2.08F	8.0 fl oz/A	mandipropamid	1	4	--
43	Presidio 4SC	4.0 fl oz/A	fluopicolide	2	12	L
45 + 40	Zampro 525SC	14.0 fl oz/A	ametoctradin + dimethomorph	0	12	--
P07	Aliette 80WDG	3.0 lb/A	fosetyl-Al	3	12	N

[1]FRAC code 11 fungicides such as Reason and Tanos should not be applied more than twice before switching to a fungicide with a different mode of action.

Leaf Spots and Anthracnose

These diseases can be prevalent in overwintered spinach and during periods between second and third cuttings. Apply one of the following as soon as symptoms appear in the spring or shortly after cutting and repeat every 7 to 10 days as long as conditions favor disease development.

Recommended Fungicides						
Code	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
Alternate one of the following fungicides if more than one application is needed:						
7	Fontelis 1.67SC	24.0 fl oz/A	penthiopyrad	3	12	L
11	Cabrio 20EG	12.0 to 16.0 oz/A	pyraclostrobin	0	12	N
Apply the following if only one application is needed:						
7 + 11	Merivon 2.09SC	4.0 to 11.0 fl oz/A	fluxapyroxad + pyraclostrobin	1	12	N
7 + 12	Miravis Prime	9.2 to 13.4 fl oz/A	pydiflumetofen + fludioxonil	0	12	--
9 + 12	Switch 62.5WG	11.0 to 14.0 oz/A	cyprodinil + fludioxonil	0	12	L

Viruses

Cucumber Mosaic Virus

Use resistant varieties. See Recommended Varieties Table above.

Strawberries

Note: "**The Mid-Atlantic Berry Guide for Commercial Growers**", a cooperative publication for PA, MD, NJ, DE, WV, and VA, provides additional information.

Annual Production System on Plastic Mulch ("Plasticulture")

This system is recommended for DE, MD, NJ, VA, southeastern PA, and for trial in other areas of PA.

Recommended Varieties[1]

Each variety has susceptibilities and resistance to different diseases, and none are completely resistant to any disease. Be aware that AC Wendy and Flavorfest are especially susceptible to angular leaf spot, a bacterial disease. Galletta and Flavorfest are fairly resistant to Anthracnose Fruit Rot, while Camarosa, Chandler, and Ruby June are especially susceptible. Sweet Charlie and Flavorfest are very susceptible to Phytophthora diseases. Day-neutral varieties are susceptible to Anthracnose Fruit Rot and powdery mildew.

Short Day Early	Short Day Midseason		Short Day Late	Day-Neutral
AC Wendy	Benicia (coastal VA, shipping only)	Flavorfest	AC Valley Sunset	Albion[6]
Galletta	Camarosa[4] (shipping only)	Merced (VA)	Merced (VA)	San Andreas[7]
Ruby June[2]	Camino Real[5] (VA and DE)	Rutgers Scarlet (trial)		Seascape
Sweet Charlie[3]	Chandler	Rutgers D'Light (trial)		Sweet Ann[8] (VA)

[1]**Listed alphabetically within type**. [2]Best regional performance has been in the lower piedmont and coastal plains of VA. [3]Matures 7-10 days earlier than Chandler; recommended for trial in southern regions of MD. Plant only in areas with low risk of frost; may require overhead sprinkler for additional frost protection during bloom. [4]Must be fully red-ripe for flavor development. [5]Camino Real fruit tolerates high rainfall events well during harvest season over other varieties. [6]Produces light yields throughout the spring summer and fall resulting in moderate total yields for the season. [7]Suitable only for tunnel production as the fruit does not take rainy conditions well during the harvest season. [8]Has produced low yields in PA.

Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and Chapter B Soil and Nutrient Management. Your state's soil test report recommendations supersede the recommendations found below.

		Soil Phosphorus Level				Soil Potassium Level				
		Low	Med	High (Opt)	Very High	Low	Med	High (Opt)	Very High	
Annual System Strawberry[1]	**N (lb/A)**	**P_2O_5 (lb/A)**				**K_2O (lb/A)**				**Nutrient Timing and Method**
	90-120	100	70	40	0-30[3]	165	115	65	0	Total nutrient recommended
	60-75	100	70	40	0-30[3]	165	115	65	0	Broadcast and disk-in
	15-25[2]	0	0	0	0	0	0	0	0	Inject through drip at first flowering in spring
	15-25[2]	0	0	0	0	0	0	0	0	Inject through drip at fruit enlargement, about 2 weeks after first flowering

For plasticulture, fertility rates are based on 5-ft row spacing. [1]Apply 1-2 lb/A of boron with broadcast fertilizer; see also Table B-7 in Chapter B Soil and Nutrient Management. [2]If day-neutrals are being grown, see information under "Irrigation" instead of making applications at these timings. [3]Replacement value of 30 lb/A of P_2O_5 is recommended in MD, DE, and VA on Very High P soils.

Background

The annual plasticulture system has the potential for a higher profit than the conventional matted-row system. Establishment costs are higher, but production is earlier (when the crop value is highest), harvest is more efficient, and the system commonly promotes larger berries and a higher number of them. Start with a small acreage and increase acreage as knowledge and experience with the system is gained. This is an integrated system, and all of the following components are important for maximizing production and efficiency.

Site Selection

Select fields with good surface and internal drainage, a southern exposure, and protection from westerly winds. If you are planning a pick-your-own operation, take into consideration that customers prefer plasticulture over matted rows. In the case of new areas selected for strawberry production, it is advisable to learn about the history of the location, temperature fluctuations, precipitation, photoperiod, past crops, potential insects, disease, and weed pressure. The location must have enough available water for plant maintenance, and in some cases freeze protection.

Plant Bed Preparation, Fumigation and Fertilization

Use soil test results to determine specific nutritional needs. It is unlikely that the soil will have enough nutrients to sustain a full production season. Apply 50-75 lb/A actual N, and P_2O_5 and K_2O as indicated by soil test results. Apply 1-2 lb/A of boron unless soil test results indicate above-normal levels, and work into the beds. Base additional P_2O_5, K_2O and B application rates on soil test results. It is particularly important to adjust the soil pH to the 6-6.5 range; see section B-2 Liming Soils.

Prepare raised beds 30 to 40 inches wide and 6 to 8 inches high on 5- to 6-ft row centers, covered with black plastic mulch to promote higher soil temperatures during the winter months. Beds should be center-crowned and firm. Avoid using beds with flat tops. Planting beds with a trapezoidal shape would help the rainwater move to the aisles and away from the plants and fruits, reducing potential disease incidence. Depending on soil type, plant vigor, and plant tissue test results, inject an additional 30-50 lb/A of N through the drip system in the spring.

Many fumigants will provide weed control early in the season. This is especially important as the plant canopy is still underdeveloped and there is little competition for light between the crop and the weeds. There are fewer options for late-season weed control. For additional control of weeds that emerge from the plant holes, and for banded treatments between the mulched beds, see Weed Control below.

Choose from the following options for bed preparation, fumigation, and fertilization:

1. Prepare soil, apply fertilizer, then apply fumigant. See section E 1.5 Soil Fumigation for fumigant choices, materials, rates, and precautions. Wait 20 days to allow the fumigant to act and disperse before transplanting.
2. Prepare raised beds as described above and apply 4.0 to 6.0 lb/A of Devrinol DF-XT to the surface of the bed and the area between beds. Lay drip irrigation and plastic mulch. Wait a few days before transplanting strawberry plants into the beds as Devrinol has the potential to injure the plants.
3. Apply fertilizer, prepare raised beds, and inject metam-sodium (Vapam HL) at 56.0 to 75.0 gal/A or 37.0 gal/mulched A. Immediately reshape beds (to form a firm, crowned bed) and apply 4.0 to 6.0 lb/A of Devrinol DF-XT to the surface of the bed and the area between beds, and lay drip irrigation and plastic mulch. Wait 20 days between fumigation and planting to allow the fumigant to act and to disperse.
4. Apply fertilizer and prepare raised beds as described above. Apply 4.0 to 6.0 lb/A of Devrinol DF-XT to the surface of the bed. Apply drip irrigation and plastic mulch. Inject metam-sodium (Vapam HL) through the drip system at 37 gal/mulched A. Wait 20 days between fumigation and planting to allow the fumigant to act and to disperse.

Plants and Planting

Use plug transplants propagated from actively growing runner tips and produced in certified nurseries. Plugs can be purchased or produced if the selected cultivar does not have intellectual property protection. To produce plugs from runner tips, use a well-drained artificial mix containing 50% peatmoss and 50% horticultural vermiculite or perlite. A poorly drained growing medium promotes root diseases. Select runners with two to three fully functional leaves. Runner tips can be grown in 50-cell trays. Maintain adequate moisture on the growing media and leaves for the first two to three days. Fungal diseases are a common challenge with plug production; maintain a frequent scouting program for foliar and root diseases. Consult your Extension office for a list of nurseries that supply plugs and runner tips and/or directions for propagating from tips. The list of nurseries can be found at the Virginia Cooperative Extension publication titled "Shoppers Guide for Berry Plants in the Mid-Atlantic and the Carolinas" accessed at the following link: *https://www.pubs.ext.vt.edu/HORT/HORT-270NP/HORT-270NP.html*.

Plugs can be planted mechanically with a waterwheel-type planter; however, be careful to plant the crown of the transplant at soil level, as deep planting can promote decay and shallow planting can cause desiccation of the plant. Space plants 12 to 16 inches apart in each of the double rows in a staggered pattern. More space between plants will promote better wind flow between plants and near the fruits, promoting an environment with lower disease pressure. However, it will decrease overall production per area. If using double rows, space rows 12-18 inches apart; this requires a 36- to 40-inch-wide bed. The 18-inch between-row spacing has produced high yields. In northern NJ and most of PA, plant in mid to late August. In southeastern PA, southern NJ, DE, MD and northern VA, plant in late August to mid-September for highest first-year yields. In southern and coastal VA, plant in late September.

Alternatively, dormant plants may be planted directly in the field with a tool that allows the roots to be inserted into the soil without digging a hole. Planting time varies from mid-June to mid-July. The roots of dormant plants may also be trimmed to allow planting in 32-cell trays, followed by growing the plants in the trays until planting at the usual time for plug plants.

Irrigation

At planting, overhead irrigation can be used to set the plants, and where conditions are warm, to cool plants and plastic and improve establishment. However, overhead irrigation will promote weeds in the aisles and increase the potential for diseases and should be avoided late in the day. Cooling from sprinkler irrigation occurs because of evaporation of the water from plant tissue and plastic mulch, absorbing approximately 15,309 calories per oz, as long as the air vapor pressure is lower than the saturated vapor pressure. For more information about strawberry transplant establishment, see "Methods for Strawberry Transplant Establishment in Florida", available for download at: *https://edis.ifas.ufl.edu/publication/HS1376*.

In cooler locations, plug transplants require little to no overhead irrigation for establishment. In the fall, irrigation through the drip system may promote plant growth before row covers are applied. In the spring, overhead mist irrigation may be required for frost and freeze protection. Farmers must be aware of the potential damage caused by overhead water as a freeze protection method. For each ounce of water turning from liquid to solid, approximately 80 calories are released, providing energy to maintain the plant tissues near or above 32°F. This is the reason why plants can survive these events as long as there is enough water reaching the foliage to maintain a layer of liquid water on the surface of the ice. However, as the ice on top of the plants starts to melt the next morning, evaporative cooling starts (same phenomenon as during plant establishment). The transition of the water from ice to liquid and then gas will absorb energy from the air and surrounding tissue, lowering the temperature below 32°F and potentially damaging the plants. Farmers must continue to apply water until there is no more ice present on the plants.

Maintain adequate soil moisture in raised beds using frequent drip irrigation during the growing season. Preferably, base your irrigation scheduling on soil moisture sensors or crop evapotranspiration estimations. This is effective in increasing fruit size without wetting the fruit and increasing rots. Soil moisture sensors are a good option to maintain adequate moisture in the system without promoting deep water percolation and nutrient leaching.

When day-neutral varieties are being grown, apply 1 to 2 lb/A of N per week through the drip system if 60-75 lb of N were incorporated preplant. Nitrogen requirements will differ with variety and soil type. On heavier soils, 'Seascape' performs well with 1 to 2 lb/A of N per week while 'Albion' has shown a higher requirement, requiring 2 to 5 lb/A of N per week. Verify the planting's nutritional status through foliar analysis.

Row Covers

Floating row covers (FRC) are an essential part of plasticulture systems in the Mid-Atlantic to reduce the desiccating effects of winter winds, and for frost and freeze protection during winter and early spring. A few studies have also found use of row covers in the late fall enhanced degree-day accumulation and produced an increase in yield. Ultraviolet light resistant covers weighing 1-1.4 oz/sq yd and providing 60-70% light transmission have been effective. If row covers are used for freeze protection, install FRC between October 15 and November 15, depending on location and planting date, if fall FRC deployment is desired. The use of row covers in the spring advances bloom and harvest; row covers can be kept on or removed depending on how early you want fruit, but be aware the earlier the plants bloom, the more likely it is that frost protection will be needed. Leaving the covers on too long in the spring may interfere with pollination, increase disease risk, and increase potential mite damage. Leave the covers at the edge of the field so plants can quickly be covered if there is a frost warning.

Pest Control

Use an effective disease control program. If there is a known risk for Phytophthora Crown Rot caused by *Phytophthora cactorum* on the newly set transplants, follow the recommendations for plant dips and/or soil-applied treatments as outlined in the Disease Control section. During late summer and fall, insecticides and miticides should be applied to prevent aphids and mites from reaching damaging levels in the spring. After plants are established and just before covering plants with the floating row in the fall, apply a fungicide to control leaf spots. After the covers are removed in the spring, maintain a good pest control program. Bloom sprays are important for control of both Botrytis Gray Mold and Anthracnose Fruit Rot (AFR). See the Disease Control and Insect Control sections below for materials and rates.

Harvesting

The harvest season lasts from 4 to 6 weeks. For local markets, harvest when fruit tips are red. Harvest with the plasticulture system begins earlier than harvest in the matted row system.

Renovation

Strawberries grown on plasticulture can be renovated in July and carried over for a second harvest year in cooler locations if the planting is still healthy. This is not recommended in warmer locations such as Virginia, and regardless of location, winter injury is more likely to occur during the second winter. Disease and insect pressure are also likely to increase substantially.

If renovation is to be undertaken, as may be desired in northern locations where fall growth was insufficient and first-year yields were low, mow tops with a rotary mower, leaving several leaves on the plant. For vigorous varieties and plantings that have thick foliage and numerous crowns (*e.g.*, Sonata), mowing, followed by crown thinning using an asparagus knife to cut away part of the plant or "breaking out" half of the plant by hand may be the most effective technique. After renovation, maintain adequate soil moisture, and insect and disease control. In early September, apply 60 lb/mulched A of N, P_2O_5, and K_2O via drip irrigation and follow the same cultural practices as for a new planting.

Berry size is usually smaller than in the first harvest season. With careful management, marketable yields of renovated beds can be equal to or greater than yields in the first harvest season. Renovation is especially useful if the planting will be harvested as a Pick-Your-Own.

Matted Row Culture

Recommended Varieties[1]

Early	Midseason		Late
AC Wendy	Allstar (VR, RSR) [2,3]	Flavorfest	AC Valley Sunset
Earliglow (RSR)[2]	Darselect[4]	Honeoye[5]	Jewel

[1]**Listed alphabetically within type**;
[2]RSR=red stele resistant; VR=Verticillium Wilt resistant.
[3]Susceptible to Angular Leaf Spot. [4]Susceptible to Anthracnose Fruit Rot and attractive to tarnished plant bug.
[5]Becomes dark and soft under hot conditions and is not recommended for warmer locations.

Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and Chapter B Soil and Nutrient Management. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede the recommendations found below.

Matted Row Strawberry		Soil Phosphorus Level				Soil Potassium Level				
		Low	Med	High (Opt)	Very High	Low	Med	High (Opt)	Very High	
	N (lb/A)	P_2O_5 (lb/A)				K_2O (lb/A)				Nutrient Timing and Method
New Plantings[1]	110-150[2]	100	70	40		165	115	65	0	Total amount of nutrients recommended
	30	100	70	40		165	115	65	0	Broadcast and disk-in deep
	20-30	0	0	0		0	0	0	0	Sidedress 2 weeks after planting
	20-30	0	0	0		0	0	0	0	Sidedress when first runners start
	30-40	0	0	0		0	0	0	0	Topdress in mid-August
	10-20[3]	0	0	0		0	0	0	0	Topdress in spring when plants begin to grow
Established Plantings	30	100	70	40		165	115	65	0	Topdress at renovation
	20-30	100	70	40		165	115	65	0	Topdress in Mid-August
	20-30	0	0	0		0	0	0	0	Topdress in spring when plants begin to grow

[1]For new plantings, apply 1-2 lb/A of boron (B) with broadcast fertilizer; see Table B-7. for more specific recommendations. Apply 20-30 lb/A of sulfur (S) for most soils.
[2]Rates are appropriate for lighter soils and should be reduced by about 25% for heavier soils in northern locations.
[3]On heavier soils in northern locations, omit this application unless rainfall has been excessive.

Plants and Spacing

Use certified dormant plants packed damp in polyliners. Plant virus-free plants as early in the spring as possible. Plant in rows approximately 4 ft apart with plants 18-30 inches apart in the row. Distance will depend on variety and soil type. The approximate number of plants needed at these spacings is between 4,400 and 7,300/A.

Renovation

Strawberry plantings must be renovated annually (immediately after harvest) to thin the plants, retain vigor, and maintain berry size in subsequent years. Follow the steps below:

1. Apply 2,4-D herbicide or another selective herbicide for broadleaf weed control. Wait 7-8 days for weeds to absorb the herbicide.
2. Mow off the leaves as close to the ground as possible without damaging the crowns.
3. Narrow row widths to 12 inches using a cultivator or rototiller. Allow ½-1 inch of soil to cover the crown.
4. Apply topdressing with N, P and K (preferably based on soil test results, or as indicated in the "Recommended Nutrients" table above).
5. Apply preemergent herbicides and irrigate to incorporate fertilizer and herbicide (see Weed Control below).

Alternative Strawberry Production Systems

Low Tunnel Production

Low tunnels are a relatively low-cost means for providing protection to plants and fruit. Specific keys to success include using thin plastic (1 to 1.5-mil) designed for low tunnel use so that the plastic can be pulled taut to avoid slippage and water collection on top of the plastic and attaching the plastic securely. In general, yields are increased, and the percentage of marketable fruit increases as long as cover over the crop is maintained. Labor needs are increased per area, but not necessarily per unit of fruit obtained. This system probably has its greatest value for organic or low-spray growers and may be used with June-bearing or day-neutral cultivars. Additional information can be found in the "Low Tunnel Strawberry Production Guide" published by the University of New Hampshire and available for download online.

High Tunnel Production: In-Ground and Containerized

High tunnel production is feasible within the region, particularly in cooler areas. Production is more likely to be profitable when day-neutral varieties are grown, as they can be grown as an annual crop, and harvested for five months or longer during the planting year. June-bearers may be grown in a plasticulture system within a tunnel; however, growers often find that there are more profitable uses for the space. Plants may be grown in-ground in a plasticulture system similarly to how the plants would be grown in the field. Be aware that strawberries are very salt-sensitive, so if salts have accumulated over time, or a crop that uses relatively high fertilizer rates such as tomatoes precedes the strawberries, the subsequent strawberry crop can be damaged. In these cases, salt levels can be decreased greatly by keeping the plastic off the tunnel over the winter in years when it is being replaced.

Strawberries may be grown in containers. In containerized production, growers are experiencing some success with day-neutral varieties, particularly 'Albion'. Keys to success include using containers that are at least 6 inches deep; using a medium that has a good combination of water-holding capacity and drainage and that is sold as a high-porosity mix; planting as early as possible to encourage early fruiting, and fertigating with an appropriate complete fertilizer constant-feed for your water type at 100 ppm N if growing 'Albion'. Other cultivars, particularly 'San Andreas' and 'Sweet Ann', appear to have a lower N requirement. Resist the urge to crowd plants and leave at least 1' between plants within the row, 2' between rows, and space to walk as plants should grow quite large. Powdery mildew and two-spotted spider mites are two main issues to expect, though not everyone experiences difficulties with them. Be prepared to treat and/or release predatory mites when the first two-spotted spider mites are seen.

Greenhouse Production

Recommendations for greenhouse strawberry production in the Mid-Atlantic have not yet been developed; it is uncertain whether greenhouse strawberries can be grown profitably in this region at this time.

Use of "Stackers" for Production

Use of vertical potted systems for fruit production outdoors or in high tunnels in this region has been fraught with difficulty, in part because this type of production, which uses only natural sunlight, is better suited to lower latitudes of the country where the sun angle is higher, and more sunlight reaches the lower portions of the canopy. In our region, poor growth in the lower levels of the stack often occurs due to excessive shading from nearby rows, which results in a decreased need for water in lower sections of the stack. This unevenness in watering requirements is difficult to manage unless an extremely porous medium is used, which then has its own set of challenges due to low water-holding capacity. This is a different situation from vertical production systems used in greenhouse production.

Pollination (see also sections A 12. Pollination and D 6.3.1. Protection of Pollinators)

Honey bees and wild bees are important for proper pollination and fruit set. Avoid applying insecticides to flowers or weeds in bloom, as pollinators may be adversely affected. If an insecticide must be applied during bloom, observe the precautions for use. Bee toxicity ratings for pesticides are available in the pesticide tables below.

Weed Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.

Recommended Herbicides

1. Identify the weeds in each field and select recommended herbicides. More information is available in the "Herbicide Effectiveness on Common Weeds in Vegetables" (Table E-3) in Chapter E Pest Management.

2. Minimize herbicide resistance development. Identify the herbicide mode of action group number and follow recommended good management practices; **bolded group numbers in tables below are herbicides at higher risk for selecting resistant weed populations.** Include non-chemical weed control whenever possible.

1.A. New Planting: Soil-Applied (Preplant Incorporated or Preemergence)						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient**	**Active Ingredient Rate**	**PHI (d)**	**REI (h)**
3	Dacthal 6F Dacthal W-75	8 to 12 pt/A 6.0 to 14 lb/A	**DCPA**	6 to 9 lb/A	--	12
-Apply preplant incorporated with shallow cultivation before transplanting or apply any time after transplanting to weed-free soil. -Dacthal will not control emerged weeds; apply to weed-free soils. Primarily controls annual grasses and a few broadleaf weeds, including common purslane. Results have been most consistent when used in fields with coarse-textured soils low in organic matter, and when the application is followed by rainfall or irrigation. Maximum application not addressed on label.						
5	Sinbar 80WDG	2 to 3 oz/A	**terbacil**	0.1 to 0.15 lb/A	110	12
-Apply after transplanting but before new runner plants start to root. If transplants are allowed to develop new foliage prior to application, the spray must be followed immediately by 0.5-1.0" of irrigation or rainfall to rinse the foliage, or unacceptable crop injury may result. -Controls many annual broadleaf weeds but may be weak on pigweed species. Use the lower rate on coarse-textured soils low in organic matter and higher rates on fine-textured soils and on soils with high organic matter. **Do not** apply Sinbar to soils with less than 0.5% organic matter. **Do not** add surfactant, oil concentrate, or any other spray additive, or tank mix with any other pesticide unless the mixture is approved on the Sinbar label. -Data have shown that more consistent weed control and less crop injury occurs when 0.05 lb/A terbacil (1.0 oz/A Sinbar) is applied at 3-week intervals. Begin applications 3-6 weeks after transplanting, when the strawberries have 3 new full size trifoliate leaves, but before weeds exceed 1 inch in height. -Maximum Sinbar application per season: 8.0 oz/A, unless otherwise directed on the label.						
15	Devrinol 2-XT 2EC Devrinol DF-XT 50DF	8 qt/A 8 lb/A	**napropamide**	4 lb/A	--	24
-Labeled for preplant incorporated application with plastic mulch production; apply and uniformly incorporate to a depth of 2 inches. -**Bareground** production: apply to weed-free soil immediately after transplanting. Activate with ½ inch sprinkler irrigation within 24 h after application. Irrigation moves the herbicide into the soil and prevents breakdown of Devrinol by the sun. -**Do not** apply from bloom through harvest. Primarily controls annual grasses and suppresses or controls certain annual broadleaf weeds. -Maximum for Devrinol 2-XT 2EC: 8 qt/A per season. -Maximum Devrinol DF-XT 50DF: 8 lb/A per season.						
27	Optogen 1.67	3.5 fl oz/A	**bicyclopyrone**	0.046 lb/A	30	24
-Apply after strawberry emergence or transplanting as either row middle treatment or as a directed spray with hooded or shielded sprayers. -**Contact with strawberry foliage will cause injury.** -Optogen will provide control of only a limited number of weed species, use in combination with other herbicides. -Do not make more than one application per crop year.						

1.B. New Planting: Postemergence

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
1	Shadow 3EC Select 2EC Select Max 0.97EC	4 to 5.33 fl oz/A 6 to 8 fl oz/A 9 to 16 fl oz/A	**clethodim**	0.07 to 0.125 lb/A	4	24
	Fusilade DX 2EC	8 to 16 fl oz/A	**fluazifop**	0.125 to 0.25 lb/A	14	12
	Poast 1.5EC	1 to 2.5 pt/A	**sethoxydim**	0.19 to 0.46 lb/A	7	12
-**Select 2EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). **Select Max**: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution). **Shadow 3EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution) for large or stressed grasses; use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution) when crop safety is a concern. **Fusilade DX**: use COC at 1.0% v/v or NIS at 0.25% v/v. **Poast**: use COC at 1.0% v/v. -**The use of COC may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. -Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control. -Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will **not** be controlled. Controls many annual and certain perennial grasses, including annual bluegrass, but Poast is preferred for goosegrass control. For best results treat annual grasses when they are actively growing and before tillers are present. Control may be reduced if grasses are large or under hot or dry weather conditions. -Repeated applications may be necessary to control certain perennial grasses. If repeat applications are necessary, allow 14 days between applications. Rainfastness is 1 h. -**Do not** tank mix with or apply within 2 to 3 days of any other pesticide, unless labeled, as this may increase the risk of crop injury or reduce the control of grasses. -**Do not** apply more than 8 fl oz/A of Select 2EC in a single application and **do not** exceed 32 fl oz/A for the season; **do not** apply more than 16 fl oz/A of Select Max in a single application and **do not** exceed 64 fl oz/A for the season. -**Do not** apply more than 5.33 fl oz/A of Shadow 3EC in a single application and **do not** exceed 21.33 fl oz/A for the season. -**Do not** apply more than 16 fl oz/A of Fusilade DX in a single application and **do not** exceed 1 pt/A per year. -**Do not** apply more than 2.5 pt/A Poast in a single application and **do not** exceed 2.5 pt/A for the season.						
5	Sinbar 80WDG	2 to 6 oz/A	**Terbacil**	0.1 to 0.3 lb/A	110	12
-Apply in late summer or early fall to control winter annual broadleaf weeds. If the crop is not dormant at the time of application, the spray must be followed immediately by 0.5-1.0 inches of irrigation or rainfall to rinse the strawberry foliage, or unacceptable crop injury may result. Controls many annual broadleaf weeds but may be weak on pigweed species. -Use the lower rate on coarse-textured soils low in organic matter and higher rates on fine-textured soils and on soils with high organic matter. **Do not** apply Sinbar to soils with less than 0.5% organic matter. -**Do not** add surfactant, oil concentrate, or any other spray additive, or tank mix with any other pesticide unless the mixture is approved on the Sinbar label. Maximum Sinbar application per season: 8.0 oz/A, unless otherwise directed on the label.						
27	Optogen 1.67	3.5 fl oz/A	**bicyclopyrone**	0.046 lb/A	30	24
- Use nonionic surfactant (NIS) at 0.25% v/v (1qt/100 gal of spray solution) or crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). Ammonium sulfate (AMS) at 8.5 to 17 lb/100 gal spray solution may be added for improved control of emerged weeds -Apply either as row middle treatment or as a directed spray with hooded or shielded sprayers. -**Contact with strawberry foliage will cause injury.** -Apply to small weeds (less than 2" tall). Optogen provides control for only a few weed species, should be used in combination with other herbicides. -Rainfastness is not specified on the label. -Do not make more than one application per year.						

1.C. New Planting: Late Fall Dormant

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
1	Shadow 3EC Select 2EC Select Max 0.97EC	4 to 5.33 fl oz/A 6 to 8 fl oz/A 9 to 16 fl oz/A	**clethodim**	0.07 to 0.125 lb/A	4	24
	Fusilade DX 2EC	8 to 16 fl oz/A	**fluazifop**	0.125 to 0.25 lb/A	14	12
	Poast 1.5EC	1 to 2 pt/A	**sethoxydim**	0.19 to 0.38 lb/A	7	12
-See Select 2EC / Select Max 0.97EC / Shadow 3EC / Fusilade DX 2EC / Poast 1.5EC in listing under "New Planting-Postemergence"						
3	Dacthal 6F Dacthal W-75	8 to 12 pt/A 6.0 to 14 lb/A	**DCPA**	6 to 9 lb/A	--	12
-Apply to weed-free soil in the fall and repeat in early spring. Dacthal will not control emerged weeds; apply to weed-free soils. Primarily controls annual grasses and a few broadleaf weeds, including common purslane. -Results have been most consistent when used in fields with coarse-textured soils low in organic matter, and when the application is followed by rainfall or irrigation. -Maximum applications per season: not specified						
5	Sinbar 80WDG	2 to 4 oz/A	**Terbacil**	0.1 to 0.2 lb/A	110	12
-Apply just prior to mulching in late fall to extend weed control through harvest the following spring. Controls many annual broadleaf weeds but may be weak on pigweed species. Use the lower rate on coarse-textured soils low in organic matter and higher rates on fine-textured soils and on soils with high organic matter. **Do not** apply Sinbar to soils with less than 0.5% organic matter. -**Do not** add surfactant, oil concentrate, or any other spray additive, or tank mix with any other pesticide unless the mixture is approved on the Sinbar label. Maximum Sinbar application per season: 8.0 oz/A, unless otherwise directed on the label.						

1.C. New Planting: Late Fall Dormant - continued next page

1.C. New Planting: Late Fall Dormant - continued

15	Devrinol 2-XT 2EC Devrinol DF-XT 50DF	8 qt/A 8 lb/A	**napropamide**	4 lb/A	--	24
-Apply in late fall through early winter (not on frozen ground) or in early spring. Activate with ½ inch sprinkler irrigation within 24 h after application. Irrigation moves the herbicide into the soil and prevents breakdown of Devrinol by the sun. -Primarily controls annual grasses and suppresses or controls certain annual broadleaf weeds. -Maximum for Devrinol 2-XT 2EC: 8 qt/A per season. Maximum Devrinol DF-XT 50DF: 8 fl oz/A per season.						

2.A. Bearing Year: Late Winter or Early Spring

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
1	Shadow 3EC Select 2EC Select Max 0.97EC	4 to 5.33 fl oz/A 6 to 8 fl oz/A 9 to 16 fl oz/A	**clethodim**	0.07 to 0.125 lb/A	4	24
	Fusilade DX 2EC	8 to 16 fl oz/A	**fluazifop**	0.125 to 0.25 lb/A	14	12
	Poast 1.5EC	1 to 2 pt/A	**sethoxydim**	0.2 to 0.4 lb/A	7	12
-See Select 2EC / Select Max 0.97EC / Shadow 3EC / Fusilade DX 2EC / Poast 1.5EC in listing under "New Planting-Postemergence"						
3	Dacthal 6F Dacthal W-75	8 to 12 pt/A 6.0 to 14 lb/A	**DCPA**	6 to 9 lb/A	--	12
-Apply anytime to weed-free soil in the early spring. **-Do not** apply after the first bloom through harvest. Dacthal will not control emerged weeds; apply to weed-free soils. Primarily controls annual grasses and a few broadleaf weeds, including common purslane. -Results have been most consistent when used in fields with coarse-textured soils low in organic matter, and when the application are followed by rainfall or irrigation. -Maximum application per season not specified on label.						
4	Weedar 64	1 to 1.5 qt/A	**2,4-D amine**	1 to 1.5 lb/A	--	48
-Apply to established stands in late winter or early spring when the strawberries are dormant. -**Do not** apply 2,4-D between mid-August and winter dormancy, as it may affect flower bud formation, resulting in distorted berries. -**Do not** apply unless possible injury to the crop is acceptable. Controls many broadleaf weeds. -Rainfastness is 6 to 8 h. -Maximum number of applications per year is 1 and **do not** exceed 1.5 qt/A per application.						
4	Stinger 3SL/ Spur 3SL	5.3 to 10.5 fl oz/A	**clopyralid**	0.125 to 0.25 lb/A	30	12
-Spur is labeled in all states. Use is for perennial strawberries only. Only one application allowed per year at a rate up to 10.5 fl oz/A. -**Special Local Needs Label 24(c) for the use of Stinger to control broadleaf weeds in strawberries in NJ, MD, PA, and VA** -Apply Stinger in 1 or 2 applications. When 2 applications are used to control susceptible hard-to-kill perennial weeds, spray the first application at least 30 days before harvest and the second application at renovation, after harvest -Controls weeds in the Composite and Legume families, including annuals (galinsoga, ragweed species, common cocklebur, groundsel, pineappleweed, clover, and vetch) and perennials (Canada thistle, goldenrod species, aster species, and mugwort). -Use Stinger at 5.3 fl oz/A to control annual weeds less than 3 inches tall. Increase the rate to 5.3 to 10.5 fl oz/A to control larger annual weeds. Apply the maximum rate of 10.5 fl oz/A (in 1 or split into 2 applications) to suppress or control perennial weeds. -**Do not** tank mix Stinger with other herbicides registered for use in strawberries. -**Do not** use Stinger with surfactants. -Stinger is a postemergence herbicide with residual soil activity. Observe crop restrictions or injury may occur from carryover. -Rainfastness is 6 h. -Maximum Stinger application per year: 10.5 fl oz/A.						
14	Chateau 51WDG Chateau EZ 4SC	3 oz/A 3 fl oz/A	**flumioxazin**	0.096 lb/A	--	12
-Apply to established stands of matted row strawberries in late winter or early spring when strawberries are dormant, or as a hooded or shielded spray between the rows of strawberries on plastic mulch before fruit set. -Controls many annual broadleaf weeds and suppresses or controls wild pansy. -Tank mix with 2,4-D to improve the spectrum of weeds controlled when treating dormant matted row strawberries, or tank mix with Gramoxone when applying a hooded or shielded spray between the rows of strawberries grown on plastic mulch. Crop oil concentrate at 1% v/v or nonionic surfactant at 0.25% v/v may be added to improve the control of emerged weeds but may also increase the risk of crop injury. -Maximum for Chateau: 3 oz/A per application, 3 oz/A per season.						
15	Devrinol 2-XT 2EC Devrinol DF-XT 50DF	8 qt/A 8 lb/A	**napropamide**	4 lb/A	--	24
-Apply in late fall through early winter (not on frozen ground) or in early spring. **Do not** apply from bloom through harvest -Activate with ½ inch sprinkler irrigation within 24 h after application. Irrigation moves the herbicide into the soil and prevents breakdown of Devrinol by the sun. -Primarily controls annual grasses and suppresses or controls certain annual broadleaf weeds; will not control emerged weeds. -Maximum for Devrinol 2-XT 2EC: 8 qt/A per season. -Maximum Devrinol DF-XT 50DF: 8 fl oz/A per season.						
27	Optogen 1.67	3.5 fl oz/A	**bicyclopyrone**	0.046 lb/A	30	24
-See Optogen 1.67 in listing under "New Planting-Postemergence"						

2.B. Bearing Year: Renovation-Summer

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
1	Shadow 3EC Select 2EC Select Max 0.97EC	4 to 5.33 fl oz/A 6 to 8 fl oz/A 9 to 16 fl oz/A	**clethodim**	0.07 to 0.125 lb/A	4	24
	Fusilade DX 2EC	8 to 16 fl oz/A	**fluazifop**	0.125 to 0.25 lb/A	14	12
	Poast 1.5EC	1 to 2 pt/A	**sethoxydim**	0.2 to 0.4 lb/A	7	12
-See Select 2EC / Select Max 0.97EC / Fusilade DX 2EC / Poast 1.5EC in listing under “New Planting - Postemergence”						
3	Dacthal 6F Dacthal W-75	8 to 12 pt/A 6.0 to 14 lb/A	**DCPA**	6 to 9 lb/A	--	12
-Apply any time after harvest to weed-free soil. Dacthal will not control emerged weeds; apply to weed-free soils. Primarily controls annual grasses and a few broadleaf weeds, including common purslane. -Results have been most consistent when used in fields with coarse-textured soils low in organic matter, and when the application are followed by rainfall or irrigation. Maximum application not addressed on label						
4	Weedar 64	1 to 1.5 qt/A	**2,4-D amine**	1.0 to 1.5 lb/A	--	48
-**Do not** apply 2,4-D between mid-August and winter dormancy, as it may affect flower bud formation, resulting in distorted berries. -**Do not** apply unless possible injury to the crop is acceptable. Controls many broadleaf weeds. -Rainfastness is 6 to 8 h. -Maximum number of applications per year is 1 and **do not** exceed 1.5 qt/A per application.						
4	Stinger 3SL / Spur 3SL	5.3 to 10.5 fl oz/A	**clopyralid**	0.125 to 0.25 lb/A	30	12
- Spur is labeled in all states. Use is for perennial strawberries only. Only one application allowed per year at a rate up to 10.5 fl oz/A. -**Special Local Needs Label 24(c) for the use of Stinger to control broadleaf weeds in strawberries in NJ, MD, PA, and VA** Apply Stinger in 1 or 2 applications. When 2 applications are used to control susceptible hard-to-kill perennial weeds, spray the first application at least 30 days before harvest and the second application at renovation, after harvest -Controls weeds in the Composite and Legume families, including annuals (galinsoga, ragweed species, common cocklebur, groundsel, pineappleweed, clover, and vetch) and perennials (Canada thistle, goldenrod species, aster species, and mugwort). -Use 5.3 fl oz/A to control annual weeds less than 3 inches tall. Increase the rate to 5.3 to 10.5 fl oz/A to control larger annual weeds. Apply the maximum rate of 10.5 fl oz/A (in 1 or split into 2 applications) to suppress or control perennial weeds. -**Do not** tank mix Stinger with other herbicides registered for use in strawberries. **Do not** use Stinger with surfactants. -Stinger is a postemergence herbicide with residual soil activity. Observe crop restrictions or injury may occur from carryover. -Rainfastness is 6 h. -Maximum Stinger application per year: 10.5 fl oz/A.						
5	Sinbar 80WDG	4 to 8 oz/A	**terbacil**	0.2 to 0.4 lb/A	110	12
-Apply at postharvest renovation after old leaves have been removed but before new growth begins. -Controls many annual broadleaf weeds but may be weak on pigweed species. Use the lower rate on coarse-textured soils low in organic matter and higher rates on fine-textured soils and on soils with high organic matter. **Do not** apply Sinbar to soils with less than 0.5% organic matter. -**Do not** add surfactant, oil concentrate, or any other spray additive, or tank mix with any other pesticide unless the mixture is approved on the Sinbar label. -Maximum Sinbar application per season: 8.0 oz/A, unless otherwise directed on the label.						
22	Gramoxone SL 2.0* Gramoxone SL 3.0*	2 pt/A 1.3 pt/A	**paraquat**	0.5 lb/A	21	24
-Apply as a directed shielded spray to control emerged weeds between the rows after crop establishment. Add nonionic surfactant to be 0.25% of the spray solution (1.0 qt/100 gal of spray solution). **Do not** allow spray or spray drift to contact the crop (use shields) or injury may result. **Do not** exceed a spray pressure of 30 psi. See the label for additional information and warnings. -Rainfastness 30 min. A maximum of 3 applications per year are allowed. -***Restricted-use pesticide***. Only certified applicators, who successfully complete the paraquat-specific training, can mix, load, or apply paraquat. Application of paraquat "under the direct supervision" of a certified applicator is no longer allowed. Required training link (*https://campus.extension.org/enrol/index.php?id=2201*); certified applicators must repeat training every three years.						

2.C. Established Planting: Late Fall Dormant

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
1	Shadow 3EC Select 2EC Select Max 0.97EC	4 to 5.33 fl oz/A 6 to 8 fl oz/A 9 to 16 fl oz/A	**clethodim**	0.07 to 0.125 lb/A	4	24
	Fusilade DX 2EC	8 to 16 fl oz/A	**fluazifop**	0.125 to 0.25 lb/A	14	12
	Poast 1.5EC	1 to 2 pt/A	**sethoxydim**	0.2 to 0.4 lb/A	7	12
-See Select 2EC / Select Max 0.97EC / Shadow 3EC / Fusilade DX 2EC / Poast 1.5EC in listing under “New Planting - Postemergence”						
3	Dacthal 6F Dacthal W-75	8 to 12 pt/A 6.0 to 14 lb/A	**DCPA**	6 to 9 lb/A	--	12

2.C. Established Planting: Late Fall Dormant (Dacthal) - continued next page

2.C. Established Planting: Late Fall Dormant (Dacthal) - continued

-Apply to weed-free soil in the fall and repeat in early spring. **Do not** apply after the first bloom through harvest. -Dacthal will not control emerged weeds; apply to weed-free soils. Primarily controls annual grasses and a few broadleaf weeds, including common purslane. Results have been most consistent when used in fields with coarse -textured soils low in organic matter, and when the application are followed by rainfall or irrigation. -Maximum application not addressed on label.						
5	Sinbar 80WDG	4 to 8 oz/A	**terbacil**	0.2 to 0.4 lb/A	110	12
-Apply just prior to mulching in late fall to extend weed control through harvest the following spring. Controls many annual broadleaf weeds but may be weak on pigweed species. Use the lower rate on coarse-textured soils low in organic matter and higher rates on fine-textured soils and on soils with high organic matter. **Do not** apply Sinbar to soils with less than 0.5% organic matter. -**Do not** add surfactant, oil concentrate, or any other spray additive, or tank mix with any other pesticide unless the mixture is approved on the Sinbar label. -Maximum Sinbar application per season: 8.0 oz/A, unless otherwise directed on the label.						
15	Devrinol 2-XT 2EC Devrinol DF-XT 50DF	8 qt/A 8 lb/A	**napropamide**	4 lb/A	--	24
-Apply in late fall through early winter (not on frozen ground) or in early spring. **Do not** apply from bloom through harvest -Activate with ½ inch sprinkler irrigation within 24 h after application. Irrigation moves the herbicide into the soil and prevents breakdown of Devrinol by the sun. Primarily controls annual grasses and suppresses or controls certain annual broadleaf weeds. -Maximum for Devrinol 2-XT 2EC: 8 qt/A per season. -Maximum Devrinol DF-XT 50DF: 8 fl oz/A per season.						
27	Optogen 1.67	3.5 fl oz/A	**bicyclopyrone**	0.046 lb/A	30	24
-See Optogen 1.67 in listing under "New Planting-Postemergence"						

3. Other Labeled Herbicides These products are labeled but limited local data are available; and/or are labeled but not recommended in our region due to potential crop injury concerns.

Group	Product Name (*=Restricted Use)	Active Ingredient
3	Prowl H2O	**pendimethalin**
14	Ultra Blazer	**acifluorfen**
14	Aim	**carfentrazone**
14	Spartan	**sulfentrazone**

Insect Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.
Recommended Insecticides

Aphids, Spittlebugs

Aphids can vector viruses into a planting, thus tolerance for this pest is low. Aphids are usually found in the crown area on tender new growth. Spittlebugs are primarily a nuisance for harvesters and are more common in weedy fields; thus, controlling weeds in the planting can help with minimizing this pest.

Apply one of the following formulations 10 days after new growth begins or in the fall if aphids appear then:

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
3A	Brigade WSB*	6.4 to 32 oz/A	bifenthrin	0	12	H
3A	Danitol 2.4EC* (spittlebugs)	10.6 fl oz/A	fenpropathrin	2	24	H
3A	Danitol 2.4EC* (aphids)	16 to 21.3 fl oz/A	fenpropathrin	2	24	H
3A	PyGanic EC 5.0 II (OMRI, aphids)	4.5 to 15.6 fl oz/A	pyrethrins	0	12	H
4A	Actara 25WDG (aphids)	1.5 to 3.0 oz/A	thiamethoxam	3	12	H
4A	Admire Pro (foliar)	1.3 fl oz/A	imidacloprid	7	12	H
4A	Admire Pro (soil, aphids)	10.5 to 14 fl oz/A	imidacloprid	14	12	H
4A	Assail 30SG Assail 30SC	1.9 to 4.0 oz/A 1.6 to 3.4 fl oz/A	acetamiprid	1	12	M
4A + 15	Cormoran	9.0 to 12.0 fl oz/A	acetamiprid + novaluron	1	12	M
4D	Sivanto Prime (aphids)	7.0 to 14.0 fl oz/A	flupyradifurone	0	4	M
21A	Apta (aphids)	27 fl oz/A	tolfenpyrad	1	12	H
29	Beleaf 50SG (aphids)	2.8 oz/A	flonicamid	0	12	L
UN	M-Pede (OMRI)	1 - 2% v/v	potassium salts of fatty acids	0	12	L
UN	Azatin O, Aza-Direct, Ecozin Plus, Neemix (OMRI)	Refer to individual labels for rates	azadirachtin	0	4	L

Cyclamen Mites

See below, after Two-Spotted Spider Mites.

Leafrollers

Leafrollers are a sporadic pest in most of the region. Treatment is usually not required.

The following formulations are available. Apply one spray 10 days after full bloom:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
3A	Brigade WSB*	6.4 to 32.0 oz/A	bifenthrin	0	12	H
3A	Danitol 2.4EC*	16 to 21.3 fl oz/A	fenpropathrin	2	24	H
3A	PyGanic EC 5.0 II (OMRI)	4.5 to 15.6 fl oz/A	pyrethrins	0	12	H
5	Radiant SC	6.0 to 10.0 fl oz/A	spinetoram	1	4	M
5	Entrust SC (OMRI)	4.0 to 6.0 fl oz/A	spinosad	1	4	M
11A	Dipel DF (OMRI)	0.5 to 2.0 lb/A	B.t. subsp. kurstaki	0	4	N
21A	Apta	27 fl oz/A	tolfenpyrad	1	12	H
28	Verdepryn 100SL	8.2 to 11.0 fl oz/A	cyclaniliprole	1	4	H
UN	Azatin O, Aza-Direct, Ecozin Plus, Neemix (OMRI)	Refer to individual labels for rates	azadirachtin	0	4	L

Potato Leafhoppers

Potato leafhoppers cause leaf yellowing and distortion. There are no effective cultural controls, though damage may be worse after neighboring fields or weedy patches are mowed as leafhoppers will move to strawberry plants.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1B	Malathion 57EC	1.5 to 3.0 pt/A	malathion	3	12	H
3A	Danitol 2.4EC*	16.0 to 21.3 fl oz/A	fenpropathrin	2	24	H
3A	PyGanic EC 5.0 II (OMRI)	4.5 to 15.6 fl oz/A	pyrethrins	0	12	H
4A	Actara 25WDG	1.5 to 3.0 oz/A	thiamethoxam	3	12	H
4A	Assail 30SG Assail 30SC	1.9 to 4.0 oz/A 1.6 to 3.4 fl oz/A	acetamiprid	1	12	M
4A + 15	Cormoran	9.0 to 12.0 fl oz/A	acetamiprid + novaluron	1	12	M
4A + 28	Voliam Flexi	2.0 to 4.0 oz/A	thiamethoxam + chlorantraniliprole	3	12	H

Root Weevils

Several species can damage strawberry plants; damage is often worst near wooded field edges. Generally, it is only problematic in matted-row plantings. Watch for characteristic leaf notching as a sign of active adults. Larvae should be targeted with a soil application in mid-summer.

Apply one of the following formulations (note: foliar sprays target adults, soil applications target larvae):						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
n/a	Entomopathogenic nematodes[1]	see footnote	see footnote	--	--	--
1B	Malathion 57EC (adults)	1.5 to 3.0 pt/A	malathion	3	12	H
3A	Brigade WSB* (adults)	8.0 to 32.0 oz/A	bifenthrin	0	12	H
3A	Danitol 2.4EC* (adults)	16.0 to 21.3 fl oz/A	fenpropathrin	2	24	H
4A	Actara 25WDG (adults, foliar)	4.0 oz/A	thiamethoxam	3	12	H
4A	Platinum 75SG (larvae, soil)	1.70 to 4.01 oz/A	thiamethoxam	75	12	H

[1]Entomopathogenic nematodes (use *Heterorhabditis bacteriophora*). Apply 1-2 billion/A during evening or early morning when soil temperatures are at or above 60°F (16°C), then irrigate them into the soil.

Sap Beetles

Sap beetles are attracted to ripe, decaying fruit and bore into berries. They are a nuisance, especially in pick-your-own fields with rotting, over-ripe berries abound. Preventing the accumulation of decaying fruit on or between beds is one way of avoiding beetle buildup. Sprays may not reach adults which are protected under the berries. Sprays that target larvae should be applied when adults are first noticed.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
3A	Brigade WSB* (adults)	6.4 to 32.0 oz/A	bifenthrin	0	12	H

Sap Beetles - continued next page

Sap Beetles - continued

3A	Danitol 2.4EC* (adults)	16.0 to 21.3 fl oz/A	fenpropathrin	2	24	H
4A	Assail 30SG (adults) Assail 30SC (adults)	4.0 to 6.9 oz/A 3.4 to 5.8 fl oz/A	acetamiprid	1	12	M
4A + 15	Cormoran (adults and larvae)	12.0 fl oz/A	acetamiprid + novaluron	1	12	M
15	Rimon 0.83EC (only affects larvae)	6 to 12.0 fl oz/A	novaluron	1	12	M

Slugs

Slugs prefer a cool, wet, dark environment, and mulch, weeds, and other plant trash in beds during a wet spring provide the perfect setting. Mulch removal and adequate weed control help reduce the slug population.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
n/a	Deadline Bullets	up to 25 lb/A	metaldehyde	0	12	N
n/a	Sluggo (OMRI)	20.0 to 44.0 lb/A	iron phosphate	0	0	N

Spittlebugs

See Aphids, Spittlebugs above.

Spotted Wing Drosophila

Mainly problematic on day-neutral strawberries during late summer and fall but can be an issue for very late cultivars of June-bearers. Choosing varieties and production methods that result in an early season harvest can help with avoiding this pest especially in cooler locations. Harvesting cleanly and frequently, and refrigerating the fruit right after harvest, can help with minimizing damage.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
3A	Danitol 2.4EC*	16.0 fl oz/A	fenpropathrin	3	24	H
3A	PyGanic EC 5.0 II (OMRI)	4.5 to 15.6 fl oz/A	pyrethrins	0	12	H
4A + 15	Cormoran	12 fl oz/A	acetamiprid + novaluron	1	12	M
5	Radiant SC	6 to 10 fl oz/A	spinetoram	1	4	M
28	Exirel	13.5 to 20.5 fl oz/A	cyantraniliprole	1	12	H
28	Verdepryn 100SL	8.2 to 11.0 fl oz/A	cyclaniliprole	1	4	H
--	Grandevo WDG (OMRI)	2 to 3 lb/A	*Chromobacterium subtsugae* strain PRAA4-1T and spent fermentation media	0	4	H

Strawberry Rootworms

Adults are small brown beetles that hide quickly and feed at night. Watch for circular or oval holes in leaves and weak growth, which may indicate a high population. Insecticides applied in summer when new damage appears will assist in preventing egg-laying and subsequent root feeding by larvae. Broad-spectrum foliar insecticides are effective against adults.

Strawberry Bud Weevils (Strawberry Clippers)

Generally, only problematic in older matted-row plantings near wooded areas where populations build over time

Apply one of the following formulations after new growth starts and before fruit buds are visible. Repeat 10 days later:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
3A	Brigade WSB*	6.4 to 32 oz/A	bifenthrin	0	12	H
3A	Danitol 2.4EC*	16.0 to 21.3 fl oz/A	fenpropathrin	2	24	H
3A	PyGanic EC 5.0 II (OMRI)	4.5 to 15.6 fl oz/A	pyrethrins	0	12	H

Tarnished Plant Bugs (Lygus)

Damage from feeding causes a condition known as “button-berry” where the tip of the berry fails to expand, and seeds are concentrated. Damage is worse on mid to late season June-bearers, as a second generation emerges as these berries are forming and also on day-neutral varieties in summer and fall. Attracted to weeds and certain cultivars of strawberries. Populations may increase rapidly in strawberry fields if nearby vegetation is mowed. Keep nearby weeds under control and avoid mowing nearby vegetation during bloom and harvest.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1B	Malathion 57EC	1.5 to 3.0 pt/A	malathion	3	12	H
3A	Brigade WSB*	6.4 to 32.0 oz/A	bifenthrin	0	12	H
3A	Danitol 2.4EC*	10.67 fl oz/A	fenpropathrin	2	24	H
3A	PyGanic EC 5.0 II (OMRI)	4.5 to 15.6 fl oz/A	pyrethrins	0	12	H
4A	Assail 30SG Assail 30SC	4.0 to 6.9 oz/A 3.4 to 5.8 fl oz/A	acetamiprid	1	12	M
4A + 15	Cormoran	12.0 fl oz/A	acetamiprid + novaluron	1	12	M
4C	Transform WG	1.5 to 2.25 oz/A	sulfoxaflor	1	24	H
21A	Apta	27.0 fl oz/A	tolfenpyrad	1	12	H
29	Beleaf 50SG	2.8 oz/A	flonicamid	0	12	L
UN	Azatin O, Aza-Direct, Ecozin Plus, Neemix (OMRI)	Refer to individual labels for rates	azadirachtin	0	4	L

Thrips

Thrips cause bronzing of berries due to surface scarring of the fruit and may cause seeds to appear raised if the berry surface is sufficiently scarred. Avoid growing strawberries near greenhouses and flowering weeds where populations of thrips may be high.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
4A[1]	Assail 30SG Assail 30SC	4.0 to 6.9 oz/A 3.4 to 5.8 fl oz/A	acetamiprid	1	12	M
4A + 15	Cormoran	12.0 fl oz/A	acetamiprid + novaluron	1	12	M
5	Radiant SC	6.0 to 10.0 fl oz/A	spinetoram	1	4	M
5	Entrust SC (OMRI)	4.0 to 6.0 fl oz/A	spinosad	1	4	M
21A	Apta	27 fl oz/A	tolfenpyrad	1	12	H
UN	Azatin O, Aza-Direct, Ecozin Plus, Neemix (OMRI)	Refer to individual labels for rates	azadirachtin	0	4	L

[1]Resistance concerns with tobacco thrips

Two-Spotted Spider Mites (TSSM)

Scout for TSSM and especially watch for leaf stippling which is an indication of a high population. Populations can build under row covers over the winter, so a treatment before row covers are applied may be warranted if mites are present. Thorough under leaf spray coverage is necessary. For resistance management, alternate materials with different modes of action. Use of broad-spectrum insecticides can kill off natural predators resulting in flare-ups of pest mites. In situations where pesticides are only minimally used or avoided, releases of predatory mites can be effective if used before populations get out of hand. If using predatory mites, avoid broad spectrum insecticides, especially pyrethroids (group 3A).

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
6	Agri-Mek SC*	3.5 fl oz/A	abamectin	3	12	H
10A	Savey 50DF[1] (immatures)	6.0 oz/A	hexythiazox	3	12	N
10B	Zeal Miticide[1] (immatures)	2.0 to 3.0 oz/A	etoxazole	1	12	L
20B	Kanemite 15SC	21.0 to 31.0 fl oz/A	acequinocyl	1	12	L
20D	Acramite 50WS	0.75 to 1.0 lb/A	bifenazate	1	12	M
21A	Nexter	4.4 to 10.67 oz/A	pyridaben	1	12	H
21A	Portal	2.0 pt/A	fenpyroximate	1	12	L
21A	Magister	32 to 36 fl oz/A	fenazaquin	1	12	H
23	Oberon 2SC	12.0 to 16.0 fl oz/A	spiromesifen	3	12	M
25A	Nealta	13.7 fl oz/A	cyflumetofen	1	12	L
UNE	Organic JMS Stylet Oil (OMRI)	3 qt/100 gal	paraffinic oil	0	4	L
UNE	M-Pede (OMRI)	1 - 2% v/v	potassium salts of fatty acids	0	12	L

[1] Effective on eggs and immature stages but has little effect on adults

Cyclamen Mites

Thorough coverage in the crown area is necessary. Sprays are best applied when foliage is minimal (early spring or renovation), and in high volumes of water directed to the crown. Predatory mites are effective if released when cyclamen mite populations are still low and confined to "hot spots", and before cool temperatures occur in Fall.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
6	Agri-Mek SC*	3.5 fl oz/A	abamectin	3	12	H
21A	Portal	2.0 pt/A	fenpyroximate	1	12	L

Disease Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.
Recommended Fungicides

Nematodes

See sections E 1.5. Soil Fumigation and E 1.6. Nematode Control.

Dip Treatments for New Plantings

Only use products registered as plant dips to control diseases just before planting. Root dip waste needs to be disposed of properly.

For Phytophthora Crown and Root Rot management:

Treatment is most likely to be needed if planting Phytophthora-susceptible cultivars (*e.g.*, Sweet Charlie), especially if the field history includes strawberries. Avoid poorly-drained sites. Use one of the following and dip plants for 15 to 30 minutes[1], then plant as quickly as possible (within 24 hours). See individual diseases below for additional treatments that may be applied after planting and through harvest.

FRAC Code	**Product Name (*=Restricted Use)**	**Rate (pre-plant dip)**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
P07	Aliette 80WDG[2]	2.5 lb/100 gal water	fosetyl-Al	0.5	24	N
P07	ProPhyt	2.0 pt/100 gal water	phosphite salts	0	4	N
P07	Phostrol	2.5 pt/100 gal water	phosphite salts	n/a	4	N
P07	K-Phite 7LP	1-2 qt/100 gal water	phosphite salts	0	4	N
P07	Fungi-Phite	1 qt/100 gal water	phosphite salts	n/a	4	N

[1]Detailed instructions may vary with the fungicides; refer to the product label for confirmation.
[2]Not all products with this formulation are labeled for use on strawberries.

For Anthracnose Crown Rot (ACR) management:

If planting susceptible cultivars (*e.g.*, Chandler, Camarosa, others) that are known or strongly suspected to have latent infections, use one of the following as a dip and see sections below for additional treatments that may be used. Use these dip treatments, only if necessary, as resistance is a concern and yield reductions have been reported in some studies. Dip plants for 2 to 5 minutes, then plant as quickly as possible. Abound has been effective in the past, but about 90% of isolates of the ACR-causing fungus exhibit resistance to FRAC code 11 fungicides. If resistance is not an issue, the dip treatment with Switch or Abound, may also reduce the amount of inoculum available to cause Anthracnose Fruit Rot (AFR) during fruit ripening. See individual diseases below for additional treatments that may be applied after planting and through harvest.

FRAC Code	**Product Name (*=Restricted Use)**	**Rate (pre-plant dip)**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
9 + 12	Switch 62.5WG	5.0 to 8.0 oz/100 gal water	cyprodinil + fludioxonil	0	12	L
11	Abound 2.08F	5.0 to 8.0 oz/100 gal water	azoxystrobin	0	4	N

Bacterial and Fungal Diseases

Diseases are categorized below by the plant parts where symptoms are most commonly found and first noticed. However, many diseases affect more than one part of the plant; instances where this occurs are mentioned under individual diseases below.

Fruit Rots

Anthracnose Fruit Rot (*Colletotrichum acutatum*)

Anthracnose fruit rot (AFR), caused mostly by *C. nymphaeae* and belonging to *C. acutatum* species complex, is a major disease in strawberries. Nursery transplants with latent infections are thought to be the primary source of inoculum. The pathogen is mainly dispersed by rain or water-splash. Any production system that can keep the rain off the plants (*e.g.*, tunnels) will help reduce disease incidence.

If plants are diagnosed with Anthracnose fruit rot, fungicides need to be applied immediately. Keep in mind that FRAC code 11 fungicides offer better efficacy for Anthracnose fruit rot control in general than fungicides in other categories, however, resistance is a concern (where the frequency of AFR resistance is about 30 to 50%). Note that control efficacy can be substantially lower when only 5% of the isolates obtained from any given field are resistant. Captan and products containing fludioxonil (Switch or Miravis Prime) have good efficacy when resistance is suspected against FRAC code 11 fungicides. Thiram also offers some efficacy and may be useful early in the season. Certain FRAC code 3 fungicides containing either difenoconazole (*e.g.*, Inspire) or propiconazole (*e.g.*, Tilt) are also effective. Except for Captan or Thiram, do not to apply fungicides in the same FRAC code more than twice in a row. Maintain continuous coverage of Captan or Thiram, and tank mix with a site-specific fungicide (such as Switch or Tilt) when disease pressure is high.

High risk can be estimated with weather-based models as recommended by the Strawberry Advisory System (*http://agroclimate.org/tools/strawberry/*) and NEWA (*https://newa.cornell.edu/strawberry-diseases/*): Note that any disease forecasting system requires on-site weather data to be most accurate and effective.

Fungicide applications should be made in the spring from bloom through harvest at 7- to 10-day intervals.						
FRAC Code	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
Maintain continuous coverage of Captan from bloom to harvest when disease pressure is moderate or high.						
M04	Captan 50W	6.0 lb/A	captan	0	24	N
M04	Captan 80WDG	3.7 lb/A	captan	0	24	N
M04	Captan Gold 4L	2.0 to 3.0 qt/A	captan	0	24	N
M03	Thiram SC	2.0 to 2.5 qt/A	thiram	1	24	--
Use the following fungicides when disease pressure is high. Application with a tank-mix partner (captan or thiram) may help with resistance management. Do not apply the same FRAC code more than twice in a row or in a season (*e.g.*, Cabrio and Pristine contain the same FRAC code).						
3	Tilt 3.6EC	4.0 fl oz/A	propiconazole	0	24	N
3	Inspire 2.08EC	7.0 fl oz/A	difenoconazole	0	12	--
3 + 9	Inspire Super 2.82EW	16.0 to 20.0 fl oz/A	difenoconazole + cyprodinil	0	12	--
3 + 11	Quadris Top	12.0 to 14 fl oz/A	difenoconazole + azoxystrobin	0	12	--
3 + 11	Quilt Xcel 2.2SE	14.0 fl oz/A	propiconazole + azoxystrobin	0	12	N
7 + 11	Luna Sensation 4.25SC	4.0 to 7.6 fl oz/A	fluopyram + trifloxystrobin	0	12	--
7 + 11	Merivon Xemium	5.5 to 8 fl oz/A	fluxapyroxad + pyraclostrobin	0	12	N
7 + 11	Pristine 38WG	18.5 to 23.0 oz/A	boscalid + pyraclostrobin	0	12	--
7 + 12	Miravis Prime	11.4 to 13.4 fl oz/A	pydiflumetofen + fludioxonil	0	12	--
9 + 12	Switch 62.5WG	11 to 14 oz/A	cyprodinil + fludioxonil	0	12	L
11	Abound 2.08F (and others)	6.0 to 15.5 fl oz/A	azoxystrobin	0	4	N
11	Cabrio 20EG	12 to 14 oz/A	pyraclostrobin	0	12	N
11	Aftershock (and others)	2.0 to 5.7 fl oz/A	fluoxastrobin	1	12	--

Gray Mold (Botrytis Fruit Rot)

Start spraying at 5 to 10% bloom, because most fruit infections occur through the flower. Repeat every 7-10 days. Spray less frequently during prolonged dry periods, but every 5-7 days during very wet periods. The risk of resistance to fungicides other than FRAC codes M, 7 and 12 is generally high. If a product like Pristine is used for Anthracnose fruit rot control, it can also reduce Gray mold due to the presence of boscalid (FRAC code 7) in it. Similarly, Switch has good efficacy against both Botrytis and Anthracnose fruit rot. High risk of Botrytis infection is estimated with weather-based models recommended by the Strawberry Advisory System. Please visit the following website(s): *http://agroclimate.org/tools/strawberry/* and NEWA *https://newa.cornell.edu/strawberry-diseases/*. *(continued next page)*

Gray Mold (Botrytis Fruit Rot) - continued

FRAC Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Apply Captan or Thiram solely when disease pressure is low to moderate. Captan is a better choice if Anthracnose is a concern or is present.						
M03	Thiram SC	1.5 to 2.5 qt/A	thiram	1	24	--
M03	Thiram Granuflo	4.4 lb/A	thiram	3	24	--
M04	Captan 50W	3.0 to 6.0 lb/A	captan	0	24	N
M04	Captan 80WDG	1.875 to 3.75 lb/A	captan	0	24	N
M04	Captan 4L	2 to 3 qt/A	captan	0	24	N
Use the following fungicides when disease pressure is high. Applying them with a tank-mix partner (captan or thiram) may help with resistance management. Do not apply the same FRAC code more than twice in a row or in a season (*e.g.*, Cabrio and Pristine contain the same FRAC code) except for FRAC codes starting with M (*i.e.*, captan and thiram).						
1	Topsin M WSB	0.75 to 1.0 lb/A	thiophanate-methyl	1	24	N
2	Meteor[1]	1.5 to 2.0 pt/A	iprodione	n/a	24	N
2	Nevado 4F[1]	1.5 to 2.0 pt/A	iprodione	n/a	24	N
2	Rovral 4F[1]	1.5 to 2.0 pt/A	iprodione	n/a	24	N
7	Fontelis 1.67SC[2]	16 to 24 fl oz/A	penthiopyrad	0	12	L
7	Kenja 400SC	13.5 to 15.5 fl oz/A	isofetamid	0	12	--
7 + 9	Luna Tranquility 4.16SC	16 to 27 fl oz/A	fluopyram + pyrimethanil	1	12	--
7 + 11	Luna Sensation 4.25SC	6 to 7.6 fl oz/A	fluopyram + trifloxystrobin	0	12	--
7 + 11	Pristine 38WG	18.5 to 23 fl oz/A	boscalid + pyraclostrobin	0	12	--
7 + 11	Merivon Xemium	8 to 11 fl oz/A	fluxapyroxad + pyraclostrobin	0	12	N
7 +12	Miravis Prime	9.1 to 13.4 fl oz/A	pydiflumetofen + fludioxinil	0	12	--
9	Scala 5SC	18 fl oz/A, if alone	pyrimethanil	1	12	--
9 + 12	Switch 62.5WG	11 to 14 oz/A	cyprodinil + fludioxonil	0	12	L
17	Elevate 50 WDG	1.5 lb/A	fenhexamid	0	12	N
19	Ph-D	6.2 oz/A	polyoxin D zinc salt	0	4	--
19	OSO 5% SC	6.5 to 13 fl oz/A	polyoxin D zinc salt	0	4	--
19	Tavano	6.5 to 13 fl oz/A	polyoxin D zinc salt	0	4	--

[1]Do not make more than 1 application/season. Do not apply these products after first fruiting flower. [2]Except for the varieties Clancy, Jewel, and L'Amour.

Root and Crown Rots

Anthracnose Crown Rot

Anthracnose crown rot (ACR) is primarily caused by *C. gloeosporioides*. However, the Anthracnose fruit rot (AFR) pathogen, *C. acutatum,* can also cause the root and crown rot. ACR is mainly problematic in plasticulture plantings. In general, FRAC code 11 containing products such as Pristine are the primary materials for controlling both ACR and AFR; however, resistance to FRAC code 11 fungicides is widespread in both pathogens. *C. gloeosporioides* is sensitive to Topsin M (thiophanate methyl, FRAC 1), whereas *C. acutatum* is naturally insensitive to Topsin M. While Topsin M has some efficacy against ACR, resistance is very common in *C. gloeosporioides* from strawberries. Upon the confirmation of the disease, plants may need to be treated every 7 to 10 days during fall and spring through foliar or drip application according to the label. Materials effective for ACR (except for Topsin M), are largely the same as for treating AFR, thus the foliar application made in spring for ACR will also cover the fruit rot. In addition, Captan may have improved efficacy for ACR and AFR when tank mixed with a phosphoric acid product. A higher water volume may be needed to drench the soil to get the materials into the crown. Do not apply the same FRAC code, except for Captan and Thiram, more than twice in a season for resistance management purposes. Removal of infected and dying plants in the field can also help.

FRAC Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Maintain continuous coverage of Captan.						
M04	Captan 50W	6.0 lb/A	captan	0	24	N
M04	Captan 80WDG	3.75 lb/A	captan	0	24	N
M04	Captan Gold 4L	2.0 to 3.0 qt/A	captan	0	24	N
Use the following fungicides when disease pressure is high. Application with a tank-mix partner (captan or thiram) may help with resistance management. Do not apply the same FRAC code more than twice in a row or in a season (*e.g.*, Cabrio and Pristine contain the same FRAC code) except for FRAC code M (*i.e.*, captan and thiram).						

Anthracnose Crown Rot - continued next page

Anthracnose Crown Rot - continued

1	Topsin M WSB[1]	0.75 to 1.0 lb/A	thiophanate-methyl	1	24	N
3 + 11	Quadris Top	12 to 14 fl oz/A	difenoconazole + azoxystrobin	0	12	--
3 + 11	Quilt Xcel 2.2SE	14 fl oz/A	propiconazole + azoxystrobin	0	12	N
7 + 11	Luna Sensation 4.25SC	4.0 to 7.6 fl oz/A	fluopyram + trifloxystrobin	0	12	--
7 + 11	Merivon Xemium	5.5 to 8 fl oz/A	fluxapyroxad + pyraclostrobin	0	12	N
7 + 11	Pristine 38WG	18.5 to 23.0 oz/A	boscalid + pyraclostrobin	0	12	--
7 +12	Miravis Prime	11.4 to 13.4 fl oz/A	pydiflumetofen + fludioxinil	0	12	--
9 + 12	Switch 62.5WG	11 to 14 oz/A	cyprodinil + fludioxonil	0	12	L
11	Abound 2.08F	6.0 to 15.5 fl oz/A	azoxystrobin	0	4	N
11	Cabrio 20EG	12 to 14 oz/A	pyraclostrobin	0	12	N

[1]For *Colletotrichum gloeosporioides* only (accurate species identification is needed to ensure effective control).

Black Root Rot

This is a disease complex caused by cultural stresses (*e.g.*, compaction of soil) coupled with many different fungi and by nematode feeding injury and is the main reason for pre-plant fumigation of strawberry. Winter injury is also a factor that facilitates the black root rot (BRR). The most prevalent fungi associated with the disease are *Rhizoctonia* and *Pythium*. Rotating a field out of strawberries for 4-5 years will reduce the incidence of BRR. In fields with a high-water table, the use of raised beds and/or pre-plant fumigation will provide some control. If rotation is not an option, pre-plant fumigation may be helpful. Fumigants are listed in section E 1.5. Soil Fumigation. Applying azoxystrobin as a soil-directed or drip application may help suppress Rhizoctonia root rot. Also see Red Stele and Phytophthora Crown Rot. In the absence of synthetic fumigation, integrated management of BRR may be considered. For example, growing strawberry plug plants in beneficial bacteria-treated planting mix followed by planting in anaerobically disinfested (ASD) field soil may reduce BRR incidence and severity.

Red Stele and Phytophthora Crown Rot

Prevent spread of the red stele pathogen via cultivation equipment and/or surface runoff water. Selecting fields with well-drained soils and planting on high, raised beds will help reduce disease. Crop rotation may be of little value, as the red stele pathogen persists in soil for many years, and length of persistence of the crown rot pathogen is unknown. However, disease is very unlikely when clean plants are introduced to soil with no history of strawberry production. If Red stele is present in the soil, consider using varieties that are resistant to several races such as 'Allstar' or 'Earliglow'. For crown rot, cultivars have differential susceptibility, but no cultivars are completely resistant. For example, 'Sweet Charlie' is highly susceptible whereas 'Albion' and 'Chandler' offer some tolerance.

The following fungicides can be applied as pre-plant dips as discussed above, and depending on the product, as foliar sprays or with ground application equipment or by drip irrigation for additional control. See labels for how application rates should be determined for each product. In addition, applying Actigard early and regularly before the onset of symptoms is beneficial if the issue occurs every year. Actigard needs to be applied at the lowest labeled dose to minimize its impact on yield. The product can also be applied through the irrigation system for best uptake.

NEW PLANTINGS						
FRAC Code	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
Foliar sprays of phosphite products should begin 14 to 21 days after planting and continue on a 30- to 60-day interval as long as favorable disease conditions occur. These products include:						
P07	Aliette 80WDG[1]	2.5 to 5.0 lb/A	fosetyl-Al	0.5	24	N
P07	ProPhyt	2 to 4 pt/A	phosphite salts	0	4	N
P07	Phostrol	2.5 to 5.0 pt/A	phosphite salts	n/a	4	N
P07	K-Phite 7LP	1 to 4 qt/A	phosphite salts	0	4	N
P07	Fungi-Phite	1 to 2 qt/A	phosphite salts	n/a	4	N
Fungicides may be applied after transplanting as a banded spray with ground application equipment and/or through drip irrigation depending on the product. See individual labels for details.						
4	MetaStar 2E	2.0 qt/*treated* A	metalaxyl	n/a	48	N
4	Ridomil Gold 4SL	1.0 pt/*treated* A	mefenoxam	0	48	N
4	Ultra Flourish 2E	2.0 pt/*treated* A	mefenoxam	0	48	N
49 + 4	Orondis Gold	20 to 62 fl oz/A	oxathiapiprolin + mefenoxam	28	48	--

Red Stele and Phytophthora Crown Rot - ESTABLISHED PLANTINGS on next page

Red Stele and Phytophthora Crown Rot - continued

ESTABLISHED PLANTINGS						
FRAC Code	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
Spring applications should begin when plants start active growth and before 1st bloom. Foliar sprays of phosphite products should be repeated every 30 to 60 days as long as weather conditions favor disease development. These products include:						
P07	Aliette 80WDG[1]	2.5 to 5.0 lb/A	fosetyl Al	0.5	24	N
P07	ProPhyt	2 to 4 pt/A	phosphite salts	0	4	N
P07	Phostrol	2.5 to 5.0 pt/A	phosphite salts	n/a	4	N
P07	K-Phite 7LP	1 to 4 qt/A	phosphite salts	0	4	N
P07	Fungi-Phite	1 to 2 qt/A	phosphite salts	n/a	4	N
Fungicides may be applied as banded sprays with ground application equipment and/or through drip irrigation depending on the product. 3 applications may be made per yearly crop cycle. Applications may be made in the spring, though exact timing varies with the product, production system, and target disease. In perennial systems, one of the three allowable applications per crop year may be made after harvest in the fall. See individual labels for details. These fungicides include (apply one of the following):						
4	MetaStar 2E	2.0 qt/*treated* A	metalaxyl	n/a	48	N
4	Ridomil Gold 4SL	1.0 pt /*treated* A	mefenoxam	0	48	N
4	Ultra Flourish 2E	2.0 pt /*treated* A	mefenoxam	0	48	N
49 + 4	Orondis Gold	20 to 62 fl oz/A	oxathiapiprolin + mefenoxam	28	48	--

[1]Not all products with this formulation are labeled for use on strawberries

Leaf and Calyx (Cap) Diseases

Angular Leaf Spot

Angular (bacterial) leaf spot, caused by the bacterium *Xanthomonas fragariae,* is characterized by water-soaked, translucent spots on lower leaf surfaces. During the fruiting stage, the sepals of the caps turn brown or black resulting in unmarketable fruit. Planting disease-free plants is critical. If symptoms appear on established plants, applying fixed copper products can help, but not if weather conditions are highly favorable to the disease. Repeat applications at 7- to 10-day intervals. Discontinue fixed copper applications if plant injury occurs, usually after 4-5 sprays. Overhead irrigation for frost protection will make angular leaf spot worse. Applying Actigard (FRAC P01) early in the season may also help, but there is no solid data regarding effectiveness.

Fungal (Phomopsis and Gnomonia) Leaf Blight, Leaf Scorch and/or Common Leaf Spot

In the fall or early spring, leaf diseases are not usually problematic in strawberries, but prolonged warm, wet weather favors the disease in the late spring and summer. Incidence may be associated with plant source.

FRAC Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
M04	Captan 50W	3 to 6 lb/A	captan	0	24	N
M04	Captan 80WDG	1.875 to 3.75 lb/A	captan	0	24	N
M04	Captan 4L	2 to 3 qt/A	captan	0	24	N
Do not apply the same FRAC code more than twice in a row or in a season except for FRAC code M.						
1	Topsin M WSB	0.75 to 1.0 lb/A	thiophanate-methyl	1	24	N
2	Meteor[1]	1.5 to 2.0 pt/A	iprodione	n/a	24	N
2	Nevado 4F[1]	1.5 to 2.0 pt/A	iprodione	n/a	24	N
2	Rovral 4F[1]	1.5 to 2.0 pt/A	iprodione	n/a	24	N
3	Rally 40WSP	2.5 to 5.0 oz/A	myclobutanil	0	24	N
11	Cabrio 20EG	12 to 14 oz/A	pyraclostrobin	0	12	N
3 + 11	Quadris Top	12 to 14 fl oz/A	difenoconazole + azoxystrobin	0	12	--
3 + 11	Quilt Xcel 2.2SE	14 fl oz/A	propiconazole + azoxystrobin	0	12	N
7 + 11	Merivon Xemium	4 to 7 fl oz/A	fluxapyroxad + pyraclostrobin	0	12	N
7 + 11	Pristine 38WG	18.5 to 23.0 oz/A	boscalid + pyraclostrobin	0	12	--

[1]Do not make more than 1 application/season. Do not apply these products after first fruiting flower.

Neopestalotiopsis (Pestalotia)

Neopestalotiopsis was found on strawberry plug plants distributed to several states in the Mid-Atlantic region in 2020, 2021, and 2023 resulting in some infected plantings. Foliar symptoms consist of tan leaf lesions that progress rapidly under moist conditions and collapsed plants if the fungus invades the crown area. Fruit lesions start out tan but develop black pycnidia (sporulation) in the center and could be mistaken for Anthracnose Fruit Rot. In the past, symptoms have been reduced in the spring compared to the fall, but whether this pattern will continue is unknown.

Fungicides are only partially effective so multiple applications are likely to be needed. Apply fungicides at 7- to 10-day intervals starting when symptoms appear. Removal of infected leaves may help but work in less severely infected areas of the field first to avoid transferring inoculum to other plants. Be sure to remove foliage from the field completely.

FRAC Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Rotate between the following fungicides with different modes of action (FRAC code):						
M03	Thiram SC	2.5 qt/A	thiram	1	24	--
9 + 12	Switch 62.5WG	14 oz/A	cyprodinil + fludioxonil	0	12	L

Powdery Mildew

Unless symptoms are severe, crop losses are rare in the fall and the disease may not reappear in the spring. Check both sides of leaves in the spring for disease pressure. Severe disease during the spring or on day-neutral cultivars in the summer may justify fungicide application on a 14-21day interval. Do not apply any fungicides in the table below more than twice in a row. Switch to another product to reduce the chance of fungicide resistance development.

FRAC Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Rotate between the following fungicides with different modes of action (FRAC code):						
U06	Torino 0.85SC	3.4 fl oz/A	cyflufenamid	0	4	--
U13	Gatten	6.0 to 8.0 fl oz/A	flutianil	0	12	--
3	Mettle 125ME	3.0 to 5.0 fl oz/A	tetraconazole	0	12	--
3	Procure 480SC	4.0 to 8.0 oz/A	triflumizole	1	12	N
3	Rally 40WSP	2.5 to 5.0 oz/A	myclobutanil	0	24	N
3 + 9	Inspire Super 2.82EW	16.0 to 20.0 fl oz/A	difenoconazole + cyprodinil	0	12	--
7	Fontelis 1.67SC[1]	16 to 24 fl oz/A	penthiopyrad	0	12	L
7	Kenja 400SC	13.5 to 15.5 fl oz/A	isofetamid	0	12	--
7 + 9	Luna Tranquility 4.16SC	16 to 27 fl oz/A	fluopyram + pyrimethanil	1	12	--
7 + 11	Luna Sensation 4.25SC	4 to 7.6 fl oz/A	fluopyram + trifloxystrobin	0	12	--
7 + 11	Merivon Xemium	4 to 7 fl oz/A	fluxapyroxad + pyraclostrobin	0	12	N
7 + 11	Pristine 38WG	18.5 to 23.0 oz/A	boscalid + pyraclostrobin	0	12	--
7 +12	Miravis Prime	9.1 to 13.4 fl oz/A	pydiflumetofen + fludioxinil	0	12	--
11	Cabrio 20EG	12 to 14 oz/A	pyraclostrobin	0	12	N
11	Flint Extra	2.5 to 3.0 fl oz/A	trifloxystrobin (**Do not apply near Concord grapes**, see label)	0	12	N
13	Quintec 2.08SC	4.0 to 6.0 fl oz/A	quinoxyfen	1	12	--

[1]Except for the varieties Clancy, Jewel, and L'Amour

Viruses

Use certified, virus-free plants.

Summer Squash

Recommended Varieties

Type	Variety[1] (all hybrids)	Reported Disease Resistance[2] CMV	WMV2	ZYMV	PRSV	PM	Comments[3]
Scallop	Flying Saucer						Yellow and Green Fruit
	Jaune et Verte						Light Green Fruit
	Lemon Sun						Bright Yellow
	Peter Pam						Light Green Fruit
	Starship						Dark Green Fruit
	Sunburst						Bright Golden Yellow Fruit
Specialty	Eight Ball		I	I		I	Round Green fruit
	One Ball						Golden Yellow Round Fruit
	Summer Ball						Golden Yellow Round Fruit
Yellow Straightneck	Conqueror III	R	R	R	I	I	Green Stem
	Cougar	I	I	I	I		Precocious Yellow
	Enterprise						Green Stem (pale yellow fruit)
	Fortune						Precocious Yellow
	Grandprize		I	I		I	Green Stem
	Lioness	I	I	I	I		Green Stem
	Multipik						Precocious Yellow
	Smooth Criminal						Green Stem
	Superpik						Precocious Yellow
	Supersonic						Precocious Yellow
	XPT 1832 III	I	I	I			Precocious Yellow
Yellow Crookneck	Destiny III	I	I	I			Yellow
	Gentry						Tolerant to High Temperatures
	Gold Star	I				I	Green Stem
	Prelude II	I	I	I		I	Green Stem
	Superset	I	I				Precocious Yellow
Green Zucchini	Cashflow			I			Medium Green Fruit
	Dunja		I	I	I	I	Medium Green Fruit
	Green Machine	I	I	I		I	Medium Green Fruit
	Payout	I	I	I	I	I	Medium Green Fruit
	Payroll		I	I		I	Medium Green Fruit
	Respect		I	I	I	I	Medium-Dark Green Fruit
	Reward	I	I	I		I	Medium-Dark Green Fruit
	Spineless Beauty						Medium Green fruit, Not for late season
	Spineless Perfection		I	I		I	Medium Green Fruit
	Spineless Supreme	I	I	I	I	I	Medium-Dark Green Fruit
	SV0914YG	R	R	R	I	I	Medium-Dark Green Fruit
	Tigress		I	I	I		Medium Green Fruit
	Tribute		I	I	I	I	Dark Green with Flecks Fruit
	Zucchini Elite						Medium Green Fruit, Not for late season
Golden Zucchini	Golden Dawn III						Green Stem
	Golden Delight		I	I			Green Stem
	Golden Glory		I	I		I	Green Stem
	Golden Rod	I	I				Green Stem
	Gold Rush						Green Stem
	Sebring					I	Green Stem

[1]**Listed alphabetically within type**; recommended for DE, MD, NJ, PA, VA, and WV. Additional information is based on seed manufacturer and/or seed distributor claims; consult seed vendor for maturity/days to harvest. [2]CMV=Cucumber Mosaic Virus, WMV2=Watermelon Mosaic Virus 2, ZYMV=Zucchini Yellow Mosaic Virus, PRSV=Papaya Ring Spot Virus, PM=Powdery Mildew. I=Intermediate and R=High Resistance. Transgenic resistance of specific varieties can be found by consulting the seed manufacturer or distributor. [3]In yellow-fruited summer squash the precocious yellow gene confers tolerance to CMV and WMV2 as compared to the green stem counterpart. Varieties expressing the precocious yellowing gene will mask the greening of fruit caused by WMV and CMV but will become bumpy and/or distorted when infected with either PRSV or ZYMV. **All 4 viruses may be detected at some level in squash fields in our region in any given year, therefore it is best to plant varieties with resistance to more than one virus, especially in later plantings when virus transmission by aphids increases. In some years aphids transmitting viruses may also be a factor in spring plantings. Virus resistance and PM resistance are recommended for fall/late planted varieties.**

Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and chapter B Soil and Nutrient Management. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede recommendations found below.

		Soil Phosphorus Level				Soil Potassium Level				
		Low	Med	High (Opt)	Very High	Low	Med	High (Opt)	Very High	
Summer Squash [1,2]	N (lb/A)	P_2O_5 (lb/A)				K_2O (lb/A)				Nutrient Timing and Method
	75-100	150	100	50	0[3]	200	150	100	0[3]	Total nutrient recommended
	25-50	150	100	50	0[3]	200	150	100	0[3]	Broadcast and disk-in
	50	0	0	0	0	0	0	0	0	Sidedress and fertigate when vines start to run
	25-30	0	0	0	0	0	0	0	0	Apply through irrigation system

[1]Apply 1-2 lb/A of boron (B) with broadcast fertilizer.; see also Table B-7. in chapter B Soil and Nutrient Management. [2]Apply 20-30 lb/A of sulfur (S) for most soils. [3]In VA, crop replacement values of 25 lb/A of P_2O_5 and 50 lb/A of K_2O are recommended on soils testing Very High.

Seed Treatment

Check the seed container label or consult with the seed manufacturer to confirm if seed has been treated with insecticide and/or fungicide; see also Disease Control below.

Seeding, Transplanting, and Spacing

Seed April 15 through August 15 in warmer, southern regions of the Mid-Atlantic, May 1 to August 10 in Southern NJ, and May 10 to August 1 in PA, Northern NJ, and other cool areas of the region. Use 4-6 lb/A of seed, or 3,500-4,500 seed/A. Transplants plants are planted through plastic mulch when daily mean temperatures have reached 60°F (16°C). Early planting dates vary from April 15 in southern regions to June 1 in northern areas. Early plantings should be protected from winds with low tunnels, hot caps, tents, or floating row covers. Space rows 5-6 ft apart with plants 2-3 ft apart in the row.

Field Preparation

Plastic mulch and fumigant should be applied to well-prepared, moist soil 30 days before field planting. Plastic mulch helps conserve soil moisture, increases soil temperature, and may increase early and total yields. Various widths of plastic are available to accommodate different production systems and equipment.

Fumigation may be necessary when there is a history of soil-borne diseases. The type of fumigant depends on the predominant pest. Several fumigants can be used on summer squash. Fumigation also aids in the control of weeds, though fumigation alone may not be adequate for weed control under plastic mulch (black plastic or paper may be used without additional herbicides, however, may not control yellow nutsedge). Foil mulches can be used to repel aphids that transmit Mosaic Virus in fall planted squash (after July 1). Direct seeding through reflective mulch is recommended for maximum virus protection.

Fertilizer must be applied during bed preparation. At least 50% of the N should be in the nitrate (NO_3^{-1}) form. Consider drip irrigation (more information in chapter C. Irrigation Management).

Pollination (see also sections A 12. Pollination and D 6.3.1. Protection of Pollinators).

Honeybees, squash bees, bumble bees and other wild bees are important for pollination and fruit set. Populations of pollinating insects may be adversely affected by insecticides applied to flowers or weeds in bloom. Apply insecticides only in the evening hours or wait until blooms are closed before application. Read the pesticide label for specific directions to protect pollinators. Check the pesticide tables below for toxicity to bees.

Harvest and Post-Harvest Considerations

Zucchini and summer squash are harvested after fruit reach the desired size but before they form hard seeds or hard rinds. Size is highly dependent on market demands. Crook-neck and straight-neck squash and zucchini should be 1.25-2 inches in diameter. Straight-neck squash and zucchini should be 7-8 inches long. Scallop squash should be 3-4 inches in diameter. For USDA Agricultural Marketing Service grading standards see:
https://www.ams.usda.gov/grades-standards/summer-squash-grades-and-standards

Summer squash and zucchini are delicate and prone to bruising and scratching. Handle with care when harvesting, grading, and packing. Squash should be stored at 41-50°F (5-10°C) and 95% relative humidity. The typical shelf life is 7-14 days. Summer squash is highly sensitive to freezing injury and will show pitting on the skin if exposed to temperatures below 41°F (5°C). Do not store, or transport with, ethylene producing crops.

Weed Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.

Recommended Herbicides

1. Identify the weeds in each field and select recommended herbicides. More information is available in the "Herbicide Effectiveness on Common Weeds in Vegetables" (Table E-3) in Chapter E Pest Management.

2. Minimize herbicide resistance development. Identify the herbicide mode of action group number and follow recommended good management practices; **bolded group numbers in tables below are herbicides at higher risk for selecting resistant weed populations.** Include non-chemical weed control whenever possible.

Labeled Application Sites for Summer Squash

Herbicide (*=Restricted Use)	HRAC group number	Plastic mulch production					Bareground production		
		Soil-Applied		Postemergence					
		Under Plastic	Row Middles	Over Plastic	Row Middles	Post-Harvest	Soil-applied	POST	Post-harvest
Sandea	2		YES		YES				
Curbit	3		YES				YES		
Prefar	8	YES	YES				YES		
Command	13		YES				YES		
Strategy	3 + 13		YES				YES		
Reflex[1]	14	YES	YES		YES		YES		
Selec / Select Max Shadow 3EC	1			YES				YES	
Poast	1			YES				YES	
Gramoxone*[1]	22				YES		YES[2]		YES

[1] Special Local Needs Label 24(c), be sure it is registered for the specific state and for the intended use.
[2] Apply preplant or after seeding but prior to crop emergence.

1.Pre-Transplant Over Plastic

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
10	Rely 280 2.34L	29 to 43 fl oz/A	**glufosinate**	0.53 to 0.79 lb/A	14	12
-**Supplemental label expires 12/1/2025 for application over plastic prior to transplanting.** -Ammonium sulfate (AMS) can be used at 1.5 lb/A to 3 lb/A. -Control is best when applied to weeds less than 4 inches, temperatures are above 80, high humidity, and bright sunlight. -Transplants can be injured if they come in contact with herbicide remaining on the plastic. Allow at least 3 days between application and transplanting. At least 0.5 inches of precipitation is needed to wash Rely off the plastic. Do not transplant within 27 days of application if no precipitation occurs. -DO NOT transplant into or within 6 inches of holes in the plastic mulch that were present at time of application. -Two applications can be made prior to transplanting. Do not apply more than 64 fl oz/A prior to transplanting; maximum number of applications is three per season. -Rainfastness is 4 h.						
22	Gramoxone SL 2.0* Gramoxone SL 3.0*	2 to 4 pt/A 1.3 to 2.7 pt/A	**paraquat**	0.5 to 1.0 lb/A	--	24
-Gramoxone can be used for preplant weed control over the top of plastic mulch. Sufficient rainfall or sprinkler irrigation is needed to wash off the Gramoxone prior to planting to prevent damage to the crop. -***Restricted-use pesticide***. Only certified applicators, who successfully complete the paraquat-specific training, can mix, load, or apply paraquat. Application of paraquat "under the direct supervision" of a certified applicator is no longer allowed. Required training link (*https://campus.extension.org/enrol/index.php?id=2201*); certified applicators must repeat training every three years. -Do not exceed 8 pt/A per season. Rainfastness is 30 min.						

2. Soil-Applied

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
2	Sandea 75DF	0.5 to 1 oz/A	**halosulfuron**	0.023 to 0.047 lb/A	30	12
-**Plasticulture**: can be applied in a band under the plastic, immediately before laying the mulch; delay seeding or transplanting for 7 days after application. Row middles: apply before or after weed emergence; apply as a shielded application to avoid contact with the crop. If weeds have emerged, use a non-ionic surfactant at 0.25% v/v or include a non-selective herbicide. -**Bareground**: apply broadcast after seeding but before crop emergence or no sooner than 7 days before transplanting.						

2. Soil-Applied (Sandea) - continued next page

2. Soil-Applied (Sandea) - continued

-Suppresses or controls yellow nutsedge and certain broadleaf weeds. Sandea provides both residual and postemergence control of susceptible weed species. Effective postemergence control requires an adjuvant.
-Sandea is an ALS inhibiting herbicide and resistant weed populations are common in the region. **Do not** use Group 2 herbicides repeatedly in the same field. -**Do not** apply Sandea to crops treated with a soil applied organophosphate insecticide or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application.
-Maximum number of Sandea applications per year is 2 and **do not** exceed 2 oz/A during the crop season.

3	Curbit 3EC	1 to 3 pt/A	**ethalfluralin**	0.38 to 1.12 lb/A	--	24

-**Plasticulture**: row middles only: apply as a banded spray after crop emergence or transplanting. **Do not** soil incorporate.
-**Bareground**: apply broadcast after direct-seeding but prior to crop emergence; **do not** use on transplanted crop.
-Controls annual grasses and certain annual broadleaf weeds, including carpetweed and pigweed sp.
-Use lower rate for coarse-textured soils or soils with low organic matter.
-Where overhead irrigation is available, activate Curbit with 0.5 inch of irrigation within 2 days after application; if no irrigation or rainfall occurs within 5 days of application, activity of Curbit can be reduced.
-Available as a pre-mix herbicide Strategy. Strategy at 3 pt/A= Curbit at 26 fl oz/A (0.6 lb ai) and Command at 8 fl oz/A (0.188 lb ai)
-Maximum applications per season: not specified

8	Prefar 4E	5 to 6 qt/A	**bensulide**	5 to 6 lb/A	--	12

-**Plasticulture** under plastic: apply in a band under the plastic, immediately before laying the mulch. Allow 7 days before making transplant holes to allow condensation to incorporate the herbicide. Plasticulture: row middles application is labeled.
-**Bareground**: apply preemergence or preplant incorporated.
-Preemergence applications should be followed by irrigation within 36 h (apply enough water to wet the soil at least 2 to 4 inches deep). Preplant incorporated applications should be incorporated 1 to 2 inches deep (deeper than 2 inches will result in reduced weed control).
-Provides control/suppression of some annual grass weeds and some broadleaves including pigweeds, purslane, and lambsquarters.
-**Do not** apply more than 6 lb ai/A per season.

13	Command 3ME	0.67 to 1.33 pt/A	**clomazone**	0.25 to 0.5 lb/A	45	12

-**Plasticulture**: row middles application only.
-**Bareground**: apply broadcast just before planting but before crop emergence, or just before transplanting.
-Use the lower rate when used on coarse-textured soils low in organic matter, when weed pressure is light, or to minimize herbicide carryover that could affect subsequent crops. -Controls annual grasses and many broadleaf weeds including common lambsquarters, velvetleaf, spurred anoda, and jimsonweed. Carpetweed, morningglory sp., pigweed sp., and yellow nutsedge will **not** be controlled. Higher rates will improve control (or expand number of species controlled) such as common cocklebur, common ragweed, or jimsonweed (refer to label for specific weeds and rates).
-**WARNINGS**: Command spray *or* vapor drift may injure sensitive crops and other vegetation up to several hundred yards from the point of application. **Do not** apply adjacent to sensitive crops (see label) or vegetation, or under unfavorable wind or weather conditions. Command may limit subsequent cropping options, see the label.
-Available as a pre-mix herbicide Strategy: Strategy at 3 pt/A= Command at 8 fl oz/A (0.188 lb ai) and Curbit at 26 fl oz/A (0.6 lb ai)
-Maximum number of Command applications per year: 1

3 + 13	Strategy 2.1SC	1.5 to 4 pt/A	**ethalfluralin *plus* clomazone**	0.39 to 1.05 lb/A	45	24

-**Plasticulture**: row middles application only.
-**Bareground**: apply broadcast just before planting or after planting but before crop emergence. -Strategy is a prepackage mixture of Curbit 3EC and Command 3ME.
-Clomazone spray or vapor drift may injure susceptible crops and other vegetation, refer to Command 3ME for comments.
-**Do not** apply prior to planting the crop. **Do not** soil incorporate. Refer to individual products for comments.
-Certain crop varieties may have the potential for injury or loss with this product. Consult qualified crop advisors for information pertaining to varieties in your area. -Maximum applications per season: not specified.

14	Reflex 2SL	8 fl oz/A	**fomesafen**	0.13 lb/A	32	24

-**Special Local Needs Label 24(c) for the use of Reflex 2SL in DE and NJ, pending in PA (expires 12/31/2025 in DE and 12/31/2027 in NJ). The use of this product is legal ONLY if a waiver of liability has been completed (see: *https://www.syngenta-us.com/labels/indemnified-label-login*).**
-**Labeled for straight neck yellow, crooked neck yellow, and zucchini types only**.
-**Plasticulture** under plastic: apply in a band under the plastic, immediately before laying the mulch. pre-transplant applications over the plastic mulch is labeled; row middles application is labeled.
-**Bareground**: apply broadcast within 24 h after direct-seeding and follow with 0.2 to 0.5 inches of overhead irrigation at least 36 h before the crop begins to crack through the soil. For transplants, apply Reflex and then irrigate with 0.2 to 0.5 inches of water and then transplant. **Do not** prepare transplant holes until after Reflex application and irrigation.
-Foliar application of Reflex will severely damage or kill squash. The potential of crop injury is greater on lighter textured soils combined with intensive irrigation programs or high amounts of rainfall, therefore, adjust rates accordingly.
-Reflex provides both residual and postemergence control of susceptible weed species. Effective postemergence control requires an adjuvant. Summer squash varieties may vary in their response to Reflex; therefore, treat small acreages first to determine crop tolerance, especially when applying to a new variety.
-Reflex rates lower than 16 fl oz/A may not provide full-season control and should be used with other herbicides and/or other methods of weed control. The rate for squash is only 8 fl oz/A and will only provide a few weeks of control.
-Consider rotational crops when applying fomesafen. If the crop is replanted, **do not** re-apply Reflex. Refer to 24(c) label for specifics on rotational restrictions. Maximum for Reflex application is 24 fl oz/A **IN ALTERNATE YEARS.**

3. Postemergence

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
1	Shadow 3EC Select 2EC Select Max 0.97EC	4 to 5.33 fl oz/A 6 to 8 fl oz/A 9 to 16 fl oz/A	**clethodim**	0.07 to 0.125 lb/A	14	24
	Poast 1.5EC	1 to 1.5 pt/A	**sethoxydim**	0.19 to 0.28 lb/A	14	12

-**Select 2EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). **Select Max**: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution). **Shadow 3EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution) for large or stressed grasses; use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution) when crop safety is a concern. **Poast**: use COC at 1.0% v/v.
-**The use of COC may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to NIS when grasses are small and soil moisture is adequate.
-Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control.
-Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will **not** be controlled.
-Controls many annual and certain perennial grasses, including annual bluegrass, but Poast is preferred for goosegrass control. For best results, treat annual grasses when they are actively growing and before tillers are present. Control may be reduced if grasses are large or under hot or dry weather conditions. -Repeated applications may be necessary to control certain perennial grasses. If repeat applications are necessary, allow 14 days between applications. Rainfastness is 1 h.
-**Do not** tank mix with or apply within 2 to 3 days of any other pesticide, unless labeled, as this may increase the risk of crop injury or reduce the control of grasses. **Do not** apply more than 8 fl oz/A of Select 2EC in a single application and **do not** exceed 32 fl oz/A for the season; **do not** apply more than 16 fl oz/A of Select Max in a single application and **do not** exceed 64 fl oz/A for the season.
-**Do not** apply more than 5.33 fl oz/A of Shadow 3EC in a single application and **do not** exceed 21.33 fl oz/A for the season
-**Do not** apply more than 1.5 pt/A Poast in a single application and **do not** exceed 3 pt/A for the season.

2	Sandea 75DF	0.5 to 1 oz/A	**halosulfuron**	0.023 to 0.047 lb/A	30	12

-**Plasticulture**: row middles application only.
-**Bareground**: broadcast for bareground. Apply Sandea after the crop has at least 3 to 5 true leaves but before first female flowers appear and no sooner than 14 days after transplanting. If weeds have emerged, use a non-ionic surfactant at 0.25% v/v 1qt/100 gal).
-Suppresses or controls yellow nutsedge and certain broadleaf; control of weeds taller than 3 inches may not be adequate. Sandea will not control common lambsquarters or eastern black nightshade if applied postemergence; for row middle application, tank mix with a non-selective herbicide to increase spectrum of control. Sandea provides both residual and postemergence control of susceptible weed species. Effective postemergence control requires an adjuvant.
-Sandea is an ALS inhibiting herbicide and resistant weed populations are common in the region. **Do not** use Group 2 herbicides repeatedly in the same field.
-**Do not** apply Sandea to crops treated with a soil applied organophosphate insecticide or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application.
-Rainfastness is 4 h. Maximum number of Sandea applications per year is 2 and **do not** exceed 2 oz/A during the crop season

10	Rely 280 2.34L	29 to 62 fl oz/A	**glufosinate**	0.53 to 1.13 lb/A	14	12

-**Supplemental Label expires 12/1/2025 for hooded spray application between the rows.** If the crop is planted without plastic, do not spray within 6 inches of running vines. -Ammonium sulfate (AMS) can be used at 1.5 lb/A to 3 lb/A.
-Do not allow spray to come in contact with crop foliage or damage will occur.
-Control is best when applied to weeds less than 4 inches, temperatures are above 80, high humidity, and bright sunlight.
-Separate sequential applications by at least 14 days. -Do not apply more than 62 fl oz/A in a single application, do not apply more than 87 fl oz/A per season; maximum number of applications is three per season. -Rainfastness is 4 h.

22	Gramoxone SL 2.0* Gramoxone SL 3.0*	1.95 pt/A 1.3 pt/A	**paraquat**	0.49 lb/A	14	24

-**Supplemental Label for the use of Gramoxone 2SL or 3SL for postemergence weed control in DE, MD, NJ, PA, and VA.** Row middles as a shielded application. Apply as a directed spray in a minimum of 20 gal spray mix/A to control emerged weeds between the rows after crop establishment. Include a nonionic surfactant at 0.25% v/v.
-Use shields or hoods to prevent spray contact with the crop and low spray pressure (maximum of 30 psi) to reduce small droplets that are prone to drift. See the label for additional information and warnings.
-Rainfastness is 30 min.
-A maximum of 3 applications per year are allowed.
-***Restricted-use pesticide***. Only certified applicators, who successfully complete the paraquat-specific training, can mix, load, or apply paraquat. Application of paraquat "under the direct supervision" of a certified applicator is no longer allowed. Required training link (*https://campus.extension.org/enrol/index.php?id=2201*); certified applicators must repeat training every three years.

4. Other Labeled Herbicides

These products are labeled but limited local data are available; and/or are labeled but not recommended in our region due to potential crop injury concerns.

Group	Product Name (*=Restricted Use)	Active Ingredient
14	Aim	**carfentrazone**
14	Vida	**pyraflufen**

Insect Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.
Recommended Insecticides

Seed and At-Plant Treatments for Seedcorn Maggot

Farmore DI-400 as a commercially applied seed treatment which contains thiamethoxam (Group 4A).
Verimark (cyantraniprole, Group 28) treatment at planting is also labeled.
Note: The use of neonicotinoid insecticides (Group 4A) at planting may help reduce seedcorn maggot populations. See also Maggots in section E 3.1. Soil Pests - Detection and Control.

Aphids

Aphids transmit multiple viruses. Cultivars resistant to multiple aphid-transmitted viruses are available.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	1.5 to 3.0 pt/A	methomyl - **- melon aphid only**	1-3	48	H
1A	Vydate L	2.0 to 4.0 pt/A	oxamyl - **foliar**	1	48	H
1B	Malathion 57 EC	1.5 pt/A	malathion	1	24	H
4A	Neonicotinoid insecticides registered for use on Summer Squash: see table at the end of Insect Control.					
4C	Transform WG	0.75 oz/A	sulfoxaflor	1	24	H
4C + 3A	Ridgeback*	5.5 to 13.8 fl oz/A	sulfoxaflor + bifenthrin	3	24	H
4D	Sivanto Prime or 200SL	21.0 to 28.0 fl oz/A	flupyradifurone - **soil/drip**	21	4	M
4D	Sivanto Prime or 200SL	7.0 to 14.0 fl oz/A	flupyradifurone - **foliar**	1	4	M
9B	Fulfill	2.75 oz/A	pymetrozine	0	12	L
9B	PQZ	2.4 to 3.2 fl oz/A	pyrifluquinazon	1	12	L
9D	Sefina	3.0 fl oz/A	afidopyropen	0	12	L
21A	Torac	17.0 to 21.0 fl oz/A	tolfenpyrad	1	12	H
28	Exirel	7.0 to 20.5 fl oz/A	cyantraniliprole	1	12	H
28	Verimark	Soil, at planting: 10 to 13.5 fl oz/A Drip chemigation: 10 fl oz/A	cyantraniliprole	1	4	H
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H
28 + 6	Minecto Pro*	10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H
29	Beleaf 50 SG	Foliar: 2.0 to 2.8 oz/A Drip: 2.8 to 4.28 oz/A	flonicamid	0	12	L

Armyworms (AW) and Cabbage Loopers (CL)

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	1.5 to 3.0 pt/A	methomyl	1-3	48	H
3A	Pyrethroid insecticides registered for use on Summer Squash: see table at the end of Insect Control.					
5	Entrust SC (OMRI)	4.0 to 8.0 fl oz/A	spinosad	3	4	M
5	Radiant SC	5.0 to 10.0 fl oz/A	spinetoram	3	4	M
6	Proclaim 5SG*	3.0 to 4.8 oz/A	emamectin benzoate	7	12	H
11A	Dipel DF, others (OMRI)	0.5 to 2.0 lb/A	*Bacillus thuringiensis kurstaki*	0	4	N
11A	XenTari (OMRI)	0.5 to 2.0 lb/A	*Bacillus thuringiensis aizawai*	0	4	N
15	Rimon 0.83EC	9.0 to 12.0 fl oz/A	novaluron	1	12	M
18	Intrepid 2F	4.0 to 10.0 fl oz/A	methoxyfenozide	3	4	L
22	Avaunt 30WDG, Avaunt eVo	2.5 to 6.0 oz/A	indoxacarb	3	12	H
28	Coragen 1.67SC Coragen eVo	3.5 to 7.5 fl oz/A 1.2 to 2.5 fl oz/A	chlorantraniliprole	1	4	L
28	Exirel (AW)	7.0 to 17.0 fl oz/A	cyantraniliprole	1	12	H
28	Verimark	6.75 to 13.5 fl oz/A	cyantraniliprole	1	4	H
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H
28 + 4A	Voliam Flexi **(CL only)**	4.0 to 7.0 oz/A	thiamethoxam + chlorantraniliprole	1	12	H
28 + 6	Minecto Pro*	7.5 to 10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H

Cucumber Beetles

Both striped (*Acalymma vittatum*) and spotted (*Diabrotica undecimpuctata howardii*) cucumber beetles are found in the Mid-Atlantic states. Both species can severely defoliate young seedlings and transmit bacterial wilt, though losses from this disease vary greatly between fields and varieties. Young plants need to be protected to manage bacterial wilt. If adult beetles are abundant and there is a disease history, insecticides should be applied before beetles feed extensively on the cotyledons and first true leaves. If foliar insecticides are used, begin spraying shortly after plant emergence and repeat applications at weekly intervals if new beetles continue to invade fields. Treat when an average of 1 beetle per two plants is found. Kaolin clay (Surround WP) does not kill the beetles but acts as a physical deterrent to early season beetle feeding. **Note:** some populations of striped cucumber beetles on Delmarva may exhibit reduced susceptibility to pyrethroids.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	1.5 to 3.0 pt/A	methomyl	1-3	48	H
1A	Sevin XLR Plus	1.0 qt/A	carbaryl	3	12	H
3A	Pyrethroid insecticides registered for use on Summer Squash: see table at the end of Insect Control.					
4A	Neonicotinoid insecticides registered for use on Summer Squash: see table at the end of Insect Control.					
28	Verimark	Soil, at planting: 13.5 fl oz/A; Drip chemigation: 10 fl oz/A	cyantraniliprole	1	4	H
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H

Cutworms See also section E 3.1. Soil Pests - Detection and Control.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV* (granulate cutworm)	1.5 to 3.0 pt/A	methomyl	1-3	48	H
3A	Pyrethroid insecticides registered for use on Summer Squash: see table at the end of Insect Control.					

Leafminers

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
3A	Pyrethroid insecticides registered for use on Summer Squash: see table at the end of Insect Control.					
4A	Neonicotinoid insecticides registered for use on Summer Squash: see table at the end of Insect Control.					
5	Entrust SC (OMRI)	6.0 to 8.0 fl oz/A	spinosad	3	4	M
5	Radiant SC	6.0 to 10.0 fl oz/A	spinetoram	3	4	M
6	Agri-Mek SC*	1.75 to 3.5 fl oz/A	abamectin	7	12	H
15	Rimon 0.83EC	9.0 to 12.0 fl oz/A	novaluron	1	12	M
17	Trigard 75WSP	2.66 oz/A	cyromazine	0	12	H
28	Coragen 1.67SC Coragen eVo	5.0 to 7.5 fl oz/A 1.7 to 2.5 fl oz/A	chlorantraniliprole	1	4	L
28	Exirel	13.5 to 20.5 fl oz/A	cyantraniliprole	1	12	H
28	Verimark	6.75 to 13.5 fl oz/A	cyantraniliprole	1	4	H
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H
28 + 6	Minecto Pro*	5.5 to 10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H

Mites

Mite infestations generally begin around field margins and grassy areas. CAUTION: DO NOT mow or maintain these areas after midsummer to prevent mites from moving into the crop. Localized infestations can be spot treated. Begin treatment when 10 to 15% of the crown leaves are infested early in the season.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
6	Agri-Mek SC*	1.75 to 3.5 fl oz/A	abamectin	7	12	H
10B	Zeal Miticide	2.0 to 3.0 oz/A	etoxazole	7	12	L
20B	Kanemite 15SC	31.0 fl oz/A	acequinocyl	1	12	L
20D	Acramite 50WS	0.75 to 1.0 lb/A	bifenazate	3	12	M
21A	Magister SC	24.0 to 36.0 fl oz/A	fenazaquin	3	12	H
23	Oberon 2SC	7.0 to 8.5 fl oz/A	spiromesifen	7	12	M
28 + 6	Minecto Pro*	5.5 to 10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H
N/A	Sulfur 80WG (OMRI)	5 to 25 lb/A	sulfur	0	24	M

Melonworms, Pickleworms

Apply one of the following formulations. If foliar materials are used, make one treatment prior to fruit set, and then treat weekly. If soil or drip applications are used, check the label for instructions on application frequency.						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	1.5 to 3.0 pt/A	methomyl	1-3	48	H
1A	Sevin XLR Plus	0.5 to 1.0 qt/A	carbaryl	3	12	H
3A	Pyrethroid insecticides registered for use on Summer Squash: see table at the end of Insect Control.					
5	Entrust SC (OMRI)	4.0 to 8.0 fl oz/A	spinosad	3	4	M
5	Radiant SC	5.0 to 10.0 fl oz/A	spinetoram	3	4	M
6	Proclaim 5SG*	3.0 to 4.8 oz/A	emamectin benzoate	7	12	H
11A	XenTari (OMRI)	0.5 to 1.0 lb/A	*Bacillus thuringiensis aizawai*	0	4	N
11A	Dipel DF, others (OMRI) **(MW)**	0.5 to 2.0 lb/A	*Bacillus thuringiensis kurstaki*	0	4	N
15	Rimon 0.83EC	12.0 fl oz/A	novaluron	1	12	M
18	Intrepid 2F	4.0 to 10.0 fl oz/A	methoxyfenozide	3	4	L
22	Avaunt 30WDG, Avaunt eVo	2.5 to 6.0 oz/A	indoxacarb	3	12	H
28	Coragen 1.67SC Coragen eVo	2.0 to 7.5 fl oz/A 0.7 to 2.5 fl oz/A	chlorantraniliprole	1	4	L
28	Exirel	7.0 to 13.5 fl oz/A	cyantraniliprole	1	12	H
28	Verimark	5.0 to 10.0 fl oz/A	cyantraniliprole	1	4	H
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H
28 + 4A	Durivo	10.0 to 13.0 fl oz/A	thiamethoxam + chlorantraniliprole	30	12	H
28 + 4A	Voliam Flexi	4.0 to 7.0 oz/A	thiamethoxam + chlorantraniliprole	1	12	H
28 + 6	Minecto Pro*	5.5 to 10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H

Rindworms

In addition to the above specified Lepidopteran pests, various species may feed on rinds, including, but not limited to corn earworm, leafrollers, webworms, and beet armyworm. Proper pest identification is important because not all species that cause rind feeding damage are susceptible to pyrethroids.

For Lepidopteran Rindworms, apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
3A	Pyrethroid insecticides registered for use on Summer Squash: see table at the end of Insect Control.					
5	Entrust SC (OMRI)	4.0 to 8.0 fl oz/A	spinosad	3	4	M
5	Radiant SC	5.0 to 10.0 fl oz/A	spinetoram	3	4	M
6	Proclaim 5SG*	3.0 to 4.8 oz/A	emamectin benzoate	7	12	H
11A	XenTari (OMRI)	0.5 to 1.0 lb/A	*Bacillus thuringiensis aizawai*	0	4	N
18	Intrepid 2F	4.0 to 10.0 fl oz/A	methoxyfenozide	3	4	L

Squash Bugs

Treat if more than 1 egg mass per plant is present. Target the nymphal stages. Under leaf spray coverage is essential.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Sevin XLR Plus	1.0 qt/A	carbaryl	3	12	H
3A	Pyrethroid insecticides registered for use on Summer Squash: see table at the end of Insect Control.					
4A	Neonicotinoid insecticides registered for use on Summer Squash: see table at the end of Insect Control.					
4D	Sivanto Prime or 200SL	10.5 to 14.0 fl oz/A	flupyradifurone - **foliar**	1	4	M

Squash Vine Borers

When vines begin to run, apply one of the following formulations to bases of plants 4 times at 7-day intervals. Pheromone traps for squash vine borer are commercially available. These traps can be used to indicate when moth activity begins. **Note:** Use of chlorantraniliprole, spinosad, or spinetoram for looper control will reduce squash vine borer populations.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
3A	Pyrethroid insecticides registered for use on Summer Squash: see table at the end of Insect Control.					

Thrips

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Vydate L	2.0 to 4.0 pt/A	oxamyl - **foliar**	1	48	H
3A[1]	Pyrethroid insecticides registered for use on Summer Squash: see table at the end of Insect Control.					
4A[2]	Neonicotinoid insecticides registered for use on Summer Squash: see table at the end of Insect Control.					
4C	Transform WG	2.5 oz/A	sulfoxaflor - *suppression only*	1	24	H
5	Entrust SC (OMRI)	6.0 to 8.0 fl oz/A	spinosad	3	4	M
5	Radiant SC	6.0 to 10.0 fl oz/A	spinetoram	3	4	M
15	Rimon 0.83EC	12.0 fl oz/A	novaluron	1	12	M
21A	Torac	21.0 fl oz/A	tolfenpyrad	1	12	H
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole - *suppression only*	1	4	H
28 + 6	Minecto Pro*	10.0 fl oz/A	cyantraniliprole + abamectin - *suppression only*	7	12	H
29	Beleaf 50SG	Drip: 2.8 to 4.28 oz/A	flonicamid	0	12	L

[1]Resistance concerns with western flower thrips [2]Resistance concerns with tobacco thrips

Group 3A Pyrethroid Insecticides Registered for Use on Summer Squash

Apply one of the following formulations (check if the product label lists the insect you intend to spray; the label is the law):					
Product Name (*=Restricted Use)	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
Asana XL*	5.8 to 9.6 fl oz/A	esfenvalerate	3	12	H
Baythroid XL*	0.8 to 2.8 fl oz/A	beta-cyfluthrin	0	12	H
Brigade 2EC*, others	2.6 to 6.4 fl oz/A	bifenthrin	3	12	H
Danitol 2.4EC*	10.67 to 16.0 fl oz/A	fenpropathrin	7	24	H
Declare*	1.02 to 1.54 fl oz/A	gamma-cyhalothrin	1	24	H
Hero*	4.0 to 10.3 fl oz/A	zeta-cypermethrin + bifenthrin	3	12	H
Lambda-Cy 1EC*, others	2.56 to 3.84 fl oz/A	lambda-cyhalothrin	1	24	H
Mustang Maxx*	1.28 to 4.0 fl oz/A	zeta-cypermethrin	1	12	H
Permethrin 3.2EC*, others	4.0 to 8.0 fl oz/A	permethrin	0	12	H
Tombstone*	0.8 to 2.8 fl oz/A	cyfluthrin	0	12	H
Warrior II*	1.28 to 1.92 fl oz/A	lambda-cyhalothrin	1	24	H
Combo products containing a pyrethroid					
Besiege*	6.0 to 9.0 fl oz/A	lambda-cyhalothrin + chlorantraniliprole (Group 28)	1	24	H
Endigo ZC and ZCX*	4.0 to 4.5 fl oz/A	lambda-cyhalothrin + thiamethoxam (Group 4A)	1	24	H
Ridgeback*	5.5 to 13.8 fl oz/A	bifenthrin + sulfoxaflor (Group 4C)	3	24	H
Savoy EC*	6.0 to 12.9 fl oz/A	bifenthrin + acetamiprid	7	12	H

Group 4A Neonicotinoid Insecticides Registered for Use on Summer Squash

Apply one of the following formulations (check if the product label lists the insect you intend to spray; the label is the law):					
Product Name (*=Restricted Use)	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
Admire Pro	7.0 to 10.5 fl oz/A	imidacloprid - **soil**	21	12	H
Assail 30SG Assail 30SC	2.5 to 5.3 oz/A 2.1 to 4.5 fl oz/A	acetamiprid	0	12	M
Belay 2.13SC	9.0 to 12.0 fl oz/A	clothianidin - **soil/drip**	21	12	H
Belay 2.13SC	3.0 to 4.0 fl oz/A	clothianidin - **foliar** (PHI note: do not make application after 4th true leaf has unfolded)	see note	12	H
Actara 25WDG	1.5 to 5.5 oz/A	thiamethoxam	0	12	H
Platinum 75SG	1.7 to 3.7 oz/A	thiamethoxam	30	12	H
Scorpion 35SL	9.0 to 10.5 fl oz/A	dinotefuran - **soil/drip**	21	12	H
Scorpion 35SL	2.0 to 7.0 fl oz/A	dinotefuran - **foliar**	1	12	H
Venom 70SG	5.0 to 7.5 oz/A	dinotefuran - **soil/drip**	21	12	H
Venom 70SG	1.0 to 4.0 oz/A	dinotefuran - **foliar**	1	12	H
Combo products containing a neonicotinoid					
Durivo	10.0 to 13.0 fl oz/A	thiamethoxam + chlorantraniliprole (Group 28)	30	12	H
Endigo ZC* and ZCX*	4.0 to 4.5 fl oz/A	thiamethoxam + lambda-cyhalothrin (Group 3A)	1	24	H
Savoy EC*	6.0 to 12.9 fl oz/A	acetamiprid + bifenthrin (Group 3A)	7	12	H
Voliam Flexi	4.0 to 7.0 oz/A	thiamethoxam + chlorantraniliprole (Group 28)	1	12	H

Disease Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.
Recommended Fungicides

Nematodes

See also sections E 1.5. Soil Fumigation and E 1.6. Nematode Control. Use fumigants listed in section E 1.5., or nematicides listed below. Consult the label.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
1A	Vydate L*	1.0 to 2.0 gal/A Incorporate into top 2-4 inches of soil, *OR* 2.0 to 4.0 pt/A apply 2 w after planting and repeat 2-3 w later.	oxamyl	1	48	H
7	Velum Prime 4.16SC	6.5 to 6.84 fl oz/A	fluopyram	0	12	--
--	Nimitz 4EC	3.5 to 5.0 pt/A incorporate or drip-apply 7 d before planting	fluensulfone	n/a	12	N

Seed Treatment

Check with your seed company if seed has been treated with an insecticide and fungicide. For untreated seed, use a mixture of Thiram 480DP (4.5 fl oz /100 lb seed) and an approved commercially available insecticide.

Damping-off caused by *Phytophthora*, *Pythium*, and *Rhizoctonia*

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Apply one of the following at-planting (see label for application timing, methods, and restrictions):						
Phytophthora and Pythium Root Rot						
4	Ridomil Gold 4SL	1.0 to 2.0 pt/A	mefenoxam	5	48	N
4	Ultra Flourish 2E	2.0 to 4.0 pt/A	mefenoxam	5	48	N
4	MetaStar 2E AG	4.0 to 8.0 pt/A	metalaxyl	AP	48	N
49 + **4**	Orondis Gold[1]	28.0 to 55.0 fl oz/A	oxathiapiprolin + mefenoxam	AP	48	N
Phytophthora, Pythium, and Rhizoctonia Root Rot						
4 + 11	Uniform 3.66SE	0.34 fl oz/1000 ft row. Avoid direct seed contact, which may cause delayed emergence.	mefenoxam + azoxystrobin	AP	0	N
Rhizoctonia root rot						
11	azoxystrobin 2.08F	0.40 to 0.80 fl oz/1000 ft row	azoxystrobin	1	4	N
Pythium root rot only						
28	Previcur Flex 6F	1.2 pt/A in transplant water, drip irrigation, or direct spray at base of plant and soil	propamocarb hydrochloride	2	12	N

[1] May cause some yellowing in leaves

Bacterial and Fungal Diseases

Bacterial Wilt

Controlling striped and spotted cucumber beetles is essential for preventing bacterial wilt. See preceding "Cucumber Beetle" section under Insect Control for specific recommendations. Insecticide applications made at seeding may not prevent beetle damage season long, therefore, additional foliar insecticide applications may be necessary.

Choanophora Fruit Rot

This disease occurs during warm wet weather and develops predominantly on flowers or fruit near the ground. Management is difficult because disease development is rapid, and weather dependent. Fungicide sprays are not effective because flowers, which open daily, must be protected immediately. Practices that reduce soil moisture or reduce soil contact, such as raised beds and plastic mulch, may be beneficial.

Downy Mildew

Scout fields early in the growing season. Begin sprays when plants meet in the row or if disease occurrence is predicted for the region (check the Cucurbit Downy Mildew Forecasting website at *https://cdm.ipmpipe.org/*. Strains of the Downy Mildew pathogen that infect one cucurbit crop may not affect summer squash. Unnecessary fungicide application can be avoided by not spraying until disease is predicted in the region on watermelon. Preventative applications are much more effective than applications made after detection.

Materials with different FRAC codes should be alternated to reduce the chances for fungicide resistance development.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Sprays should be applied on a 7-day schedule when disease is forecast or present in the region. Under severe disease conditions spray interval may be reduced IF the label allows.						
TANK-MIX one of the following products with a protectant such as chlorothalonil 6F 1.5 to 2.0 pt/A:						
49 + 40	Orondis Ultra 2.33SC	5.5 to 8.0 fl oz/A	oxathiapiprolin + mandipropamid	0	4	--
49+M05	Orondis Opti	1.75 to 2.5 pt/A **contains protectant**	oxathiapiprolin + chlorothalonil	0	12	--
21	Ranman 400SC	2.10 to 2.75 fl oz/A (**do not apply with copper**; see label for details)[1]	cyazofamid	0	12	L
Other materials for use in rotation as tank mix partners with a protectant:						
28	Previcur Flex 6F	1.2 pt/A	propamocarb hydrochloride	2	12	N
43	Presidio 4SC	4.0 fl oz/A (**caution**: pathogen is now less sensitive to Presidio)	fluopicolide	2	12	L
40 + 45	Zampro 525SC	14.0 fl oz/A	dimethomorph + ametoctradin	0	12	--
22	Elumin 4SC	8.0 fl oz/A	ethaboxam	2	12	--
M03+22	Gavel 75DF	1.5 to 2.0 lb/A **contains protectant**	mancozeb + zoxamide	5	48	--
M05+22	Zing! 4.9SC	36 fl oz/A **contains protectant**	chlorothalonil + zoxamide	0	12	N
M05+27	Ariston 42SC	1.9 to 3.0 pt/A **contains protectant**	chlorothalonil + cymoxanil	3	12	--
11 + 27	Tanos 50DF	8.0 oz/A	famoxadone + cymoxanil	3	12	--
27	Curzate 60DF	3.2 to 5.0 oz/A	cymoxanil	3	12	N
29	Omega 500F	12.0 to 24.0 fl oz/A	fluazinam	7	12	N
40	Forum 4.17SC	6.0 fl oz/A	dimethomorph	0	12	N

[1]Ranman should be tank mixed with an organosilicone surfactant when disease is severe, or a non-ionic surfactant or blend of organosilicone and non-ionic surfactant disease is moderate or light.

Phytophthora Crown and Fruit Rot

Multiple practices should be used to minimize the occurrence of this disease. Rotate away from susceptible crops (such as peppers, eggplants, tomatoes, lima and snap beans, and other cucurbits) for as long as possible. Pre-plant fumigants will also suppress disease. Fields should be adequately drained to ensure that water does not accumulate around the base of the plant. Once the canopy closes, subsoil between the rows to allow for faster drainage following rainfall. **Materials with different modes of action (FRAC codes) should always be alternated to reduce the chances for fungicide resistance development.** Apply fungicides when conditions are favorable for disease development. Fruit are susceptible at all growth stages and must be protected season-long.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Apply one of the following formulations pre-plant for early season control:						
4	MetaStar 2E AG	4.0 to 8.0 pt/A	metalaxyl	AP	48	N
4	Ridomil Gold 4SL	1.0 to 2.0 pt/A	mefenoxam	5	48	N
4	Ultra Flourish 2E	2.0 to 4.0 pt/A	mefenoxam	5	48	N
4 + 11	Uniform 3.66SE	0.34 fl oz/1000 ft row	mefenoxam + azoxystrobin	AP	0	N
28	Previcur Flex 6F	1.2 pt/A in transplant water, drip irrigation, or spray directed to the base of the plants and soil.	propamocarb hydrochloride	2	12	N
49 + **4**	Orondis Gold 1.67SC[1]	28.0 to 55.0 fl oz/A in furrow or by drip	oxathiapiprolin + mefenoxam	5	48	--
When conditions favor disease development, apply one of the following WITH FIXED COPPER at labeled rates (for suppression only):						
49 + 40	Orondis Ultra 2.33SC	5.5 to 8.0 fl oz/A	oxathiapiprolin + mandipropamid	0	4	--
49+M05	Orondis Opti	1.75 to 2.5 pt/A	oxathiapiprolin + chlorothalonil	0	12	--
40	Revus 2.08F	8.0 fl oz/A	mandipropamid	0	4	--
40 + 45	Zampro 525SC	14.0 fl oz/A	dimethomorph + ametoctradin	0	12	--
22	Elumin 4SC	8 fl oz/A	ethaboxam	2	12	--

Phytophthora Crown and Fruit Rot - continued next page

Phytophthora Crown and Fruit Rot - continued

43	Presidio 4SC[2]	4.0 fl oz/A	fluopicolide	2	12	L
M03+22	Gavel 75DF	1.5 to 2.0 lb/A	mancozeb + zoxamide	5	48	--
21	Ranman 400SC	2.75 fl oz/A (**do not apply with copper**; see label for details)[3]	cyazofamid	0	12	L
40	Forum 4.17SC	6.0 fl oz/A	dimethomorph	0	12	N
M05+22	Zing! 4.9SC	36 fl oz/A	chlorothalonil + zoxamide	0	12	N

[1]Do not follow soil applications of Orondis Gold 1.67SC with foliar applications of oxathiapiprolin-containing products. [2]Presidio may also be applied through the drip irrigation (see label). Soil drench followed by drip application has given good results in some trials on crown rot caused by *Phytophthora capsici*. [3]Ranman should be tank mixed with an organosilicone surfactant when disease is severe, or a non-ionic surfactant or blend of organosilicone and non-ionic surfactant disease is moderate or light.

Plectosporium Blight (Microdochium blight)

A 3-year rotation with crops other than cucurbits is advised. It is important to achieve maximum foliage coverage with the fungicide application.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Once symptoms appear on petioles or after fruit form, apply one of the following and repeat every 7 to 10 d (a spray schedule that rotates Cabrio 20EG or Flint Extra 500SC with chlorothalonil will also provide control (note: do not apply Flint Extra 500SC near Concord grapes, see label):						
M03	mancozeb 75DF	2.0 to 3.0 lb/A	mancozeb	5	24	N
M05	chlorothalonil 6F	2.0 to 3.0 pt/A	chlorothalonil	0	12	N
3 + 11	Quadris Top 1.67SC[1]	12.0 to 14.0 fl oz/A	difenoconazole + azoxystrobin	1	12	--
7 + 11	Pristine 38WG[2]	18.5 oz/A	boscalid + pyraclostrobin	0	12	--
7 + 11	Merivon 2.09SC[2]	5.5 fl oz/A	fluxapyroxad + pyraclostrobin	0	12	N

[1]**Do not apply near apples**, see label. [2]Tank mixes of additives, adjuvants, and/or other products may result in crop injury.

Powdery Mildew

Some varieties have intermediate resistance; they should be used if possible (see Recommended Varieties above). The fungus that causes cucurbit Powdery mildew has developed resistance to high-risk fungicides. Resistance to strobilurin (FRAC code 11) and DMI (FRAC code 3) fungicides have been reported in the Eastern U.S. Proper fungicide management should be followed to help delay the development of resistance and minimize control failures. Powdery Mildew generally occurs from mid-July until the end of the season. Once observed in the area or detected by scouting (1 lesion on the underside of 45 old leaves per acre), begin the following fungicide program:

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
TANK-MIX one of these products with a protectant such as chlorothalonil 6F 2.0 to 3.0 pt/A:						
50	Vivando 2.5SC[1]	15.4 fl oz/A	metrafenone	0	12	--
3 + 7	Luna Experience 3.34SC[2]	6.0 to 17.0 fl oz/A	tebuconazole + fluopyram	7	12	--
AND ALTERNATE with a TANK-MIX of one of the following and a protectant such as chlorothalonil 6F 2.0 to 3.0 pt/A:						
3	Procure 480SC	4.0 to 8.0 fl oz/A	triflumizole	0	12	N
3	Proline 480SC	5.7 fl oz/A	prothioconazole	7	12	--
3	Rally 40WSP	2.5 to 5.0 oz/A	myclobutanil	0	24	N
3	tebuconazole 3.6F	4.0 to 6.0 fl oz/A	tebuconazole	7	12	N
3	Rhyme 2.08SC	5.0 to 7.0 fl oz/A	flutriafol	0	12	--
3 + 7	Aprovia Top 1.62EC	10.5 to 13.5 fl oz/A	difenoconazole + benzovindiflupyr	0	12	--
39	Magister 1.6SC[3]	24.0 to 36.0 fl oz/A	fenazaquin	3	12	H
7 + 12	Miravis Prime	9.2 to 11.4 fl oz/A	pydiflumetofen + fludioxonil	1	12	--
U13	Gatten 5EC	6.0 to 8.0 fl oz/A	flutianil	0	12	--
OR with one of the following:						
3 + 9	Inspire Super 2.82EW	16.0 to 20.0 fl oz/A	difenoconazole + cyprodinil	7	12	--
7	Fontelis 1.67SC	12.0 to 16.0 fl oz/A	penthiopyrad	1	12	L
7 + **11**	Pristine 38WG[4]	12.5 to 18.5 oz/A	boscalid + pyraclostrobin	0	12	--
P05	Regalia (OMRI)	4.0 qt/A	Extract of *Reynoutria sachalinensis*	0	4	--
U06	Torino 0.85SC	3.4 fl oz/A	cyflufenamid	0	4	--

[1]Do not mix Vivando with horticultural oils. [2]A mild yellowing on leaf margins is sometimes seen following application of Luna Experience in cucurbits. [3]Do not make more than one application per year of Magister. [4]Tank mixes of additives, adjuvants, and/or other products may result in crop injury.

Scab

Select scab-resistant varieties. The fungus that causes scab typically occurs during periods of cool, wet weather when temperatures are below normal. Rotate away from fields with a history of scab for at least 2 years.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Begin sprays as true leaves form and repeat every 5 to 7 days:						
M05	chlorothalonil 6F	2.0 to 3.0 pt/A	chlorothalonil	0	12	N

Viruses (WMV, PRSV, ZYMV, and CMV)

The most prevalent virus in the Mid-Atlantic region is WMV, followed by PRSV, ZYMV, and CMV. Varieties with multiple resistance packages are available (see table Recommended Varieties). Varieties expressing the precocious yellowing gene such as “Multipik” will mask the greening of fruit caused by WMV and CMV but will become distorted when infected with either PRSV or ZYMV. All 4 viruses may be detected at some level in squash fields in the region in any given year, therefore plant varieties with resistance to more than one virus. The following control measures should also be used. Plant fields as far apart as possible from existing cucurbit plantings to reduce the chances for aphid transmission. Using reflective mulch may help to prevent aphid transmission of viruses.

Sweet Corn

Recommended Varieties

Type	Variety[1]	Relative Maturity	Kernel Type[2]	Disease Resistance[3]					Bt Insect Resistance[4]
				Et	Pst	Ps	MDMV	Bm	
Fresh Market Bicolor	Temptation	72	Sugary Enhanced						
	Temptation II (GMO)	72	Sugary Enhanced						Performance
	Awesome XR	74	Synergistic		I	R			
	Nirvana	74	Augmented Shrunken						
	BSS0977(GMO)	78	Supersweet	I	I	R			Attribute
	Xtra-Tender 278A	78	Augmented Shrunken	I	I			I	
	Montauk	79	Synergistic	I	I				
	Obsession	79	Augmented Shrunken	I	I	R			
	Obsession II (GMO)	79	Augmented Shrunken	I	I	R			Performance
	BC0805 (GMO)	82	Synergistic			I		I	Attribute
	Providence	82	Synergistic			R		I	
	Serendipity	82	Synergistic					I	
	Delectable	84	Sugary Enhanced	I	I	R	R		
Fresh Market White	Natalie	72	Supersweet			R			
	Nicole	72	Supersweet			R	R		
	Eden RMN	75	Augmented Shrunken	I		R	R		
	XTH 3174	76	Augmented Shrunken	I					
	Diamond Mine	76	Synergistic	I					
	Coronado	77	Supersweet			R			
	Xtra-Tender 378A	78	Augmented Shrunken		I			I	
	SV1580SC	80	Supersweet	I		R			
	Mattapoisett	80	Synergistic	I	I	I			
	Devotion	82	Augmented Shrunken		I				
	Silver King	82	Sugary Enhanced	I	I	I		I	
	Argent	83	Sugary Enhanced	I	R	I			
Fresh Market Yellow	Vision MXR	73	Augmented Shrunken		I	R		I	
	Incredible	82	Sugary Enhanced		I	R	R		
Processing Yellow[5]	Protégé	77	Supersweet	R	I	R		R	
	GH 9597	83	Sugary Normal	I	R	R	R		
	GSS 1453	84	Supersweet	R		R			
	Overland	84	Supersweet	R	R	R		I	

[1]**Listed by relative maturity.**
[2]See also: "Sweet Corn Genetics and Isolation Requirements" below.
[3]R=resistance; I=intermediate/partial resistance. Et=Northern Corn Leaf Blight caused by *Exserohilum turcicum,* Pst=Stewart's Wilt caused by *Pantoea stewartii*, Ps=Common Rust caused by *Puccinia sorghi*, MDMV=Maize Dwarf Mosaic Virus, Bm=Southern Corn Leaf Blight caused by *Bipolaris maydis*.
[4]Insect resistance from *Bacillus thuringiensis* transgenes is available in some varieties. Attribute varieties have the Cry1Ab gene for corn earworm and European corn borer resistance. Performance Series varieties have the Cry1A.105 and Cry2AB genes for corn earworm, European corn borer and fall armyworm resistance, as well as the transgenes conferring glyphosate resistance.
[5]Processors requirements must be considered. Consult the DE Extension Vegetable and Small Fruits Program for variety trial results at: *http://extension.udel.edu/ag/vegetable-fruit-resources/vegetable-small-fruits-program/variety-trial-results/*.

Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and chapter B Soil and Nutrient Management. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede recommendations found below. *(continued on next page)*

Recommended Nutrients Based on Soil Tests - continued

Sweet Corn[1,2]		**Soil Phosphorus Level**				**Soil Potassium Level**				
		Low	**Med**	**High (Opt)**	**Very High**	**Low**	**Med**	**High (Opt)**	**Very High**	
	N (lb/A)	**P_2O_5 (lb/A)**				**K_2O (lb/A)**				**Nutrient Timing and Method**
Fresh Market	125-175	160	120	80	0[3,4]	160	120	80	0[3,4]	Total nutrient recommended
	40-60[5]	120	100	60	0[3]	120	100	60	0[3]	Broadcast and disk-in
	20	40	20	20	0[3,4]	40	20	20	0[3,4]	Band-place with planter
	50-100[5]	0	0	0	0	0	0	0	0	Sidedress when corn is 12 inches tall
Processing	150-200	160	120	80	0[3,4]	160	120	80	0[3,4]	Total nutrient recommended
	55-80	120	100	60	0[3]	120	100	60	0[3]	Broadcast and disk-in
	20	40	20	20	0[3,4]	40	20	20	0[3,4]	Band-place with planter
	50-100	0	0	0	0	0	0	0	0	Sidedress 2 weeks after emergence

[1]Apply 1 to 2 lb/A of boron (B) with broadcast fertilizer; see also Table B-7. in chapter B Soil and Nutrient Management. [2]Apply 20-30 lb/A of sulfur (S) for most soils. [3]In VA, crop replacement values of 40 lb/A of P_2O_5 and 40 lb/A of K_2O are recommended on soils testing Very High. [4]For early planting when soil temperatures are low, band 20 lb/A P_2O_5 and 20 lb/A K_2O when soil tests are Very High to facilitate early growth. [5]On very sandy soils, reduce the amount of N applied via broadcast application and disked-in. Instead, split N applications to include an additional split when corn is 6 in. tall of 40 lb/A of N. So, N is applied with the broadcast fertilizer, at-planting in a band, when corn is 6 in. tall, and again when corn is 12 in. tall. In NJ, consult your Extension Agent for information on the approved pre-sidedress nitrate test.

Plant Tissue Testing

Plant tissue testing can be a valuable tool to assess crop nutrient status during the growing season to aid with in-season fertility programs or to evaluate potential deficiencies or toxicities. Critical sweet corn tissue test values for most recently matured leaves at the 30-inch growth stage are: N 2.5-4 %, P 0.2-0.4 %, K 2.5-4 %, 0.5-0.8 %, Mg 0.2-0.4 % and S 0.2-0.4 %. For additional nutrients and other growth stages consult with a tissue testing laboratory or this web link at the University of Florida: *https://edis.ifas.ufl.edu/publication/ep081*.

Pre-Sidedress Soil Nitrogen Test (PSNT)

The PSNT was developed to determine the need for sidedress nitrogen (N) on corn. The PSNT is effective for soils with loamy-texture and high organic matter or where manure has been applied. Sandy soils with low organic matter are already known to have low N availability. Contact your county Extension Agent/Educator for information on sampling and using the PSNT (**NJ and PA only**).

Sweet Corn Genetics and Isolation Requirements

The tenderness of corn kernels is determined by the silk parent. However, kernel sweetness is determined by both the tassel and silk parents. If sweet corn is pollinated by field corn, popcorn or by certain other sweet corn varieties starchy kernels will form on the sweet corn ear. To isolate sweet corn from incompatible corn types or varieties plant at least 500 ft away from incompatible corn or time plantings so that there is at least a 12-day difference in silking time. All sweet corn must be isolated from field corn and popcorn. Among sweet corn varieties, Sugary Isolation Group varieties must be isolated from Supersweet Isolation Group varieties to prevent the formation of starchy kernels. Within the isolation groups, varieties of different types can be isolated to maximize the quality attributes of the variety (*i.e.*, isolate sugary enhanced from synergistic within the Sugary Isolation Group) The table below includes types and common brands in each isolation group.

Sugary Isolation Group (SU_1)	**Supersweet Isolation Group (SH_2)**
normal (sugary) sugary enhanced/sugary enhancer synergistic Sweet Breed™ Triple Sweet™ Quadsweet™	supersweet or shrunken augmented or augmented shrunken Multisweet™ Xtra-Tender

Seed Treatment

Request that seed be treated with fungicides, see Disease Control below. For seed corn maggot and wireworm control, see Insect Control below. Super sweet (sh_2) varieties are more difficult to establish than other types. Handle seeds gently and use plateless planters to prevent seed damage. Soil temperature and soil moisture should be optimal to reduce seed decay and obtain good stands.

Seeding and Spacing

Sow in rows 30-36 inches apart and at a depth of 1-1.5 inches. First sowing is as early as late March for warmer regions of the Mid-Atlantic, and on sandy soils, and as late as early May in cooler regions. Fresh market growers often plant successively through July to ensure continuity of supply. Use varieties that are resistant to frost and chilling injury for early plantings.

Fresh Market:
Small-eared early varieties are sown at an in-row spacing of 8-10 inches. Larger-eared mid- and late-season varieties are planted at an in-row spacing of 10-12 inches. This equates to planting densities ranging from 14,500-22,000/A.

Processing:
The recommended planting density is usually 22,000-24,000/A, though some varieties may be planted at densities of up to 30,000/A. Consult the seed company for the target density that best maximizes crop yield and quality.

Mulching

Using clear plastic mulch as a row cover can improve stands, conserve moisture, and result in earlier maturity. Corn is seeded in the usual manner except 10-20 days earlier in double rows 14 inches apart and on 5-6 ft centers. Apply herbicide and then cover with clear plastic. Using ridges between double rows or wire hoops allows space for corn seedlings to grow vertically. Allow plastic to remain over plants for 30 days after emergence, then cut and remove plastic from the field. Plants can then be grown out in the usual manner. It is recommended that the soil is tested for nematodes. If present, control measures are necessary before the above procedure can be used. Clear plastic will allow weeds to germinate and grow quickly, and preemergence herbicides should be used under the plastic. Otherwise, weeds become too large to be effectively controlled with herbicides after the plastic is removed. Use a cold-tolerant variety to avoid uneven stand and uneven vigor. Sweet corn can also be grown by planting as seed or transplants through black plastic or IRT mulch in early plantings using plastic mulch planters.

Harvest and Handling

Fresh Market:
Harvesting sweet corn at the proper stage is critical for its sweetness and tenderness. In the field, sweet corn stays in prime condition for only 1-2 days. As the ear reaches prime condition the silks begin to dry down, the husk fills out with plump kernels, and the kernels exude a milky liquid when punctured with the thumbnail. Ear tips should be filled. Sweet corn approaches maturity 18-22 days after silking and should be picked daily, preferably early in the morning at low field heat. After prime harvest time, sugars in the kernel convert to starch and the hull becomes tough. Supersweet varieties maintain sweetness longer than other varieties and extra tender varieties maintain eating quality for a longer period.

Sweet corn may be harvested by hand or mechanically. Handpicking is done by grasping the ear near the base and sharply twisting it downward. Mechanical harvesters are more efficient; however, the entire crop is picked when primary ears are ready, and any secondary ears will not be marketable.

Corn is normally piled on a wagon in the field or is put in baskets or bins and then graded/packed at a nearby packing area. Sweet corn should be trimmed uniformly to eliminate flag leaves and long shanks. If left on the ear, they will cause packaging problems and induce further moisture loss. Objectionable kernel denting may occur from a moisture loss of 2% or less. Only first-quality sweet corn devoid of defects and of uniform maturity, color, shape, and size should be selected and packed. Any ears exhibiting signs of disease or mechanical or insect damage should be discarded along with any ears that lack adequate shuck coverage.

For optimum sweetness and tenderness, sweet corn should be cooled immediately after harvest and kept near 32°F (0°C). Hydrocooling is the most efficient and effective cooling method. Corn is immersed in ice cold water, which quickly removes all field heat. Hydrocooling is recommended for sweet corn that is shipped long distance. For smaller growers and short distance shippers, ice can be added to the crate (or burlap bags) during packing; 1 lb ice/5 lb corn is usually sufficient. Ice can also be blown on top of the crates when placed in a cooler or refrigerated truck. Sweet corn placed in cold storage before being pre-cooled will not retain freshness for nearly as long as hydrocooled or iced sweet corn.

Sweet corn for shipping is most commonly packaged in wire bound crates or perforated wax boxes. Pallet or bin boxes are sometimes used, however, corn packed in this manner will be hard to cool completely and ears will heat up in the center of the bin from respiration. Burlap bags may be used for local shipments.

Processing Sweet Corn:
Harvest of standard sugary (su) and sugary-extender (se) varieties begins when kernels reach 70-75% moisture. Supersweet (sh_2) varieties have a much higher sugar content than su or se varieties and maintain their sugar content longer after harvest. They are usually harvested at 77-78% moisture. Harvest timing will be determined by the processing companies.

Weed Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.

Recommended Herbicides

1. Identify the weeds in each field and select recommended herbicides. More information is available in the "Herbicide Effectiveness on Common Weeds in Vegetables" (Table E-3) in Chapter E Pest Management.
2. Minimize herbicide resistance development. Identify the herbicide mode of action group number and follow recommended good management practices; **bolded group numbers in tables below are herbicides at higher risk for selecting resistant weed populations.** Include non-chemical weed control whenever possible.

1. Non-Selective or Burndown

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
9	Roundup PowerMax 4.5L "Generic" glyphosate 3L	16 to 32 fl oz/A 24 to 48 fl oz/A	**glyphosate**	0.75 to 1.13 lb acid equivalent/A	--	4
-Apply before or after seeding but before crop emergence. (Ensure planter slits are fully closed if applying after planting.) -Tank mix with other herbicides (see table below) for enhanced burndown and/or residual weed control. -Glyphosate controls many perennial weeds as well as annuals if applied when the weed is actively growing and has reached the stage of growth listed on the label. -Glyphosate may be applied in clear liquid nitrogen fertilizers and clear liquid complete-analysis fertilizers, but it may be less effective on certain annual grasses and perennials. **Do not** use glyphosate with suspension-type liquid fertilizers. -Repeat applications are allowed, with maximum application of 5.3 qt/A per year.						
22	Gramoxone SL 2.0* Gramoxone SL 3.0*	2.5 to 4 pt/A 1.7 to 2.7 pt/A	**paraquat**	0.6 to 1 lb/A	--	24
-Apply before or after seeding but before crop emergence. (Ensure planter slits are fully closed if applying after planting.). Tank mix with other herbicides (see table below) for enhanced burndown and/or residual weed control. Paraquat may not control established grasses. -Apply in 20 to 60 gal/A for control of emerged annual weeds. Spray coverage is essential for optimum control. -Add 16 to 32 oz non-ionic surfactant/100 gal of spray. -Phosphate-containing liquid fertilizer solutions diminish paraquat activity if used as a carrier. -Use appropriate precautions when handling paraquat to minimize exposure to the herbicide. **Do not** use flood jet tips larger than size 20 or spacing greater than 40 inches. -Rainfastness 30 min. -A maximum of 3 applications per year are allowed. -***Restricted-use pesticide***. Only certified applicators, who successfully complete the paraquat-specific training, can mix, load, or apply paraquat. Application of paraquat "under the direct supervision" of a certified applicator is no longer allowed. Required training link (*https://campus.extension.org/enrol/index.php?id=2201*); certified applicators must repeat training every three years.						

2a. Soil-Applied (Preplant Incorporated or Preemergence)

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
3	Prowl 3.3EC Prowl H2O 3.8CS	1.8 to 4 pt/A 2 to 4 pt/A	**pendimethalin**	0.75 to 1.65 lb/A 0.95 to 1.9 lb/A	--	24
-Controls several common annual grasses and broadleaves but does not control yellow nutsedge and ragweed. -Plant corn at least 1.5 inches deep to avoid Prowl injury; however most sweet corn seeds need to be seeded less than 1 inch for optimum emergence. -**Do not** incorporate. Must be applied after planting up until corn reaches 30 inches tall. -Preemergence applications can injure corn. Delaying application until spike stage helps maximize crop safety. -Prowl H2O and Satellite HydroCap are water-based capsule suspension formulations that provides similar weed control as the older 3.3EC product but causes less staining and odor. Other generic pendimethalin products are available.						

2a. Soil-Applied (Preplant Incorporated or Preemergence) - continued next page

2a. Soil-Applied (Preplant Incorporated or Preemergence) - continued

<table>
<tr><td>5</td><td>Atrazine 4L*</td><td>1.0 to 1.5 qt/A</td><td>atrazine</td><td>1.0 to 1.5 lb/A</td><td>--</td><td>12</td></tr>
<tr><td colspan="7">-Primarily controls broadleaf weeds and provides some suppression of annual grasses. Mostly used in combination with other herbicides, especially acetamides. Some prepackaged mixture examples include Bicep II Magnum*, Harness Xtra*, and Keystone NXT*.
<u>Atrazine Use Restrictions</u>
-Preplant or Preemergence: On highly erodible soils (as defined by the U.S. Natural Resources Conservation Service):
-Fields where more than 30% of the soil surface is covered with plant residue at planting, apply a maximum of 2 lb/A of active ingredient as a broadcast spray. Fields where less than 30% of the soil surface is covered with plant residue at planting, apply a maximum of 1.6 lb/A of active ingredient as a broadcast spray.
-Postemergence: If no atrazine was applied prior to crop emergence, use a maximum rate of 2 lb/A of active ingredient. If a soil-applied application was made in the same calendar year, the combined preplant or preemergence and postemergence applications may not exceed 2.5 lb/A of active ingredient.
<u>Safety Precautions for Using Atrazine</u>
-Do not mix, load, or apply within 50 ft of drinking water wells, livestock wells, agricultural drainage wells, irrigation wells, abandoned wells, or sinkholes. Do not mix or load within 50 ft of intermittent streams, perennial streams, rivers, lakes, or reservoirs.
-Do not apply within 200 ft of lakes or reservoirs. Do not apply within 66 ft of the points where surface water runoff enters intermittent streams, perennial streams, or rivers. The 66-ft buffers should be planted to a crop or seeded with grass on highly erodible land.</td></tr>
<tr><td>15</td><td>Dual II Magnum 7.64E</td><td>1.0 to 2.0 pt/A</td><td>s-metolachlor</td><td>0.96 to 1.91 lb/A</td><td>30</td><td>24</td></tr>
<tr><td colspan="7">-Dual II Magnum are similar in activity to Harness, Outlook, and Surpass NXT. Dual II Magnum contains a crop-safening agent. Primarily controls annual grasses, controls, or suppresses yellow nutsedge, and suppresses certain broadleaf weeds.
-Use preplant incorporated to improve yellow nutsedge control. Combine with atrazine to improve control of most broadleaf weeds.
-Also commonly sold as prepackaged mixture with atrazine:
Bicep II Magnum 5.5L* at 2.1 qt/A = 1.3 pt Dual II Magnum 7.64E + 1.6 qt atrazine 4L
Bicep Lite II Magnum 6L* at 1.3 qt/A= 1.13 pt Dual II Magnum 7.64E + 0.9 qt atrazine 4L
Other premix includes (S-metolachlor plus Shieldex [tolpyralate]), do not apply to emerged sweet corn.
-Other generic versions of metolachlor and s-metolachlor may be available, and may or may not be labeled for use in the crop and may or may not include the safener for corn,</td></tr>
<tr><td>15</td><td>Harness 7E
Surpass NXT 7E</td><td>1.25 to 2.75 pt/A
1.5 to 3 pt/A</td><td>acetochlor</td><td>1 to 2.4 lb/A
1.09 to 2.6 lb/A</td><td>--</td><td>12</td></tr>
<tr><td colspan="7">-Acetochlor products can be applied preplant incorporated or preemergence but prior to weed emergence, and before corn height exceeds 11 inches. Control many annual grasses and yellow nutsedge as well as certain small-seeded broadleaves.
-Check label for specific rate depending on soil type and organic matter. Also commonly sold as prepackaged mixture with atrazine:
Harness Xtra* 5.6L at 2.5 qt/A= 2.2 pt Harness 7E + 1.6 qt atrazine 4L
Degree Xtra* 4.04ME at 3 qt/A= 4.3 pt Degree 3.8ME + 1 qt atrazine 4L
Keystone NXT* 5.6SE at 2.5 qt/A= 2.2 pt Surpass NXT 7E + 3 pt atrazine 4L
-Other products and formulations may be available, including the premix Restraint (acetochlor plus Shieldex [tolpyralate]). Do not apply Restraint to emerged corn.</td></tr>
<tr><td>15</td><td>Outlook 6E</td><td>10 to 21 fl oz/A</td><td>dimethenamid</td><td>0.47 to 0.98 lb/A</td><td>50</td><td>12</td></tr>
<tr><td colspan="7">-Outlook is similar in activity to Dual, and Harness. -Primarily controls annual grasses, controls, or suppresses yellow nutsedge, and suppresses certain broadleaf weeds. Local data has shown sweet corn injury with Outlook applied preemergence on coarse-textured soils. Outlook may be applied preemergence on up to 12-inch-tall corn prior to weed emergence.
-Incorporation improves control of yellow nutsedge.
-Prepackaged mixture with saflufenacil (Sharpen): Verdict 5.57EC at 10 fl oz/A = 8.5 fl oz/A Outlook 6E + 2 fl oz/A Sharpen 2.85L</td></tr>
<tr><td>15</td><td>Zidua 85WG
Zidua SC 4.17L
Anthem Flex
Anthem Maxx 4.3SE</td><td>1.5 to 4oz/A
1.75 to 6.5 fl oz/A
3.5 to 6 fl oz/A
3 to 6 fl z/A</td><td>pyroxasulfone (± carfentrazone or fluthiacet)</td><td>0.06 to 0.21 lb/A
0.06 to 0.21 lb/A
0.1 to 0.17
0.1 to 0.2 lb/A</td><td>37</td><td>12</td></tr>
<tr><td colspan="7">-Zidua contains the single active ingredient pyroxasulfone. Anthem Flex contains carfentrazone (Aim) and Anthem Maxx contains fluthiacet (Cadet). However, carfentrazone or fluthiacet do not provide any residual weed control. Pyroxasulfone has annual grass activity similar to Dual, Harness, Outlook, Surpass, etc., but also provides good control of several annual broadleaves. These herbicides can be applied preplant (surface or incorporated) up to 45 d before planting or preemergence. Rates can be adjusted for soil type or 2-pass application programs. Corn must be planted at least 1 inch deep.
-These herbicides can be tank mixed with atrazine or other corn herbicides to broaden weed control spectrum.
-Do not apply Anthem Flex or Anthem Maxx on coarse-textured soils, or medium-textured soils with less than 2% organic matter.
-Stunting has been observed with pyroxasulfone on coarse-textured soils.</td></tr>
<tr><td>27</td><td>Callisto 4SC</td><td>5.3 to 7.7 fl oz/A</td><td>mesotrione</td><td>0.166 to 0.24 lb/A</td><td>45</td><td>12</td></tr>
<tr><td colspan="7">-Primarily controls common lambsquarters and many other annual broadleaf weeds, including triazine resistant biotypes, but Callisto is weak on ragweed and morningglory species. Typically combined with other herbicides to improve control of grasses and broaden broadleaf spectrum. (See comments under Lumax, Lexar, and Acuron for more details about these prepackaged mixtures.) Other premixes with mesotrione include Calibra or Coyote,
-Cold weather that slows corn growth will also retard recovery from injury following preemergence treatments.
-Sweet corn varieties differ in sensitivity to mesotrione. -Severe crop injury may occur if an organophosphate or carbamate insecticide is applied within 7 days of Callisto. -See the sweet corn section of the Callisto label for additional use precautions.</td></tr>
</table>

2a. Soil-Applied (Preplant Incorporated or Preemergence) - continued next page

2a. Soil-Applied (Preplant Incorporated or Preemergence) - continued)

27, 15, **5**	Lexar EZ 3.7SC* Lumax EZ 3.67SC* Acuron 3.44SC* Acuron Flexi 3.26SC	3 to 3.5 qt/A 2.7 to 3.25 qt/A 2.5 to 3 qt/A 2 to 2.25 qt/A	**mesotrione** + **s-metolachlor** + **atrazine** **(± bicyclopyrone)**	2.78 to 3.24 lb/A 2.48 to 2.98 lb/A 2.15 to 2.58 lb/A 1.63 to 1.83 lb/A	45	24

-Lexar EZ and Lumax EZ are mixtures of s-metolachlor (Dual II Magnum), mesotrione (Callisto), and atrazine.
-Acuron contains the same active ingredients as Lumax/Lexar with the addition of another Group 27 herbicide, bicyclopyrone. In general, it controls a broader weed spectrum and is better on ragweed, cocklebur, and annual morningglory, and effective on many annual broadleaves and some grasses compared to Lumax/Lexar.
-The typical use rates in all tillage systems are 3 qt/A Lexar EZ, 2.7 qt/A Lumax EZ, and 2.5 qt/A Acuron. These products may be applied broadcast on up to 12-inch-tall corn, but prior to annual grass emergence.
-**Do not** apply more than 3.5 qt/A Lexar EZ, 3.25 qt/A Lumax EZ, 3 qt/A Acuron or 2.25 qt/A Acuron Flexi per growing season.
-**Sweet corn varieties differ in sensitivity to mesotrione**.
-**Do not** apply Lexar, Lumax, or Acuron early POST if the corn was treated with Counter insecticide.
-**Do not** tank mix Lexar, Lumax, or Acuron with organophosphate (OP) or carbamate insecticides and apply as a foliar POST application. **Do not** make a foliar POST application of any OP or carbamate insecticide within 7 days before or 7 days after a Lexar EZ, Lumax EZ, or Acuron application, or severe corn injury may occur. Corn, soybeans, small grains, and sorghum may be planted in the spring following Lexar EZ, Lumax EZ, or Acuron application. Zemax is similar to Lumax EZ but contains no atrazine. The typical use rate is 2 qt/A. -**Do not** apply any of these herbicides postemergence in sweet corn.

27, 15, **5**	Storen	2.1 to 2.4 qt/A	**mesotrione** + **s-metolachlor** + **pyroxasulfone** + **bicyclopyrone**	0.163 to 0.186 lb/A 1.14 to 1.61 lb/A 0.08 to 0.09 lb/A 0.039 to 0.045 lb/A	45	24

-Improved fall panicum control compared to Lexar, Acuron products
-Broadleaf weed control is improved with the addition of atrazine.
-See comments for individual products in this table.
-Do not apply to emerged sweet corn.

2b. Application Timing for Use of Soil-Applied Herbicides on Emergence Corn

Herbicide (*=Restricted Use)	Timing		Premix Herbicides (*=Restricted Use)	Timing
Prowl 3.3 E / Prowl H20	up to 24 inches or V8*		Bicep*	up to 12 inches
Atrazine*	before corn is 12 inches		Harness Xtra*	not allowed
Dual II Magnum	up to 40 inches		Keystone NXT*	not allowed
Harness 7E	before corn is 12 inches		Acuron*	not allowed
Surpass NXT	not allowed		Acuron Flexi	not allowed
Outlook	before corn is 12 inches		Lexar*	not allowed
Zidua	up to V4 stage		Lumax*	not allowed
Anthem Flex / Anthem Max	through the V4 stage		Storen	not allowed
Callisto	up to 30 inches or 8 leaves*			

*Use whichever criteria is more restrictive

3a. Postemergence

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
2	Accent Q 54.5WG	0.9 oz/A	**nicosulfuron**	0.031 lb/A	--	4

-Apply as a broadcast or with drop nozzles as a directed spray as an early postemergence rescue treatment to control emerged annual grasses. Treat sweet corn with a broadcast spray or with drop nozzles as a directed spray up to 18 inches tall or up to and including 6 leaf collars (V6).
-**Do not** treat sweet corn more than 18 inches tall to control many annual grasses and certain annual broadleaf weeds.
-Tank mix with atrazine to increase the spectrum of weeds controlled.
-Add nonionic surfactant to be 0.25% of the spray solution (1 qt/100 gal of spray solution).
-**Accent Q is safe to apply to certain varieties but injures or kills others**. Contact your DuPont Crop Protection Sales Representative for information on local sweet corn varieties that have been evaluated for tolerance to Accent Q.
-**Do not** use if organophosphate (OP) insecticides have been applied to the crop or tank mix with bentazon (Basagran) or the risk of crop injury may increase.
-**Do not** tank mix with 2,4-D otherwise grass control will be reduced.
-Accent Q is an ALS inhibitor, Group 2 herbicide, and there is widespread resistance in the region to this family of herbicides.
-**Do not** make more than one application of Accent Q per year. The following prepackaged mixture also contains nicosulfuron: Revulin Q 51.2WG at 4 oz/A= 1.1 oz/A Accent Q 54.5WG + 3 fl oz/A Callisto 4SC
-Rainfastness is 4 h.

3a. Postemergence - continued next page

3a. Postemergence - continued

<table>
<tr><td>2</td><td>Sandea 75DF
Permit 75DF</td><td>0.5 to 0.66 oz/A</td><td>halosulfuron</td><td>0.023 to 0.031 lb/A</td><td>30</td><td>12</td></tr>
<tr><td colspan="7">-Apply to control yellow nutsedge and broadleaf weeds, including common cocklebur, redroot pigweed, smooth pigweed, ragweed species, and velvetleaf. Sandea/Permit applied postemergence will not control common lambsquarters or eastern black nightshade and will only suppress morningglory species. -Spray before corn reaches 8” in height or use drop nozzles when corn is over 8” tall to avoid spraying the foliage and into the whorl. -Always add nonionic surfactant to be 0.25% of the spray solution (1 qt/100 gal).
-Corn varieties may vary in sensitivity to Sandea. Use caution when treating new varieties. Do not apply to “Jubilee”.
-Do not use if organophosphate (OP) insecticides have been applied to the crop, or the risk of crop injury may increase.
-Sandea is an ALS inhibitor, Group 2 herbicide, and there is widespread resistance in the region to this family of herbicides.
-Rainfastness is 4 h.</td></tr>
<tr><td>4</td><td>2,4-D amine 4L</td><td>0.5 to 1.0 pt/A</td><td>2,4-D amine</td><td>0.25 to 0.5 lb/A</td><td>45</td><td>48</td></tr>
<tr><td colspan="7">-Apply after corn and weeds emerge. Use drop nozzles when corn is over 8” tall to avoid spraying the foliage or into the whorl.
-Warm, wet weather at application may increase the possibility of crop injury. Use the lower recommended rate under these conditions.
-Delay cultivation for 8-10 days after treatment to avoid damaging corn due to temporary brittleness sometimes caused by 2,4-D.
-Sweet corn varieties differ in 2,4-D tolerance. Super sweet varieties may be more sensitive than other varieties. Injury will be less when the minimum recommended rate is used. Use with caution on new varieties. At high rates, 2,4-D may cause temporary injury to corn. -Do not apply from tasseling to dough stage. Ester formulations, although labeled, are more subject to volatilization and movement to sensitive crops and are not recommended. Rainfastness is 6 to 8 h.</td></tr>
<tr><td>4</td><td>Starane Ultra 2.8L</td><td>0.4 pt/A</td><td>fluroxypyr</td><td>0.14 lb/A</td><td>31</td><td>12</td></tr>
<tr><td colspan="7">-Apply in 1 or 2 applications to control certain annual and perennial broadleaf weeds when sweet corn is less than V5 growth stage.
-Starane Ultra has a limited control spectrum but the label lists weeds such as chickweed, cocklebur, ragweed, purslane, bindweed, dogbane, morningglory, and velvetleaf. Starane can cause poor development of brace roots. Rainfastness is 1 h.
-Maximum Starane Ultra application per year: 0.7 pt/A and no more than 2 applications per crop season.</td></tr>
<tr><td>4</td><td>Stinger 3SL</td><td>5.3 to 10.5 fl oz/A</td><td>clopyralid</td><td>0.125 to 0.25 lb/A</td><td>30</td><td>12</td></tr>
<tr><td colspan="7">-Apply in 1 or 2 applications to control certain annual and perennial broadleaf weeds when sweet corn is less than 18 inches tall.
-Stinger controls weeds in the Composite and Legume plant families. Common annuals controlled include galinsoga, ragweed species, common cocklebur, groundsel, pineappleweed, clover, and vetch. Perennials controlled include Canada thistle, goldenrod species, aster species, and mugwort (wild chrysanthemum). Stinger is very effective on small seedling annual and emerging perennial weeds less than 2-4 inches tall but is less effective and takes longer to work when weeds are larger.
-Use 5.3 fl oz/A to control annual weeds less than 3 inches tall. Increase the rate to 5.3 to 10.5 fl oz/A to control larger annual weeds. Apply the maximum rate of 10.5 fl oz/A, in 1 or split into 2 applications to suppress or control perennial weeds.
-Spray additives are not needed or required by the label and are not recommended. Observe follow-crop restrictions, or injury may occur from herbicide carryover.
-Rainfastness is 6 h. Maximum Stinger application per year: 10.5 fl oz/A.</td></tr>
<tr><td>5</td><td>Atrazine 4L*</td><td>1.0 to 2.0 qt/A</td><td>atrazine</td><td>1.0 to 2.0 lb/A</td><td>--</td><td>12</td></tr>
<tr><td colspan="7">-Primarily controls broadleaf weeds. Apply postemergence when weeds are less than 2 inches tall. Add oil concentrate to be 1% of the spray solution. Do not apply if corn is greater than 12” tall
-Do not exceed the maximum rate per acre per year listed on the label for your soil’s erodibility class.
-ATRAZINE RESTRICTIONS: Refer to “Atrazine Use Restrictions” in the Soil-applied section above.
-When this and other atrazine treatments are used, do not double-crop during this season. Cover crops after corn are satisfactory providing the recommended rate of atrazine is not exceeded. Mold-board plowing before planting grain or vegetables the following spring will minimize the risk of atrazine residue injury. See label for specific crop rotation restrictions.
-Rainfastness is 1 to 2 h.</td></tr>
<tr><td>6</td><td>Basagran 4L
Basagran 5L</td><td>1 to 2.0 pt/A
0.8 to 1.6 pt/A</td><td>bentazon</td><td>0.5 to 1.0 lb/A</td><td>--</td><td>48</td></tr>
<tr><td colspan="7">-See label for susceptible broadleaf weeds; results are better when weeds are young. Basagran will provide partial control of yellow nutsedge. Basagran will not control grasses or pigweeds. Cultivation within 10-14 days will increase control. Rainfastness is 4 h.</td></tr>
<tr><td>14</td><td>Aim 2EC</td><td>0.5 fl oz/A</td><td>carfentrazone</td><td>0.008 lb/A</td><td>--</td><td>12</td></tr>
<tr><td colspan="7">-Apply before corn reaches 8 inches in height to control seedling broadleaf weeds including pigweeds, common lambsquarters, morningglory species, eastern black nightshade, and velvetleaf. Aim will not control ragweed species nor Palmer amarnath.
-Tank mix with atrazine at reduced rates or another broadleaf weed herbicide to increase the spectrum of weeds controlled. Do not tank mix with Basagran due to concerns for crop safety. Always add nonionic surfactant to be 0.25% of the spray solution (1.0 qt/100 gal of spray solution). Expect to see speckling on the crop foliage after application. Initially the injury may appear to be substantial, but it is not systemic, and corn outgrows the injury rapidly.
-Variety sensitivity to Aim may vary. Use caution when treating new varieties. Weather conditions may affect the degree of injury observed. Injury may be more severe during periods of warm, cloudy weather with high humidity and plentiful soil moisture when corn growth is rapid and "soft." To reduce the risk of crop injury, use drop nozzles when corn is over 8 inches tall to avoid spraying the foliage and into the whorl. Rainfastness is 1 h.</td></tr>
<tr><td>14</td><td>Cadet 0.91EC</td><td>0.6 to 0.9 fl oz/A</td><td>fluthiacet</td><td>0.004 to 0.006 lb/A</td><td>40</td><td>12</td></tr>
<tr><td colspan="7">-Apply before corn is 48 inches tall or prior to tasseling. While Cadet has a wide application window, it will only control weeds less than 2 inches tall, except velvetleaf which is very sensitive to Cadet. Cadet should not be tank mixed with Basagran due to concerns of crop safety. See comments for carfentrazone above. Rainfastness is 1 h.</td></tr>
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3a. Postemergence - continued next page

3a. Postemergence - continued

<table>
<tr><td>27</td><td>Callisto 4SC</td><td>3.0 fl oz/A</td><td>mesotrione</td><td>0.094</td><td>45</td><td>12</td></tr>
<tr><td colspan="7">-Primarily controls common lambsquarters and many other annual broadleaf weeds, including triazine resistant biotypes, but Callisto is weak on ragweed and morningglory species.
-Always add nonionic surfactant to be 0.25% of the spray solution (1 qt/100 gal of spray solution), but do not add oil concentrate, liquid fertilizer, or ammonium sulfate (AMS), or tank mix Callisto and bentazon (Basagran), or severe crop injury may be observed. Temporary minor injury, appearing as whitening of the new foliage, may occur. The crop will quickly outgrow minor injury with no effect on yield or earliness.
-Tank mix with 0.25 to 1.0 lb ai/A of atrazine for improved control and to broaden the spectrum of weed control. Research results support the use of at least 0.5 lb ai/A of atrazine. Do not apply tank mixes of Callisto and atrazine to corn greater than 12 inches tall.
-Sweet corn varieties differ in sensitivity to mesotrione. Most varieties may exhibit slight injury symptoms. Certain varieties are tolerant while others exhibit more noticeable injury. No variety was severely injured by the recommended rates applied with nonionic surfactant.
-Do not tank mix Callisto with organophosphate or carbamate insecticides or apply if the crop was treated with Counter, or severe crop injury may occur. See the sweet corn section of the Callisto label for additional use precautions.
-Prepackaged mixture that also contain mesotrione for postemergence use:
Revulin Q 51.2WG at 4 oz/A = 1.1 oz/A Accent Q 54.5WG + 3 fl oz/A Callisto 4SC
Calibra or Coyote = S-metolachlor plus mesotrione.
-Rainfastness is 1 h.</td></tr>
<tr><td>27</td><td>Shieldex 400SC
(3.33SC)</td><td>1.0 to 1.35 fl oz</td><td>tolpyralate</td><td>0.026 to 0.035 lb/A</td><td>35</td><td>12</td></tr>
<tr><td colspan="7">-Primarily controls common lambsquarters and many other annual broadleaf weeds, including triazine resistant biotypes, but Shieldex is weak on morningglory species.
-Label recommends methylated seed oil over nonionic surfactant or crop oil concentrate. Use MSO at 0.5 to 1% of the spray solution (0.5 to 1 gal/100 gal of spray solution); NIS at 0.25 to 0.5% (1 to 2 qt/100 gal of spray solution); COC at 1% (1 gal/100 gal of spray solution). Use 2.5 gal/100 gal of liquid fertilizer or ammonium sulfate (AMS) at 8.5 lb/100 gal.
-Tank mix with 0.25 to 1.0 lb ai/A of atrazine for improved control and to broaden the spectrum of weed control. Research results support the use of at least 0.5 lb ai/A of atrazine. Do not apply tank mixes of Shieldex and atrazine to corn greater than 12 inches tall.
-Shieldex rotation to snap beans, peas, cucurbits, and other vegetables is 9 to 12 months, refer to label.
-Do not apply more than two applications during the growing season; applications should be separated by 14 days; maximum rate of 2.7 fl oz/yr. Rainfastness is 1 h.</td></tr>
<tr><td>27</td><td>Armezon 2.8SC
Impact 2.8SC</td><td>0.75 to 1.0 fl oz/A
0.75 to 2.0 fl oz/A</td><td>topramezone</td><td>0.016 to 0.022 lb/A
0.016 to 0.044 lb/A</td><td>45</td><td>12</td></tr>
<tr><td colspan="7">-Note that maximum rates differ between Armezon and Impact.
-Apply postemergence to control many annual broadleaf weeds, including common lambsquarters and triazine-resistant broadleaf weed biotypes, and annual grasses. Impact/Armezon will control/suppress crabgrass and most other annual grass species but may not control certain grass species or grasses larger than the maximum recommended size when treated. Most broadleaf weeds should be treated before they are 6 inches tall and grass weeds should be treated before they are 2 inches tall. Use the higher recommended rate to suppress or control panicum species or in rescue applications where the target weeds have grown beyond the size indicated on the label.
-Add oil concentrate (COC) to be 1% of the spray solution (1 gal/100 gal of spray solution). In addition, the label requires N fertilizer, liquid or ammonium sulfate (AMS).
-Tank mix with 0.25 to 1.0 lb ai/A of atrazine for improved control and to broaden the spectrum of weed control. Research results support the use of at least 0.5 lb ai/A of atrazine. Do not apply tank mixes of Impact/Armezon and atrazine to corn greater than 12 inches tall.
-Local research has not seen issues with postemergence application if mesotrione (e.g., Callisto, Lumax, Lexar, Acuron) was used preemergence; however not all sweet corn hybrids have been tested. -Do not tank mix with Callisto. -Impact/Armezon has an 18-month replant restriction for most vegetables.
-Armezon: do not apply more than 1 fl oz/A during the growing season. Impact: do not apply more than 2 fl oz/A during the season.
-Rainfastness is 1 h.
-Prepackaged mixture that also contains topramezone:
Armezon PRO 5.35EC at 24 fl oz/A= 0.76 fl oz/A Armezon 2.85SC (or Impact) + 18 fl oz/A Outlook 6E</td></tr>
<tr><td>27</td><td>Laudis</td><td>3.0 fl oz/A</td><td>tembotrione</td><td>0.082 lb/A</td><td>--</td><td>12</td></tr>
<tr><td colspan="7">-Apply postemergence to control many annual broadleaf weeds, including common lambsquarters and triazine-resistant broadleaf weed biotypes, and many annual grasses. Laudis will control/suppress most annual grass species but may not control certain grass species or grasses larger than the maximum recommended size when treated. Fall panicum is not controlled. Most broadleaf weeds should be treated before they are 6 inches tall and grass weeds should be treated before 2 inches in height and before V7 sweet corn growth stage.
-Add methylated seed oil (MSO) or concentrate (COC) to be 1% of the spray solution (1.0 gal/100 gal of spray solution). In addition, the label requires the addition of N liquid fertilizer (1.5 qt/A) or ammonium sulfate (AMS) (1.5 lb/A).
-Tank mix with 0.25 to 1.0 lb ai/A of atrazine for improved control and to broaden the spectrum of weed control. Research supports the use of at least 0.5 lb ai/A of atrazine. Do not apply tank mixes of Laudis and atrazine to corn greater than 12 inches tall.
-Local research has not seen issues with postemergence application if mesotrione (e.g., Callisto, Lumax, Lexar, Acuron) was used preemergence; however not all sweet corn hybrids have been tested.
-Do not tank mix with Callisto. -Laudis has up to an 18-month replant restriction for many vegetables.
-Rainfastness is 1 h. Do not apply more than 1 application per growing season</td></tr>
</table>

3.b. Postemergence for Herbicide Resistant Sweet Corn Varieties ONLY!						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient**	**Active Ingredient Rate**	**PHI (d)**	**REI (h)**
1	Poast 1.5EC	0.75 to 1.5 pt/A	**sethoxydim**	0.15 to 0.3 lb/A	30	12
-**USE ONLY ON "POAST PROTECTED" SWEET CORN!** Other sweet corn varieties will be severely injured or killed. -Use 1% crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). -**The use of COC may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to nonionic surfactant (NIS) when grasses are small and soil moisture is adequate. -Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control. -Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will **not** be controlled. -Controls many annual and certain perennial grasses. For best results, treat annual grasses when they are actively growing, before tillers are present. Control may be reduced if grasses are large or under hot dry weather conditions. -Repeated applications may be necessary to control certain perennial grasses. If repeat applications are necessary, allow 14 days between applications. -**Do not** tank mix with or apply within 2 to 3 days of any other pesticide, unless labeled, as this may increase the risk of crop injury or reduce the control of grasses. Rainfastness is 1 h. -**Do not** exceed more than 3pt/A Poast per season. -Refer to Poast label for additional application guidelines.						
9	Roundup PowerMax 4.5L (or other labeled generic formulation)	16 to 44 fl oz/A	**glyphosate**	0.75 to 1.5 lb acid equivalent/A	30	4
-**USE ONLY ON "ROUNDUP READY" SWEET CORN!** Other sweet corn varieties will be severely injured or killed. -Apply before weeds exceed 2 inches in height or have 4 true leaves. Larger weeds can be killed but yield may be reduced before the weeds are killed. Treat 3-4 weeks after planting when growing conditions are favorable. Perennial weeds must be treated at the proper growth stage to obtain effective control (see label for application time and rate). -Tank mix glyphosate with Dual II Magnum for residual annual grass control and atrazine for residual annual broadleaf control. -Rainfastness is 6 h. Observe all rate restrictions and Pre-harvest Intervals for all products. **Do not** apply more than 44 fl oz/A in a single application and before 48" tall corn and more than 4.1 qt/A total of all in-crop applications.						
10	Liberty 280 2.34L Scout 2.34L Interline 2.34L	22 fl oz/A	**glufosinate**	0.4 lb/A	50	4
-**USE ONLY ON "LIBERTY LINK" (ATTRIBUTE OR ATTRIBUTE II) SWEET CORN!** Other sweet corn varieties will be severely injured or killed. Control many annual broadleaves and grasses. Apply before weeds exceed 3 inches tall and corn reaches V6 growth stage. Include ammonium sulfate (AMS) at 1.5-3 lb/A in the spray mixture. -Sinate is a prepackaged mixture of Impact 2.8SC plus Liberty 2.34L -Use at least 15 gal/A spray volume and medium to coarse spray nozzles. -Tank mix with other labeled sweet corn herbicides to broaden control spectrum and for residual control. -Rainfastness is 4 h. **Do not** apply more than 22 fl oz/A in a single application and 44 fl oz/A per year.						

4. Other Labeled Herbicides These products are labeled but limited local data are available; and/or are labeled but not recommended in our region due to potential crop injury concerns.		
Group	**Product Name (*=Restricted Use)**	**Active Ingredient**
14	Sharpen	**saflufenacil**
14,15	Verdict	**saflufenacil + dimethenamid**

Insect Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.

Insect pest management in sweet corn typically occurs in five separate phases:

1) preventive measures at the time of seed purchase such as selecting a transgenic *Bt* hybrid and/or pretreated a commercially applied insecticide seed treatment; **2)** at-planting insecticide applications for soil pests; **3)** managing early seedling pests up to V6, **4)** managing whorl stage corn for lepidopteran pests; and **5)** ear protection.

1) Preventive Control

Bt Transgenic Sweet Corn

Bacillus thuringiensis (Bt) sweet corn hybrids are available that express single or pyramided insecticidal proteins for protection against lepidopteran "worm" pests. Attribute® hybrids (Syngenta Seeds) expressing the cry1Ab protein (YieldGard trait) have been available since 1998, and growers can purchase 80K or 25K seed units of white, yellow, and bicolor SE and Sh2 hybrids for local, shipping, and processing markets. These hybrids now express the Liberty Link herbicide tolerance trait. Performance Series™ hybrids (Seminis Seeds) expressing two Bt proteins (cry1A.105 and cy2Ab2) are also available in 80K or 25k seed units. These pyramided traits provide additional protection, particularly for corn earworm and fall armyworm, and also are Roundup Ready. In addition, Attribute® II hybrids (Syngenta Seeds) with pyramided genes expressing YieldGard and Viptera traits (Vip3A protein) and stacked with the Liberty Link trait are now available. This Bt pyramided gene technology currently provides nearly 100% control of all lepidopteran pests of sweet corn.

All Bt sweet corn hybrids, regardless of whether single or pyramided traits, provide 100% protection against European corn borers, thus no insecticides are needed during the whorl or tasseling stages, or even during silking if this pest is the only concern. However, corn earworm and fall armyworm are more tolerant to the cry proteins, and sweet corn is also exposed to sap beetles, stink bugs, and silk feeding by corn rootworm adults which can reduce pollination. Because of this pest complex, insecticide sprays may be needed to ensure fresh market quality of Bt hybrids. Furthermore, control efficacy of the YieldGard trait against corn earworm has significantly declined in the Attribute hybrids, and there is recent evidence that the Performance Series hybrids are also showing reduced efficacy due to corn earworm resistance development to the cry proteins. Thus, fields planted in these Bt hybrids will need insecticide applications, depending on the insect pressure and level of resistance in the population. In addition, under moderate to high moth activity (early August-early September), many eggs are laid later in ear development after the expressed Bt protein has degraded in dead silk tissue. This loss of protein activity also is accelerated by hot, dry conditions, which cause rapid desiccation of the silk tissue. As a result, earworms and fall armyworms have a greater chance of surviving and invading the ear. Under high moth activity, up to 50% or more of the Attribute ears can become infested with larvae. In this situation, spray schedules of 3 or 4 applications starting 3-4 days after the first onset of silking and repeated 3-4 days apart may be required. The pyramided Bt hybrids (Performance Series™, Attribute® II) are more effective than the single protein Attribute hybrids and should require much fewer applications, depending on the ear quality requirements. For these hybrids under high corn earworm pressure, a single application of insecticide applied when 100% of the ears have silked (about 5-6 days after the first onset of silking) has been sufficient to ensure fresh market quality. This timing, compared to an earlier silk application conserves beneficial insects that provide an important ecological service by feeding on eggs and small larvae during the fresh silking period.

Insecticidal Seed Treatments

Commercially Applied Seed Treatments Only		
Group	**Product Name (*=Restricted Use)**	**Active Ingredient(s)**
4A	Cruiser 5FS	thiamethoxam
4A	Gaucho 600	imidacloprid
4A	Poncho 600	clothianidin
4A + 6	Avicta Complete Corn*	abamectin + thiamethoxam
4A + 11B	Poncho/Votivo	clothianidin + *Bacillus firmus*
28	Lumivia	chlorantraniliprole

2) At-Planting Insecticide Applications for Soil Pests

Seedcorn Maggots (SCM), Wireworms (WW), and White Grubs (WG)

These insects can attack germinating corn seeds and the early developing roots. Early season control can be achieved with either commercially treated seed or in-furrow insecticide treatments. Larger white grubs may not be completely controlled with most seed treatments. Rescue treatments applied post-planting are not effective.

At planting soil-applied treatment. Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1B	Counter 20G SmartBox® system*	4.5 to 6.0 oz/1000 row ft	terbufos	see label	see label	H
3A	Force 3G, Force 3G SmartBox® system*	4.0 to 5.0 oz/1000 row ft	tefluthrin	n/a	48	H
30	Nurizma	0.05 to 0.07 fl oz/1000 row ft	broflanilide	AP	12	H

Corn Rootworm Larvae

Western corn rootworm can be a serious pest of corn planted continuously year after year in the same field. Eggs are laid in cornfields the previous summer and hatch the following spring. Rootworm larvae can only survive on corn. The larvae prune back and tunnel into roots. Crop rotation is the most effective control for corn rootworm. Avoid planting corn after corn, cucumbers, pumpkins, or squash; rotation distance of even 3 ft is effective. Soil insecticides applied at planting aim to protect the root zone for about 6-8 weeks after application. When allowed on the label, T-band tends to be more effective than in-furrow application.

3) Seedling Pests

Corn Flea Beetles

Corn flea beetles transmit bacterial wilt disease (also known as Stewart's wilt) and are numerous after mild winters. If possible, use varieties resistant to bacterial wilt disease. Plants are most vulnerable to this disease in the seedling stage. Treat susceptible varieties at spike stage when > 5% of the plants are infested with beetles. **Note: Commercially applied neonicotinoid seed treatments (Cruiser, Gaucho, or Poncho) provide early-season protection from corn flea beetle injury.**

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Sevin XLR Plus[1]	1.0 to 2.0 qt/A[1]	carbaryl[1]	2	24	H
3A	Pyrethroid insecticides registered for use on Sweet Corn: see table at the end of Insect Control.					
4A	Assail 30SG Assail 30SC	4.0 to 5.3 oz/A 3.4 to 4.5 fl oz/A	acetamiprid	7	12	M

[1]Use of carbaryl prohibited on hand harvested corn.

Cutworms See also section E 3.1. Soil Pests - Detection and Control.

Black cutworm is a sporadic pest that can be particularly problematic in no-till situations. Cutworms can clip corn seedlings killing entire plants as they craw down a row. Use of a soil-applied insecticide for other pests such as white grubs and rootworms will provide some control of cutworms.

For rescue treatment, apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Sevin XLR Plus[1]	2.0 qt/A[1]	carbaryl[1]	see label	see label	H
3A	Pyrethroid insecticides registered for use on Sweet Corn: see table at the end of Insect Control.					

[1]Use of carbaryl prohibited on hand harvested corn

True Armyworms

Armyworms are a sporadic pest that chew jagged holes in the edges of leaves. They are primarily a concern of seedling to early-whorl stage corn. They are active at night.

For rescue treatment, apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*[1]	0.75 to 1.5 pt/A[1]	methomyl[1]	see label	48	H
3A	Pyrethroid insecticides registered for use on Sweet Corn: see table at the end of Insect Control.					
5	Blackhawk 36WG	2.2 to 3.3 oz/A	spinosad	1	4	M
5	Radiant SC	3.0 to 6.0 fl oz/A	spinetoram	1	4	M
18	Intrepid 2F	4.0 to 16.0 fl oz/A	methoxyfenozide	3	4	L
18 + 5	Intrepid Edge	4.0 to 12.0 fl oz/A	methoxyfenozide + spinetoram	3	4	M
28	Vantacor	1.7 to 2.5 fl oz/A	chlorantraniliprole **- soil**	1	4	L
28	Vantacor	1.2 to 2.5 fl oz/A	chlorantraniliprole **- foliar**	1	4	L

[1]Read new methomyl label restrictions regarding use on seedling stage corn and before tassel push!

Stink Bugs

Note: Brown and brown marmorated stink bugs are less susceptible to pyrethroids than green and southern green stink bugs. Careful pyrethroid selection is advised, consult your local Cooperative Extension Service for recommendations for your area.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
3A	Pyrethroid insecticides registered for use on Sweet Corn: see table below.					

4) Managing Whorl Stage Corn for Lepidopteran Pests

Whorl/Tassel Infestation by European Corn Borer (ECB) and Fall Armyworm (FAW)

In general, insect larval feeding (ECB and FAW) during the whorl stage of development has a greater impact on early planted, short-season varieties. For ECB on early plantings, apply first spray when 15% of the plants show fresh feeding signs. Additional applications may be necessary if infestation remains above 15%. An early tassel treatment is usually more effective than a whorl treatment because larvae are more exposed to the chemicals.

For mid- and late-season plantings, the impact of infestation depends on the growth stage of the plants. Treat for FAW during the early whorl stage when more than 15% of the plants are infested. During mid- to late-whorl stages, treatment for both FAW and ECB may be necessary if more than 30% of the plants are infested. Treat fields in early tassel stage if more than 15% of the emerging tassels are infested with ECB, FAW, or young CEW larvae. Thorough spray coverage in whorls and on plants is essential; direct spray over the plants so that it penetrates leaf whorls. For foliar spray applications, 50-75 gal/A is necessary for effective control. Group 3A pyrethroids may not provide complete control of FAW.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*[1]	0.75 to 1.5 pt/A[1]	methomyl[1]	see label	48	H
3A	Pyrethroid insecticides registered for use on Sweet Corn: see table at the end of Insect Control.					
5	Blackhawk 36WG	2.2 to 3.3 oz/A	spinosad	1	4	M
5	Radiant SC	3.0 to 6.0 fl oz/A	spinetoram	1	4	M
18	Intrepid 2F	4.0 to 16.0 fl oz/A	methoxyfenozide	3	4	L
18 + 5	Intrepid Edge	4.0 to 12.0 fl oz/A	methoxyfenozide + spinetoram	3	4	M
22	Avaunt 30WDG, Avaunt eVo	2.5 to 3.5 oz/A	indoxacarb-**through tassel push only**	3	see label	H
28	Vantacor	1.2 to 2.5 fl oz/A	chlorantraniliprole – **foliar**	1	4	L

[1]Read new methomyl label restrictions regarding use on seedling stage corn and before tassel push!

5) Ear Protection

Corn Earworms (CEW) and Other "Worm" Pests Including European Corn Borers (ECB), Fall Armyworms (FAW), and Western Bean Cutworms (WBC)

CEW is the major pest attacking corn ears in the Mid-Atlantic U.S. Moth activity increases after mid-July and continues into September. One female can deposit an egg on hundreds of ears. Direct sampling for CEW, FAW, and ECB during silking is not practical. Begin treatment when the ear shanks emerge or the very first silks appear. Silk sprays should continue on a schedule based on area blacklight or pheromone trap counts, geographical location, and time of year. Before mid-July, silk sprays may be required on a 3-6-d schedule. When CEW populations are heavy (> 10 moths per night), and/or later in the summer, it may be necessary to treat on a 2-3 day schedule.

Note that CEW populations have developed resistance to pyrethroids (Group 3A) which may result in inadequate control, particularly in the late season. Pyrethroids should be used with caution and rotated to other insecticide classes within a season or tank mixed with other, effective insecticides.

Applications during the low populations can be terminated up to 5 d before last harvest. During heavy populations and high temperatures, treatments will need to be made according to the legal "days to harvest" of the chemical. For best control during heavy infestations, maximize the gallonage of water per acre, use a wetting agent, and make applications during the early morning if possible**. If irrigation or rain wash off the spray within 24 h** after an application, repeat treatment as soon as the foliage dries. For more precise timing of silk sprays, use blacklight and pheromone traps to determine the actual moth activity on your farm. Contact your county Extension agent or consult your state pest management newsletter for more information on these techniques.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	1.0 to 1.5 pt/A	methomyl	see label	48	H
3A	Pyrethroid insecticides registered for use on Sweet Corn: see table at the end of Insect Control.					
5	Blackhawk	2.2 to 3.3 oz/A	spinosad	1	4	M
5	Radiant SC	3.0 to 6.0 fl oz/A	spinetoram	1	4	M
18 + 5	Intrepid Edge	4.0 to 12.0 fl oz/A	methoxyfenozide + spinetoram	3	4	M
28	Vantacor	1.2 to 2.5 fl oz/A	chlorantraniliprole - **foliar**	1	4	L

Corn Leaf Aphids

Corn leaf aphids are contamination concerns for sweet corn as their densities can reach extremely high numbers on corn husks leading to sticky honey dew build up and concomitant sooty mold growth on the husks. This hurts marketability. Aphid outbreaks are typically caused by frequent applications of pyrethroid insecticides, which **do not** control the aphids, but rather eliminate natural enemies that consume the aphids under normal conditions. In recent years, melon aphids and bird cherry oat aphids have also reached high densities in Delmarva corn; melon aphids are less susceptible to methomyl than corn leaf aphids and bird cherry oat aphids. *(continued next page)*

Corn Leaf Aphids - continued

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A[1]	Lannate LV*	0.75 to 1.5 pt/A	methomyl	see label	48	H
4A	Assail 30SG Assail 30SC	2.1 to 2.9 oz/A 1.8 to 2.4 fl oz/A	acetamiprid	1	12	M
4C	Transform WG	0.75 to 1.5 fl oz/A	sulfoxaflor	7	24	H
4D	Sivanto Prime	7.0 to 14.0 fl oz/A	flupyradifurone	7	4	M

[1]Susceptibility concerns with melon aphids

Corn Rootworm Adults and Japanese Beetles - Silk Clipping Beetles

High rates of silk feeding by corn rootworm beetles, Japanese beetles, and other silk-feeders can affect pollination and cause ear quality problems. **Note: Sweet corn varieties with the *Bacillus thuringiensis* genes will NOT control any of these insects.** For silk feeding insects, when more than 50% of ears have fresh silks cut back and the plants are still pollinating, an insecticide spray also is recommended.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	0.75 to 1.5 pt/A	methomyl	see label	48	H
3A	Pyrethroid insecticides registered for use on Sweet Corn: see table at the end of Insect Control.					
4A	Assail 30SG Assail 30SC	4.0 to 5.3 oz/A 4.5 fl oz/A	acetamiprid	7	12	M

Grasshoppers

Grasshoppers may be quite conspicuous on corn feeding on leaves, but they are seldom of economic concern because they often move into corn later in the season after other grasses and plants have dried down or been harvested. Unless they are seedlings, corn plants typically can tolerate their feeding injury. Grasshoppers also are more abundant on field edges giving the impression that their pest densities are higher than they actually are across the field. Most insecticides (Group 1A, 1B, 3, or 4A) applied to other insects will also control grasshoppers.

Mites

Mites feed by removing fluids from plant tissue leading to lighter colored or white areas described as stippling. Extensive feeding may lead to reduced photosynthesis and reduced vigor of plants.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
10B	Zeal Pro / MVP	11.5 to 34.6 fl oz/A	etoxazole	**21**	**12**	**L**
10B	Zeal SC	2.0 to 6.0 fl oz/A	etoxazole	21	12	L
23	Oberon 2SC	5.7 to 16.0 fl oz/A	spiromesifen	5	12	M
23	Oberon 4SC	2.85 to 8.0 fl oz/A	spiromesifen	5	12	M

Sap (Picnic, Dusky) Beetles

Most sap beetle infestations follow behind "worm" infestations, which create entry holes for the beetles to reach kernels to deposit their eggs. Nevertheless, on farms with a known history of sap beetle problems, an insecticide application 5-6 days after the first onset of silking is the best timing for maximum protection against these pests, which are attracted to the ear zone to lay eggs as silk tissue degrades. Varieties with long, tight silk tubes can reduce sap beetle damage. Begin sampling at pollen shed and treat when 5% of the ears have adults and/or eggs. Most insecticides used for "worm" control at silking will control these beetles. **Note: Sweet corn varieties with the *Bacillus thuringiensis* genes will NOT control sap beetles.**

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	0.75 to 1.5 pt/A	methomyl	see label	48	H
1A	Sevin XLR Plus[1]	1.0 to 2.0 qt/A[1]	carbaryl[1]	see label	see label	H
3A	Pyrethroid insecticides registered for use on Sweet Corn: see table at the end of Insect Control					
4A	Assail 30SG Assail 30SC	4.0 to 5.3 oz/A 3.4 to 4.5 fl oz/A	acetamiprid	7	12	M

[1]Use of carbaryl prohibited on hand harvested corn

Stink Bugs

Stink bugs including the invasive brown marmorated stink bug can feed on developing ears resulting in misshapen ears, unfilled kernels, collapsed kernels, and kernels that turn dark after corn is cooked. **Note: Sweet corn varieties with the *Bacillus thuringiensis* genes will NOT control any of these insects.**

Note: Brown and brown marmorated stink bugs are less susceptible to pyrethroids than green and southern green stink bugs. Careful pyrethroid selection is advised, consult your local Cooperative Extension Service for recommendations for your area.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
3A	Pyrethroid insecticides registered for use on Sweet Corn: see table below.					

Group 3A Pyrethroid Insecticides Registered for Use on Sweet Corn					
Apply one of the following formulations (check if the product label lists the insect you intend to spray; the label is the law):					
Product Name (*=Restricted Use)	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
Asana XL*	5.8 to 9.6 fl oz/A	esfenvalerate	1	12	H
Baythroid XL*	0.8 to 2.8 fl oz/A	beta-cyfluthrin	0	12	H
Brigade 2EC*, others	2.1 to 6.4 fl oz/A	bifenthrin	1	12	H
Hero*	4.0 to 10.3 fl oz/A	zeta-cypermethrin + bifenthrin	3	12	H
Lambda-Cy 1EC*, others	2.56 to 3.84 fl oz/A	lambda-cyhalothrin	1	24	H
Mustang Maxx*	2.24 to 4.0 fl oz/A	zeta-cypermethrin	1	12	H
Permethrin 3.2EC*, others	4.0 to 8.0 fl oz/A	permethrin	1	12	H
Tombstone*	0.8 to 2.8 fl oz/A	cyfluthrin	0	12	H
Warrior II*	1.28 to 1.92 fl oz/A	lambda-cyhalothrin (see label for cutworm rate)	1	24	H
Combo products containing a pyrethroid					
Besiege*	6.0 to 10.0 fl oz/A	lambda-cyhalothrin+chlorantraniliprole (Group 28)	1	24	H
Elevest*	4.8 to 9.6 fl oz/A	bifenthrin + chlorantraniliprole (Group 28)	1	12	H
Ethos XB*	3.4 to 17.0 fl oz/A (at plant) 4.0 to 5.3 fl oz/A (PPI) 3.4 fl oz/A (PRE)	bifenthrin + *Bacillus amyloliquefaciens* - **soil**	n/a	12	H
Ethos XB*	2.8 to 8.5 fl oz/A	bifenthrin + *Bacillus amyloliquefaciens* - **foliar**	1	12	H
Savoy EC*	6.0 to 12.9 fl oz/A	bifenthrin + acetamiprid Group 4A)	7	12	H

Disease Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F. Recommended Fungicides

Nematodes

Control is very important to the production of sweet corn. See also sections E 1.5. Soil Fumigation and E 1.6 Nematode Control. Use fumigants listed in section E 1.5., or one of the following:

Code	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1B	Counter 20G*	see label for use directions (**not for use in WV**)	terbufos	AP	48	H
1B	Mocap 15G*	see label for use directions	ethoprop	AP	48	H

Seed Treatment

Request that seed be treated with one or more of the following fungicides for seedling diseases and damping-off: Allegiance, Apron XL, Dynasty, Captan, Thiram, Vitavex or Maxim XL. Seed treatment with these fungicides is especially important for preventing early season seeding diseases of Super Sweet (sh) varieties.

Bacterial and Fungal Diseases

Leaf Blights (Northern, Southern, and Anthracnose Leaf Blights), and Leaf Spots (Gray Leaf Spot, Northern Corn Leaf Spot)

These diseases originate in corn residue and progress up the plant with persistent rain or overhead irrigation. Avoid planting continuous corn and bury residue with deep tillage immediately after harvest. For optimal control, begin sprays before symptoms appear or very early stage of symptom appearance if favorable weather for disease development persists. Regular scouting and protectant fungicides late in the season may be necessary.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Apply one of the following protectant fungicides:						
M03	mancozeb 75DF	1.5 lb/A	mancozeb	7	24	N
M05	chlorothalonil 6F (7-day schedule, **do not** apply to corn to be processed)	0.75 to 2.0 pt/A	chlorothalonil	12	12	N
AND rotate on a 7-14 day schedule with one of the following (do not apply the same fungicide more than twice in a row; switch to fungicides with different FRAC codes):						
3	Tilt 3.6EC (not registered for Anthracnose)	2.0 to 4.0 fl oz/A	propiconazole	12	12	N
3 + 3	Prosaro 421SC	6.5 fl. oz/A (5-14 day schedule)	tebuconazole + prothioconazole	7	12	N
3+7+11	Trivapro 2.21SE	14.5 fl oz/A	propiconazole + benzovindiflupyr + azoxystrobin	7	12	N
3+7+11	Miravis Neo	13.7 fl oz/A	propiconazole + pydiflumetofen + azoxystrobin	14	12	N
3 + 11	Headline AMP 1.68SC	10.0 to 14.4 fl oz/A	metconazole + pyraclostrobin	20	12	N
3 + 11	Quilt Xcel 2.2SE	10.5 to 14 fl oz/A	propiconazole + azoxystrobin	14	12	N
3 + 11	Stratego 2.08EC (Anthracnose, GLS)	10.0 fl oz /A	propiconazole + trifloxystrobin	14	12	N
3 + 11	Stratego YLD 4.18EC (Anthracnose, GLS)	4.0 to 5.0 fl oz/A (5-14 d. schedule)	prothioconazole + trifloxystrobin	0	12	N
3 + 11	Veltyma 3.34SC	7.0 to 10.0 fl oz/A	mefentrifluconazole + pyraclostrobin	21	12	N
7 + 11	Priaxor 4.17SC	4.0 to 8.0 fl oz/A	fluxapyroxad + pyraclostrobin	7	12	N
M03+11	Dexter Max (not registered for Anthracnose)	1.6 lb/A	mancozeb + azoxystrobin	7	24	--
11	Aproach 2.08SC	6.0 to 12.0 fl oz/A	picoxystrobin	7	12	N
11	azoxystrobin 2.08F	9.2 to 15.5 fl oz/A	azoxystrobin	7	4	N
11	Headline 2.09EC	9.0 to 12.0 fl oz/A	pyraclostrobin	7	12	N

Root and Stalk Rots

Root and stalk rots are caused by several species of fungi, including *Fusarium*, *Diplodia*, and *Macrophomina,* as well as species of the oomycete *Pythium*. Some of these fungi enter through the roots and move up into the stalk, while others enter the stalk directly at the nodes. Insects can increase infection by enabling fungi to enter the plant in damaged areas. Use fungicide-treated seed and plant in well-drained areas. Do not exceed recommended plant densities. Keep soil fertility balanced based on soil tests. Manage insects throughout the growing season.

Rust (Common and Southern)

Rust is caused by a pathogen that blows into our region from Southern areas. In most years chemical control measures are not necessary but rust occasionally becomes troublesome on susceptible hybrids planted later in the growing season. Corn warrants spraying if infection occurs prior to the whorl stage, particularly if Southern rust is detected. Scout fields on a regular basis.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
If pustules are observed prior to the whorl stage, apply one of the following on a 7-14 day schedule (do not apply the same fungicide more than twice in a row; switch to fungicides with different FRAC codes):						
3 + 3	Prosaro 421SC	6.5 fl. oz/A (5-14 day schedule)	tebuconazole + prothioconazole	7	12	N
3+7+11	Trivapro 2.21SE	14.5 fl oz/A	propiconazole + benzovindiflupyr + azoxystrobin	7	12	N
3+7+11	Miravis Neo	13.7 fl oz/A	propiconazole + pydiflumetofen + azoxystrobin	14	12	N
3 + 11	Headline AMP 1.68SC	10.0 to 14.4 fl oz/A	metconazole + pyraclostrobin	20	12	N

Rust (Common and Southern) - continued next page

Rust (Common and Southern) - continued

3 + 11	Quilt Xcel 2.2SE	10.5 to 14 fl oz/A	propiconazole + azoxystrobin	14	12	N
3 + 11	Stratego 2.08EC	10.0 fl oz /A	propiconazole + trifloxystrobin	14	12	N
3 + 11	Stratego YLD 4.18EC	4.0 to 5.0 fl oz/A (5-14 day schedule)	prothioconazole + trifloxystrobin	0	12	N
7 + 11	Priaxor 4.17SC	4.0 to 8.0 fl oz/A	fluxapyroxad + pyraclostrobin	7	12	N
M03+11	Dexter Max[1] (for common rust)	1.6 lb/A	mancozeb + azoxystrobin	7	24	--

[1]Dexter Max is extremely toxic to some apple varieties. See label.

Smut

There is no true genetic resistance to smut in sweet corn. Later maturing, larger varieties tend to be more tolerant to smut than early maturing, smaller varieties. Since damaged tissue is more prone to infection, control corn borers, stink bugs, and other problematic insect pests as the first tassel appears.

Stewart's Bacterial Wilt

Use varieties resistant to Stewart's wilt listed in the sweet corn varieties table at the front of this section in areas with a history of bacterial wilt. More variety information relative to Stewart's Bacterial Wilt is available at: *http://sweetcorn.illinois.edu/index.html*. Control of flea beetles is essential for effective disease management. Flea beetles transmit Stewart's wilt and are prevalent after mild winters. Use insecticide-treated seed or a recommended insecticide at seedling emergence. Treat susceptible varieties at spike stage when 5% of the plants are infested. See Insect Control Section for flea beetle control recommendations.

Tar Spot (*Phyllachora maydis*)

Corn Tar Spot is a fungal leaf disease that was first detected in the United States in 2015 in Illinois and Indiana and has since spread to multiple states. Fungicide application time may vary depending on the onset of disease, however, application during corn reproductive stage (silking-growth stage R1) has been found most effective for controlling tar spot.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
3 + 7	Lucento	5.0 to 5.5 fl oz/A	flutriafol + bixafen	10	See label	N
3 + 11	Veltyma	7.0 to 10.0 fl oz/A	mefentrifluconazole + pyraclostrobin	21	12	N
3 + 11	Delaro 325 SC	8.0 to 12.0 fl oz/A	prothioconazole + trifloxystrobin	See label	24	--
3+11+7	Trivapro 2.21 SE	13.7 fl oz/A	propiconazole + azoxystrobin + benzovindiflupyr	14	12	N
3+11+7	Adastrio 4.0 SC[1]	7.0 to 9.0 fl oz/A	flutriafol + azoxystrobin + fluindapyr	See label	See label	--
3+11+7	Miravis Neo 2.5 SE	13.7 fl oz/A	propiconazole + azoxystrobin + pydiflumetofen	14	12	N
3+11+7	Delaro Complete	8.0 fl oz/A	prothioconazole + trifloxystrobin + fluopyram	See label	12	NA
7 + 11	Priaxor Xemium[1]	4.0 to 8.0 fl oz/A	fluxapyroxad + pyraclostrobin	7	12	N
7+3+11	Revytek	8.0 to 15 fl oz/A	fluxapyroxad + mefentrifluconazole + pyraclostrobin	21	12	N
11	Aproach[1]	6.0 to 12.0 fl oz/A	picoxystrobin	7	12	N
11 + 3	Headline AMP[1]	10.0 to 14.4 fl oz/A	pyraclostrobin + metconazole	7	12	N
11 + 3	Topguard EQ[1]	5.0 to 7.0 fl oz/A	azoxystrobin+ flutrifol	7	72	N
11 + 3	Quilt Xcel 2.2 SE[1]	10.5 to 14 fl oz/A	azoxystrobin+ propiconazole	14	12	N

[1] See section 2(ee) label and confirm availability in your state.

Viruses

Maize Dwarf Mosaic Virus (MDMV)

MDMV is most likely to occur on corn planted after July 1. The virus is transmitted by aphids to sweet corn from infected weeds, especially Johnsongrass. Less frequently, the disease may be transmitted in/on seed. For control, manage weeds and aphids and plant healthy (disease free) seeds of resistant varieties for fall harvest.

Sweet Potatoes

Recommended Varieties

Variety[1]	Skin	Flesh	SB[2]	SR[2]	RK[2]	FW[2]	RZ[2]	BSR[2]	FRR[2]
Averre	Light Rose	Orange	I	I	S	R			
Bayou Belle	Red/Purple	Orange		R	S	R	I		R
Beauregard B-14 (compact)	Light Rose	Orange	I	I	S	R	R	S	R
Beauregard B-63 (extended vine)	Light Rose	Orange	I	I	S	R	R	S	R
Bellevue	Copper	Orange		I	R	R	R	S	
Bonita	Light Tan	White		I	R	I	S		S
Burgundy	Red	Orange		I	R	R	S	I	
Covington	Rose	Orange		R	R				R
Evangeline	Light Rose	Orange	R	I	R	R	R		R
Jewel	Copper	Orange	I	S	R	R	I	I	I
O'Henry	Cream	White	I	I	S	R	R	S	R
Orleans	Light Rose	Orange		I	S	R	R	S	R
Purple Splendor	Dark Purple	Purple		R	R	R			

[1]**Listed alphabetically**.
[2]S Susceptible, I Intermediate Resistant; R Resistant; SB = Sclerotinia Blight; SR = Soil Rot (Pox); RK = Root Knot Nematode; FW = *Fusarium* Wilt; RZ = *Rhizopus* Rot; BSR = Bacterial Soft Rot; FRR = *Fusarium* Root Rot.

Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and chapter B Soil and Nutrient Management. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede recommendations found below.

Sweet Potatoes[1]		Soil Phosphorus Level				Soil Potassium Level				
		Low	Med	High (Opt)	Very High	Low	Med	High (Opt)	Very High	
	N (lb/A)	P_2O_5 (lb/A)				K_2O (lb/A)				Nutrient Timing and Method
	50-75	200	100	50	0[2]	300	200	100	0[2]	Total nutrient recommended.
	25	200	100	50	0[2]	300	200	100	0[2]	Broadcast and disk-in
	25-50	0	0	0	0	0	0	0	0	Sidedress when vines start to run.

[1]Apply 20-30 lb/A of sulfur (S) for most soils. [2]In VA, crop replacement values of 25 lb/A of P_2O_5 and 50 lb/A of K_2O are recommended on soils testing Very High.

Variety Selection

Select variety according to market preferences, local adaptation, and specific soil problems. Current varieties require 100 to 140 days to achieve maximum yield, depending on cultural practices, irrigation, and environmental conditions. Use certified G1 or G2 (generations), virus tested, disease-free "seed" (storage root used for transplant/slip production) or cuttings (sprouts or slips for field planting) to maximize yield and quality.

Site Selection, Soil and Fertilization

Well-drained sandy to sandy loam soils are best for sweet potato, either bedding or production. Avoid heavy soils and soils that will stand water for more than 24 hr. Avoid excessive amounts of organic matter (such as fields just broken from hay or pastures). Soils with high levels of organic matter may promote scurf, and fields previously in hay/pasture/turf may be infested with high populations of Asian beetle larvae. Use long rotations with grains and soybeans to decrease the incidence of soil-borne diseases. Avoid fields with high nematode populations and those that had sweet potato in the past two years. Test the soil for nematodes and fertility. Optimum soil pH is 5.8-6.2. If lime is needed, apply it several months before planting. All P and K can be applied before planting. Apply half of the recommended N before planting (broadcast or band) and apply the rest at layby when vines start to run.

Irrigation

Although sweet potatoes are traditionally known as drought tolerant, they still require adequate moisture to produce good quality roots. Plant available soil water fluctuations can cause small, cracked, and misshaped roots. Sweet potatoes can be irrigated using overhead or drip irrigation. The total amount of water applied to the crop should be equal to its requirement plus the volume lost through evaporation and runoff. Soil moisture and irrigation management are key for the success of the crop (see Chapter C Irrigation Management).

Plant Production

Sweet potato is propagated vegetatively by sprouts or slips from storage roots (“seed”). Select good quality, certified G1 or G2 “seeds” that are uniform and free from insects and diseases. Before bedding, “seed roots” should be pre-sprouted at 85°F (29°C) and 90% relative humidity for 3-4 weeks until the sprouts are 1-1½ inch long. Make sure “seed roots” are well ventilated because the process requires oxygen. For bedding, avoid sites that had sweet potato in the past 3 years to reduce the risk of diseases. Fertilize with 4-5 lb/100 sq ft bed area of 8-8-8 or its equivalent. Bed “seed root” stock the first week of April and use black or clear plastic mulch to warm up the soil. The minimum soil temperature for sweet potato to grow is 60°F (16°C). Treat “seed roots” with appropriate fungicides to reduce decay. Spread “seed roots” (one layer) in beds 2-3 ft wide, cover with 2-3 inches of soil or sand and cover with plastic mulch. After 5-7 days, punch holes every 4 ft on each side of the bed to prevent accumulation of carbon dioxide. When clear plastic mulch is used, apply an herbicide (see the Weed Control section). Remove plastic mulch when sprouts begin to emerge and cover with floating row cover to promote growth and protect against cold temperatures. Remove row covers 5-7 days prior to planting to harden the slips. The warmer conditions in greenhouses and high tunnels (hoop houses) promote sprouting and growth for an early production of slips. For optimal growing conditions keep beds moist and temperature between 75-85°F (24-29°C); however, greenhouse or high tunnel slips are less sturdy than slips from field beds for field planting. One 50-lb bushel of “seed” roots produces 500 to 1,000 sprouts in 10-15 sq ft of bed area. For field planting, the best slips are 10-12 inches long and they should be cut (not pulled) from the beds at 1 inch above the soil line to minimize transmission of pests and diseases.

Field Planting

Sweet potato is cold sensitive and should be planted after all danger of frost is over and the soil temperature at 4 inch-deep is >65°F (>18°C). The optimum growth temperature is between 70-85°F (21-29°C), although plants can tolerate temperatures between 65-95°F (18-35°C). Plant slips in the field between May 5 and June 15 in warmer, southern areas and between May 20 and June 5 in cooler areas. Plant slips on moist ridged rows 8 to 10” high. Within-row spacing depends on variety selection and runs between 10 to 18" between individual plants (note: larger spacing between plants can promote larger than normal storage roots). Row spacing can range between 36 to 42” (14,500 to 12,500 slips per acre at 12” within row spacing). Optimal spacing is contingent on soil fertility and soil water. In cooler climates, black plastic mulch can be used supplied with drip irrigation with rows spaced between 48 to 60” (8,712 to 10,890 slips per acre at 12” within row spacing). Water or starter fertilizer solution (1 oz/gal of 15-30-15 or equivalent) at 4 to 5 oz/slip applied at planting will benefit establishment. If irrigation is available, water field immediately after planting and then as needed (see also **Irrigation** above).

Harvest and Post-Harvest Considerations

Prior to harvest, scout the field to determine storage root size and appropriate proportion of desired market grade. Pre-harvest conditioning and appropriate harvest handling is critical to reduce bruising of the delicate skin. Bruising, wounding, and skinning roots during harvest increase the incidence of diseases. Even if the injury heals, large scars render unappealing storage roots with no fresh market value. Kill vines mechanically (devining) with a flail mower of appropriate design 5-10 d before harvest to improve skin set and facilitate harvest.

Various methods can be used to harvest sweet potatoes. Growers with a small area may harvest by hand using a garden fork. Intermediate sized commercial growers can use a 1 or 2-row modified mold board or disc plow, or middle buster with a notched coulter adjusted just left of the main stems to turn the rows and expose the storage roots. Remove roots from the vines by hand and place them into smooth baskets. Use gloves to keep bruises and abrasions to a minimum. Mechanical diggers patterned after a low flat-bed type potato digger or digger-windrower can facilitate harvest in larger areas. These are 1 or 2-row diggers that incorporate a short separating chain behind a wide blade to dig both soil and roots onto the chain. Soil falls through the chain as the storage roots move up with the chain and drop off to the ground in the back of the digger. Care must be taken to bring enough soil up with the chain to minimize bruises. Storage roots are then picked up by hand and placed in smooth sided baskets. With more advanced harvesters, the storage roots continue on the chain through a platform where they are picked up by hand and placed directly into bins. After the roots are harvested, they should be cured in the storage house at 85°F (29°C) and 85-90% relative humidity for 5-7 days to promote wound healing, reduce disease incidence, and improve sweetness. After curing, the temperature should be lowered to 55°F (13°C), but relative humidity should be maintained at 85% for long term storage.

Sweet potato is marketed based on the U.S. Standards for Grades of Sweet Potatoes. U.S. No.1 (roots of 1¾ to 3½ inches in diameter and 3 to 9 inches long) is the preferred grade for fresh market and has the highest price. U.S. No.2 includes smaller roots (canner) and larger roots (jumbo) and are accepted by the processing industry. Petite sweet potato (well-shaped small storage roots) free of blemishes have been sold also as fingerling or nuggets in specialty markets.

Weed Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.

Recommended Herbicides

1. Identify the weeds in each field and select recommended herbicides. More information is available in the "Herbicide Effectiveness on Common Weeds in Vegetables" (Table E-3) in Chapter E Pest Management.

2. Minimize herbicide resistance development. Identify the herbicide mode of action group number and follow recommended good management practices; **bolded group numbers in tables below are herbicides at higher risk for selecting resistant weed populations.** Include non-chemical weed control whenever possible.

1.a. Soil-Applied: Pretransplant

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
14	Valor SX 51WDG Valor EZ 41.4SC	3 oz/A 3 fl oz/A	**flumioxazin**	0.078 lb/A	--	12
-Apply 2 to 5 day pre-transplant after all tillage has been completed. Limit disturbance of treated soil with transplant equipment. Tillage or cultivation after applying Valor SX reduces or eliminates weed control. Valor controls many broadleaf weeds, but only suppresses annual grasses. Tank mix with Command pretransplant or follow with a residual grass product to improve control of annual grasses. -**Do not** apply postemergence to sweet potatoes. -**Do not** use on any variety other than 'Beauregard' unless user has tested Valor and found tolerance to be acceptable. -**Do not** use on greenhouse grown transplants or transplants that have been harvested more than 2 days prior to transplanting. -Flumioxazin can be difficult to clean out of spray tank and hoses. Follow tank cleaning recommendations on the label. -Maximum for Valor SX 51WDG: 3 oz/A per growing season; maximum for Valor EZ is 3 fl oz/A per year.						

1.b. Soil-Applied: After Transplanting

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
3	Dacthal 6F Dacthal W-75	8.0 to 14.0 pt/A 6.0 to 14 lb/A	**DCPA**	6.0 to 10.5 lb/A	--	12
-Apply at transplanting or 10-14 days after transplanting. Labeled for applications directly over transplants without injury. -If weeds are present, the crop should be weeded or cultivated prior to application. Dacthal controls annual grasses and certain broadleaf weeds. -Maximum application not addressed on label.						
13	Command 3ME	1.33 to 2.66 pt/A	**clomazone**	0.5 to 1.0 lb/A	95	12
-Apply after transplanting and prior to weed emergence. Use lower rates on coarse-textured soils low in organic matter and higher rates on fine-textured soils and soils with high organic matter. Use the lower rate when used on coarse-textured soils low in organic matter, when weed pressure is light, or to minimize herbicide carryover that could affect subsequent crops. -Controls annual grasses and many broadleaf weeds depending on use rate, except pigweed sp., carpetweed, morningglory sp., and yellow nutsedge. Some temporary crop injury (partial whitening of leaf or stem tissue) may occur. Complete recovery will occur from minor early injury without affecting yield or delaying maturity. -**WARNINGS**: Command spray *or* vapor drift may injure sensitive crops and other vegetation up to several hundred yards from the point of application. **Do not** apply adjacent to sensitive crops (see label) or vegetation, or under unfavorable wind or weather conditions. Command may limit subsequent cropping options, see the label. -Maximum number of applications per season is 1.						
15	Devrinol 2-XT 2EC Devrinol DF-XT 50DF	2.0 to 4.0 qt/A 2.0 to 4.0 lb/A	**napropamide**	1.0 to 2.0 lb/A	--	24
-Apply immediately after transplanting and prior to weed emergence. Rainfall or irrigation within 24 h after application improves performance (½ inch sprinkler irrigation). Annual grasses and certain annual broadleaf weeds will be suppressed or controlled. Use lower rate on coarse textured or sandy soil. Devrinol may reduce stand and yield of fall grains. Moldboard plowing will reduce the risk of injury to a small grain follow crop. Maximum Devrinol application per season: 4 qt/A (2-XT) or 4 lb/A (DF-XT).						

1.b. Soil-Applied: After Transplanting - continued next page

1.b. Soil-Applied: After Transplanting - continued

27	Optogen 1.67	2.6 to 3.5 fl oz/A	**bicyclopyrone**	0.034 to 0.046 lb/A	60	24
-Do not apply to sweet potatoes when grown on sand or loamy sand soils with less than 1% organic matter. -Apply prior to transplanting and avoid moving treated soil during transplanting. Exposed sweet potato roots could result in unacceptable injury if irrigation or rainfall moves the herbicide into the root zone. -Limited local experience with Optogen as a soil-applied herbicide. -Do not make more than one application per year.						

2. Postemergence

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
1	Shadow 3EC Select 2EC Select Max 0.97EC	4 to 10.67 fl oz/A 6 to 8 fl oz/A 9 to 16 fl oz/A	**clethodim**	0.07 to 0.24 lb/A	30	24
	Poast 1.5EC	1 to 1.5 pt/A	**sethoxydim**	0.2 to 0.3 lb/A	30	12
	Fusilade DX 2EC	8 to 12 fl oz/A	**fluazifop**	0.125 to 0.188 lb/A	14	12
-**Select 2EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). **Select Max**: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution). **Shadow 3EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution) for large or stressed grasses; use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution) when crop safety is a concern. **Poast**: use COC at 1.0% v/v. **Fusilade DX:** use COC at 1.0% v/v or NIS at 0.25% v/v. -The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to NIS when grasses are small and soil moisture is adequate. -Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control. -Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will **not** be controlled. Controls many annual and certain perennial grasses, including annual bluegrass, but Poast is preferred for goosegrass control. For best results, treat annual grasses when they are actively growing and before tillers are present. Control may be reduced if grasses are large or under hot or dry weather conditions. -Repeated applications may be necessary to control certain perennial grasses. If repeat applications are necessary, allow 14 days between applications. Rainfastness is 1 h. -Do not tank mix with or apply within 2 to 3 days of any other pesticide, unless labeled, as this may increase the risk of crop injury or reduce the control of grasses. Do not apply more than 8 fl oz/A of Select 2EC in a single application and do not exceed 2 pt/A for the season; do not apply more than 16 fl oz/A of Select Max in a single application and do not exceed 4 pt/A for the season. -Do not apply more than 5.33 fl oz/A of Shadow 3EC in a single application and do not exceed 21.33 fl oz/A for the season. -Do not apply more than 1.5 pt/A Poast in a single application and do not exceed 4.5 pt/A for the season. -Do not apply more than 12 fl oz/A of Fusilade DX in a single application and do not exceed 3 pt/A per season.						
27	Optogen 1.67	3.5 fl oz/A	**bicyclopyrone**	0.046 lb/A	45	24
-Row middle application only. -Use nonionic surfactant (NIS) at 0.25% v/v (1qt/100 gal of spray solution) or crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). Ammonium sulfate (AMS) at 8.5 to 17 lb/100 gal spray solution may be added for improved control of emerged weeds. -Apply after transplanting as either row middle treatment or as a directed spray. Hooded or shielded sprayers will reduce the risk of injury for row middle or directed sprays. -**Contact with foliage will cause injury.** -Apply to small weeds (less than 2" tall). Optogen provides control for only a few weed species, should be used in combination with other herbicides. -Rainfastness is not specified on the label. -Do not make more than one application per year.						

3. Other Labeled Herbicides These products are labeled but limited local data are available; and/or are labeled but not recommended in our region due to potential crop injury concerns.

Group	Product Name (*=Restricted Use)	Active Ingredient
14	Aim	**carfentrazone**

Insect Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.

Recommended Insecticides

In the Mid-Atlantic U.S., the primary insect pest concerns for sweet potatoes are a complex of soil-inhabiting beetle larvae including white grubs, wireworms, flea beetles, and southern corn rootworms. In general, very little economic damage occurs to this crop from above-ground insect pests. Pest control mostly occurs at planting.

Soil Insects:
Wireworms, Flea Beetle Larvae, White Grubs, and Rootworms

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1B	Mocap EC*	5.1 to 6.9 fl oz/1000 row ft	ethoprop - **preplant application in a 12-15-inch band on the row 2-3 w before planting.**	see label	48	H
3A	Brigade 2EC*, others	19.2 fl oz/A	bifenthrin **- at-planting in-furrow (wireworms)**	21	12	H
3A	Brigade 2EC*, others	3.2 to 9.6 fl oz/A	bifenthrin **- apply to soil prior to lay-by or first cultivation**	21	12	H
3A	Capture LFR*	12.75 to 25.5 fl oz/A	bifenthrin **- at-planting in-furrow or to soil prior to lay-by or first cultivation**	21	12	H
4A	Admire Pro 4.6 SC	10.5 fl oz/A	imidacloprid	125	72	H
4A	Belay 2.13SL	12 fl oz/A	clothianidin	21	12	H
30	Nurizma	0.08 to 0.16 fl oz/ 1000 row ft	broflanilide	AP	12	H

Cutworms

See also section E 3.1. Soil Pests - Detection and Control.
Various species can cause direct damage to sweet potatoes as well as sever plant stems.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
3A	Baythroid XL*	0.8 to 1.6 fl oz/A	beta-cyfluthrin	0	12	H
3A	Hero*	2.6 to 6.1 fl oz/A	zeta-cypermethrin + bifenthrin	21	12	H
3A	Lambda-Cy 1EC*, others	1.92 to 3.2 fl oz/A	lambda-cyhalothrin	7	24	H
3A	Mustang Maxx*	1.28 to 4.00 fl oz/A	zeta-cypermethrin	1	12	H
3A	Tombstone*	0.8 to 1.6 fl oz/A	cyfluthrin	0	12	H
3A	Warrior II*	0.96 to 1.6 fl oz/A	lambda-cyhalothrin	7	24	H
3A + 28	Besiege*	5.0 to 8.0 fl oz/A	lambda-cyhalothrin + chlorantraniliprole	14	24	H

Cucumber Beetles, Flea Beetles, Click Beetles, and Tortoise Beetle Adults

Well timed foliar applications during the summer months targeting beetle adults can help reduce the number of eggs deposited in fields, which may reduce the amount of larval damage to roots.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Sevin XLR Plus	0.5 to 1.0 qt/A	carbaryl	7	12	H
3A	Baythroid XL*	1.6 to 2.8 fl oz/A	beta-cyfluthrin	0	12	H
3A	Brigade 2EC*, others	2.1 to 6.4 fl oz/A	bifenthrin	21	12	H
3A	Hero*	4.0 to 10.3 fl oz/A	zeta-cypermethrin + bifenthrin	21	12	H
3A	Lambda-Cy 1EC*, others	2.56 to 3.84 fl oz/A	lambda-cyhalothrin	7	24	H
3A	Mustang Maxx*	1.76 to 4.00 fl oz/A	zeta-cypermethrin	1	12	H
3A	Tombstone*	1.6 to 2.8 fl oz/A	cyfluthrin	0	12	H
3A	Warrior II*	1.28 to 1.92 fl oz/A	lambda-cyhalothrin	7	24	H
3A + 4A	Brigadier*	5.1 to 7.7 fl oz/A	bifenthrin + imidacloprid - **foliar**	21	12	H
3A + 4A	Endigo ZC*	3.5 to 4.5 fl oz/A	lambda-cyhalothrin + thiamethoxam	14	24	H
3A + 4A	Endigo ZCX*	3.0 to 3.5 fl oz/A	lambda-cyhalothrin + thiamethoxam	14	24	H
3A + 4A	Leverage 360*	2.4 to 2.8 fl oz/A	imidacloprid + beta-cyfluthrin	7	12	H
3A + 4A	Savoy EC*	3.6 to 6.1 fl oz/A	bifenthrin + acetamiprid	21	12	H
3A + 28	Besiege*	6.0 to 9.0 fl oz/A	lambda-cyhalothrin + chlorantraniliprole	14	24	H
4A	Actara 25WDG	1.5 to 3.0 oz/A	thiamethoxam	14	12	H
4A	Admire Pro	1.2 fl oz/A	imidacloprid - **foliar**	7	12	H
4A	Assail 30SG Assail 30SC	1.5 to 4.0 oz/A 1.3 to 3.4 fl oz/A	acetamiprid	7	12	M
4A	Belay 2.13SC	2.0 to 3.0 fl oz/A	clothianidin - **foliar**	14	12	H

Disease Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.
Recommended Fungicides

Nematodes

See also sections E 1.5. Soil Fumigation and E 1.6. Nematode Control. Use fumigants listed in section E.1.5 or below. Consult the label.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
1A	Vydate L*	1 to 2 gal/A in at least 20 gal/A pre-plant in furrow treatment. See label.	oxamyl	AP	48	H
1B	Mocap 15G*	1.6 to 2.1 lb per 1,000 ft row in a band 12 to 15-inches wide on the row 2 to 3 weeks before planting. See label.	ethoprop	AP	48	H
7	Velum Prime 4.16SC	6.0 to 6.84 fl oz/A	fluopyram	7	12	--
N-UN	Nimitz 480EC	3.5 to 7.0 pints/treated A	fluensulfone	AP	12	--

Damping-off (*Pythium and Phytophthora* spp.)

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
4	Ridomil Gold 4SL	1.0 to 2.0 pt/A	mefenoxam	AP	48	N
21	Ranman 400SC	6.1 fl oz/A (on 36" row spacing). Apply at planting. See label.	cyazofamid	7	12	L
22	Elumin 4SC	8.0 fl oz/A	ethaboxam	--	12	--
43	Presidio 4SC	3.0 to 4.0 fl oz/A	fluopicolide	7	12	L
4	MetaStar 2 E	4.0 to 8.0 pt/treated acre preplant incorporated or soil surface spray. See label.	metalaxyl	7	48	N

Damping-off (*Pythium and Rhizoctonia*)

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
4 + 11	Uniform 3.66SE	0.34 fl oz/1,000 ft row	mefenoxam + azoxystrobin	AP	12	N
11	azoxystrobin 2.08F	0.4 to 0.8 fl oz/1,000 ft row	azoxystrobin	AP	4	N

Bacterial and Fungal Diseases

Bacterial Stem and Root Rot (*Dickeya dadantii*)

Management should be based on sanitation and handling to prevent wounds and contamination. Select disease-free "seed" roots and cut slips 1 inch above ground. Make holes in the plastic mulch to avoid anaerobic conditions. Use field with good drainage to avoid waterlogging. Maintain dry roots before packing.

Black Rot (*Ceratosistis fimbriata*), Scurf (*Monilochaetes infuscans*), and Foot Rot (*Plenodomus destruens*)

Sanitation, "seed" root free of diseases, cut slips 1-inch above soil, field rotation, and curing immediately after harvest (see Harvest and Post-Harvest Considerations) help reduce the incidence of these diseases.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
1	Mertect 340-F	107 fl oz/100 gal, dip "seed" roots before bedding, see label	thiabendazole	0.5	12	N

Sclerotinia Blight and Circular Spot (*Sclerotium rolfsii*)

Also known as Southern Blight. Plant in fields without a history of the problem. Dip roots in registered fungicides. Remove bed mulch as soon as sprouts start to emerge.

Streptomyces Soil Rot (Pox)

Use resistant varieties. Maintain a pH between 4.8-5.2 to assist in control. Use crop rotation, clean seed, and clean beds. Fumigation prior to planting may also help.

Post-Harvest

Post-Harvest Black Rot (*Ceratosistis fimbriata*)

Sanitation, “seed” root free of diseases, cut slips 1-inch above soil, field rotation, and curing immediately after harvest (see Harvest and Post-Harvest Considerations) help reduce the incidence of these diseases.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
1	Mertect 340-F	0.42 fl oz in a minimum 0.5 gallons water per 2,000 lb of roots See label.	thiabendazole	0.5	12	N

Post-Harvest Fusarium Rot/Silver Scurf

Care handling to reduce wounding. Cure immediately after harvest (see Harvest and Post-Harvest Considerations).

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
11+12+3	Stadium 34.78SC (only labeled in PA)	1 fl oz per 2,000 lb of roots (only labeled in PA)	azoxystrobin + fludioxonil + difenoconazole	--	--	L

Post-Harvest Soft Rot (*Rhizopus*)

Care handling to reduce wounding. Cure immediately after harvest
(see Harvest and Post-Harvest Considerations).

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
12	Scholar 1.9SC	8 to 16 fl oz/100 gal, see label	fludioxonil	--	12	L

Tomatoes

Recommended Varieties (listed in alphabetical order within type)

Market Tomatoes

Type	Variety[1]	Color	Season	Culture	Use[2]	Disease Resistance[3]	Plant Habit[4]
Globe	Amelia	Red	Mid	Field	LW, S	V,F,Tswv	D
	Bella Rosa	Red	Mid	Field	DM, LW, S	V,F,Asc,Gls,Tswv	D
	BHN 589	Red	Mid	Field, High Tunnel	DM, LW	V,F,Tomv	D
	BHN 602	Red	Mid, Late	Field	DM, LW, S	V,F,Tswv	D
	BHN 871	Yellow	Mid	Field, High Tunnel	DM, LW	V,F,Tomv	D
	BHN 964	Red	Mid	Field	DM, LW, S	V,F,Tomv,Eb	D
	BHN 1021	Red	Mid	Field, High Tunnel	DM, LW	V,F,Tomv, Tswv	
	Biltmore	Red	Mid	Field	DM, LW,	V,F,Asc,Gls	D
	Camaro	Red	Mid	Field	LW, S	V,F,Gls, Asc, Tylc	D
	Carolina Gold	Yellow	Mid	Field	DM, LW	V,F	D
	Charger	Red	Mid	Field, High Tunnel	DM, LW, S	V,F,Gls,Asc,Tylc	D
	Defiant	Red	Mid	Field	DM, LW	V,F,Lb, Eb	D
	Dixie Red	Red	Mid	Field	DM, LW, S	V,F,N,Gls,Tswv,Asc	D
	Florida 47R	Red	Mid	Field	LW, S	V,F,Asc,Gls	D
	Florida 91	Red	Mid, Late	Field	DM, LW, S	V,F,Asc,Gls	D
	Grand Marshall	Red	Mid	Field, High Tunnel	DM, LW, S	V,F,Gls, Asc, Tylc	D
	Lemon Boy	Yellow	Mid	Field, High Tunnel	DM, LW	V,F,N	I
	Mountain Glory	Red	Mid	Field	DM, LW, S	V,F,Gls,Tswv	D
	Mountain Merit	Red	Mid	Field	DM, LW, S	V,F,N,Tswv, Lb,	D
	Mountain Spring	Red	Mid	Field	DM, LW	V,F	D
	Phoenix	Red	Mid, Late	Field	LW, S	V,F,Asc,Gls	D
	Primo Red	Red	Early	Field	DM, LW, S	V,F,Tomv	D
	Red Bounty	Red	Mid, Late	Field, High Tunnel	DM, LW	V,F,N,Gls,Tswv	D
	Red Defender	Red	Mid	Field	DM, LW, S	V,F,N,Tswv	D
	Red Deuce	Red	Mid	Field	DM, LW, S	V,F,Tomv,Gls,Asc	D
	Red Morning	Red	Mid	Field	DM, LW, S	V,F, Tomv, Tswv	D
	Red Mountain	Red	Mid	Field, High Tunnel	DM, LW, S	V,F,Tswv	D
	Red Snapper	Red	Mid, Late	Field	DM, LW, S	V,F,Asc,Gls,Tswv,Tylc	D
	Rocky Top	Red	Mid	Field, High Tunnel	DM, LW, S	V,F,Gls	D
	Scarlet Red	Red	Mid	Field, High Tunnel	DM, LW, S	V,F	D
	STM 2255	Red	Early	Field	DM, LW, S	V,F,Asc,Gls,Tswv,Tylc	D
	Sunbrite	Red	Early	Field, High Tunnel	DM, LW, S	Asc, V,F,Gls	D
	SV 7101	Red	Late	Field	DM, LW, S	V,F,Asc,Gls,Tswv	D
	Volante	Red	Mid	Field	DM. LW, S	V,F,Gls,Asc, Tswv	D

[1]All varieties are hybrids.
[2]DM=Direct Market, LW=Local Wholesale, S=Shipping.
[3]Resistances or tolerances: Asc=Alternaria Stem Canker, Eb=Early Blight, F=Fusarium Wilt, Gls=Gray Leaf Spot, Lb=Late Blight, N=Root-knot Nematode, Tomv=Tomato Mosaic Virus, Tswv=Tomato Spotted Wilt Virus, Tylc=Tomato Yellow Leaf Curl Virus, V=Verticillium Wilt.
[4]D=Determinate, I=Indeterminate.

Heirloom Tomatoes

Type	Variety	Color	Size	Maturity	Plant Habit
Beefsteak	Brandywine Red	Red skin, red flesh	Large	Late	I, potato leaf
	Mortgage Lifter	Pink skin, Pink flesh	Large	Late	I
Globe	Cherokee Purple	Burgundy	Medium-Large	Mid	I
	Prudens Purple	Deep pink skin and flesh	Large	Mid	I, potato leaf
Round	Eva Purple Ball	Deep pink skin and flesh	Medium	Mid	I
	Green Zebra	Yellow-gold with dark green strips	Medium	Mid	I
Small pear	Yellow Pear	Yellow skin and flesh	Small	Late	I

Cherry, Grape, Plum, and Cluster Tomatoes

Type	Variety	Color	Disease Resistance[2]	Plant Habit[3]
Cherry	Artemis	Red	F,Tmv,Tomv, N	
	BHN 762	Red	V,F	D
	Sun Gold	Orange	F, Tomv	I
	Sun Sugar	Orange	F, Tmv	I
	Sweet Treats	Pink	F,Tomv,Gls	I
Grape	BHN 784	Red	F	D
	Cupid	Red	F, Asc	I
	Jolly Girl	Red	V, F	D
	Mini Charm	Red	V,F,Tomv	I
	Mountain Honey	Red	V, F,Tswv, Lb	SD
	Smarty	Red	V, F	I
	Valentine[4]	Red	Eb	I
Large Grape	Juliet	Red	Eb, Lb	I
Plum	Daytona	Red	Asc, F, N, V	D
	Mariana	Red	V,F,N,Asc	D
	Picus	Red	V,F,Asc,Gls,Tswv	D
	Plum Crimson	Red	V,F	D
	Plum Regal	Red	V,F,Lb,Tswv,	D
	Pony Express	Red	V,F,N,Tomv,Bs	D
Small cluster	Mt. Magic	Red	V,F,Lb	I

[1]All varieties are hybrids. [2]Resistances or tolerances: Asc=Alternaria Stem Canker, Bs=Bacterial Speck, Eb=Early Blight, F=Fusarium Wilt, Gls=Gray Leaf Spot, Lb=Late Blight, N=Root-Knot Nematode, Tmv=Tobacco Mosaic Virus, Tomv=Tomato Mosaic Virus, Tswv=Tomato Spotted Wilt Virus, V=Verticillium Wilt. [3]D=Determinate, SD=Semi Determinate, I=Indeterminate.[4]High lycopene.

Processing Tomatoes

Type	Variety	Season	Disease Resistance
Processing	H-3402	Mid	V,F,N,Bs
	H-3406	Full	V,F,Bs,Eb,Bc

All processing varieties are hybrids. Most plantings are contracted by processor; consult with processor to determine preferred varieties Disease resistance or tolerance: Asc=Alternaria Stem Canker, Bs = Bacterial Speck, Bc=Bacterial Canker, Eb = Early Blight F=Fusarium Wilt, N=Root-knot Nematode, V=Verticillium Wilt.

Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and Chapter B Soil and Nutrient Management. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede the recommendations found below.

Tomatoes[1,2]		Soil Phosphorus Level				Soil Potassium Level				
		Low	Med	High (Opt)	Very High	Low	Med	High (Opt)	Very High	
	N (lb/A)	P_2O_5 (lb/A)				K_2O (lb/A)				Nutrient Timing and Method
Bareground Fresh Market	80-90	200	150	100	0[3]	300	200	100	0[3]	Total nutrient recommended
	40-45	200	150	100	0[3]	300	200	100	0[3]	Broadcast and disk-in
	40-45	0	0	0	0	0	0	0	0	Sidedress when first fruits are set
Processing Machine Harvest	50-75	200	150	100	0[3]	250	150	100	0[3]	Total nutrient recommended
	25	200	150	100	0[3]	250	150	100	0[3]	Broadcast and disk-in
	25-50	0	0	0	0	0	0	0	0	Sidedress at first cultivation
Polyethelene Mulched Fresh Market	120-200	200	150	100	0[3]	300	200	100	0[3]	Total nutrient recommended
	0	200	150	100	0[3]	150	100	50	0	Broadcast and disk-in
	50	0	0	0	0	0	0	0	0	Incorporate into the plant bed before laying polyethylene mulch
	70-150	0	0	0	0	150	100	50	0[3]	Fertigate 0.5 to 2.5 lb/day. See chart and Drip/Trickle Fertilization section

[1]Apply 1-2 lb/A of boron (B) with broadcast fertilizer; see also Table B-7. in Chapter B Soil and Nutrient Management. [2]Apply 20-30 lb/A of sulfur (S) for most soils. [3]In VA, crop replacement values of 50 lb/A of P_2O_5 and 50 lb/A of K_2O are recommended on soils testing Very High. [4]Bareground includes organic mulches that allow irrigation or rainfall to reach the soil.

Irrigation

The basic principle for an adequate irrigation plan is that the total amount of water applied to the crop should be equal to its requirement plus the volume lost through evaporation and runoff. Different methods are available for the estimation of the crop water requirement. If available, a simple adjustment of the historic local reference evapotranspiration should give a good reference for the volume of water to apply. The reference evapotranspiration represents the fraction of the water lost via evaporation and transpiration from a soil surface covered with a reference crop. This reference can be adjusted using a crop specific coefficient (Kc), which represents the transpiration portion of the system. A generally accepted range of crop coefficient for tomato is: Initial = 0.60 (1 to 4 weeks), mid-season = 1.15 (4 to 10 weeks), end of season = 0.90 (10 to 12 weeks). Other useful tools are soil-water sensors and tensiometers, which can help determine the adequate frequency and volume of irrigation. The sensors help maintain a specific range of plant available water within the soil profile. Soil-water sensors can measure the soil water potential and/or estimate the volumetric soil moisture content. Based on these indicators, plant available water in the soil should be maintained below soil capacity and above the permanent wilting point. These two standards depend on the soil texture and should be identified before establishing an irrigation program.

Drip/Trickle Fertigation

Before laying plastic mulch, adjust soil pH to 6.5 and broadcast and disk in preplant nutrients (see table above) Apply the balance of your needed K_2O that you do not plan to apply via fertigation as a modified broadcast application that treats only the mulched area. Nitrogen fertilizer should be incorporated into the bed or split between incorporated and a surface band bed treatment immediately before laying plastic mulch.

After laying plastic mulch and installing the trickle irrigation system, apply completely soluble fertilizer through the drip system weekly to supply additional N and K_2O throughout the season and adjust rates as necessary based on soil and tissue tests (see tables below). For more information, see **Fertigation Rates for Drip Irrigated Plasticulture Crops** in section C.3 Fertigation.

Fertigation Schedule Examples for Fresh Market Tomatoes

This table provides examples of fertigation schedules based on two common scenarios – sandy coastal plain soils and heavier upland soils. Modify according to specific soil tests and base fertility.

Fertigation recommendations for 150 lb N and 150 lb K_2O[1,2] For soils with organic matter content less than 2% or coarse texture and low to medium or deficient K								
			Nitrogen			**Potash**		
Preplant (lb/A)[3]			**50**			**125**		
			N	**N**	**N**	**K_2O**	**K_2O**	**K_2O**
Stage and Description	Weeks	Days	lb/day	lb/week	lb/stage	lb/day	lb/week	lb/stage
1 Early vegetative	1-2	1-14	0.5	3.5	7	0.5	3.5	7
2 Late vegetative	3-4	15-28	0.7	4.9	9.8	0.7	4.9	9.8
3 Early flowering	5-6	29-42	1.0	7	14	1	7	14
4 Flowering and fruiting	7-8	43-56	1.5	10.5	21	1.5	10.5	21
5 Early harvest	9-11	57-77	2.2	15.4	46.2	2.2	15.4	46.2
6 Later harvest[4]	12-14	78-98	2.5	17.5	52.5	2.5	17.5	52.5
Fertigation recommendations for 75 lb N and 75 lb K_20[1,2] For soils with organic matter content greater than 2% or fine texture and high or optimum K								
			Nitrogen			**Potash**		
Preplant (lb/A)[3]			**50**			**50**		
			N	**N**	**N**	**K_2O**	**K_2O**	**K_2O**
Stage and Description	Weeks	Days	lb/day	lb/week	lb/stage	lb/day	lb/week	lb/stage
1 Early vegetative	1-2	1-14	0.25	1.75	3.5	0.25	1.75	3.5
2 Late vegetative	3-4	15-28	0.35	2.45	4.9	0.35	2.45	4.9
3 Early flowering	5-6	29-42	0.5	3.5	7	0.5	3.5	7
4 Flowering and fruiting	7-8	43-56	0.75	5.25	10.5	0.75	5.25	10.5
5 Early harvest	9-11	57-77	1.1	7.7	23.1	1.1	7.7	23.1
6 Later harvest[4]	12-14	78-98	1.25	8.75	26.25	1.25	8.75	26.25

[1]Rates above are based on 7,260 linear bed ft/A (6 ft bed spacing). If beds are closer or wider, fertilizer rates should be adjusted proportionally. Drive rows should not be used in acreage calculations. See section C 3. Fertigation for more information. [2]Base overall application rate on soil test recommendations. [3]Applied under plastic mulch to effective bed area using modified broadcast method. [4]For extended harvest after 10 weeks continue fertigation at this rate.

Plant Tissue Testing

Plant tissue testing can be a valuable tool to assess crop nutrient status during the growing season to aid with in-season fertility programs or to evaluate potential deficiencies or toxicities. Critical tomato tissue test values for most recently matured leaves at first flower are: 2.8-4.0 %, P 0.2-0.4 %, K 2.5-4.0 %, Ca 1.0-2.0 %, Mg 0.25-0.5% and S 0.3-0.6%. For additional nutrients and other growth stages consult with a tissue testing laboratory or this web link at the University of Florida: *https://edis.ifas.ufl.edu/publication/ep081*.

Plant Petiole Sap Testing

Plant petiole sap and tissue testing are valuable tools to assess crop nutrient status during the growing season, to aid with in-season fertility programs, or to evaluate potential deficiencies or toxicities.

	Fresh Petiole Sap Concentration (ppm)	
Tomato Developmental Stage	**NO_3-N**	**K**
First buds	1000-1200	3500-4000
First open flowers	600-800	3500-4000
Tomato Developmental Stage	**NO_3-N**	**K**
Fruits 1 inch diameter	400-600	3000-3500
Fruits 2 inch diameter	400-600	3000-3500
First harvest	300-400	2500-3000
Second harvest	200-400	2000-2500

Seed Treatment

Purchase hot water treated seed if possible or request hot water seed treatment. Hot water treatment is administered to eradicate bacterial pathogens. For more information see Disease Control below. The germination rate of tomatoes is strongly influenced by temperature, with a minimum temperature for germination ranging from 48°F to 55°F, depending on the selected cultivar.

Grafting

Grafting of fresh-market tomatoes into rootstocks that confer resistance or tolerance to soil-borne pests and diseases is practiced as an alternative to chemical soil fumigation and may increase plant vigor impacting water and nutrient requirements, plant density, pruning, and training, as well as fruit yield and quality. Although it would likely increase the overall production cost of the system. Grafting tomato plants into vigorous rootstocks is also used to enhance plant tolerance to abiotic stress conditions including non-optimal temperatures, excess or deficiency of nutrients, salinity, drought, or alkalinity stress.
To find rootstocks commonly used for tomatoes, and their disease resistance or susceptibility go to:
http://www.vegetablegrafting.org/resources/rootstock-tables/solanaceous-rootstocks/

Hardening Transplants

Hardening seedlings before field planting is recommended. However, hardening by exposure to cool temperatures 60-65°F (16-18°C) day and 50-60°F (10-16°C) night for one week or more causes catfacing. No growth will occur below 53°F (12°C). Instead, harden plants by withholding N and reducing water; allow plants to wilt slightly between light waterings.

Fresh Market

The yield and fruit size and quality of fresh market tomatoes are increased using plastic mulch in combination with trickle irrigation. Form raised, dome-shaped beds to aid in disease control. Lay 4 ft wide black, white, or reflective plastic mulch tightly over the beds. Farmers in warmer areas of the Mid-Atlantic region should consider using white or reflective mulch, instead of black mulch. For early summer harvest of market tomatoes, start transplanting April 10-20 in southern or normally warmer areas, and May 10-25 in cooler, northern areas.
Ground Culture: Space determinate vined varieties in rows 4-5 ft apart with plants 24 inches apart in the row. For indeterminate varieties, space rows 5-6 ft apart with plants 24-36 inches apart in the row.
Stake Culture: Staking tomatoes is a highly specialized production system. Staking improves fruit quality by keeping plants and fruit off the ground and allows for better spray coverage. Staked tomatoes are easier to harvest than non-staked tomatoes. The recommendations below are for the short-stake cultural system using determinate cultivars that grow 3-4 ft tall. Row widths of 5-6 ft with in-row spacings of 18-24 inches between plants are recommended. Farmers should consider the partial or full transition to fiberglass stakes over wooden stakes, given that they last longer, are easier to handle, and weigh less than the traditional wooden stakes.

Pruning is practiced to establish a desired balance between vine growth and fruit growth. Depending on the ***variety***, little to no pruning results in a plant with a heavy load of smaller fruit. Moderate pruning results in fewer fruits that are larger and easier to harvest. Pruning can result in earlier maturity of the crown fruit and improve spray coverage and pest control. The pruning method is variety and fertility dependent. Less vigorous determinate cultivars generally require less or no pruning. Growers should experiment with several degrees of pruning on a small scale to determine pruning requirements for specific cultivars and cultural practices.

Removing all suckers up to the one immediately below the first flower cluster is adequate for most determinate cultivars. Removing the sucker immediately below the first flower cluster or pruning above the first flower cluster can result in severe leaf curling and stunting of the plant. Prune when the suckers are 2-4 inches long. A 2nd pruning may be required to remove suckers that are too small to be easily removed during the 1st pruning and to remove ground suckers that may develop. Pruning when suckers are too large requires more time and can damage the plants, delay maturity, and increase disease incidence. Do not prune plants when they are wet to avoid the spread of bacterial diseases. Pruning should be done before the first stringing because the string can slow down the pruning process.

Staking involves setting up a series of wooden or fiberglass stakes with twine woven around the stakes to train the plants to grow vertically off the ground. Stakes 4-4½-ft long by 1-inch square are driven approximately 12 inches into the soil between the plants.

Vigorous cultivars may require larger and longer stakes. A stake placed between every other plant is adequate to support most determinate varieties. Placing an additional stake at an angle and tied to the end stake of each section or row is needed to strengthen the trellis system. Stakes can be driven by hand with a homemade driving tool or with a commercially available, power-driven stake driving tool. Drive stakes to a consistent depth so that spray booms can be operated in the field without damaging the trellis system. Select "tomato twine" that is resistant to weathering and stretching and that binds well to the wooden stakes. Tomato twine is available in 3-4-lb boxes and approximately 30 lb/A are required. To make tying convenient, use a homemade stringing tool made from a length of metal conduit, PVC pipe, broom handle, or wooden dowel. With conduit or PVC pipe, the string is fed through the pipe. With a broom handle or wooden dowel, two small parallel holes, each approximately ½-1 inch from the end, must be drilled to feed the string through one hole along the length of the tool and through the other hole. The tool serves as an extension of the worker's arm (the length cut to the worker's preference) and helps to keep the string tight.

Stringing consists of tying the twine to an end stake passing the string along one side of the plants, looping the twine around each stake until you reach the end of a row or section (100-ft sections with alleys may be helpful for harvesting). The same process continues on the other side of the row. The string tension must be tight enough to hold the plants upright, but harvest can be difficult, and strings can scar fruit if they are too tight.

The first string should be strung 8-10 inches above the ground when plants are 12-15 inches tall and before they fall over. Run the next string 6-8 inches above the preceding string before plants start to fall over. Three to 4 stringings are required for most determinate varieties. Stringing should be done when the foliage is dry to prevent the spread of bacterial diseases.

Processing Tomatoes

Transplanting: Processing tomatoes can be transplanted starting April 15-20 in warmer, southern areas to May 5-10 in PA and normally cooler areas. Successive plantings can be made through early June. Space transplants 9-12 inches apart in single rows 5 ft. apart or to accommodate machine harvesters. Small, determinate varieties may be grown in double rows. Space double rows 12 inches apart and space plants 12-18 inches apart in each of the double rows.

Fruit Ripening: Ethephon is a growth regulator labeled for use on processing tomatoes. Proper application increases earliness and yield and decreases sorting of green fruit in machine-harvested tomatoes. Rate and time of application are critical for successful use, see state fact sheets and check product label for details.

Harvest and Post-Harvest Considerations

Depending on marketing requirement, tomatoes may be harvested at the **mature green stage** (when and after which the fruit cavity is filled by gel), **breaker stage** (just showing pink at the bottom of the fruit), **semi-ripe** (with different amounts of red pigmentation) or **fully ripe**. Fruit are very perishable and subject to surface and internal damage and must be handled with care. Tomato fields should be harvested often and thoroughly to hasten the ripening of later fruits and reduce the range of ripeness if a specific stage is desired. Harvesting every day may be required during peak season. Remove all diseased, misshapen, and otherwise cull tomatoes from the vines as soon as they are discovered. Remove discarded tomatoes from the field to avoid the spread and buildup of diseases and insect pests. For standard slicing tomatoes, cherry tomatoes, and plum tomatoes, remove the stem during picking. Cluster tomatoes are harvested with the whole truss attached to fruits.

Tomatoes should be washed sufficiently to remove dust and foreign material, by hand or mechanically by spraying them with chlorinated water as they move over a set of soft brush rolls. The small amount of retained water may be removed by absorbent rollers alone or in combination with an overhead air-blast drier. The wash water should be several degrees warmer than the pulp temperature of the tomatoes to avoid drawing water and disease organisms into the fruit. The water should be chlorinated at the rate of 125 ppm. The chlorine level and pH (6 to 7) of the wash water should be checked at least hourly during the day with test papers or a meter. Tomatoes are then sized and separated by color and grade and carefully packed into 25 lb boxes.

Size Classification of Tomatoes

Size Designation	Minimum Diameter (inch)	Maximum Diameter (inch)
Extra small	1-28/32	2-4/32
Small	2-4/32	2-9/32
Medium	2-9/32	2-17/32
Large	2-17/32	2-28/32
Extra large	2-28/32	3-15/32

Color Classification of Tomatoes

Tomatoes may be graded into the following color classes (some classes may be combined).

Green	The surface of the tomato is completely green. The shade of green may vary from light to dark. Mature green fruits are typically ripened at the terminal market or by the repacker with ethylene gas.
Breakers	There is a definite break in the color from green to tannish yellow with pink or red skin covering not more than 10% of the surface.
Turning	More than 10% but not more than 30% of the surface, shows a definite change in color from green to tannish yellow, pink, red, or a combination of those colors.
Pink	More than 30% but not more than 60% of the surface shows pinkish red or red color.
Light Red	More than 60% but not more than 90% shows pinkish red or red color.
Red	More than 90 % of the surface shows red color.

Shipping

For long distance shipping, mature green harvest is the common practice. For local wholesale, harvest is usually at the breaker stage. For direct market, harvest is at the ripe stage. Store mature-green tomatoes at 55-70°F (13-21°C); breakers, partially ripe, and ripe fruit at 50°F (10°C) and a relative humidity of 90-95%. Exposing tomatoes to temperatures below 50°F results in loss of color, shelf life, firmness, and flavor.

Tomato Disorders

Blossom-End Rot (BER): This physiological disorder is caused by inadequate movement of calcium into the fruit. BER occurs at low soil moisture and is more severe when plants have small, shallow root systems. Symptoms occur first internally, and then extend to the external part of the fruit. Plastic mulch can restrict the movement of water to the root zone and increase BER. Hot, windy conditions increase water loss from the plant and increase the incidence of BER.

Be sure soil calcium is sufficient and in balance with other essential plant nutrients. Test the soil and apply calcitic lime and fertilizer according to recommendations, then lay plastic mulch when soil moisture is optimal for planting. Apply irrigation to wet the root zone and encourage deep root development.

Blotchy Ripening, Graywall and Internal White Tissue: These problems are a complex of physiological disorders and pathological diseases. Blotchy Ripening and Graywall often appear on shaded fruit growing in the interior of dense vegetative plants. Yellow-eye, a ring of yellow tissue surrounding the blossom scar, often occurs in fruit with blotchy ripening and internal white tissue.

Blotchy ripening is when areas of the fruit do not ripen or do so after the rest of the fruit is ripe. White or yellow blotches may appear on the surface of the fruit while the internal tissue is still hard. Usually, this disorder occurs on the upper portion of the fruit and there is no internal browning of the fruit. This disorder is more often seen during cool, wet, and cloudy conditions. It is worsened by too much or too little water. High N and/or low K will cause an increase in the disorder. Older varieties are often more susceptible to this disorder.

Research in California indicates that for proper fruit color development higher K levels than are necessary for yield alone are needed. Soils and plants with high K had lower levels of the disorder. Foliar applications of K were not totally effective in reducing the disorder. Work in Michigan suggests that soils high in organic matter (above 3.5%) helped to reduce the disorder in a tomato crop. In addition, soils with a pH of 6.4 had a low incidence of yellow shoulder while tomatoes grown on soils with a pH above 6.7 had a high incidence.

Growers should have K tissue levels of at least 3% before the fruit is one inch in diameter. In addition, the ratio of Magnesium (MG) to Calcium (Ca) is important and a ratio of Mg:Ca of 1:4 to 1:6 should be maintained in the crop.

Graywall appears as grayish and sometimes sunken areas on a fruit. Internally the vascular tissue is brown resulting from collapse of the tissue. This can occur on the outer part of the fruit as well as in the center. It is usually more of a problem with cool, short days and often occurs in a late tomato crop. Graywall usually develops in green fruit but can occur as fruit is ripening. Fruit do not ripen properly and will have a blotchy appearance making them unmarketable. Graywall occurs on any part of the fruit. High N may increase the incidence of Graywall, and adequate K may reduce the problem. The disorder may also be caused by stress on the plants resulting from drought, excessive heat, root problems, severe nutrient deficiencies, etc. and there are varietal differences in susceptibility. This disorder is not clearly understood. Note that internal browning can also be caused by Tobacco Mosaic Virus.

Internal white tissue is a disorder where the fruit usually show no external symptoms. When a ripe, affected fruit is cut there will be white, hard areas found in the outer tissue and sometimes in the center of the fruit as well. High temperatures during ripening are believed to be the cause of this disorder. Maintaining adequate K in the soil may reduce but not eliminate it. Some varieties are more susceptible to this disorder, especially high colored varieties. This disorder can be severe enough to cause fruit to be unmarketable.

Catfacing: Catfacing is where fruit are malformed and scarred, usually at the blossom end. It is caused by exposure of seedlings to 60-65°F (16-18°C) day temperatures and 50-60°F (10-16°C) night temperatures for 1 week, approximately 4 weeks before pollination. The first flower cluster is susceptible to low temperature-induced catfacing when seedlings have 4-5 true leaves. Fruit on later clusters will show catfacing if exposed to low temperatures in the field. Avoid hardening seedlings by exposure to low temperatures. Varieties differ in their susceptibility to the disorder.

Cracking: Cracking is due to the rapid uptake of water, resulting in enlargement of cells and separation of the epidermis of the fruit. Water can be taken up through the roots or through the tissue around the stem scar. The type of cracking (concentric, radiating out from the stem, or diagonal or transverse cracks across the fruit) is determined primarily by fruit structure and variety. Different types of cracking may be present in a variety or an individual fruit.

The severity of cracking is determined by water availability, variety and maturity. As the fruit ripens, the bonding between cells progressively weakens, resulting in more severe cracking. High rainfall and irrigation, or frequent low to moderate rainfall, especially following a period of low soil moisture may increase cracking. To minimize cracking, select a crack-resistant variety, maintain a high calcium level in the soil and keep fruit growing at a uniform rate by maintaining uniform soil moisture levels. Maintain good fruit cover by proper fertilization and fungicide applications. Harvest fruit at the earliest stage of maturity that is acceptable by your market.

Puffiness: Also known as boxiness or hollowness, this disorder creates flat-sided fruits or angular fruits with one or more seed cavities empty of tissue. Affected fruits are less dense and can be identified by flotation in water. Extremely low or elevated temperatures, high soil N concentrations, and low light conditions contribute to improper pollination which in term contribute to the disorder.

Russeting: Russeting, or weather checking of the surface of the fruit is caused by the presence of water on the fruit surface for extended periods of time when there are frequent light rainfalls, mist, fog, and dew. Wide fluctuations in temperature of exposed fruit also contribute to this disorder. Russeting can cause fruit to be unmarketable. Maintain good fruit cover by proper fertilization and fungicide applications. Use varieties that feature a dense canopy and resistance to foliar diseases.

Sunburn and Sunscald: Sunburn and sunscald result from exposure to direct sunlight. Mild sunburn appears as yellowish or yellow-red color of fruit on the side exposed to the sun. Severe symptoms appear as whitish, water-soaked, scalded, or blistered areas. Sunscald is more severe on fruit that developed in shaded conditions but was exposed to direct sunlight after defoliation or harvesting. Under dry conditions, the white areas can become dry and leathery. Secondary infection can produce dark, dry rot. Under moist conditions, scalded areas can decay from secondary infections. To control sunburn and sunscald, select varieties with good fruit cover, supply sufficient water and nutrients to provide good vegetative growth and manage pests. Train workers to avoid turning vines during harvesting or to reposition vines to shade fruit.

Yellow Shoulders: Yellowing may occur on the shoulders of fruit exposed to the sun, especially on varieties that have darker green shoulders when immature (those lacking the uniform ripening gene). The tissue beneath the yellow shoulder is usually corky and may vary from greenish white to pale yellow. Select varieties with the uniform ripening gene and provide good fruit cover as described above.

Weed Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.

Recommended Herbicides

1. Identify the weeds in each field and select recommended herbicides. More information is available in the "Herbicide Effectiveness on Common Weeds in Vegetables" (Table E-3) in Chapter E Pest Management.

2. Minimize herbicide resistance development. Identify the herbicide mode of action group number and follow recommended good management practices; **bolded group numbers in tables below are herbicides at higher risk for selecting resistant weed populations.** Include non-chemical weed control whenever possible.

Labeled Application Sites for Tomato

Herbicide (*=Restricted Use)	**HRAC group number**	**Plastic mulch production**					**Bareground production**		
		Soil-Applied		Postemergence					
		Under Plastic	Row Middles	Over Plastic	Row Middles	Post-Harvest	Soil-applied	POST	Post-harvest
Sandea	2	YES[4]	YES		YES		YES[2]	YES	
League	2		YES		YES		row middle		
Dacthal	3							YES[5]	
Prowl H2O	3		YES				YES[3]		
Treflan	3		YES				YES[3]		
Metribuzin	5	YES	YES		YES		YES	YES	
Devrinol	15	YES	YES				YES		
Dual	15	YES	YES				YES		
Select / Select Max Shadow 3EC	1			YES				YES	
Poast	1			YES				YES	
Matrix	2		YES		YES			YES	
Gramoxone*[1]	22				YES	YES			YES
Rely 280	10				YES				
Reglone[1]	22				YES	YES	YES[4]		YES

[1] Special Local Needs Label 24(c), be sure it is registered for the specific state and for the intended use.
[2] Delay transplanting for 7 days after application; not labeled for direct seeding.
[3] Transplants only.
[4] Apply prior to planting or after seeding but prior to crop emergence.
[5] Dacthal is labeled for over the top application, but it will not control emerged weeds.

1. Pre-Transplant Over Plastic

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
10	Rely 280 2.34L	29 to 43 fl oz/A	**glufosinate**	0.53 to 0.79 lb/A	30	12

-**Supplemental label expires 12/1/2025 for application over plastic prior to transplanting.**
-Ammonium sulfate (AMS) can be used at 1.5 lb/A to 3 lb/A.
-Control is best when applied to weeds less than 4 inches, temperatures are above 80, high humidity, and bright sunlight.
-Transplants can be injured if they come in contact with herbicide remaining on the plastic. Allow at least 3 days between application and transplanting. At least 0.5 inches of precipitation is needed to wash Rely off the plastic. Do not transplant within 27 days of application if no precipitation occurs.
-DO NOT transplant into or within 6 inches of holes in the plastic mulch that were present at time of application.
-Two applications can be made prior to transplanting. Do not apply more than 64 fl oz/A prior to transplanting; maximum number of applications is three per season. -Rainfastness is 4 h.

1. Pre-Transplant Over Plastic - continued next page

1. Pre-Transplant Over Plastic - continued

22	Gramoxone SL 2.0* Gramoxone SL 3.0*	2 to 4 pt/A 1.3 to 2.7 pt/A	**paraquat**	0.5 to 1.0 lb/A	30	24
-Gramoxone can be used for preplant weed control over the top of plastic mulch. Sufficient rainfall or sprinkler irrigation is needed to wash off the Gramoxone prior to planting to prevent damage to the crop. ***-Restricted-use pesticide***. Only certified applicators, who successfully complete the paraquat-specific training, can mix, load, or apply paraquat. Application of paraquat "under the direct supervision" of a certified applicator is no longer allowed. Required training link (*https://campus.extension.org/enrol/index.php?id=2201*); certified applicators must repeat training every three years. -Do not exceed 8 pt/A per season. -Rainfastness is 30 min.						

2. Soil Applied

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
2	Sandea 75DF	0.5 to 1.0 oz/A	**halosulfuron**	0.023 to 0.047 lb/A	30	12
-**Plasticulture**: under plastic application is labeled delay transplanting 7 days after herbicide application. Apply in a band under the plastic, immediately before laying the mulch; use on transplants only (not for seeded tomatoes), avoid herbicide treated soil from moving into the holes during transplanting. Plasticulture: labeled for row middle application with directed/shield application. -**Bareground**: for transplants only: apply preplant incorporated 7 days before transplanting; use on transplants only (not for seeded tomatoes), avoid herbicide treated soil from moving into the holes during transplanting. -Bareground: for directed-seeded apply as directed/shielded application to row middles -Suppresses or controls yellow nutsedge and certain broadleaf weeds. Sandea provides both residual and postemergence control of susceptible weed species. Effective postemergence control requires an adjuvant. -Sandea is an ALS inhibiting herbicide and resistant weed populations are common in the region. **Do not** use Group 2 herbicides repeatedly in the same field. **Do not** apply Sandea to crops treated with a soil applied organophosphate insecticide or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application. -Maximum Sandea applications per year is 2 and **do not** exceed 2 oz/A during the crop season.						
2	League 75WDG	4 to 6.4 oz/A	**imazosulfuron**	0.19 to 0.3 lb/A	21	12
-Local research has only evaluated League as a row middle application for plasticulture and directed application between the rows for bareground production. -For control of emerged weeds be sure to include appropriate adjuvant (see label). -Movement of soil may reduce residual control. -Avoid rainfall or overhead irrigation (0.5 to 1 inch) within 12 hours of application. However, rainfall or irrigation within 5 days of application is needed to activate League. -League controls a limited number of species including common purslane and hairy galinsoga. -League is an ALS inhibiting herbicide and resistant weed populations are common in the region. -**Do not** use Group 2 herbicides repeatedly in the same field. -**Do not** apply League to crops treated with a soil applied organophosphate insecticide, or 21 days before a foliar applied organophosphate insecticide or 7 days after a organophosphate application. -Maximum League applications per year is 1 and **do not** exceed 6.4 oz/A during the crop season.						
3	Dacthal 6F Dacthal W-75	8.0 to 14.0 pt/A 6.0 to 14 lb/A	**DCPA**	6.0 to 10.5 lb/A	--	12
-Labeled for applications over the top of transplants without injury (Dacthal will not control emerged weeds; apply to weed-free soils); transplants should be well-established and growing conditions favorable for good plant growth. -Label recommends 4 to 6 weeks after transplanting or direct-seeded plants at 4 to 6 inches in height. -Post-transplant applications can only be made with bareground production. -Primarily controls annual grasses and a few broadleaf weeds, including common purslane. -Results have been most consistent when used in fields with coarse -textured soils low in organic matter, and when the application is followed by rainfall or irrigation. -Maximum application not addressed on label.						
3	Prowl H2O 3.8CS	1.0 to 3.0 pt/A	**pendimethalin**	0.48 to 1.42 lb/A	70	24
-**Plasticulture**: recommended for row middles only. Labeled for under plastic, but no local data or experience with this application. -**Bareground**: broadcast preplant or preplant incorporated before transplanting; not labeled for direct-seeded crop. -Avoid root contact with Prowl-treated soil when placing transplants into furrow or hole or injury may occur. -Prowl labeled for directed application to transplanted or established direct-seeded tomatoes; avoid contact with leaves or stems. -Prowl will not control emerged weeds, only provides residual control; row middle applications may be made with Gramoxone using shielded sprayers. Use the lower rate on coarse-textured or sandy soils. Activate with ½ inch of rainfall or sprinkler irrigation within 48 h of application to control most annual grasses and certain broadleaf weeds.-Maximum Prowl H2O application per season is 3 pt/A.						
3	Treflan 4E	1 to 2 pt/A	**trifluralin**	0.5 to 1.0 lb/A	--	12
-**Plasticulture**: labeled for row middles only. -**Bareground**: broadcast preplant or preplant incorporated before transplanting; not labeled for direct-seeded crop. All applications need to be mechanically incorporated. -Stunting may occur if the weather is cool and damp at time of transplanting. -Maximum application per season: not specified.						

2. Soil Applied - continued next page

2. Soil Applied - continued

5	Metribuzin 75DF Metribuzin 4L	0.33 to 0.66 lb/A 0.5 to 1 pt/A	**metribuzin**	0.25 to 0.5 lb/A	7	12
-**Plasticulture**: under plastic application is labeled; apply in a band under the plastic, immediately before laying the mulch; use on transplants only (not for seeded tomatoes), roots of the transplants need to be placed below the zone of treated soil. There is no local data and limited experience with this use. Plasticulture: labeled for row middle application with directed/shield application. -**Bareground**: broadcast preplant or preplant incorporated before transplanting; use on transplants only (not for seeded tomatoes), roots of the transplants need to be placed below the zone of treated soil. -Metribuzin primarily controls broadleaf weeds and is weak on grasses; tank mix to improve grass control. -Metribuzin has some postemergence activity. To get consistent control, apply metribuzin before weeds are 1 inch tall. -Rainfastness is 6 h. -Maximum for metribuzin 75DF: 1.33 lb/A per crop season; metribuzin 4L: 2 pt/A per crop season.						
15	Devrinol 2-XT 2EC Devrinol DF-XT 50DF	2 to 4 qt/A 2 to 4 lb/A	**napropamide**	1.0 to 2.0 lb/A	--	24
-**Plasticulture**: under plastic is labeled for seeded or transplanted tomatoes; apply in a band under the plastic, immediately before laying mulch. Use lower rate on coarse textured or sandy soil. Condensation that forms on the underside of the mulch will activate the herbicide. Plasticulture: row middles application is labeled. -**Bareground**: apply as broadcast, preemergence treatment for seeded and transplanted tomatoes. Rainfall or irrigation within 24 h after application improves performance (½ inch sprinkler irrigation). -Annual grasses and certain annual broadleaf weeds will be suppressed or controlled. May reduce stand and yield of fall planted small grain crop. Moldboard plowing will reduce the risk of injury. -Maximum Devrinol application per season: 4 qt/A (2-XT) or 4 lb/A (DF-XT).						
15	Dual Magnum 7.62E	1.0 to 2.0 pt/A	**s-metolachlor**	0.95 to 1.9 lb/A	30 to 90	24
-**Plasticulture**: under plastic is labeled transplanted tomatoes; apply in a band under the plastic, immediately before laying mulch. Use lower rate on coarse textured or sandy soil. Condensation that forms on the underside of the mulch will activate the herbicide. Plasticulture: row middles application is labeled. -**Bareground**: apply for preplant incorporated or broadcast, preemergence treatment before transplanting tomatoes. Seeded tomatoes can be treated when at least 4 inches tall at time of application and spray is directed at the soil and minimal amounts of herbicide contact tomato plants. Avoid moving treated soil into transplant holes. -Use lower rates on coarse-textured soils low in organic matter and higher rates on fine-textured soils with greater organic matter. -Application to varieties with unknown tolerance to Dual Magnum may result in crop injury. Transplants weakened by any cause may be injured by Dual Magnum. Plant healthy transplants and avoid planting when wet, cool, or unfavorable growing conditions exist. -Delaying transplanting for 7 days or more can reduce the risk of injury. -**Do not harvest** within 90 days of application if more than 1.33 pt/A was used per season; PHI is 30 days if 1.33 pt/A or less is used. **Do not** exceed 2 applications per growing season.						
5+14	Authority MTZ Preview 2.1	Refer to labels for specific rates.	**metribuzin + sulfentrazone**		--	--
-**Processing tomatoes only.** -Authority MTZ and Preview 2.1 are two prepackaged mixtures of sulfentrazone plus metribuzin, labeled for transplanted processing tomatoes only: preplant application only. The ratio of metribuzin and sulfentrazone differs for these two products, see table E-6 for specific ratios. -Local research has shown potential injury with sulfentrazone. -These rates of sulfentrazone will not provide extended residual control.						

3. Postemergence

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
1	Shadow 3EC Select 2EC Select Max 0.97EC	4 to 10.67 fl oz/A 6 to 8 fl oz/A 9 to 16 fl oz/A	**clethodim**	0.07 to 0.24 lb/A	20	24
	Poast 1.5EC	1 to 1.5 pt/A	**sethoxydim**	0.2 to 0.28 lb/A	20	12
-**Select 2EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). **Select Max**: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution). **Shadow 3EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution) for large or stressed grasses; use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution) when crop safety is a concern. **Poast**: Apply with COC at 1.0% v/v. -**The use of COC may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to NIS when grasses are small and soil moisture is adequate. -Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control. -Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will **not** be controlled. -Controls many annual and certain perennial grasses, including annual bluegrass, but Poast is preferred for goosegrass control. For best results, treat annual grasses when they are actively growing and before tillers are present. Control may be reduced if grasses are large or under hot or dry weather conditions. Repeated applications may be necessary to control certain perennial weeds. If repeat applications are necessary, allow 14 days between applications. Rainfastness is 1 h.						

3. Postemergence (Shadow, Select, Select Max, Poast) - continued next page

3. Postemergence (Shadow, Select, Select Max, Poast) - continued

<table>
<tr><td colspan="7">-Do not tank mix with or apply within 2 to 3 days of any other pesticide, unless labeled, as this may increase the risk of crop injury or reduce the control of grasses. -Do not apply more than 8 fl oz/A of Select 2EC in a single application and do not exceed 2 pt/A for the season; do not apply more than 16 fl oz/A of Select Max in a single application and do not exceed 4 pt/A for the season.
-Do not apply more than 10.67 fl oz/A of Shadow 3EC in a single application and do not exceed 21.33 fl oz/A for the season.
-Do not apply more than 1.5 pt/A Poast 1.5EC in a single application and do not exceed 4.5 pt/A for the season.</td></tr>
<tr><td>2</td><td>Matrix 25DF
Solida 25DF</td><td>1.0 to 2.0 oz/A</td><td>rimsulfuron</td><td>0.0156 to 0.0312 lb/A</td><td>45</td><td>4</td></tr>
<tr><td colspan="7">-Apply early postemergence but not before the crop has at least 2 full-sized true leaves (label allows applications as early as cotyledon stage of tomatoes; but no local data is available at that stage). Not recommended for over the top application with plasticulture.
-Apply with nonionic surfactant at 0.25% v/v (1.0 qt/100 gal of spray solution); use of an adjuvant may cause temporary chlorosis, but symptoms usually disappear within 5 to 15 days.
-Controls many weeds including foxtail species, pigweed species, wild mustard, and wild radish. Suppresses common lambsquarters, common ragweed, jimsonweed, morningglory species, and yellow nutsedge. Optimum performance is obtained when weeds are less than 1 inch in height and are actively growing. Tank mix with metribuzin to improve broadleaf weed control.
-Best results occur with 0.5 inches of rainfall or irrigation no sooner than 4 h but not more than 5 days after application.
-Matrix provides both residual and postemergence control of susceptible weed species.
-Matrix is an ALS inhibiting herbicide and resistant weed populations are common in the region. Do not use Group 2 herbicides repeatedly in the same field. -Rainfastness is 4 h. -Maximum for Matrix: 4 oz/A per year.</td></tr>
<tr><td>2</td><td>Sandea 75DF</td><td>0.5 to 1.0 oz/A</td><td>halosulfuron</td><td>0.023 to 0.047 lb/A</td><td>30</td><td>12</td></tr>
<tr><td colspan="7">-Apply over the top, post directed, or with crop shields; not recommended for over the top application with plasticulture.
-Apply to tomato plants that are established, actively growing and a minimum of 14 days after transplanting or after the 4th leaf stage of seeded tomatoes. Applications during bloom can cause bloom drop under certain environmental conditions.
-Apply with nonionic surfactant at 0.25% v/v (1.0 qt/100 gal).
-Provides control of yellow nutsedge and certain annual broadleaf weeds. Control of weeds taller than 3 inches may not be adequate.
-Sandea provides both residual and postemergence control of susceptible weed species.
-Sandea is an ALS inhibiting herbicide and resistant weed populations are common in the region. Do not use Group 2 herbicides repeatedly in the same field. Do not apply Sandea to crops treated with a soil-applied organophosphate insecticide or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application. -Rainfastness is 4 h.
-Do not apply more than 2 applications, or more than 2 oz/A of product, per crop cycle; do not exceed 2 oz/A per 12 month period.</td></tr>
<tr><td>3</td><td>Dacthal 6F
Dacthal W-75</td><td>8.0 to 14.0 pt/A
6.0 to 14 lb/A</td><td>DCPA</td><td>6.0 to 10.5 lb/A</td><td>--</td><td>12</td></tr>
<tr><td colspan="7">-Labeled for applications over the top of transplants.
-Dacthal will not control emerged weeds; apply to weed-free soils. See comments under soil applied section</td></tr>
<tr><td>5</td><td>Metribuzin 75DF
Metribuzin 4L</td><td>0.33 to 0.66 lb/A
0.5 to 1 pt/A</td><td>metribuzin</td><td>0.25 to 0.5 lb/A</td><td>7</td><td>12</td></tr>
<tr><td colspan="7">-Apply over the top, post directed, or with crop shields; not recommended for over the top application with plasticulture. The maximum rate for over the top application is 0.67 lb (75DF) or 1 pt (4L); and maximum rate for post directed is 1.33 lb (75DF) or 2 pt (4L).
-Apply postemergence to transplants with at least 5 true leaves and have recovered from transplant shock (new growth evident) or at least 2 weeks after transplanting. Transplants with fewer than 5 true leaves are at greater risk of herbicide injury.
-Do not use hot caps on tomatoes within 7 days before or after application. -Do not apply within 3 days after periods of cool, wet, or cloudy weather or crop injury will occur. -Do not apply within 24 h of applications of other pesticides.
-Allow at least 14 days between applications or severe crop injury may occur.
-Metribuzin primarily controls broadleaf weeds and is weak on grasses.
-Metribuzin has some postemergence activity. To get consistent control, apply metribuzin before weeds are 1 inch tall.
-Tank mix with appropriate postemergence herbicides if weeds are emerged at time of application.
-Rates up to 1.3 lb of metribuzin 75DF or 2 pt of metribuzin 4L are labeled for directed applications, refer to label.
-Maximum for metribuzin 75DF: 1.33 lb/A per crop season; metribuzin 4L: 2 pt/A per crop season.</td></tr>
<tr><td>10</td><td>Rely 280 2.34L</td><td>29 to 62 fl oz/A</td><td>glufosinate</td><td>0.53 to 1.13 lb/A</td><td>30</td><td>12</td></tr>
<tr><td colspan="7">-Supplemental Label expires 12/1/2025 for hooded spray application between the rows.
-Ammonium sulfate (AMS) can be used at 1.5 lb/A to 3 lb/A.
-Do not allow spray to come in contact with crop foliage or damage will occur.
-Control is best when applied to weeds less than 4 inches, temperatures are above 80, high humidity, and bright sunlight.
-Separate sequential applications by at least 14 days.
-Do not apply more than 62 fl oz/A in a single application, do not apply more than 87 fl oz/A per season; maximum number of applications is three per season.
-Rainfastness is 4 h.</td></tr>
<tr><td>22</td><td>Reglone 2SL</td><td>1 qt/A</td><td>diquat</td><td>0.5</td><td>30</td><td>24</td></tr>
<tr><td colspan="7">-Special Local Needs Label 24(c) in NJ (expires 12/31/2027).
-Apply as post-directed application to the row middles either prior to transplanting or with a hooded sprayer to row middles when transplants are well established. Do not allow spray to contact crop foliage.
-Always include non-ionic surfactant at 2 pt/100 gal. Spray coverage is essential for optimum effectiveness.
-Rainfastness 30 min.
-A maximum of 2 applications during the growing season are allowed.</td></tr>
</table>

3. Postemergence - continued next page

3. Postemergence - continued

22	Gramoxone SL 2.0* Gramoxone SL 3.0*	1.95 pt/A 1.3 pt/A	**paraquat**	0.49 lb/A	14	24
-**Supplemental Label for the use of Gramoxone 2SL or 3SL for postemergence weed control in DE, MD, NJ, PA, and VA.** Row middles as a shielded application. -Apply as a directed spray in a minimum of 20 gal spray mix/A to control emerged weeds between the rows after crop establishment. Include a nonionic surfactant at 0.25% v/v. -Use shields or hoods to prevent spray contact with the crop and low spray pressure (maximum of 30 psi) to reduce small droplets that are prone to drift. See the label for additional information and warnings. -Rainfastness is 30 min. A maximum of 3 applications per year are allowed. -***Restricted-use pesticide***. Only certified applicators, who successfully complete the paraquat-specific training, can mix, load, or apply paraquat. Application of paraquat "under the direct supervision" of a certified applicator is no longer allowed. Required training link (*https://campus.extension.org/enrol/index.php?id=2201*); certified applicators must repeat training every three years.						

4. Postharvest

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
22	Reglone 2SL	1.5 pt/A	**diquat**	0.375	--	24
-**Special Local Needs Label 24(c) for NJ for postharvest application to desiccate the crop (expires 12/31/2025).** -Apply after the last harvest for bareground or plasticulture. Always include non-ionic surfactant at 1 to 2 pt/100 gal. -Spray coverage is essential for optimum effectiveness, label recommends 60 to 100 gal/A. -Rainfastness 30 min.						
22	Gramoxone SL 2.0* Gramoxone SL 3.0*	2.4 to 3.75 pt/A 1.6 to 2.5 pt/A	**paraquat**	0.6 to 0.94 lb/A	--	24
-Apply after the last harvest for bareground or plasticulture. Always include an adjuvant. -Spray coverage is essential for optimum effectiveness. See the label for additional information and warnings. -Rainfastness 30 min. -A maximum of 2 applications for crop desiccation are allowed. -***Restricted-use pesticide***. Only certified applicators, who successfully complete the paraquat-specific training, can mix, load, or apply paraquat. Application of paraquat "under the direct supervision" of a certified applicator is no longer allowed. Required training link (*https://campus.extension.org/enrol/index.php?id=2201*); certified applicators must repeat training every three years.						

5. Other Labeled Herbicides These products are labeled but limited local data are available; and/or are labeled but not recommended in our region due to potential crop injury concerns.

Group	Product Name (*=Restricted Use)	Active Ingredient
2	Envoke	**trifloxysulfuron**
14	Aim	**carfentrazone**
14	Vida	**pyraflufen**
14	Spartan	**sulfentrazone**
14	Tuscany, others	**flumioxazin**

Insect Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.
Recommended Insecticides Field Tomatoes (Fresh Market and Processing Tomatoes)

Aphids

Tomatoes in the Mid-Atlantic U.S. can suffer late-season infestations from green peach aphids or potato aphids. Frequent pyrethroid applications are often the cause of outbreaks of green peach aphid. Adequate coverage of the undersides of leaves is important for effective aphid control.

Apply one of the following formulations (thorough spray coverage between leaves is important):						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	1.5 to 3.0 pt/A	methomyl	3	48	H
4A	Neonicotinoid insecticides registered for use on Tomatoes: see table at the end of Insect Control.					
4C	Transform WG	0.75 to 1.0 oz/A	sulfoxaflor	1	24	H
4C + 3A	Ridgeback*	5.5 to 13.8 fl oz/A	sulfoxaflor + bifenthrin	1	24	H
4D	Sivanto Prime or 200SL	21.0 to 28.0 fl oz/A	flupyradifurone - **soil**	45	4	M
4D	Sivanto Prime or 200SL	10.5 to 14.0 fl oz/A	flupyradifurone - **foliar**	1	4	M

Aphids - continued next page

Aphids - continued

9B	Fulfill 50WDG	2.75 oz/A	pymetrozine	0	12	L
9B	PQZ	2.4 to 3.2 fl oz/A	pyrifluquinazon	1	12	L
9D	Sefina	3.0 fl oz/A	afidopyropen	0	12	L
21A	Torac	17.0 to 21.0 fl oz/A	tolfenpyrad	1	12	H
23	Movento	4.0 to 5.0 fl oz/A	spirotetramat	1	24	L
23+7C	Senstar	8.0 to 10.0 fl oz/A	spirotetramat + pyriproxyfen	1	24	L
28 + 6	Minecto Pro*	10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H
29	Beleaf 50SG	2.8 to 4.3 oz/A	flonicamid	0	12	L

Caterpillar "Worm" Pests Including:
Corn Earworms (=Tomato Fruitworms) (CEW), European Corn Borers (ECB), Beet Armyworms (BAW), Cabbage Loopers (CL), Hornworms, and Other Armyworms

Tomatoes are frequently attacked by various lepidopteran pest species. CEW (or Tomato Fruitworm) is the most important pest species, but a mix of any of the above-listed pest species can also contribute to "worm" damage on tomatoes. Local pheromone or blacklight traps are effective for monitoring key moth pest populations. Consult your Extension Agent or IPM alerts for information about trap catches. Also, visually inspecting plants and fruit or beat sheeting can help determine the presence or absence of lepidopteran pests. There is no reliable economic threshold. Note that not all lepidopteran pest species are listed on all the insecticide labels below, but, unless noted, these products have activity on all caterpillars. **Pyrethroid (Group 3A) resistance is common in BAW and CEW. Caution should be used when using that class of insecticide. Rotating insecticide classes within a season is strongly recommended.**

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	1.5 to 3.0 pt/A	methomyl	3	48	H
3A	Pyrethroid insecticides registered for use on Tomatoes: see table at the end of Insect Control.					
5	Entrust SC (OMRI)	3.0 to 6.0 fl oz/A	spinosad	1	4	M
5	Radiant SC	5.0 to 10.0 fl oz/A	spinetoram	1	4	M
6	Proclaim 5SG*	2.4 to 4.8 oz/A	emamectin benzoate	7	12	H
11A	Dipel DF, others (OMRI)	1.0 to 2.0 lb/A	*Bacillus thuringiensis kurstaki*	0	4	N
11A	XenTari (OMRI)	0.5 to 2.0 lb/A	*Bacillus thuringiensis aizawai*	0	4	N
15	Rimon 0.83EC	9.0 to 12.0 fl oz/A	novaluron	1	12	M
18	Confirm 2F	6.0 to 8.0 fl oz/A (early season); 8.0 to 16.0 fl oz/A (late season)	tebufenozide (not labeled for CEW)	7	4	M
18	Intrepid 2F	4.0 to 8.0 fl oz/A (early season); 8.0 to 16.0 fl oz/A (late season) (ECB, HW, CL only)	methoxyfenozide	1	4	L
22	Avaunt 30WDG, Avaunt eVo	2.5 to 6.0 oz/A (HW, CL); 3.5 to 6.0 oz/A (CEW)	indoxacarb	3	12	H
28	Coragen 1.67SC Coragen eVo	2.0 to 7.5 fl oz/A 0.7 to 2.5 fl oz/A	chlorantraniliprole	1	4	L
28	Exirel	7.0 to 13.5 fl oz/A (CEW, HW, ECB); 10.0 to 17.0 fl oz/A (CL)	cyantraniliprole	1	12	H
28	Verimark	5.0 to 10.0 fl oz/A (CEW, HW); 6.75 to 10.0 fl oz/A (CL)	cyantraniliprole	1	4	H
28 + 6	Minecto Pro*	7.5 to 10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H

Colorado Potato Beetles (CPB)

Rotation to crops other than potato, tomato, and eggplant is extremely important in reducing CPB problems. Also, transplants placed into no-till fields, mulches or other crop residue will reduce or delay potato beetle infestations.

Look for CPB adults shortly after seedling emergence or transplanting. Early season populations tend to be concentrated in areas where tomatoes or potatoes were previously grown. Thoroughly scout tomato fields and spray only when necessary. For established direct-seeded or transplant tomatoes, begin treatment if the population level exceeds 15 CPB adults per 10 plants throughout the field. If early treatment is not applied, wait for egg hatch and spray when larvae are young and exceed 20 CPB larvae and/or adults per 10 plants. Reassess after each treatment. Avoid the application of late-season sprays to prevent the buildup of insecticide-resistant beetles.

(continued next page)

Colorado Potato Beetles (CPB) - continued

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Vydate L*	2.0 to 4.0 pt/A	oxamyl - **foliar**	7	48	H
4A	Neonicotinoid insecticides registered for use on Tomatoes: see table at the end of Insect Control.					
4D	Sivanto Prime or 200SL	10.5 to 14.0 fl oz/A	flupyradifurone - **foliar**	1	4	M
5	Entrust SC (OMRI)	3.0 to 6.0 fl oz/A	spinosad	1	4	M
5	Radiant SC	5.0 to 10.0 fl oz/A	spinetoram	1	4	M
6	Agri-Mek SC*	1.75 to 3.5 fl oz/A	abamectin	7	12	H
11A	Trident (OMRI)	3.0 to 6.0 qt/A	*Bacillus thuringiensis tenebrionis*	0	4	L
15	Rimon 0.83EC	9.0 to 12.0 fl oz/A	novaluron	1	12	M
21A	Torac	17.0 to 21.0 fl oz/A	tolfenpyrad	1	12	H
28	Coragen 1.67SC Coragen eVo	3.5 to 7.5 fl oz/A 1.2 to 2.5 fl oz/A	chlorantraniliprole - **soil and foliar**	1	4	L
28	Exirel	7.0 to 13.5 fl oz/A	cyantraniliprole	1	12	H
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H
28	Shenzi 400SC	1.0 to 3.8 fl oz/A	chlorantraniliprole	1	4	L
28	Verimark	5.0 to 10.0 fl oz/A	cyantraniliprole	1	4	H
28 + 6	Minecto Pro*	5.5 to 10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H

Cutworms

See also section E 3.1. Soil Pests - Detection and Control.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
Pre-planting field treatment. just before seeding or transplanting, broadcast on the soil surface the following:						
1B	Diazinon AG500*	2.0 to 4.0 qt/A	diazinon	n/a	48	H
Post-planting treatment. if control is required after seedling emergence or after transplanting, treat soil thoroughly beneath plants with the following:						
3A	Pyrethroid insecticides registered for use on Tomatoes: see table at the end of Insect Control.					

Flea Beetles

Are small dark beetles that feed by chewing round holes into leaves. They usually only pose a problem to small tomato plants. Heavy feeding on small plants during hot dry periods can result in stand loss. Watch for flea beetle feeding on transplanted tomatoes. If needed one insecticide application is usually all that is needed for control.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
3A	Pyrethroid insecticides registered for use on Tomatoes: see table at the end of Insect Control.					
4A	Neonicotinoid insecticides registered for use on Tomatoes: see table at the end of Insect Control.					
21A	Torac	17.0 to 21.0 fl oz/A	tolfenpyrad	1	12	H
28	Verimark	6.75 to 13.5 fl oz/A	cyantraniliprole	1	4	H

Leafminers

Leafminers are generally not a significant problem in most fields. Adults are small, black and yellow flies that insert their eggs into leaves and the larvae feed between leaf surfaces, creating a meandering track. A few of these tracks per leaf will not affect yield.

Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
Treat with one of the following formulations when first mines appear and repeat every 7 days or as needed.						
1B	Dimethoate 400	0.5 to 1.0 pt/A	dimethoate	7	48	H
3A	Pyrethroid insecticides registered for use on Tomatoes: see table at the end of Insect Control.					
4A	Neonicotinoid insecticides registered for use on Tomatoes: see table at the end of Insect Control.					
5	Entrust SC (OMRI)	6.0 to 10.0 fl oz/A	spinosad	1	4	M
5	Radiant SC	6.0 to 10.0 fl oz/A	spinetoram	1	4	M
6	Agri-Mek SC*	1.75 to 3.5 fl oz/A	abamectin	7	12	H
15	Rimon 0.83EC	12 fl oz/A	novaluron	1	12	M

Leafminers - continued next page

Leafminers - continued

17	Trigard 75WSP	2.66 oz/A	cyromazine	0	12	H
28	Coragen 1.67SC (larvae only) Coragen eVo	5.0 to 7.5 fl oz/A 1.7 to 2.5 fl oz/A	chlorantraniliprole - **soil and foliar**	1	4	L
28	Exirel	13.5 to 20.5 fl oz/A	cyantraniliprole	1	12	H
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H
28	Verimark	6.75 to 13.5 fl oz/A	cyantraniliprole **(at planting)**	1	4	H
28 + 6	Minecto Pro*	5.5 to 10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H

Mites

Spider mite infestations generally begin around field margins, grassy areas, and windbreaks during hot dry periods that favor the mites. Beginning infestations are sometimes caused by infested transplants that were produced in GHs with bedding plants - be sure to check transplants for mites. **DO NOT** mow or maintain grassy areas after mid-summer since this causes mites into the crop. Localized infestations can be spot treated. Watch for mite feeding, *i.e.*, stippling of leaves, in mid-summer. The use of dimethoate for other pests can reduce spider mite populations. Thresholds are 2-4 mites per upper canopy leaflet. **Note:** Other mite species that can cause problems in tomatoes are russet mites and broad mites. Consult the label to determine for which mite species a miticide is labeled.

Apply one of the following formulations: **Note: Thorough spray coverage beneath leaves is important.**						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
6	Agri-Mek SC*	1.75 to 3.5 fl oz/A	abamectin	7	12	H
10A	Onager 1EC	12 to 24 fl oz/A	hexythiazox	1	12	N
20B	Kanemite 15SC	31 fl oz/A	acequinocyl	1	12	L
21A	Portal	2.0 pt/A	fenpyroximate	1	12	L
21A	Torac (broad mites only)	14.0 to 21.0 fl oz/A	tolfenpyrad	1	12	H
21A	Magister SC	24.0 to 36.0 fl oz/A	fenazaquin	3	12	H
23	Oberon 2SC	7.0 to 8.5 fl oz/A	spiromesifen	1	12	M
20D	Acramite 50WS	0.75 to 1.0 lb/A	bifenazate	3	12	M
25	Nealta	13.7 fl oz/A	cyflumetofen	3	12	L
28 + 6	Minecto Pro*	5.5 to 10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H
N/A	Sulfur 80WG (OMRI)	3 to 20 lb/A	sulfur	0	24	M

Pinworms

This pest is introduced on southern transplants. Begin sprays if leaf damage is observed. Late evening sprays may be most effective when moths are active.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	1.5 to 3.0 pt/A	methomyl	1	48	H
3A	Pyrethroid insecticides registered for use on Tomatoes: see table at the end of Insect Control.					
4A	Neonicotinoid insecticides registered for use on Tomatoes: see table at the end of Insect Control.					
5	Entrust SC (OMRI)	4.0 to 8.0 fl oz/A	spinosad	1	4	M
5	Radiant SC	5.0 to 10.0 fl oz/A	spinetoram	1	4	M
6	Agri-Mek SC*	3.5 fl oz/A	abamectin	7	12	H
6	Proclaim 5SG*	2.4 to 4.8 oz/A	emamectin benzoate	7	12	H
15	Rimon 0.83EC	9.0 to 12.0 fl oz/A	novaluron	1	12	M
22	Avaunt 30WDG, Avaunt eVo	3.5 to 6.0 oz/A	indoxacarb	3	12	H
28	Coragen 1.67SC Coragen eVo	3.5 to 7.5 fl oz/A 1.2 to 2.5 fl oz/A	chlorantraniliprole	1	4	L
28	Exirel	7.0 to 13.5 fl oz/A	cyantraniliprole	1	12	H
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H
28	Verimark	5.0 to 10.0 fl oz/A	cyantraniliprole	1	4	H
28 + 6	Minecto Pro*	10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H
n/a	NoMate TPW Spiral[1]	200 to 400 spirals/A	mating disruption hormone	n/a	n/a	n/a

[1]NoMate uses a disruption pheromone for preventing mating of emerging adults from young transplants. The pheromone is applied to a hard plastic matrix formed into a hanging “spiral” for dispersal into the air. Apply at first sign of pinworm larvae in leaves.

Stink Bugs

Several different species of stink bugs feed on tomatoes, but they produce similar damage. Adult stink bugs are shield shaped and usually brown or green sometimes having colored markings. Adults overwinter on the ground under leaves, or other protected areas. Feeding damage appears as dark pinpricks, surrounded by a white area that turns yellow on ripe fruit (cloudy spot). Because stinkbugs are so mobile and are quick to drop to the ground when the plant is disturbed there is no good scouting program for them. Watch the edges of fields for the first sign of cloudy spot to appear on green fruit. High spray gallonages and pressures are needed to penetrate the plant canopy to reach stinkbugs (especially immatures) that are hiding in the interior of the plant.

Note: Brown and brown marmorated stink bugs are less susceptible to pyrethroids than green and southern green stink bugs. Careful pyrethroid selection is advised, consult your local Cooperative Extension Service for recommendations for your area.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV* (brown marmorated stink bug only)	3.0 pt/A	methomyl	1	48	H
3A	Pyrethroid insecticides registered for use on Tomatoes: see table at the end of Insect Control.					
4A	Neonicotinoid insecticides registered for use on Tomatoes: see table at the end of Insect Control.					

Thrips

Very high numbers of thrips can cause damage with their feeding, which distorts plant growth, deforms flowers, and causes small white marks (stippling) on emerging leaves that often have tiny black fecal specks in them. Several species of thrips also spread Tomato Spotted Wilt Virus. Watch for the first symptom of thrips which is stippling on leaves or the first sign which is adults in flowers. Stippling marks or 3-5 thrips/flower indicate treatment may be necessary. Do not produce vegetable transplants with bedding plants in the same greenhouse.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
3A[1]	Pyrethroid insecticides registered for use on Tomatoes: see table at the end of Insect Control.					
4A[2]	Neonicotinoid insecticides registered for use on Tomatoes: see table at the end of Insect Control.					
5	Entrust SC (OMRI)	4.0 to 8.0 fl oz/A	spinosad	1	4	M
5	Radiant SC	6.0 to 10.0 fl oz/A	spinetoram	1	4	M
21A	Torac	21.0 fl oz/A	tolfenpyrad	1	12	H
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H

[1]Resistance concerns for Western flower thrips [2]Resistance concerns with tobacco thrips

Whiteflies

Usually are only a problem late in the season on field tomatoes. However, if they become a more frequent problem then avoid the use of broad-spectrum pesticides early in the season. Check field margins for whiteflies; these areas are usually infested first. Allow beneficials an opportunity to control light whitefly infestations. If higher populations are present at the field margins than the field centers, then treat only the field margins.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
4A	Neonicotinoid insecticides registered for use on Tomatoes: see table at the end of Insect Control.					
4C	Transform WG	2.0 to 2.25 oz/A	sulfoxaflor	1	24	H
4C + 3A	Ridgeback*	5.5 to 13.8 fl oz/A	sulfoxaflor + bifenthrin	1	24	H
4D	Sivanto Prime or 200SL	21.0 to 28.0 fl oz/A	flupyradifurone - **soil**	45	4	M
4D	Sivanto Prime or 200SL	10.5 to 14.0 fl oz/A	flupyradifurone - **foliar**	1	4	M
7C	Knack	8.0 to 10.0 fl oz/A	pyriproxyfen	1	12	L
9B	Fulfill 50WDG	2.75 oz/A	pymetrozine	0	12	L
9B	PQZ	2.4 to 3.2 fl oz/A	pyrifluquinazon	1	12	L
9D	Sefina	14.0 fl oz/A	afidopyropen	0	12	L
16	Courier SC	9.0 to 13.6 fl oz/A	buprofezin	1	12	L
23	Movento	4.0 to 5.0 fl oz/A	spirotetramat	1	24	L
23	Oberon 2SC	7.0 to 8.5 fl oz/A	spiromesifen	1	12	M
23+7C	Senstar	8.0 to 10.0 fl oz/A	spirotetramat + pyriproxyfen	1	24	L
28 + 6	Minecto Pro*	10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H
n/a	Requiem EC	2.0 to 3.0 qt/A	*Chenopodium* extract	0	4	L

Group 3A Pyrethroid Insecticides Registered for Use on Tomatoes					
Apply one of the following formulations (check if the product label lists the insect you intend to spray; the label is the law): Note: resistance concerns with this class of insecticide with western flower thrips, BAW, and CEW					
Product Name (*=Restricted Use)	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
Asana XL*	2.9 to 9.6 fl oz/A	esfenvalerate	1	12	H
Baythroid XL*	1.6 to 2.8 fl oz/A	beta-cyfluthrin	0	12	H
Brigade 2EC*, others	2.1 to 5.2 fl oz/A	bifenthrin	1	12	H
Danitol 2.4EC*	10.67 fl oz/A	fenpropathrin	3	24	H
Hero*	4.0 to 10.3 fl oz/A	zeta-cypermethrin + bifenthrin	1	12	H
Lambda-Cy 1EC*, others	1.92 to 3.84 fl oz/A	lambda-cyhalothrin	5	24	H
Mustang Maxx*	2.24 to 4.0 fl oz/A	zeta-cypermethrin	1	12	H
Proaxis*	1.92 to 3.84 fl oz/A	gamma-cyhalothrin	5	24	H
Tombstone*	1.6 to 2.8 fl oz/A	cyfluthrin	0	12	H
Warrior II*	0.96 to 1.92 fl oz/A	lambda-cyhalothrin	5	24	H
Combo products containing a pyrethroid					
Besiege*	5.0 to 9.0 fl oz/A	lambda-cyhalothrin + chlorantraniliprole (Group 28)	5	24	H
Brigadier*	3.8 to 9.85 fl oz/A	bifenthrin + imidacloprid (Group 4A) **- foliar**	1	12	H
Endigo ZC and ZCX*	4.0 to 4.5 fl oz/A	lambda-cyhalothrin + thiamethoxam (Group 4A)	5	24	H
Leverage 360*	3.8 to 4.1 fl oz/A	beta-cyfluthrin + imidacloprid (Group 4A)	0	12	H
Ridgeback*	5.5 to 13.8 fl oz/A	bifenthrin + sulfoxaflor (Group 4C)	1	24	H
Savoy EC*, others	3.6 to 9.6 fl oz/A	bifenthrin + acetamiprid (Group 4A)	1	12	H

Group 4A Neonicotinoid Insecticides Registered for Use on Tomatoes					
Apply one of the following formulations (check if the product label lists the insect you intend to spray; the label is the law): Note: resistance concerns with this class of insecticide with tobacco thrips					
Product Name (*=Restricted Use)	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
Admire Pro	7.0 to 10.5 fl oz/A	imidacloprid - **soil**	21	12	H
Admire Pro	1.3 to 2.2 fl oz/A	imidacloprid - **foliar**	0	12	H
Assail 30SG	1.5 to 4.0 oz/A	acetamiprid	7	12	M
Actara 25WDG	2.0 to 5.5 oz/A	thiamethoxam	0	12	H
Belay 50WDG	4.8 to 6.4 oz/A	clothianidin - soil	7	12	H
Belay 50WDG	1.6 to 2.1 oz/A	clothianidin - foliar	7	12	H
Platinum 75SG	1.66 to 3.67 oz/A	thiamethoxam	30	12	H
Scorpion 35SL	9.0 to 10.5 fl oz/A	dinotefuran - **soil**	21	12	H
Scorpion 35SL	2.0 to 7.0 fl oz/A	dinotefuran - **foliar**	1	12	H
Venom 70SG	5.0 to 7.5 oz/A	dinotefuran - **soil**	21	12	H
Venom 70SG	1.0 to 4.0 oz/A	dinotefuran - **foliar**	1	12	H
Combo products containing a neonicotinoid					
Brigadier*	3.8 to 9.85 fl oz/A	imidacloprid + bifenthrin (Group 3A) **- foliar**	1	12	H
Durivo	10.0 to 13.0 fl oz/A	thiamethoxam + chlorantraniliprole (Group 28)	30	12	H
Endigo ZC* and ZCX*	4.0 to 4.5 fl oz/A	thiamethoxam + lambda-cyhalothrin (Group 3A)	5	24	H
Leverage 360*	3.8 to 4.1 fl oz/A	imidacloprid + beta-cyfluthrin (Group 3A)	7	12	H
Savoy EC*	3.6 to 9.6 fl oz/A	acetamiprid + bifenthrin (Group 3A)	1	12	H
Voliam Flexi	4.0 to 7.0 oz/A	thiamethoxam + chlorantraniliprole	1	12	H

Disease Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.
Recommended Fungicides

Nematodes

See sections E 1.5. Soil Fumigation and E 1.6. Nematode Control.

Seed Treatment

Purchase hot water treated seed or request hot water treatment. Heat treatment is a non-chemical alternative to conventional chlorine treatments that only kills pathogens on the surface of the seed coat. Heat treatment has the additional benefit of killing pathogens within the seed coat and is particularly useful for crops that are prone to seed-borne bacterial infections such as tomato and pepper. Seed heat treatment follows a strict time and temperature protocol and is best done with thermostatically controlled water baths. Two baths are required: one for pre-heating, and a second for the effective (pathogen killing) temperature. Seeds stay in the first bath at 100ºF (38ºC) for 10 minutes, and in the second bath at 122°F (50°C) for 25 minutes. Immediately after removal from the second bath, seeds should be thoroughly rinsed with cool water, and dried on a screen or paper.

Alternatively, soak seeds in a mixture of 1part Alcide (sodium chlorite), 1 part lactic acid, and 18 parts water for 1-2 minutes under constant agitation, and rinse for 5 minutes in cool running water. Do not use pelleted seeds because moisture results in the loss of coating material.

Only treat seed that will be used during the current production season. Following heat or chlorine treatment, dust dried seed with Captan 50WP or Thiram 480DP at 1 level tsp/lb seed (3.0 oz/100 lb).

Damping-off and Root Rots

Greenhouse: Use seed treatment and plant in a disease-free mix.
Field: At planting apply one of the fungicides via drip or banded spray. Additional field applications may be made as needed, see label for specific instructions.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
4	MetaStar 2E AG	2.0-4.0 pt/A	metalaxyl	AP	48	N
4	Ridomil Gold 4SL[1]	1.0-2.0 pt/A[1]	mefenoxam	AP	48	N
4	Ultra Flourish 2E[1]	2.0-4.0 pt/A[1]	mefenoxam	AP	48	N
P07	Aliette 80WDG	2.5 to 5.0 lb/A	fosetyl-Al	14	12	N
28	Previcur Flex	1.5 pt/A	propamocarb	5	12	--
49 + 4	Orondis Gold	28.0 to 55.0 fl oz/A	oxathiapiprolin + mefenoxam	7	4	--

[1]Apply in a 7-inch band at transplanting. Determine the amount of Ridomil Gold or Ultra Flourish per acre using the calibration formula for changing from broadcast to band application (see the section E 1.3 Calibrating Granular Applicators in chapter E Pest Management).

Bacterial Diseases

Bacterial Canker

Use certified transplants. Rotate to allow 3 years between plantings. When producing transplants, use Clorox or heat-treated seed and treat used flats with sodium hypochlorite (bleach) (see section A 5. Transplant Production). Stakes from bacterial canker infested fields should be power washed, soaked in a 20% (1part bleach plus 4 parts water) commercial bleach solution for at least 30 minutes, and power wash a second time prior to use. Avoid pruning and stringing when foliage is wet as this will promote the spread of the disease in infested fields. Applications of Actigard 50WG (0.33 oz/A increasing to 0.75 oz/A when plants are full size, see label) PLUS fixed copper (1.5 lb active/A) have been shown to reduce bacterial canker symptoms on fruit.

Bacterial Speck and Bacterial Spot

When producing transplants, use Clorox or heat-treated seed as described above under Seed Treatment. Apply streptomycin sprays (Agri-Mycin 17, Agri-Strep, 1.0 lb/100gal, 1.25 tsp/gal) when the first true leaves appear and continue every 45 days until transplanting. Streptomycin cannot be used after transplanting. Limit handling of plants and keep greenhouse moisture levels low.

Rotate to allow 2 -3 years between plantings. Use only certified transplants. Cultural practices discussed in the bacterial canker section will also suppress levels of Bacterial Speck and/or Spot. Bacterial Speck and/or Spot occur more often on southern-produced transplants. Strains of copper resistant Bacterial Spot are common in some areas of the Mid-Atlantic particularly on the Eastern Shore of VA. Use Actigard alone or in conjunction with copper-containing materials. Where disease is present or anticipated, do not work in fields when plant surfaces are wet.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Tank mix the following beginning shortly after transplanting and repeat every 7 days.						
M01	copper (OMRI)	1.0 lb ai/A	copper	0	see label	N
M03	mancozeb 75DF	1.5 lb/A	mancozeb	5	12/24	N
And rotate with or apply the following:						
M01+M03	ManKocide 61WP	2.5 to 5.0 lb/A	copper hydroxide + mancozeb	5	48	N
The following is a plant defense activator and preventative applications should begin prior to the onset of symptoms.						
P01	Actigard 50WG[1]	0.33 to 0.75 oz/A (see label)	acibenzolar-S-methyl	14	12	N

[1]Use in areas where copper resistance is known. See label for rates and times of use.

Bacterial Wilt

Use certified transplants. Avoid growing tomatoes in fields where bacterial wilt has occurred. Crop rotation to non-host crops is the best measure to reduce levels of bacterial wilt. In particular, avoid planting where tomatoes or peppers were grown in the preceding year. Some resistant cultivars, such as BHN669, are available. Grafting onto resistant rootstocks will also suppress disease levels. Avoid irrigating with pond water, when possible, especially for ponds that are adjacent to previously diseased fields as they may be contaminated with the causal agent.

Fungal Diseases

Botrytis Fruit Rot (Gray Mold)

Gray Mold is a problem during the fall in fields with dense foliage and poor drainage. For fall production, select fields with good drainage.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Shortly before harvest or when conditions are wet and cool, rotate the following as long as weather conditions favor disease development:						
M05	chlorothalonil 6F	2.0 to 2.75 pt/A	chlorothalonil	0	12	N
7	Endura 70W	9.0 to 12.5 oz/A	boscalid	0	12	--
7	Fontelis 1.67SC	16.0 to 24.0 fl oz/A	penthiopyrad	0	12	--
9	Scala SC	7.0 fl oz/A	pyrimethanil	1	12	--
11	Cabrio EG	12.0 to 16.0 fl oz/A	pyraclostrobin	0	12	--
7 + 9	Luna Tranquility	11.2 fl oz/A	fluopyram + pyrimethanil	1	12	--
7 + 3	Luna Flex	8.0 to 13.6 fl oz/A	fluopyram + difenoconazole	0	12	--
7 + 11	Luna Sensation	7.6 fl oz/A	fluopyram + trifloxystronin	3	12	--
7 + 11	Priaxor Xemium	4.0 to 8.0 fl oz/A	fluxapyroxad + pyraclostrobin	7	12	--
7 + 12	Miravis Prime	11.4 fl oz/A	pydiflumetofen + fludioxonil	0	12	--
3 +9	Inspire Super	16.0 to 20.0 fl oz/A	difenoconazole + cyprodinil	0	12	--
9 + 12	Switch 62.5WG	11.0 to 14.0 oz/A	cyprodinil + fludioxonil	0	12	L

Buckeye Rot caused by *Phytophthora parasitica,* and Fruit Rot caused by *Pythium* spp.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Apply one of the following as a soil surface application under the vines 4 to 8 weeks before harvest. Apply broadcast or banded (adjust amount). Irrigate after application.						
4	Ridomil Gold 4SL	1.0 pt/A	mefenoxam	AP	48	N
4	Ultra Flourish 2E	1.0 qt/A	mefenoxam	AP	48	N
4 + 49	Orondis Gold	28.0 55.0 fl oz/A	mefenoxam + oxathiapiprolin	AP	4	--
Rotate the following beginning when crown fruit are one-third their final size and prior to disease development or as long as weather conditions favor disease development.						
4 + M01	Ridomil Gold Copper 65WP	2.0 lb/A	mefenoxam + copper	14	48	N
4 + M05	Flouronil 76WP	2.0 lb/A	mefenoxam + chlorothalonil	14	48	N
4 + M05	Ridomil Gold Bravo 76WP	2.0 lb/A	mefenoxam + chlorothalonil	14	48	N
49 + M5	Orondis Opti	1.75 to 2.5 pt/A	oxathiapiprolin + chlorothalonil	0	12	--
49 + 40	Orondis Ultra	5.5 to 8.0 fl oz/A	oxathiapiprolin + mandipropamid	1	4	--
11 + 27	Tanos 50DF	8.0 oz/A	famoxadone + cymoxanil	3	12	--
22+M03	Gavel 75DF	1.5 to 2.0 lb/A	zoxamide + mancozeb	5	48	--

Fusarium Wilt and Verticillium Wilt

Select varieties with resistance to Fusarium and Verticillium Wilt. For Fusarium Wilt, select cultivars that are resistant to Races 1, 2, and 3 as all are prevalent on in the Mid-Atlantic region. Soil fumigation and proper crop rotation are essential components of a successful management program.

Late Blight

Use disease free transplants. If possible, produce your own transplants since transplants obtained from other regions may increase the risk of a late blight infestation. A strong scouting program, preventative fungicide applications when warranted, and microclimate management to reduce levels of free moisture on foliage are essential to help reduce the potential for disease development. Tomato cultivars with resistance to Late blight are available.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
When plants are 6 inches tall, apply one of the following protectant fungicides and repeat every 7 days.						
M03	mancozeb 75DF	3.0 lb/A	mancozeb	5	12,24	N
M03+22	Gavel 75DF	1.5 to 2.0 lb/A	mancozeb + zoxamide	5	48	--
M05	chlorothalonil 6F	1.0 to 3.0 pt/A	chlorothalonil	0	12	N
M05+22	Zing! 4.9SC	36.0 fl oz/A	chlorothalonil + zoxamide	7	12	N
Protectant fungicides should only be applied preventatively. Monitor the movement of the disease at http://www.usablight.org/ or via local online Extension resources. Once late blight is detected in your area, TANK MIX one of the following translaminar fungicides which can move into and through leaves WITH A PROTECTANT FUNGICIDE such as chlorothalonil, Gavel, or mancozeb. Products containing mefenoxam should not be used unless your extension professional or the aforementioned website are certain that current strains are sensitive. To achieve the best control, rotate between one of the following options:						
3 + 40	Revus Top 4.16SC	5.5 to 7.0 fl oz/A; also offers protection from Leaf Spots; **not** for use on small-fruited varieties.	difenoconazole + mandipropamid	1	12	M
49+M05	Orondis Opti	1.75 to 2.5 pt/A; also offers protection from Leaf Spots	oxathiapiprolin + chlorothalonil	0	12	--
49 + 40	Orondis Ultra 2.33SC	5.5 to 8.0 fl oz/A	oxathiapiprolin + mandipropamid	1	4	--
11	Reason 500SC	5.5 to 8.2 fl oz/A	fenamidone	14	12	--
11+27	Tanos 50DF	8.0 oz/A; also offers protection from Leaf Spots	famoxadone + cymoxanil	3	12	--
21	Ranman 400SC	2.10 to 2.75 fl oz/A	cyazofamid	0	12	L
27	Curzate 60DF	3.2 to 5.0 oz/A	cymoxanil	3	12	N
28	Previcur Flex 6F	1.5 pt/A	propamocarb HCl	5	12	N
40	Forum 4.17SC	6.0 fl oz/A	dimethomorph	4	12	N
43	Presidio 4SC	3.0 to 4.0 fl oz/A	fluopicolide	2	12	L
GREENHOUSE USE: Consult fungicide labels to ensure greenhouse applications are permitted. The following materials permit greenhouse applications and can offer suppression. Apply one of the following:						
M05+P07	Catamaran 5.3F	5.5 to 7.0 pt/A	chlorothalonil + phosphite	0	12	--
11	Heritage 50WG	1.6 to 2.0 oz/A	azoxystrobin	0	4	N

Leaf Mold

Leaf Mold is caused by the fungus *Passalora fulva* (previously called *Fulvia fulva* or *Cladosporium fulvum*). Leaf Mold may occur during periods of high moisture particularly within the canopy. Leaf Mold is primarily damaging in greenhouse and high tunnel tomato settings with long periods of high relative humidity. Vent structures regularly to reduce humidity and leaf wetness. See Table E-13 for fungicides labeled for use in greenhouses.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Apply or rotate between the following fungicides as long as conditions are favorable for disease development:						
M05+P07	Catamaran 5.3F	4.5 to 7.0 pt/A	chlorothalonil + phosphite	4	12	--
3 + 40	Revus Top 4.16SC	5.5 to 7.0 fl oz/A	difenoconazole + mandipropamid	1	12	M
3 + 11	Quadris Top	8.0 fl oz/A	difenoconazole + azoxystrobin	0	12	--
3 + 7	Aprovia Top 1.62EC	10.5 to 13.5 fl oz/A	difenoconazole + benzovindiflupyr	0	12	--
3 + 7	Luna Flex	8.0 to 13.6 fl oz/A	difenoconazole + fluopyram	0	12	--
3 + 9	Inspire Super	16.0 to 20.0 fl oz/A	difenoconazole + cyprodinil	0	12	--

Leaf Spots caused by Early blight and Septoria leaf spot and Fruit Rots caused by Anthracnose and Early blight:

Follow a crop rotation with at least 2 years without tomatoes or potatoes. Use disease-free transplants and disease resistant varieties when possible. In high elevated areas, in fields not rotated away from tomatoes, or in late planted fields begin sprays shortly after transplanting. In all other areas, follow a regular (7-day) spray schedule.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Alternate or tank mix one of the following protectant fungicides:						
M03	mancozeb 75DF	3.0 lb/A (also for Gray Leaf Spot and Leaf Mold)	mancozeb	5	12/24	N
M03+22	Gavel 75DF	1.5 to 2.0 lb/A	mancozeb + zoxamide	5	48	--
M05	chlorothalonil 6F	2.0 to 3.0 pt/A (also for Gray Leaf Spot, Black Mold, and Soil Rot)	chlorothalonil	0	12	N
M05+22	Zing! 4.9SC	36.0 fl oz/A	chlorothalonil + zoxamide	7	12	N
WITH one of the following fungicides (fungicides from different FRAC codes should be rotated to help reduce the chances for fungicide resistance development):						
3	Cevya	3.0 to 5.0 fl oz/A	mefentrifluconazole	0	12	--
3	Mettle 125ME	6.0 to 8.0 fl oz/A	Tetraconazole	0	12	--
3	Rhyme	5.0 to 7.0 fl oz/A	flutriafol	0	12	--
3	Mettle 125ME	6.0 to 8.0 fl oz/A	tetraconazole	0	12	--
3 + 7	Aprovia Top 1.62EC	10.5 to 13.5 fl oz/A	difenoconazole + benzovindiflupyr	0	12	--
3 + 9	Inspire Super 2.82EW	16.0 to 20.0 fl oz/A	difenoconazole + cyprodonil	0	12	--
3 + 11	Quadris Top 1.67SC	8.0 fl oz/A	difenoconazole + azoxystrobin	0	12	--
3 + 40	Revus Top 4.16SC	5.5 to 7.0 fl oz/A	difenoconazole + mandipropamid	1	12	M
3 + 11	Topguard EQ4.29SC	4.0 to 8.0 fl oz/A	flutriafol + azoxystrobin	0	12	--
7	Endura 70W	2.5 to 3.5 oz/A (also for *Botrytis* at 9.0 to 12.5 oz/A)	boscalid	3	12	--
7	Fontelis 1.67SC	16.0 to 24.0 fl oz/A	penthiopyrad	0	12	L
7 + 3	Luna Flex	8.0 to 13.6 fl oz/A	fluopyram + difenoconazole	0	12	--
7 + 9	Luna Tranquility	11.2 fl oz/A	fluopyram + pyrimethanil			
7 + 11	Luna Sensation	5.0 to 7.6 fl oz/A	fluopyram + trifloxystrobin	3	12	--
7 + 11	Priaxor 4.17SC	4.0 to 8.0 fl oz/A	fluxapyroxad + pyraclostrobin	7	12	N
7 + 12	Miravis Prime	9.2 to 11.4 fl oz/A	pydiflumetofen + fludioxonil	0	12	--
9	Scala SC	7.0 fl oz/A	pyrimethanil	1	12	--
11	azoxystrobin 2.08F	5.0 to 6.2 fl oz/A (also for Black Mold and Buckeye Rot)	azoxystrobin (**Do not apply near apples**, see label)	0	4	N
11	Cabrio 20EG	8.0 to 12.0 oz/A	pyraclostrobin	0	12	N
11	Flint Extra 500SC	3.0-3.8 fl oz/A	trifloxystrobin (**Do not apply near Concord grapes**, see label)	3	12	N
11	Reason 500SC	5.5 to 8.2 fl oz/A	fenamidone	14	12	--
11	Aftershock, Evito 480 SC	2.0 to 5.7 fl oz/A	fluoxastrobin	3	12	--
11 + M5	Quadris Opti	1.6 pt/A	azoxystrobin + chlorothalonil	0	12	--
11 + 27	Tanos 50DF	8.0 oz/A *PLUS* protectant fungicide (also for Buckeye Rot suppression and Gray Leaf Spot).	famoxadone + cymoxanil	3	12	--

Powdery Mildew

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
At first appearance of the disease, rotate between the following fungicides[1]:						
FIELD, repeat every 7 to 14 days:						
3	Rally 40WSP	2.5 to 4.0 oz/A	myclobutanil	0	12	N
3	Rhyme	5.0 to 7.0 fl oz/A	flutriafol	0	12	--
3	Mettle 125ME	6.0 to 8.0 fl oz/A	tetraconazole	0	12	--
3 + 7	Aprovia Top 1.62EC	10.5 to 13.5 fl oz/A	difenoconazole + benzovindiflupyr	0	12	--
3 + 9	Inspire Super 2.82EW	16.0 to 20.0 fl oz/A	difenoconazole + cyprodonil	0	12	--
3 + 11	Topguard EQ	4.0 to 8.0 fl oz/A	flutriafol + azoxystrobin	0	12	--
3 + 40	Revus Top 4.16SC	5.5 to 7.0 fl oz/A	difenoconazole + mandipropamid	1	12	M

Powdery Mildew - continued next page

Powdery Mildew - continued

7 + 3	Luna Flex	8.0 to 13.6 fl oz/A	fluopyram +difenoconazole	0	12	--
7 + 11	Luna Sensation	5.0 to 7.6 fl oz/A	fluopyram + trifloxystrobin	3	12	--
7 + 11	Priaxor Xemium	4.0 to 8.0 fl oz/A	fluxapyroxad + pyraclostrobin	7	12	--
7 + 12	Miravis Prime	9.2 to 11.4 fl oz/A	pydiflumetofen + fludioxonil	0	12	--
11	Quadris Top	8.0 fl oz/A	azoxystrobin + difenoconazole	0	12	--
9 + 12	Switch 62.5WG	11.0 to 14.0 oz/A	cyprodinil + fludioxonil	0	12	--
11	Cabrio 20EG	8.0 to 12.0 oz/A	pyraclostrobin	0	12	N
50	Prolivo	4.0 to 5.0 l oz/A	pyriofenone	0	4	--
M2	Various	See label	sulfur	See label	24	--
GREENHOUSE[2], thoroughly cover upper and lower leaf surfaces and repeat every 7 days:						
--	JMS Stylet-Oil	1.0 to 2.0 gal/100 gal	paraffinic oil	--	--	--
9	Scala 5SC	7.0 fl oz/A	pyrimethanil	1	12	--

[1] Fungicides from different FRAC codes should be rotated to help reduce the chances for fungicide resistance development. [2] Powdery Mildew can cause serious problems in greenhouse and high tunnel settings. See Table E-13 for additional fungicides labeled for use in greenhouses.

Southern Blight (*Sclerotium rolfsii*)

Southern Blight is most commonly seen in the southern part of the Mid-Atlantic region. High soil moisture and temperatures favor disease, while long crop rotations with corn and small grains help reduce disease incidence. Weed control is important as *Sclerotium rolfsii* can infect several common weeds in the Mid-Atlantic region. Soil fumigation and staking will greatly reduce disease incidence. Applications of fungicides in transplant water or as an in-furrow treatment may suppress the disease.

Code	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
14	Blocker 4F	See label	pentachloronitrobenzene (PCNB)	AP	12	H
7	Fontelis 1.67SC	1.0 to 1.6 fl oz/1000 row ft	penthiopyrad	0	12	--

Timber Rot (*Sclerotinia sclerotiorum)*

Tomato timber rot, also known as sclerotinia stem rot, is a fungal disease caused by *Sclerotinia sclerotiorum*. Rotate away from fields where snap or lima beans, peas, peanuts, lettuce, or cucurbits were grown in the past. -- Timber rot occurs during prolonged wet periods and cooler temperatures (<80°F).

Viruses: Tomato Spotted Wilt Virus (TSWV)

TSWV can result in severely stunted plants. The virus is spread by thrips from ornamental flowering plants, field crops, and weeds to tomatoes. TSWV can be particularly devastating in southern and eastern parts of VA. Use resistant varieties when available. Do not grow any ornamental bedding plants in the same greenhouse as tomato transplants. Control weeds in and around greenhouses, high tunnels, or transplant areas. Monitor greenhouses and tomato fields for thrips and begin an insecticide control program once observed. Use of reflective mulch can help repel thrips. If tomato crops are near wheat or barley fields be aware of increased thrips pressure once these crops start to turn brown in the spring.

Post-Harvest Rots

Avoid harvesting when the foliage is wet. To prevent rots in mature green tomatoes, avoid washing freshly harvested fruit in cold water. To prevent movement of bacteria into the stem end of the fruit, do not allow water temperatures in flumes and tanks of more than 10°F above fruit temperature. Use a minimum of 100 ppm free chlorine and keep pH between 6.5-7.0 in the flume. Store at 55°F (13°C) with relative humidity of 80%. For more information on post-harvest tomato diseases, see http://edis.ifas.ufl.edu/HS131.

Watermelons

Recommended Varieties[1]

Type	Reported Disease Resistance[2]						Size (lb)	Shape	Flesh Color	Rind Description
	Fon[3] Gen	Fon 0	Fon 1	Fon 2	Co[4]	Px[5]				
Seeded (also see seeded pollenizers)										
Crimson Sweet	R				R		16-20	globe	red	medium green with dark green stripes
Jamboree			I		I		24-28	oblong	red	dark green with broken light green stripes
Jubilee II			I				20-30	oblong		medium green with dark green stripes
Sangria	I				I		20-24	oblong	red	dark green with broken light green stripes
Starbrite					R		22-31	oblong	red	medium green with dark green stripes
Top Gun			I		I		21-24	globe	red	medium green with dark green stripes
Seedless Early										
Blackjack			I		I		15-23	globe	red	dark green
Charismatic							13-16	globe	red	medium green with dark green stripes
Jetski			I				17-20	oval	red	medium green with dark green stripes
Melody					I		14-16	globe	red	medium green with dark green stripes
Secretariat							16-20	oval	red	light green with broad, medium green stripes
Sweet Eat'n	I				I		15-20	oval	red	light green with broad, medium green stripes
Sweet Gem							13-16	globe	red	dark green
Warrior		I	I				16-20	oval	red	medium green with dark green stripes
Seedless Mid-Season										
Amarillo							13-15	globe	yellow	light green with narrow dark green stripes
Bottle Rocket			I				18-21	oblong	red	medium green with dark mottled stripes
Buttercup							12-18	globe	yellow	light green with narrow dark green stripes
Cut Above	I						15-17	oval	red	medium green with dark green stripes
Eleanor		I	I		I		15-19	oval	red	medium green with dark green stripes
Embasy			I		I		15-20	oval	red	medium green with dark green stripes
Excursion			I		I		17-24	oval	red	medium green with dark green stripes
Fascination			I		I		16-20	oval	red	medium green with dark green stripes
Guardsman			I		I	I	14-19	oval	red	medium green with dark green stripes
Kingman							16-20	oval	red	light green with broad, medium green stripes
Neptune							16-20	oval	red	medium green with dark green stripes
Paradigm						I	13-15	globe	red	medium green with dark green stripes
Red Opal			I		I		15-19	oval	red	medium green with dark green stripes
Road Trip	R				R		16-18	oblong	red	medium green with mottled green stripe
Shoreline			I		I		16-18	oval	red	medium green with dark mottled stripes
SS 7167							16-20	oval	red	medium green with dark green stripes
SV0241WA			I		R		12-15	oval	red	light green with medium green stripes
Tailgate							17-18	oval	red	medium green with dark green stripes
Traveler					R		15-20	oval	red	medium green with dark green stripes
Troubadour					R		13-18	oval	red	medium green with dark green stripes
Turnpike							16-20	oval	red	light green with medium green stripes
Unbridled							13-16	globe	red	medium green with dark green stripes
Seedless Late										
Captivation			I		I		14-17	oval	red	medium green with dark green stripes
Crunchy Red					R		16-20	oval	red	light green with broad, medium green stripes
Exclamation			I		I		17-21	oval	red	medium green with dark green stripes
Maxima							19-22	globe	red	medium green with dark green stripes
Orange Crisp							17-19	globe	orange	medium green with dark green stripes
Premont			I		I		15-17	oval	red	medium green with green stripes
Red Amber			I		I		16-20	oval	red	light green with medium green stripe
Shoreline							16-18	oblong	red	medium green with dark mottled stripes
Talca							17-20	oval	red	green with very dark green stripes

Recommended Varieties (Seedless Late) - continued next page

Recommended Varieties (Seedless Late)- continued

Type	Reported Disease Resistance[2] Fon[3] Gen	Fon 0	Fon 1	Fon 2	Co[4]	Px[5]	Size (lb)	Shape	Flesh Color	Rind Description
Seedless Late *(continued)*										
Wolverine							16-18	oval	red	medium green with dark green stripes
7187HQ							16-20	oval	red	medium green with dark green stripe
7197HQ					I		16-20	oval	red	medium green with dark green stripes
Seedless Personal Melon										
Ana							6-8	globe	red	medium green with dark green stripes
Extazy							4-7	globe	red	medium green with dark green stripes
Ocelot							3-5	globe	red	medium green with dark green stripes
Sorbet		R	R		R		6-8	globe	red	dark green with thin darker stripes
Edible Pollenizers										
Estrella			I		I		20-24	oblong	red	dark green with broken, light green stripes
Jade Star							13-16	globe	red	dark green
Mickeylee	R				R		8-12	globe	red	light green
Premium		I	I				5-7	oval	red	light green with thin dark green strips
Sangria			I		I		20-24	oblong	red	dark green with broken light green stripes
Stargazer					I		24-26	oblong	red	dark green with broken light green stripes
Inedible Special Pollenizers										
Accomplice					R					
Ace Plus			I		I					
Sidekick					R					
SP 6			I	I	I	I				
SP 7			R		R	R				
Wild Card Plus			I		I					
Wingman										

[1]**Alphabetical order within type**.
[2]Reported disease resistance from source seed companies and university trials. R=Resistance; I=intermediate/partial resistance.
[3]Fon Gen=general resistance to Fusarium Wilt. Fon=Fusarium Wilt caused by *Fusarium oxysporum f. sp. niveum* Race 1,2, or 3.
[4]Co=Anthracnose caused by *Colletotrichum orbiculare*.
[5]Px=Powery Mildew caused by *Podosphaeria xanthii.*

Grafted Watermelons

Commercially produced grafted watermelons are available. Watermelons are susceptible to Fusarium Wilt and watermelon varieties are often grafted onto resistant rootstocks where wilt is present. Common rootstocks are bottle gourd (*Lagenaria siceraria*) and interspecific winter squash hybrids (*Cucurbita maxima* x *Cucurbita moschata*). Bottle gourd rootstocks include 'Liga' RST12-123-W, and PelopsRZ. Interspecific hybrid rootstocks include RS841, AQ, BS1, Carnivor, Flexifort, FerroRZ, Cobalt, and Super Shintosa. The citron melon (*Citrullus lanatus* var. *citroides*) rootstock resistant to both Fusarium Wilt and Root Knot Nematode is Carolina Strongback. Grafted watermelon may also increase tolerance to high and low temperatures, improve nutrient uptake, improve water use efficiency, and improve yield, fruit quality, and fruit size. Watermelon grafted onto these rootstocks will often have a more extensive root system and will require less nitrogen and can be planted further apart with no impact on yield.

Recommended Nutrients Based on Soil Tests

In addition to using the table below, check the suggestions on rate, timing, and placement of nutrients in your soil test report and chapter B Soil and Nutrient Management. Your state's soil test report recommendations and/or your farm's nutrient management plan supersede recommendations found below.

Watermelons[1]		Soil Phosphorus Level				Soil Potassium Level				
		Low	Med	High (Opt)	Very High	Low	Med	High (Opt)	Very High	
	N (lb/A)	P_2O_5 (lb/A)				K_2O (lb/A)				Nutrient Timing and Method
Non-Irrigated	80-100	150	100	50	0[2]	200	150	100	0[2]	Total nutrient recommended
	50	150	100	50	0[2]	200	150	100	0[2]	Broadcast and disk-in
	25-50	0	0	0	0	0	0	0	0	Sidedress when vines start to run

Recommended Nutrients Based on Soil Tests - ***see next page for Irrigated Watermelons and Footnotes.***

Recommended Nutrients Based on Soil Tests - continued. ***See previous page for Non-Irrigated Watermelons***

Watermelons[1]		Soil Phosphorus Level				Soil Potassium Level				
		Low	**Med**	**High (Opt)**	**Very High**	**Low**	**Med**	**High (Opt)**	**Very High**	
Irrigated	125-150[1]	150	100	50	0[2]	200	150	100	0[2]	Total nutrient recommended
	25-50	150	100	50	0[2]	200	150	100	0[2]	Broadcast and disk-in or follow fertigation schedule for K
	25-50	0	0	0	0	0	0	0	0	Sidedress when vines start to run or follow fertigation schedule
	25-50	0	0	0	0	0	0	0	0	Sidedress after first harvest or follow fertigation schedule

[1]Apply 20-30 lb/A of sulfur (S) for most soils. [2]In VA, crop replacement values of 25 lb/A of P_2O_5 and 50 lb/A of K_2O are recommended on soils testing Very High.

Fertigation Schedule Examples

This table provides examples of fertigation schedules based on two common scenarios – sandy coastal plain soils and heavier upland soils. Modify according to specific soil tests and base fertility.

Fertigation recommendations for 125 lb N and 125 lb K_2O[1,2] For soils with organic matter content less than 2% or coarse texture and low to medium or deficient K								
			Nitrogen			**Potash**		
Preplant (lb/A)[3]			**25**			**50**		
			N	**N**	**N**	**K_2O**	**K_2O**	**K_2O**
Stage and Description	Weeks	Days	lb/day	lb/week	lb/stage	lb/day	lb/week	lb/stage
1 Early vegetative	1-2	1-14	1	7	14	1	7	14
2 Late vegetative	3-4	15-28	1.5	10.5	21	1.5	10.5	21
3 Flowering and fruiting	5-8	29-56	2	14	56	2	14	56
4 Harvest	9-10	57-70	1.5	10.5	21	1.5	10.5	21
5 Repeat harvest[4]	11-12	71-84	1	7	14	1	7	14
Fertigation recommendations for 100 lb N and 50 lb K_20[1,2] For soils with organic matter content greater than 2% or fine texture and high or optimum K								
			Nitrogen			**Potash**		
Preplant (lb/A)[3]			**50**			**50**		
			N	**N**	**N**	**K_2O**	**K_2O**	**K_2O**
Stage and Description	Weeks	Days	lb/day	lb/week	lb/stage	lb/day	lb/week	lb/stage
1 Early vegetative	1-2	1-14	0.4	2.8	5.6	0.3	2.1	4.2
2 Late vegetative	3-4	15-28	0.9	6.3	12.6	0.6	4.2	8.4
3 Flowering and fruiting	5-8	29-56	1.4	9.8	39.2	0.9	6.3	25.2
4 Harvest	9-10	57-70	0.9	6.3	12.6	0.6	4.2	8.4
5 Repeat harvest[4]	11-12	71-84	0.4	2.8	5.6	0.3	2.1	4.2

[1]Rates are based on 6,222 linear bed ft/A (7 ft bed spacing). If beds are closer or wider, fertilizer rates should be adjusted proportionally. Drive rows should not be used in acreage calculations (see section C 3. Fertigation). [2]Base overall application rate on soil test recommendations.[3]Applied under plastic mulch to effective bed area using modified broadcast method.[4]For extended harvest after 12 weeks continue fertigation at this rate.

Plant Tissue and Petiole Sap Testing

Plant tissue and petiole sap testing are useful tools for monitoring plant nutrient status, especially for N and K.

Petiole sap:

Petiole sap can be tested with a portable meter. When vines are 6 inches long, petiole sap nitrate-N should be 1200-1500 ppm and K 4000-5000 ppm. When fruit are 2 inches long, nitrate-N should be 1000-1200 ppm for seeded cultivars, 900-1100 ppm for seedless cultivars and K 4000-5000 ppm. When fruit are half mature, nitrate-N should be 800-1000 ppm for seeded cultivars, 600-800 ppm for seedless cultivars and K 3500-4000 ppm. At first harvest, nitrate-N should be 600-800 ppm for seeded cultivars, 400-600 ppm for seedless cultivars and K 3000-3500 ppm.

Tissue testing:

For tissue testing, sample the most recent fully expanded leaves at first fruit set and follow laboratory instructions for handling. Plant tissue testing can be a valuable tool to assess crop nutrient status during the growing season to aid with in-season fertility programs or to evaluate potential deficiencies or toxicities. Critical watermelon tissue test values for most recently matured leaves at first fruit set: N 2-3 %, P 0.3-0.5 %, K 2.7-3.5 %, Ca 1-2%, Mg 0.25-0.5% and S 0.2-0.4%. For additional nutrients and other growth stages consult with a tissue testing laboratory or this web link at the University of Florida: *https://edis.ifas.ufl.edu/publication/ep081*.

Seed Treatment

Check if seed has been treated with an insecticide and fungicide. See Disease Control below.

Plant Production

Transplants should be grown in plug trays with cells at least 1.5 inches in diameter and 2 inches deep. Smaller pots or cells will restrict root growth and provide less protection to the transplant. Plant 1 seed per cell. Triploid (seedless) watermelon seeds require a special regime to germinate well. The seed coat tends to adhere to the seedling as it emerges, at times slowing growth or reducing stand. Seeds are of lower vigor than standard diploid types.

Seedless watermelon transplant production can be broken into 6 stages:

1) Seeding

Trays should be evenly filled with a general commercial greenhouse growing medium with a starter fertilizer. Do not use fine seed starter or plug mix types. Do not compress the growing media. Trays should be watered to capacity and then allowed to drain excess water for 24 h in a heated area so that the media can warm up to 85°F (29°C). This temperature should be maintained during seeding. Make 1 inch deep planting holes and plant seeds with the "pointed" side up. Cover with a small amount of warm moist medium. Do not water after seeding.

2) Initial Germination

During germination it is critical that trays are kept at a uniform temperature of 85-90°F (29-32°C) and at high humidity. It may be necessary to move trays around after 24 h (trays on bottom shelves moved to top shelves and vice versa) to ensure even temperature exposure. During this 48 h phase, the root will emerge but the epicotyl ("crook") that will carry the leaves above the media surface should not be visible. If crooks are visible, trays may have been left in the germination area for too long. In that case, plants may "stretch" during emergence which results in poor transplant quality.

3) Emergence

After initial germination, move plants immediately to the greenhouse. If another grower germinates your seeds, schedule pickup or delivery without delays. Greenhouses should be set at 72-75°F (22-24°C) during the day and 65°F (18°C) at night. Do not water until after crook emergence. Thereafter, water sparingly as needed to prevent media and emerging seedlings from drying out. Excess water and too high temperatures during the emergence phase will lead to stretch.

4) Seed Leaf Stage to First True Leaf

Maintain greenhouse temperatures in the 72-75°F range during the day and at 65°F at night. Water moderately. Do not fertilize if you are using a medium with starter fertilizer. Plants should grow slowly for the highest quality.

5) First True Leaf to Second True Leaf

Maintain greenhouse temperatures in the 72-75°F range during the day and at 65°F at night. Once the first true leaf emerges, trays can be fertilized. Generally, 2 fertilizations of 100 ppm N, one at first true leaf and one at second true leaf appearance will be sufficient. If a constant feed system is used, set for 50 ppm N for each watering once the first true leaf has emerged. Avoid using fertilizers with large amounts of ammonium as the N source as this can lead to stretch. Use fertilizers with calcium nitrate and potassium nitrate instead. Avoid over-watering. These rates are for media that contain starter fertilizer, like the ones listed in the seeding section above. If a medium without starter fertilizer is used, use a different fertilizer program. Using fertilizers with calcium nitrate and potassium nitrate as N sources, apply 50 ppm N every 3 days from emergence to first true leaf, and 200 ppm N every other day from first true leaf to second true leaf.

6) Hardening Off

It will take 4-6 weeks from sowing to finish transplants. Prior to transplanting into the field, harden off plants for one week. This is accomplished by lowering day temperatures (if greenhouses have side curtains, roll them up during days if temperatures are not too cool). Reduce watering and stop fertilization. If possible, place plants on wagons or move benches outside during the day and bring them in at night, but make sure the area is sheltered from high winds and avoid days where the temperature is below 60°F (16°C).

Seeded pollenizers and standard seeded watermelon transplant production do not need special germinating conditions and can be done directly in the greenhouse. Time the production so that plants are produced and hardened off at the same time as the seedless types. Grow plants slowly to avoid stretch. Follow the same recommendations as for seedless watermelons from seed leaf stage through hardening off, *i.e.*, stages 4 to 6 above.

Planting and Spacing

<u>Transplants</u>: Transplant container-grown plants through plastic mulch when daily mean temperatures have reached 60°F (16°C). Planting dates vary from April 25 in southern areas to June 20 in northern areas. Early plantings should be protected from winds with row covers, or rye windbreak strips.
<u>Direct-seeded</u>: Seed April 20 to June 15 in VA and normally warmer areas, and May 15 to June 10 in PA and normally cooler areas. Seed 3-5 lb/A of seed.
<u>Recommended Spacing</u>: 6-8 ft between rows with 3-4 ft between plants in the row.
<u>Seedless varieties</u>: see the Pollination and Pollenizers section below for planting recommendations.

Mulching

Watermelons are usually grown on black plastic mulch with drip irrigation (see also chapter C Irrigation Management). Weeds under the plastic are controlled by labeled herbicides (see Weed Control below) or by fumigation. Fumigation is also used to control soil borne diseases such as *Fusarium*. Fumigation is necessary when there is a history of soil-borne diseases in the field (recommendations can be found in section E 1.5. Soil Fumigation).

Plastic and fumigant should be applied on well-prepared planting beds 30 days before field planting. Plastic should be 3-4 ft wide and laid on 6-8 ft centers immediately over the fumigated soil. The soil must be moist when laying the plastic. Infra-Red Transmitting (IRT) plastic has been used in cooler areas for additional soil heating. Fertilizer must be applied during bed preparation. At least 50% of the N should be in the nitrate form. Direct seeding through the mulch is possible for seeded watermelons but is not generally recommended for seedless varieties.

Pollination and Pollenizers (see also sections A 12. Pollination and D 6.3.1. Protection of Pollinators)

Watermelon fruit set and enlargement is dependent on growth regulators from the pollen grains and from embryos in developing seeds. Inadequate pollination results in triangular-shaped triploid watermelon fruit of inferior quality. Inadequate pollination may increase the incidence of hollow heart. Triploid watermelon flowers do not produce sufficient viable pollen to induce fruit set and development; pollen from a normal or a special diploid pollenizer variety must be present. Field should be **inter-planted** with triploid and pollenizer plants (the pollenizer variety and the seedless variety should **not** be planted in separate but adjacent blocks!). Three methods can be used: 1) Pollenizer plants may be dedicated to every 3rd row, 2) Plant a pollenizer every 3rd or 4th plant in-row with additional spacing for pollenizers, and 3) Plant the pollenizer between every 3rd and 4th plant in-row without changing plant spacing. Co-planted pollinizers are also available and widely used (pollenizer planted in the same cell as seedless in every 3rd or 4th cell). When the latter methods are chosen, the use of a special pollenizer is recommended, as standard diploid varieties planted in-row may decrease yields of closely associated triploid plants. Special pollenizer varieties (see Recommended Varieties table above) have been developed solely for pollen production and most do not produce marketable fruit. The use of special pollenizers planted in-row allows the field to be 100% seedless.

When using pollenizer plants arranged in dedicated rows if marketing in-row pollenizers, it is important to use a marketable pollenizer variety, because up to one-third of the melons produced in the field will be of this variety. The rind pattern and/or shape of the seeded pollenizer fruit should be easily distinguishable from that of the triploid fruit. Most special pollenizers are distinguishable from triploid fruit by size, however, if mini seedless watermelons are planted rind pattern must be used to distinguish pollenizer and seedless fruit. Selection of a pollenizer variety that will be harvested should also consider the market demand, plant vigor, pollen production, disease resistance, and environmental conditions.

Pollen from the diploid pollenizer variety should be available when the female blossoms on the triploid plants are ready for pollination. Special pollenizer plants should be transplanted at the same time as triploid plants. As a general rule, direct field seeding of the pollenizer variety should be done on the same day the triploid seed is planted in the greenhouse. If transplants are used for pollenizers, they can be seeded a few days after triploid transplants are seeded.

Honey bees, squash bees, bumble bees and other wild bees are essential for proper watermelon pollination and fruit set. Honey bee or bumble bee colonies are commonly rented or purchased. Populations of pollinating insects may be adversely affected by insecticides applied to flowers or weeds in bloom. Apply insecticides only in the evening hours or wait until bloom is completed before application. Bee Toxicity ratings are available in the insecticide tables. Growers should follow insecticide label restrictions for pollinator protection.

Windbreaks

Use windbreaks as necessary. Small grain windbreaks are recommended and may be established between every bed, every 2-3 beds, or in drive row areas (every 6-8 beds). Use windbreaks between every row for the earliest plantings for additional protection. Rye is most commonly used, due to its height and rapid growth. Establish windbreaks in the fall, either as a solid planting, or in windbreak rows. Plant at high density to ensure a good stand. In the spring, for solid plantings, till areas where plastic is to be laid before small grain starts to elongate. Windbreaks may be eliminated with herbicides or mowed out after the crop is well established.

Vine Turning

Move vines in outer rows out of driveways so they are not damaged by vehicle traffic. This reduces disease incidence. Several trips over the field may be necessary. Vines can also be managed in roads by cutting.

Irrigation

Watermelons can be grown under dryland conditions; however, the highest yields are obtained with irrigation. Irrigation is recommended for seedless watermelons. Schedule irrigation so that soil moisture does not drop below 50% of field capacity. At peak, during fruit set and full vine cover, watermelons will use up to 0.30 inches of water per day.

Harvest and Post-Harvest Considerations

Watermelons are hand harvested into bins, trucks, or buses for shed packing. Use every sixth or eighth row as a drive row for field access. Ripeness is indicated by a creamish to slight yellowing of the white background color of the part of the melon that rests on the ground. The drying of the stem tendril nearest the attachment point of the melon and green color tone of the rind are also indicators of ripeness but these vary with cultivar. Melons should be cut from the vine rather than pulled, twisted, or broken off. Rough handling will result in serious losses. Bulk bins with pallets, if used, can speed handling, and minimize melon damage.

Harvested watermelons should be kept at 50-60°F (10-16°C) and a relative humidity of 90% during storage and shipping. Watermelons are not suitable for long storage. At low temperatures, they may develop various chilling injury symptoms and lose quality, and at high temperatures they are susceptible to decay.

Watermelons should be consumed within 2-3 weeks after harvest, primarily because of the gradual loss of crispness. High quality in watermelons is determined largely by high sugar content, deep red fresh color, and a pleasant crisp texture of the edible flesh. These factors are dependent on maturity, cultivar, and handling methods.

Commercial melons for distant markets are usually harvested when mature, but before full ripeness, to minimize handling damage and flesh breakdown. Watermelons are sensitive to high levels of ethylene gas during storage and should not be stored or shipped with fruit that emit substantial amounts of ethylene.

Watermelons are marketed by weight and bin counts: “Large” is 32-35 melons/bin (more than 18 lb/melon), “medium” is 45 melons/bin (14-18 lb/melon) and “small” is 50-60 melons/bin (≤ 14 lb/melon). The wholesale grower is generally paid by the pound. “Personal” (very small) watermelons are marketed by box counts and weight. The trend in consumer preference has been increased demand for smaller sizes.

Watermelon Disorders

Hollow Heart is an internal crack in the flesh of the melon. Hollow heart is generally more severe in seedless varieties and in crown-set fruit. Inadequate pollen has been shown to be one causal factor. Cold weather during fruit set, poor fruit set and low fruit load, excess nutrients (especially N), and factors producing rapid growth have been reported to impact the severity of hollow heart.

Internal Rind Necrosis is indicated by the presence of a corky, red-brown layer of tissue on the inside of the rind of affected fruit without extending into the fruit flesh. The disease occurs sporadically and is thought to be caused by bacteria (*Erwinia*) that are naturally present on fruit. Drought stress has been implicated in this disorder.

Irregular Ripening can be a problem in some years and varieties. Watermelons are classified as non-climacteric since they do not ripen significantly after harvest. However, research has shown that watermelon fruit produce a burst of ethylene at the white fruit stage and factors that reduce ethylene at this stage will slow ripening. Watermelon fruit development and ripening also depend on the accumulation of sugars. Loss of foliage or stem tissue due to diseases such as Gummy Stem Blight or insect or mite feeding can reduce the amount of sugar available to the fruit. Different varieties, low K nutrition, or variability in vine health will lead to variability in fruit ripening.

Misshapen Fruits Poor pollination due to low bee activity, may result in "bottlenecks", or constricted growth at the stem end of the fruit, especially in seeded/elongated watermelons. Research has shown that the distribution of a minimum of 1,000 pollen over the three lobes of the flower stigma are required to produce a uniformly shaped fruit. In seedless watermelons, poor pollination may lead to undesirable “triangular” fruit.

Ozone Injury Ozone is a common air pollutant. When present in high concentrations, ozone will cause chlorosis and upper surface bronzing and scorching in older leaves, which leads to defoliation. ‘Sugar Baby’ is one of the more sensitive varieties.

Splitting during handling occurs in fruit under excessive water pressure as a result of excess irrigation or rainfall.

Sunscald occurs when fruit are exposed to direct sunlight, especially on extremely hot days. Under these conditions, rind surfaces can reach temperatures exceeding 140ºF (60°C), killing cells and resulting in sunburn spots. Fruit with little or no foliar cover are at most risk. Sunscald or sunburn first appears as a gray or white area on the exposed upper surface of the fruit. Fruit with dark rinds are more susceptible to sunscald than those with light colored rinds. Sunscald severity is related directly to fertility regime and foliage cover. Proper fertility and soil management promotes adequate vine growth and coverage of fruit. Sunscald severity is also associated with diseases that reduce foliage cover, such as Anthracnose, Alternaria, Gummy Stem Blight, and Downy Mildew. Recommendations for managing these diseases may be found in the Disease Control section below.

Water Soaking occurs where excess water accumulates at the bottom of the fruit resulting in a water-soaked appearance of internal flesh. Water accumulates during cloudy weather when transpiration from vines is low. Water soaking sometimes appears in fruits where foliage has deteriorated since excess water cannot be transpired.

Weed Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.

Recommended Herbicides

1. Identify the weeds in each field and select recommended herbicides. More information is available in the “Herbicide Effectiveness on Common Weeds in Vegetables” (Table E-3) in Chapter E Pest Management.

2. Minimize herbicide resistance development. Identify the herbicide mode of action group number and follow recommended good management practices; **bolded group numbers in tables below are herbicides at higher risk for selecting resistant weed populations.** Include non-chemical weed control whenever possible.

Labeled Application Sites for Watermelon

Herbicide (*=Restricted Use)	HRAC group number	Plastic mulch production					Bareground production		
		Soil-Applied		Postemergence					
		Under Plastic	Row Middles	Over Plastic	Row Middles	Post-Harvest	Soil-applied	POST	Post-harvest
Sandea	2	YES	YES		YES		YES		
Curbit	3		YES				YES		
Prowl H2O	3		YES						
Treflan	3		YES						
Sinbar	5	YES	YES				YES		
Prefar	8	YES	YES				YES		
Command	13		YES				YES		
Strategy	3 + 13		YES				YES		
Reflex[1]	14	YES	YES		YES		YES		
Dual[1]	15		YES						
Poast	1			YES				YES	
Select / Select Max Shadow 3EC	1			YES				YES	
Gramoxone*[1]	22				YES	YES	YES[2]		YES

[1] Special Local Needs Label 24(c), be sure it is registered for the specific state and for the intended use.

[2] Apply preplant or after seeding but prior to crop emergence.

F. Watermelons

1. Pre-Transplant Over Plastic						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient**	**Active Ingredient Rate**	**PHI (d)**	**REI (h)**
10	Rely 280 2.34L	29 to 43 fl oz/A	**glufosinate**	0.53 to 0.79 lb/A	30	12
-**Supplemental Label expires 12/1/2025 for application over plastic prior to transplanting.** -Ammonium sulfate (AMS) can be used at 1.5 lb/A to 3 lb/A. -Control is best when applied to weeds less than 4 inches, temperatures are above 80, high humidity, and bright sunlight. -Transplants can be injured if they come in contact with herbicide remaining on the plastic. Allow at least 3 days between application and transplanting. At least 0.5 inches of precipitation is needed to wash Rely off the plastic. Do not transplant within 27 days of application if no precipitation occurs. -DO NOT transplant into or within 6 inches of holes in the plastic mulch that were present at time of application. -Two applications can be made prior to transplanting. Do not apply more than 64 fl oz/A prior to transplanting; maximum number of applications is three per season. -Rainfastness is 4 h.						
22	Gramoxone SL 2.0* Gramoxone SL 3.0*	2 to 4 pt/A 1.3 to 2.7 pt/A	**paraquat**	0.5 to 1.0 lb/A	--	24
-Gramoxone can be used for preplant weed control over the top of plastic mulch. Sufficient rainfall or sprinkler irrigation is needed to wash off the Gramoxone prior to planting to prevent damage to the crop. ***-Restricted-use pesticide***. Only certified applicators, who successfully complete the paraquat-specific training, can mix, load, or apply paraquat. Application of paraquat "under the direct supervision" of a certified applicator is no longer allowed. Required training link (*https://campus.extension.org/enrol/index.php?id=2201*); certified applicators must repeat training every three years. -Do not exceed 8 pt/A per season. Rainfastness is 30 min.						

2. Soil-Applied						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient**	**Active Ingredient Rate**	**PHI (d)**	**REI (h)**
2	Sandea 75DF	0.5 to 1 oz/A	**halosulfuron**	0.023 to 0.047 lb/A	57	12
-**Plasticulture**: can be applied in a band under the plastic, immediately before laying the mulch; delay seeding or transplanting for 7 days after application. Plasticulture row middles: apply before or after weed emergence; apply as a shielded application to avoid contact with the crop. If weeds have emerged, use a non-ionic surfactant at 0.25% v/v or include a non-selective herbicide. -**Bareground**: apply broadcast after seeding but before crop emergence or no sooner than 7 days before transplanting. -Maximum rate for application in seeded or transplanted row is 0.75 oz/A, and up to 1 oz/A for row middle application. -Limit movement of treated soil into transplant hole during transplanting. -Suppresses or controls yellow nutsedge and certain broadleaf weeds. Sandea provides both residual and postemergence control of susceptible weed species. Effective postemergence control requires an adjuvant. -Sandea is an ALS inhibiting herbicide and resistant weed populations are common in the region. **Do not** use Group 2 herbicides repeatedly in the same field. -**Do not** apply Sandea to crops treated with a soil applied organophosphate insecticide, or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application. -Maximum Sandea applications per year is 2 and **do not** exceed 1 oz/A during the crop season.						
3	Curbit 3EC	1 to 3 pt/A	**ethalfluralin**	0.38 to 1.13 lb/A	--	24
-**Plasticulture**, row middles only: apply as a banded spray after crop emergence or after transplanting. **Do not** soil incorporate. -**Bareground**: apply broadcast after direct-seeding but prior to crop emergence; **do not** use on transplanted melons. -Controls annual grasses and certain annual broadleaf weeds, including carpetweed and pigweed sp. -Use lower rate for coarse-textured soils or soils with low organic matter. -Where overhead irrigation is available, activate Curbit with 0.5 inch of irrigation within 2 days after application; if no irrigation or rainfall occurs within 5 days of application, activity of Curbit can be reduced. -Available as a pre-mix herbicide Strategy. Strategy at 3 pt/A= Curbit at 26 fl oz/A (0.6 lb ai) and Command at 8 fl oz/A (0.188 lb ai) -Maximum applications per season: not specified						
3	Prowl H2O 3.8CS	2.1 pt/A	**pendimethalin**	1 lb/A	35	24
-**Plasticulture**: row middles only: apply as a banded spray before seeded crop has emerged or before transplanting. -**Bareground**: apply with shielded sprayer band between rows, leaving 6 inches of untreated area on both sides of the seeded or transplanted row. Apply before seeded crop emerges or before transplanting. -Where overhead irrigation is available, activate Prowl with 0.5 inch of rainfall or sprinkler irrigation within 48 h of application; if no irrigation or rainfall occurs within 5 days of application, activity of Prowl can be reduced -A second application at the same rate may be applied to row middles as a banded spray postemergence a minimum of 21 days after the first application, but before the vines begin to run. **Do not** apply over the top of the crop, or severe injury may occur. -Maximum Prowl H2O applications per season is 2 and **do not** exceed 4.2 pt/A during the crop season.						
3	Treflan 4EC	1 to 2 pt/A	**trifluralin**	0.5 to 1 lb/A	60	12
-**Plasticulture**: row middles only: apply as a directed spray after emergence when plants have reached the 3 to 4 true leaf stage. -**Not labeled for bareground production.** Primarily controls annual grasses with a few broadleaf weeds. -**Do not** use (or reduce the rate) when cold, wet soil conditions are expected, or crop injury may result. -Maximum applications per season: not specified.						

2. Soil-Applied - continued next page

2. Soil-Applied - continued

3 + 13	Strategy 2.1SC	1.5 to 6 pt/A	**ethalfluralin *plus* clomazone**	0.39 to 1.58 lb/A	45	24
-**Plasticulture**: row middles application. -**Bareground**: apply broadcast just before planting or after planting but before crop emergence. -Strategy is a prepackage mixture of Curbit 3EC and Command 3ME. -Clomazone spray or vapor drift may injure susceptible crops and other vegetation, refer to Command 3ME for comments. -**Do not** apply prior to planting the crop. **Do not** soil incorporate. -Refer to individual products for comments. Maximum applications per season: not specified.						
5	Sinbar 80WDG	2 to 4 oz/A	**terbacil**	0.1 to 0.2 lb/A	70	12
-**Plasticulture**: can be applied in a band under the plastic, immediately before laying the mulch. Sinbar can be broadcast over the plastic before transplanting or before holes are made in the plastic; but must be washed off with a minimum of 0.5 inches for rainfall or irrigation before transplanting. Plasticulture row middles: apply before or after weed emergence; apply as a shielded application to avoid contact with the crop. If weeds have emerged include a non-selective herbicide. -**Bareground**: apply broadcast after seeding but before crop emergence. -**Do not** apply over the top of the crop or allow spray to contact crop foliage, or injury may result. -Controls many annual broadleaf weeds but may be weak on pigweed species. Use the lower rate on coarse-textured soils low in organic matter and higher rates on fine-textured soils and on soils with high organic matter. -Maximum Sinbar applications per year is 2 and **do not** exceed 4 oz/A during the crop season						
8	Prefar 4E	5 to 6 qt/A	**bensulide**	5 to 6 lb/A	--	12
-**Plasticulture**: under plastic: apply in a band under the plastic, immediately before laying the mulch. Allow 7 days before making transplant holes to allow condensation to incorporate the herbicide. Plasticulture: row middles application is labeled. -**Bareground**: apply preemergence or preplant incorporated. -Preemergence applications should be followed by irrigation within 36 h (apply enough water to wet the soil at least 2 to 4 inches deep). Preplant incorporated applications should be incorporated 1 to 2 inches deep (deeper than 2 inches will result in reduced weed control). -Prefar provides control/suppression of some annual grass weeds and some broadleaves including pigweeds, purslane, and lambsquarters. -**Do not** apply more than 6 lb ai/A per season.						
13	Command 3ME	0.4 to 0.67 pt/A	**clomazone**	0.15 to 0.25 lb/A	--	12
-**Plasticulture**: row middles application only. -**Bareground**: apply broadcast just before planting or after planting but before crop emergence. Use the lower rate when used on coarse-textured soils low in organic matter, when weed pressure is light, or to minimize herbicide carryover that could affect subsequent crops. -Controls annual grasses and many broadleaf weeds including common lambsquarters, velvetleaf, spurred anoda, and jimsonweed. Carpetweed, morningglory sp., pigweed sp., and yellow nutsedge will **not** be controlled. Higher rates will improve control (or expand number of species controlled) such as common cocklebur, common ragweed, or jimsonweed (refer to label for specific weeds and rates). -**WARNINGS**: Command spray *or* vapor drift may injure sensitive crops and other vegetation up to several hundred yards from the point of application. **Do not** apply adjacent to sensitive crops (see label) or vegetation, or under unfavorable wind or weather conditions. Command may limit subsequent cropping options, see the label. -Available as a pre-mix herbicide Strategy: Strategy at 3 pt/A= Command at 8 fl oz/A (0.188 lb ai) and Curbit at 26 fl oz/A (0.6 lb ai) -Maximum Command applications per year is 1.						
14	Reflex 2SL	Rates vary, refer to the specific label	**fomesafen**	0.16 to 0.25 lb/A	35	24
-Special Local Needs Label 24(c) for the use of Reflex 2SL to control weeds in watermelon in DE and NJ and pending in PA (expires 12/31/2025 for DE and 12/31/2027 for NJ). The use of this product is legal ONLY if a waiver of liability has been completed, see: *https://www.syngenta-us.com/labels/indemnified-label-login*). **-Rates vary by state and application method; refer to label to determine correct rates.** -**Plasticulture**: can be applied in a band under the plastic at 10 to 12 fl oz, immediately before laying the mulch. -Plasticulture: Reflex at 10 to 12 fl oz/A can be broadcast over the plastic before transplanting or before holes are made in the plastic; but must be washed off with a minimum of 0.5 inches for rainfall or irrigation before transplanting. -Plasticulture row middles: before emergence of seeded crop or before transplanting; apply up to 12 fl oz/A in VA or up to 16 fl oz/A in DE. Plasticulture row middles with shielded/hood sprayers after transplanting; apply 16 to 24 fl oz/A in DE prior to vines "running" off the plastic. Severe crop injury can occur if spray comes in contact with crop foliage. -**Bareground direct-seeded**: apply broadcast within 24 h after seeding followed by 0.2 to 0.5 inch of overhead irrigation at least 36 h before watermelon crack the soil surface. -**Bareground transplants**: apply as broadcast spray followed by irrigation of 0.2 to 0.5 inches. Then prepare holes and transplant; avoid moving herbicide-treated soil into transplant holes. -Reflex provides both residual and postemergence control of susceptible weed species. Effective postemergence control requires an adjuvant. -**Watermelon varieties may vary in their response to Reflex**. Treat small acreages first to determine crop tolerance, especially when applying to a new variety. -Consider rotational crops when applying fomesafen. If the crop is replanted **do not** re-apply Reflex. Rotational restrictions are dependent on whether fomesafen was applied under the plastic, bare ground, or over plastic mulch, refer to 24(c) label for specifics. -Maximum Reflex per season is 24 fl oz/A **IN ALTERNATE YEARS**						

2. Soil-Applied - continued next page

2. Soil-Applied - continued

15	Dual Magnum 7.62E	0.67 to 1.27 pt/A	**s-metolachlor**	0.64 to 1.21 lb/A	60	24

-**Special Local Needs Label 24(c) for the use of Dual Magnum 7.62E to control weeds between the rows of plastic mulch in watermelon in DE (expires 2/24/2025). The use of this product is legal ONLY if a waiver of liability is completed (see: *https://www.syngenta-us.com/labels/indemnified-label-login*).**
-**Plasticulture**: row middle application only. -**Do not** apply Dual Magnum to the plastic mulch or allow the spray to contact watermelon foliage. **Do not** soil incorporate. -Suppresses or controls annual grasses, yellow nutsedge, and certain annual broadleaf weeds including nightshade species. Use the lower rate on fields with coarse-textured soils low in organic matter. Use the higher rates on fields with fine-textured soil and those with high organic matter.
-Maximum number of Dual Magnum applications per year is one and **do not** exceed 1.27 pt/A during the crop season.

27	Optogen 1.67	3.5 fl oz/A	**bicyclopyrone**	0.046 lb/A	14	24

-Apply before transplanting. Limited local data on crop safety when used under plastic layer (use under plastic is not addressed on the label). Optogen will provide control of only a limited number of weed species, use in combination with other herbicides.
-Do not make more than one application per crop year.

3. Postemergence

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
1	Shadow 3EC Select 2EC Select Max 0.97EC	4 to 5.33 fl oz/A 6 to 8 fl oz/A 9 to 16 fl oz/A	**clethodim**	0.07 to 0.125 lb/A	14	24
	Poast 1.5EC	1 to 1.5 pt/A	**sethoxydim**	0.19 to 0.28 lb/A	14	12

-**Select 2EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). **Select Max**: use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution). **Shadow 3EC**: use crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution) for large or stressed grasses; use nonionic surfactant (NIS) at 0.25% v/v (1 qt/100 gal of spray solution) when crop safety is a concern. **Poast**: use COC at 1.0% v/v.
-**The use of COC may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to NIS when grasses are small and soil moisture is adequate.
-Use lower labeled rates for annual grass control and higher labeled rates for perennial grass control.
-Yellow nutsedge, wild onion, wild garlic, and broadleaf weeds will **not** be controlled. Controls many annual and certain perennial grasses, including annual bluegrass, but Poast is preferred for goosegrass control. For best results, treat annual grasses when they are actively growing and before tillers are present. Control may be reduced if grasses are large or under hot or dry weather conditions.
-Repeated applications may be necessary to control certain perennial grasses. If repeat applications are necessary, allow 14 days between applications. Rainfastness is 1 h.
-**Do not** tank mix with or apply within 2 to 3 days of any other pesticide, unless labeled, as this may increase the risk of crop injury or reduce the control of grasses. **Do not** apply more than 8 fl oz/A of Select 2EC in a single application and **do not** exceed 32 fl oz/A for the season; **do not** apply more than 16 fl oz/A of Select Max in a single application and **do not** exceed 64 fl oz/A for the season.
-**Do not** apply more than 5.33 fl oz/A of Shadow 3EC in a single application and **do not** exceed 21.33 fl oz/A for the season.
-**Do not** apply more than 1.5 pt/A Poast in a single application and **do not** exceed 3 pt/A for the season.

10	Rely 280 2.34L	29 to 62 fl oz/A	**glufosinate**	0.53 to 1.13 lb/A	30	12

-**Supplemental Label expires 12/1/2025 for hooded spray application between the rows**. If the crop is planted without plastic, do not spray within 6 inches of running vines. -Ammonium sulfate (AMS) can be used at 1.5 lb/A to 3 lb/A.
-**Do not allow spray to come in contact with crop foliage or damage will occur.**
-Control is best when applied to weeds less than 4 inches, temperatures are above 80, high humidity, and bright sunlight.
-Separate sequential applications by at least 14 days. -Do not apply more than 62 fl oz/A in a single application, do not apply more than 87 fl oz/A per season; maximum number of applications is three per season. -Rainfastness is 4 h.

14	Reflex 2SL	Rates vary, refer to the specific label	**fomesafen**	0.25 to 0.375 lb/A	35	24

-**Special Local Needs Label 24(c) for the use of Reflex 2SL for Post-Transplant control of weeds in watermelon in DE (expires 12/31/2025). The use of this product is legal ONLY if a waiver of liability has been completed (see: *https://www.syngenta-us.com/labels/indemnified-label-login*). Rates vary by state and application method; refer to label to determine correct rates.**
-See soil applied section for application prior to planting or transplanting.
-**Plasticulture** row middles with shielded/hood sprayers after transplanting; apply prior to vines "running" off the plastic. Severe crop injury can occur if spray comes in contact with crop foliage. Foliar application of Reflex will severely damage or kill watermelon.
-**Watermelon varieties may vary in their response to Reflex**. Treat small acreages first to determine crop tolerance, especially when applying to a new variety.
-Reflex provides both residual and postemergence control of susceptible weed species. Effective postemergence control requires an adjuvant. Consider rotational crops when applying fomesafen. Rotational restrictions are dependent on whether fomesafen was applied under the plastic, bare ground, or over plastic mulch, refer to 24(c) label for specifics.
-Consider rotational crops when applying fomesafen. If the crop is replanted **do not** re-apply Reflex. Rotational restrictions are dependent on whether fomesafen was applied under the plastic, bare ground, or over plastic mulch, refer to 24(c) label for specifics.
-Maximum Reflex application in DE, MD, NJ, and VA: 24 fl oz/A **IN ALTERNATE YEARS**

3. Postemergence - continued next page

3. Postemergence - continued

22	Gramoxone SL 2.0* Gramoxone SL 3.0*	1.95 pt/A 1.3 pt/A	**paraquat**	0.49 lb/A	14	24
-**Supplemental Label for the use of both Gramoxone formulations for postemergence weed control in DE, MD, NJ, PA, and VA. Row middles** as a shielded application. Apply as a directed spray in a minimum of 20 gal spray mix/A to control emerged weeds between the rows after crop establishment. Include a nonionic surfactant at 0.25% v/v. Use shields or hoods to prevent spray contact with the crop and low spray pressure (maximum of 30 psi) to reduce small droplets that are prone to drift. See the label for additional information and warnings. -Rainfastness is 30 min. A maximum of 3 applications per year are allowed. -***Restricted-use pesticide***. Only certified applicators, who successfully complete the paraquat-specific training, can mix, load, or apply paraquat. Application of paraquat "under the direct supervision" of a certified applicator is no longer allowed. Required training link (*https://campus.extension.org/enrol/index.php?id=2201*); certified applicators must repeat training every three years.						
27	Optogen 1.67	2.6 to 3.5 fl oz/A	**bicyclopyrone**	0.034 to 0.046 lb/A	14	24
-Row middle application only. -Apply as either row middle treatment or as a directed spray. Hooded or shielded sprayers will reduce the risk of injury for row middle or directed sprays. -**Contact with foliage will cause injury.** -Use nonionic surfactant (NIS) at 0.25% v/v (1qt/100 gal of spray solution) or crop oil concentrate (COC) at 1% v/v (1 gal/100 gal of spray solution). Ammonium sulfate (AMS) at 8.5 to 17 lb/100 gal spray solution may be added for improved control of emerged weeds -Apply to small weeds (less than 2" tall). Optogen provides control for only a few weed species, should be used in combination with other herbicides. -Rainfastness is not specified on the label. -Do not make more than one application per year.						

4. Postharvest

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient	Active Ingredient Rate	PHI (d)	REI (h)
22	Gramoxone SL 2.0* Gramoxone SL 3.0*	2.25 to 3 pt/A 1.5 to 2 pt/A	**paraquat**	0.56 to 0.75 lb/A	--	24
-**Supplemental Label in DE for the use of both Gramoxone formulations for postharvest application to desiccate the crop.** -Apply after the last harvest for bareground or plasticulture. Always include an adjuvant. -Spray coverage is essential for optimum effectiveness. See the label for additional information and warnings. -Rainfastness 30 min. -A maximum of 2 applications for crop desiccation are allowed. -***Restricted-use pesticide***. Only certified applicators, who successfully complete the paraquat-specific training, can mix, load, or apply paraquat. Application of paraquat "under the direct supervision" of a certified applicator is no longer allowed. Required training link (*https://campus.extension.org/enrol/index.php?id=2201*); certified applicators must repeat training every three years.						

5. Other Labeled Herbicides These products are labeled but limited local data are available; and/or are labeled but not recommended in our region due to potential crop injury concerns.

Group	Product Name (*=Restricted Use)	Active Ingredient
2	League	**imazosulfuron**
3	Dacthal	**DCPA**
14	Aim	**carfentrazone**
14	Arterio 4F	**sulfentrazone**
14	Vida	**pyraflufen**
14	Valkos 51 WDG	**flumioxazin**

Insect Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.
Recommended Insecticides

Seed Corn Maggots

See also Maggots in section E 3.1. Soil Pests - Detection and Control.

Maggot problems can occur in the field and in transplant bedding trays in the greenhouse. An application of a soil-incorporated insecticide may be needed immediately before planting.

FarMore FI400 as a commercially applied seed treatment which contains thiamethoxam (Group 4A).

Verimark (cyantraniliprole, Group 28) is also labeled but should be applied no earlier than 72 hours prior to planting.

Rescue treatments are not effective.

Note: The use of neonicotinoid insecticides (Group 4A) at planting will help reduce seedcorn maggot damage

Aphids

Aphids found in cucurbits include green peach aphid and melon aphid. Aphids may infest plants at any point during the season, even including transplant production facilities. Scout for aphids searching undersides of leaves on runners. During the summer, consider treating if 20 percent of runners or more have live aphids. Good coverage of the undersides of leaves is needed for control. Use selective insecticides for other pests to conserve natural enemies (ladybird beetle and green lacewing larvae).

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	1.5 to 3.0 pt/A	methomyl **- melon aphid only**	1-3	48	H
1B	Dimethoate 400	0.5 to 1.0 pt/A	dimethoate	3	48	H
1B	Malathion 57 EC	1.5 pt/A	malathion	1	12	H
4A	Neonicotinoid insecticides registered for use on Watermelons: see table at the end of Insect Control.					
4C	Transform WG	0.75 oz/A	sulfoxaflor	1	24	H
4C + 3A	Ridgeback*	5.5 to 13.8 fl oz/A	sulfoxaflor + bifenthrin	3	24	H
4D	Sivanto Prime or 200SL	21.0 to 28.0 fl oz/A	flupyradifurone - **soil/drip**	21	4	M
4D	Sivanto Prime or 200SL	7.0 to 14.0 fl oz/A	flupyradifurone - **foliar**	1	4	M
9B	Fulfill	2.75 oz/A	pymetrozine	0	12	L
9B	PQZ	2.4 to 3.2 fl oz/A	pyrifluquinazon	1	12	L
9D	Sefina	3.0 fl oz/A	afidopyropen	0	12	L
21A	Torac	17.0 to 21.0 fl oz/A	tolfenpyrad	1	12	H
28	Exirel	13.5 to 20.5 fl oz/A	cyantraniliprole	1	12	H
28	Verimark	6.75 to 13.5 fl oz/A	cyantraniliprole	1	4	H
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H
28 + 6	Minecto Pro*	10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H
29	Beleaf 50 SG	2.0 to 2.8 oz/A	flonicamid	0	12	L

Armyworms and Cabbage Loopers

Various armyworm species and cabbage loopers can be found feeding on melon leaves. Their damage seldom requires treatment. Defoliation exceeding 25% may justify control measures. Insecticide sprays for cucumber beetles often will control these pests.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV*	1.5 to 3.0 pt/A	methomyl	1-3	48	H
3A	Pyrethroid insecticides registered for use on Watermelons: see table at the end of Insect Control.					
5	Entrust SC (OMRI)	4.0 to 8.0 fl oz/A	spinosad	3	4	M
5	Radiant SC (not for yellow striped armyworm)	5.0 to 10.0 fl oz/A	spinetoram	3	4	M
6	Proclaim 5SG*	3.0 to 4.8 oz/A	emamectin benzoate	7	12	H
11A	Dipel DF, others (OMRI)	0.5 to 2.0 lb/A	*Bacillus thuringiensis kurstaki*	0	4	N
11A	XenTari (OMRI)	0.5 to 2.0 lb/A	*Bacillus thuringiensis aizawai*	0	4	N
15	Rimon 0.83EC	9.0 to 12.0 fl oz/A	novaluron	1	12	M
18	Intrepid 2F	4.0 to 10.0 fl oz/A	methoxyfenozide	3	4	L
22	Avaunt 30WDG, Avaunt eVo	2.5 to 6.0 oz/A	indoxacarb	3	12	H
28	Coragen 1.67SC Coragen eVo	3.5 to 7.5 fl oz/A 1.2 to 2.5 fl oz/A	chlorantraniliprole	1	4	L
28	Exirel	7.0 to 17.0 fl oz/A	cyantraniliprole	1	12	H
28	Verimark	6.75 to 13.5 fl oz/A	cyantraniliprole	1	4	H
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H
28 + 4A	Voliam Flexi (cabbage looper only)	4.0 to 7.0 oz/A	thiamethoxam + chlorantraniliprole	1	12	H
28 + 6	Minecto Pro*	5.5 to 10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H

Cucumber Beetles

Both striped (*Acalymma vittatum*) and spotted (*Diabrotica undecimpuctata howardii*) cucumber beetles are found in the Mid-Atlantic states. Watermelons are resistant to bacterial wilt; however, control may be needed to prevent feeding damage to seedlings. Seeds pretreated with a neonicotinoid seed treatment such as Farmore DI-400 should provide up to 14 days of control of cucumber beetle. Transplant tray treatments may also be done prior to planting.

Check labels for rates and guidance. Treat when on average 2 beetles per plant are found.
Management of adult cucumber beetles early in the season may help reduce first generation beetle populations which could feed on rinds. Larvae damage rinds along with white grubs, primarily on ground spot. Adults begin emerging in late June to early July. Kaolin clay (Surround WP) does not kill the beetles but instead acts as a physical deterrent to early season beetle feeding.
Note: some populations of striped cucumber beetles on Delmarva may exhibit reduced susceptibility to pyrethroids.

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
1A	Lannate LV*	1.5 to 3.0 pt/A	methomyl	1-3	48	H
1A	Sevin XLR Plus	1.0 qt/A	carbaryl	3	12	H
1B	Malathion 57 EC	2.0 pt/A	malathion	1	12	H
3A	Pyrethroid insecticides registered for use on Watermelons: see table at the end of Insect Control.					
4A	Neonicotinoid insecticides registered for use on Watermelons: see table at the end of Insect Control.					
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H

Cutworms

See also section E 3.1. Soil Pests - Detection and Control.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1A	Lannate LV* (variegated cutworm)	1.5 pt/A	methomyl	1	48	H
1A	Lannate LV* (granulate cutworm)	1.5 to 3.0 pt/A	methomyl	1-3	48	H
3A	Pyrethroid insecticides registered for use on Watermelons: see table at the end of Insect Control.					

Leafminers

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
1B	Dimethoate 400	0.5 to 1.0 pt/A	dimethoate	3	48	H
3A	Pyrethroid insecticides registered for use on Watermelons: see table at the end of Insect Control.					
4A	Neonicotinoid insecticides registered for use on Watermelons: see table at the end of Insect Control.					
5	Entrust SC (OMRI)	6.0 to 8.0 fl oz/A	spinosad	3	4	M
5	Radiant SC	6.0 to 10.0 fl oz/A	spinetoram	3	4	M
6	Agri-Mek SC*	1.75 to 3.5 fl oz/A	abamectin	7	12	H
15	Rimon 0.83EC	9.0 to 12.0 fl oz/A	novaluron	1	12	M
17	Trigard 75WSP	2.66 oz/A	cyromazine	0	12	H
28	Coragen 1.67SC Coragen eVo	5.0 to 7.5 fl oz/A 1.7 to 2.5 fl oz/A	chlorantraniliprole	1	4	L
28	Exirel	13.5 to 20.5 fl oz/A	cyantraniliprole	1	12	H
28	Verimark	6.75 to 13.5 fl oz/A	cyantraniliprole	1	4	H
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H
28 + 6	Minecto Pro*	5.5 to 10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H

Mites

Mite infestations generally begin around field margins and grassy areas. **DO NOT mow or maintain these areas after midsummer** as this causes mites into the crop. Localized infestations can be spot treated. Begin treatment when 10-15 % of the crown leaves are infested early in the season, or when 50% of the terminal leaves are infested later in the season. **Note:** Continuous use of carbaryl or pyrethroids may result in mite outbreaks.

Apply one of the following formulations:						
Group	**Product Name (*=Restricted Use)**	**Product Rate**	**Active Ingredient(s)**	**PHI (d)**	**REI (h)**	**Bee TR**
6	Agri-Mek SC*	1.75 to 3.5 fl oz/A	abamectin	7	12	H
10B	Zeal Miticide	2.0 to 3.0 oz/A	etoxazole	7	12	L
10B	Zeal SC	4.0 to 6.0 fl oz/A	etoxazole	7	12	L
20B	Kanemite 15SC	31.0 fl oz/A	acequinocyl	1	12	L
21A	Magister SC	24.0 to 36.0 fl oz/A	fenazaquin	3	12	H
21A	Portal	2.0 pt/A	fenpyroximate	3	12	L
23	Oberon 2SC	7.0 to 8.5 fl oz/A	spiromesifen	7	12	M

Mites - continued next page

Mites - continued

28 + 6	Minecto Pro*	5.5 to 10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H
20D	Acramite 50WS	0.75 to 1.0 lb/A	bifenazate	3	12	M
N/A	Sulfur 80WG (OMRI)	5 to 25 lb/A	sulfur	0	24	M

Melonworms and Pickleworms

Apply one of the following formulations. If foliar materials are used, make one treatment prior to fruit set, and then treat weekly. If soil or drip applications are used, check the label for instructions on treatment frequency.

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
1A	Lannate LV*	1.5 to 3.0 pt/A	methomyl	1-3	48	H
1A	Sevin XLR Plus	0.5 to 1.0 qt/A	carbaryl	3	12	H
1B	Malathion 57 EC	2.0 pt/A	malathion	1	12	H
3A	Pyrethroid insecticides registered for use on Watermelons: see table at the end of Insect Control.					
5	Entrust SC (OMRI)	4.0 to 8.0 fl oz/A	spinosad	3	4	M
5	Radiant SC	5.0 to 10.0 fl oz/A	spinetoram	3	4	M
6	Proclaim 5SG*	3.5 to 4.8 oz/A	emamectin benzoate	7	12	H
11A	XenTari (OMRI) **(MW)**	0.5 to 1.0 lb/A	*Bacillus thuringiensis aizawai*	0	4	N
11A	Dipel DF (OMRI) **(MW)**	0.5 to 2.0 lb/A	*Bacillus thuringiensis kurstaki*	0	4	N
15	Rimon 0.83EC	12.0 fl oz/A	novaluron	1	12	M
18	Intrepid 2F	4.0 to 10.0 fl oz/A	methoxyfenozide	3	4	L
22	Avaunt 30WDG, Avaunt eVo	2.5 to 6.0 oz/A	indoxacarb	3	12	H
28	Coragen 1.67SC Coragen eVo	2.0 to 7.5 fl oz/A 0.7 to 2.5 fl oz/A	chlorantraniliprole	1	4	L
28	Exirel	7.0 to 13.5 fl oz/A	cyantraniliprole	1	12	H
28	Verimark	5.0 to 10.0 fl oz/A	cyantraniliprole	1	4	H
28	Harvanta 50SL	10.9 to 16.4 fl oz/A	cyclaniliprole	1	4	H
28 + 4A	Durivo	10.0 to 13.0 fl oz/A	thiamethoxam + chlorantraniliprole	30	12	H
28 + 4A	Voliam Flexi	4.0 to 7.0 oz/A	thiamethoxam + chlorantraniliprole	1	12	H
28 + 6	Minecto Pro*	5.5 to 10.0 fl oz/A	cyantraniliprole + abamectin	7	12	H

Rindworms In addition to the above specified Lepidopteran pests, various species feed on rinds, including, but not limited to corn earworm, leafrollers, webworms, and beet armyworm. Proper pest identification is important because not all species that cause rind feeding damage are susceptible to pyrethroids.

For Lepidopteran Rindworms, use one of the following formulations:

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
3A[1]	Pyrethroid insecticides registered for use on Watermelons: see table at the end of Insect Control.					
5	Entrust SC (OMRI)	4.0 to 8.0 fl oz/A	spinosad	3	4	M
5	Radiant SC	5.0 to 10.0 fl oz/A	spinetoram	3	4	M
6	Proclaim	3.0 to 4.8 oz/A	emamectin benzoate	7	12	H
11A	XenTari (OMRI)	0.5 to 1.0 lb/A	*Bacillus thuringiensis aizawai*	0	4	N
11A	Dipel DF, others (OMRI)	0.5 to 2.0 lb/A	*Bacillus thuringiensis kurstaki*	0	4	N
18	Intrepid 2F	4.0 to 10.0 fl oz/A	methoxyfenozide	3	4	L
28 + 3A	Besiege*	6.0 to 9.0 fl oz/A	chlorantraniliprole + lambda-cyhalothrin	1	24	H

[1]**Resistance concerns with beet armyworm and corn earworm**

Thrips

Apply one of the following formulations:

Group	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
3A[1]	Pyrethroid insecticides registered for use on Watermelons: see table at the end of Insect Control.					
4A[2]	Neonicotinoid insecticides registered for use on Watermelons: see table at the end of Insect Control.					
5	Entrust SC (OMRI)	6.0 to 8.0 fl oz/A	spinosad	3	4	M
5	Radiant SC	6.0 to 10.0 fl oz/A	spinetoram	3	4	M
15	Rimon 0.83EC	12.0 fl oz/A	novaluron	1	12	M
21A	Torac	21.0 fl oz/A	tolfenpyrad	1	12	H
28 + 6	Minecto Pro*	10.0 fl oz/A	cyantraniliprole + abamectin - *suppression only*	7	12	H

[1]**Resistance concerns with western flower thrips**
[2]**Resistance concerns with tobacco thrips**

Group 3A Pyrethroid Insecticides Registered for Use on Watermelons

Apply one of the following formulations (check if the product label lists the insect you intend to spray; the label is the law):

Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Asana XL*	5.8 to 9.6 fl oz/A	esfenvalerate	3	12	H
Baythroid XL*	0.8 to 2.8 fl oz/A	beta-cyfluthrin	0	12	H
Brigade 2EC*, others	2.6 to 6.4 fl oz/A	bifenthrin	3	12	H
Danitol 2.4EC*	10.67 to 16.00 fl oz/A	fenpropathrin	7	24	H
Declare*	1.54 fl oz/A	gamma-cyhalothrin	1	24	H
Hero*	4.0 to 10.3 fl oz/A	zeta-cypermethrin + bifenthrin	3	12	H
Lambda-Cy 1EC*, others	2.56 to 3.84 fl oz/A	lambda-cyhalothrin	1	24	H
Mustang Maxx*	1.28 to 4.0 fl oz/A	zeta-cypermethrin	1	12	H
Permethrin 3.2EC*, others	4.0 to 8.0 fl oz/A	permethrin	0	12	H
Tombstone*	0.8 to 2.8 fl oz/A	cyfluthrin	0	12	H
Warrior II*	1.28 to 1.92 fl oz/A	lambda-cyhalothrin	1	24	H
Combo products containing a pyrethroid					
Besiege*	6.0 to 9.0 fl oz/A	lambda-cyhalothrin + chlorantraniliprole (Group 28)	1	24	H
Endigo ZC* and ZCX*	4.0 to 4.5 fl oz/A	lambda-cyhalothrin + thiamethoxam (Group 4A)	1	24	H
Ridgeback*	5.5 to 13.8 fl oz/A	bifenthrin + sulfoxaflor (Group 4C)	3	24	H
Savoy EC*	6.0 to 12.9 fl oz/A	bifenthrin + acetamiprid (Group 4A)	7	12	H

Group 4A Neonicotinoid Insecticides Registered for Use on Watermelons

Apply one of the following formulations (check if the product label lists the insect you intend to spray; the label is the law):

Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Admire Pro	7.0 to 10.5 fl oz/A	imidacloprid - **soil**	21	12	H
Assail 30SG	2.5 to 5.3 oz/A	acetamiprid	0	12	M
Actara 25WDG	1.5 to 5.5 oz/A	thiamethoxam	0	12	H
Belay 2.13SC	9.0 to 12.0 fl oz/A	clothianidin - **soil/drip**	21	12	H
Belay 2.13SC	3.0 to 4.0 fl oz/A	clothianidin - **foliar** (note: PHI: do not make application after 4th true leaf has unfolded)	see note	12	H
Platinum 75SG	1.66 to 3.67 oz/A	thiamethoxam	30	12	H
Scorpion 35SL	9.0 to 10.5 fl oz/A	dinotefuran - **soil/drip**	21	12	H
Scorpion 35SL	2.0 to 7.0 fl oz/A	dinotefuran - **foliar**	1	12	H
Venom 70SG	5.0 to 7.5 oz/A	dinotefuran - **soil/drip**	21	12	H
Venom 70SG	1.0 to 4.0 oz/A	dinotefuran - **foliar**	1	12	H
Combo products containing a neonicotinoid					
Durivo	10.0 to 13.0 fl oz/A	thiamethoxam + chlorantraniliprole (Group 28)	30	12	H
Endigo ZC* and ZCX*	4.0 to 4.5 fl oz/A	thiamethoxam + lambda-cyhalothrin (Group 3A)	1	24	H
Savoy EC*	6.0 to 12.9 fl oz/A	acetamiprid + bifenthrin (Group 3A)	7	12	H
Voliam Flexi	4.0 to 7.0 oz/A	thiamethoxam + chlorantraniliprole (Group 28)	1	12	H

Disease Control

THE LABEL IS THE LAW-see the Pesticide Use Disclaimer on the first page of Chapter F.

Recommended Fungicides

Nematodes See also sections E 1.5. Soil Fumigation and E 1.6. Nematode Control.
Use fumigants listed in section E 1.5., or apply one of the following:

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
1A	Vydate L*	1.0 to 2.0 gal/A Incorporate into top 2-4 inches of soil, *OR* 2.0 to 4.0 pt/A apply 2 w after planting and repeat 2-3 w later.	oxamyl	1	48	H
7	Velum Prime 4.16SC	6.5 to 6.84 fl oz/A	fluopyram	0	12	--
--	Nimitz 4EC	3.5 to 5.0 pt/A Incorporate or drip-apply 7 d before planting.	fluensulfone	n/a	12	N

Seed Treatment Check with your seed company if the seed has been treated with an insecticide and fungicide. For untreated seed, use a mixture of Thiram 480DP (4.5 fl oz/100 lb seed) and an approved commercially available insecticide.

Damping-off caused by *Phytophthora*, *Pythium*, and *Rhizoctonia*

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Apply one of the following at-planting (see label for application timing, methods, and restrictions):						
Phytophthora and Pythium Root Rot:						
4	Ridomil Gold 4SL	1.0 to 2.0 pt/A	mefenoxam	5	48	N
4	Ultra Flourish 2E	2.0 to 4.0 pt/A	mefenoxam	5	48	N
4	MetaStar 2E AG	4.0 to 8.0 pt/A	metalaxyl	AP	48	N
49 + **4**	Orondis Gold[1]	28.0 to 55.0 fl oz/A	oxathiapiprolin + mefenoxam	AP	48	N
Phytophthora, Pythium, and Rhizoctonia Root Rot:						
4 + 11	Uniform 3.66SE	0.34 fl oz/1000 ft row. Avoid direct seed contact, which may cause delayed emergence.	mefenoxam + azoxystrobin	AP	0	N
Rhizoctonia root rot only:						
11	azoxystrobin 2.08F	0.40 to 0.80 fl oz/1000 ft row	azoxystrobin	1	4	N
Pythium root rot only:						
28	Previcur Flex 6F	1.2 pt/A in transplant water, drip irrigation, or direct spray at base of plant and soil	propamocarb hydrochloride	2	12	N

[1] may cause some yellowing in cucurbit leaves

Bacterial and Fungal Diseases

Alternaria Leaf Blight

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Begin sprays when vines begin to run. ALTERNATE one of the following:						
M03	mancozeb 75DF	2.0 to 3.0 lb/A	mancozeb	5	24	N
M05	chlorothalonil 6F	2.0 to 3.0 pt/A[1]	chlorothalonil	0	12	N
WITH A TANK MIX of one of the following fungicides PLUS chlorothalonil 6F 2.0 to 3.0 pt/A every 14 days						
3 + 9	Inspire Super 2.82EW	16.0 to 20.0 fl oz/A	difenoconazole + cyprodinil	7	12	--
3 + **11**	Topguard EQ 4.29SC[2,3,4]	5.0 to 8.0 fl oz/A	flutriafol + azoxystrobin	1	12	--
3 + **11**	Quadris Top 1.67SC[2,4]	12.0 to 14.0 fl oz/A	difenoconazole + azoxystrobin	1	12	--
3 + 7	Aprovia Top 1.62EC	10.5 to 13.5 fl oz/A	difenoconazole + benzovindiflupyr	0	12	--
7 + **11**	Luna Sensation 4.25SC[2,5]	7.6 fl oz/A	fluopyram + trifloxystrobin	0	12	--
7 + **11**	Pristine 38WG[6]	12.5 to 18.5 oz/A	boscalid + pyraclostrobin	0	12	--
7 + **11**	Merivon 2.09SC[2,6]	4 to 5.5 fl oz/A	fluxapyroxad + pyraclostrobin	0	12	N
11	azoxystrobin 2.08F[2,3,4]	11.0 to 15.5 fl oz/A[3]	azoxystrobin	1	4	N
11	Cabrio 20EG[2,6]	12.0 to 16.0 oz/A	pyraclostrobin	0	12	N
11	Reason 500SC[2]	5.5 fl oz/A	fenamidone	14	12	--

[1]Low rate early in the season. [2]**Do not** use if resistance to FRAC code 11 fungicides exists in the area. [3]Do not tank mix with crop oil concentrates, methylated spray oil, or silicon adjuvants. Do not tank mix with Malathion, Thiodan, Lannate, MPede, or Botran. [4]**Do not apply near apples**, see label. [5]A mild yellowing on leaf margins is sometimes seen following application of Luna Sensation in cucurbits. [6]Tank mixes of additives, adjuvants, and/or other products may result in crop injury.

Angular Leaf Spot

At first sign of disease, apply the labeled rates of fixed copper plus mancozeb. Repeat every 7 d. To minimize the spread of disease, avoid working in the field while foliage is wet.

Anthracnose

Excellent resistance is available in some varieties and those should be used when possible. Begin fungicide applications when vines run or earlier if symptoms are detected. **If resistance to FRAC code 11 (strobilurin) fungicides has been detected in the area, do not use azoxystrobin, Quadris Top, Merivon or Cabrio.**

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Under LIGHT or MODERATE disease pressure, ALTERNATE:						
M05	chlorothalonil 6F	1.5 to 2.0 pt/A (low rate early in the season)	chlorothalonil	0	12	N
WITH a TANK MIX the following fungicide PLUS mancozeb 80 DF 2.0 to 3.0 lb/A OR chlorothalonil 6F 2.0 to 3.0 pt/A:						
1	Topsin M WSB	0.5 lb/A	thiophanate-methyl	1	24	N

Anthracnose - continued next page

Anthracnose - continued

Under HIGH disease pressure, TANK-MIX one of the following fungicides WITH chlorothalonil 6F 2.0 to 3.0 pt/A:						
3 + **11**	Quadris Top 1.67SC[1]	12.0 to 14.0 fl oz/A	difenoconazole + azoxystrobin	1	12	--
3 + **11**	Topguard EQ 4.29SC[1,2]	5.0 to 8.0 fl oz/A	flutriafol + azoxystrobin	1	12	--
7 + **11**	Merivon 2.09SC[3]	5.5 fl oz/A	fluxapyroxad + pyraclostrobin	0	12	N
7 + **11**	Pristine 38WG[3]	18.5 oz/A	boscalid + pyraclostrobin	0	12	--
11	azoxystrobin 2.08F[1,2]	11.0 to 15.5 fl oz/A	azoxystrobin	1	4	N
11	Cabrio 20EG[3]	12.0 to 16.0 fl oz/A	pyraclostrobin	0	12	N
AND ROTATE with a TANK MIX of the following fungicide PLUS mancozeb 75DF 2.0 to 3.0 lb/A OR chlorothalonil 6F 2.0 to 3.0 pt/A every 7 days:						
1	Topsin M WSB	0.5 lb/A	thiophanate-methyl	1	24	N

[1]**Do not apply near apples**, see label. [2]Do not tank mix with crop oil concentrates, methylated spray oil, or silicon adjuvants. Do not tank mix with Malathion, Thiodan, Lannate, MPede, or Botran. [3]Tank mixes of additives, adjuvants, and/or other products may result in crop injury.

Bacterial Fruit Blotch (BFB)

Obtain seed or seedlings that were tested and found to have "no evidence" of the pathogen, which will reduce the risk of BFB development. Practice good sanitation during transplant production. Segregate different seed lots in the transplant house to reduce the chance of cross contamination. Scout seedlings daily, have suspect plants tested and destroy all diseased plants. Use only transplants from houses in which there were no seedling symptoms of BFB. If BFB is detected after transplanting, always work infested fields at the end of the day. Rotate to allow 2 years between watermelon plantings and control volunteers during those years.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Apply one of the following fungicide schedules beginning before the first flower is open and continuing until 3 weeks after flowering. Subsequent fruit sets must also be protected.						
M01	copper (OMRI)	at labeled rates	copper	0	see label	N
P01	Actigard 50WG (must apply 1 or 2 weeks prior to flowering to be effective)	0.5 to 1.0 oz/A	acibenzolar-S-methyl	0	12	N

Downy Mildew

Scout fields for disease incidence regularly. Begin targeted sprays when disease occurrence is predicted for the region (check the Cucurbit Downy Mildew Forecasting website at *https://cdm.ipmpipe.org*). Strains of Downy Mildew that infect one cucurbit crop may not affect watermelon. Unnecessary fungicide application can be avoided by not spraying until disease is predicted in the region on watermelon. **Preventative applications are much more effective than applications made after detection. Materials with different Modes of Action (FRAC codes) should be alternated.** The following are the most effective products.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Sprays should be applied on a 7-day schedule when disease is forecast or present in the region. Under severe disease conditions and conducive weather, spray interval may be reduced IF the label allows. TANK-MIX one of these products WITH a protectant fungicide such as chlorothalonil 1.5 to 2.0 pt 6F/A:						
49 + 40	Orondis Ultra 2.33SC	5.5 to 8.0 fl oz/A	oxathiapiprolin + mandipropamid	0	4	--
49+M05	Orondis Opti[1]	1.75 to 2.5 pt/A	oxathiapiprolin + chlorothalonil	0	12	--
21	Ranman 400SC	2.10 to 2.75 fl oz/A (**Do not apply with copper**; see label for details)[2]	cyazofamid	0	12	L
Other materials for use in rotation as tank mix partners with a protectant:						
43	Presidio 4SC	4.0 fl oz/A	fluopicolide	2	12	L
28	Previcur Flex 6F	1.2 pt/A	propamocarb hydrochloride	2	12	N
40 + 45	Zampro 525SC	14.0 fl oz/A	dimethomorph + ametoctradin	0	12	--
22	Elumin 4SC	8.0 fl oz/A	ethaboxam	2	12	--
M03+22	Gavel 75DF	1.5 to 2.0 lb/A **contains protectant**	mancozeb + zoxamide	5	48	--
M05+22	Zing! 4.9SC[1]	36.0 fl oz/A **contains protectant**	chlorothalonil + zoxamide	0	12	N
M05+27	Ariston 42SC[1]	1.9 to 3.0 pt/A **contains protectant**	chlorothalonil + cymoxanil	3	12	--
11 + 27	Tanos 50DF	8.0 oz/A	famoxadone + cymoxanil	3	12	--
27	Curzate 60DF	3.2 to 5.0 oz/A	cymoxanil	3	12	N
29	Omega 500F	12.0 to 24.0 fl oz/A	fluazinam	30	12	N
40	Forum 4.17SC	6.0 fl oz/A	dimethomorph	0	12	N

[1]Tank mixes of additives, adjuvants, and/or other products may result in crop injury. [2]Ranman should be tank mixed with an organosilicone surfactant when disease is severe, or a non-ionic surfactant or blend of organosilicone and non-ionic surfactant disease is moderate or light.

Fusarium Wilt

Use a rotation of at least 5 years and resistant varieties when possible. Several newly released *seedless* varieties have resistance to Fusarium Wilt caused by race 1. However, their level of resistance is lower than that of resistant *seeded* varieties and race 2 also occurs in our region. Some *pollinizers* have good resistance to Fusarium Wilt caused by race 1.

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Application of Proline through drip irrigation or as a post-plant drench followed by two foliar applications may reduce Fusarium Wilt early season. NOTE: only one soil application of Proline is allowed per season.						
3	Proline 480SC[1]	5.7 fl oz /A	prothioconazole	7	12	--
3	Rhyme 2.08SC[2,3]	7.0 fl oz/A	flutriafol	0	12	--

[1]Only one soil application of Proline is allowed per season. [2]FIFRA 2(ee) label for chemigation of Rhyme to suppress Fusarium Wilt has been approved in DE, MD, PA, NJ. VA, and WV. See label for details. [3]Do not use organosilicone adjuvants, or crop oil concentrate surfactants. Under certain environmental conditions, may result in phytotoxicity symptoms. FMC recommends the grower and/or user test this product to determine its suitability for use in watermelon.

Gummy Stem Blight

Fungicide solo products within the FRAC code 11 (Cabrio, azoxystrobin and Flint Extra 500SC) are not recommended in the Mid-Atlantic region. Pristine or Luna Sensation, which contain both FRAC code 11 and 7 components should always be tank-mixed with a protectant fungicide to reduce the chances for resistance development (see Table E-10). **When tank-mixing, use at least the minimum labeled rate of each fungicide. Do not apply FRAC code 11 fungicides more than 4 times total per season.**

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Begin sprays when vines begin to run. Apply the following under LOW disease pressure every 7 days:						
M05	chlorothalonil 6F	2.0 to 3.0 pt/A	chlorothalonil	0	12	N
Under HIGH disease pressure, ALTERNATE:						
M05	chlorothalonil 6F	2.0 to 3.0 pt/A	chlorothalonil	0	12	N
WITH a TANK-MIX containing chlorothalonil or mancozeb PLUS one of the following fungicides:						
3	Proline 480SC	5.7 fl oz/A	prothioconazole	7	12	--
3	tebuconazole 3.6F[1]	8.0 fl oz/A[1]	tebuconazole	7	12	N
3	Rhyme 2.08SC[2]	5.0 to 7.0 fl oz/A	flutriafol	0	12	--
3 + 7	Luna Experience 3.34SC[3]	10.0 to 17.0 fl oz/A	tebuconazole + fluopyram	7	12	--
3 + 9	Inspire Super 2.82EW	16.0 to 20.0 fl oz/A	difenoconazole + cyprodinil	7	12	--
3 + 7	Aprovia Top 1.62EC	10.5 to 13.5 fl oz/A	difenoconazole + benzovindiflupyr	0	12	--
7 + **11**	Merivon 2.09SC[4]	5.5 fl oz/A	fluxapyroxad + pyraclostrobin	0	12	N
7 + **11**	Pristine 38WG[4]	12.5 to 18.5 oz/A	boscalid + pyraclostrobin	0	12	--
9 + 12	Switch 62.5WG	11.0 to 14.0 oz/A	cyprodinil + fludioxonil	1	12	L
7 + 12	Miravis Prime	9.2 to 11.4 fl oz/A	pydiflumetofen + fludioxonil	1	12	--

[1]Note: reduced sensitivity of the pathogen to tebuconazole 3.6F has occurred in the Southern U.S. [2]Do not use organosilicone adjuvants, or crop oil concentrate surfactants. Under certain environmental conditions, may result in phytotoxicity symptoms. FMC recommends the grower and/or user test this product to determine its suitability for use in watermelon. [3]A mild yellowing on leaf margins is sometimes seen following application of Luna Experience in cucurbits. [4]Tank mixes of additives, adjuvants, and/or other products may result in crop injury.

Phytophthora Crown and Fruit Rot

Multiple practices should be used to minimize the occurrence of this disease. Grow watermelons on raised beds and drain fields adequately so that water will not accumulate around the base of the plants. Rotate away from susceptible crops (cucurbits, peppers, lima beans and beans, eggplants, and tomatoes) for as long as possible. Apply pre-plant fumigants to suppress disease. When the vines begin to run, subsoil between rows to allow for faster drainage following rainfall. Fruit are susceptible at all growth stages and must be protected season-long.

Phytophthora Crown and Fruit Rot - continued

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Apply one of the following fungicides and tank mix with fixed copper at labeled rates when conditions favor disease development (for suppression only). Materials with different modes of action (FRAC codes) should always be alternated to reduce the chances for fungicide resistance development:						
49 + 40	Orondis Ultra 2.33SC	5.5 to 8.0 fl oz/A	oxathiapiprolin + mandipropamid	0	4	--

Phytophthora Crown and Fruit Rot- continued next page

Phytophthora Crown and Fruit Rot - continued

49+M05	Orondis Opti[1]	1.75 to 2.5 pt/A	oxathiapiprolin + chlorothalonil	0	12	--
40	Revus 2.08F	8.0 fl oz/A	mandipropamid	0	4	--
40 + 45	Zampro 525SC	14.0 fl oz/A	dimethomorph + ametoctradin	0	12	--
43	Presidio 4SC[2]	4.0 fl oz/A	fluopicolide	2	12	L
M03+22	Gavel 75DF	1.5 to 2.0 lb/A	mancozeb + zoxamide (**note:** some cultivars are sensitive to mancozeb)	5	48	--
21	Ranman 400SC	2.75 fl oz/A (**Do not apply with copper,** see label for details)[2]	cyazofamid	0	12	L
40	Forum 4.17SC	6.0 fl oz/A	dimethomorph	0	12	N
22	Elumin 4SC	8 fl oz/A	ethaboxam	2	12	--
M05+22	Zing! 4.9SC[1]	36.0 fl oz/A	chlorothalonil + zoxamide	0	12	N

[1]Tank mixes of additives, adjuvants, and/or other products may result in crop injury. [2]Presidio may also be applied through the drip irrigation (see supplemental label). [3]Ranman should be tank mixed with an organosilicone surfactant when disease is severe, or a non-ionic surfactant or blend of organosilicone and non-ionic surfactant disease is moderate or light.

Powdery mildew

Detection of Powdery mildew is more difficult in watermelons than in other cucurbits because sporulation is sparse and masked by leaf color. Look for chlorotic spots on the upper surface of young, fully expanded leaves, and then inspect the corresponding lower surface with a hand lens to confirm presence of the fungus.

The fungus that causes cucurbit Powdery Mildew can develop resistance to high risk fungicides. Resistance to strobilurin (FRAC code 11) and DMI (FRAC code 3) fungicides have been reported in the Eastern U.S. Proper fungicide resistance management should be followed. **Materials with different modes of action (FRAC codes) should always be alternated.**

Powdery Mildew generally occurs from mid-July until the end of the season. Observe fields for its presence. mildew. If 1 lesion is found on the underside of 45 old leaves per acre, begin the following fungicide program:

Code	Product Name (*=Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
TANK MIX one of these products with a protectant such as chlorothalonil 6F 2.0 to 3.0 pt/A:						
50	Vivando 2.5SC[1]	15.4 fl oz/A	metrafenone	0	12	--
13	Quintec 2.08SC	4.0 to 6.0 fl oz/A	quinoxyfen	3	12	--
3 + 7	Luna Experience 3.34SC[2]	6.0 to 17.0 fl oz/A	tebuconazole + fluopyram	7	12	--
7 + **11**	Luna Sensation 4.25SC[2]	4.0 to 7.6 fl oz/A	fluopyram + trifloxystrobin	0	12	--
AND ALTERNATE with a TANK MIX of one of the following and a protectant such as chlorothalonil 6F 2.0 to 3.0 pt/A:						
3	Proline 480SC	5.7 fl oz/A	prothioconazole	7	12	--
3	Procure 480SC	4.0 to 8.0 fl oz/A	triflumizole	0	12	N
3	Rally 40WSP	2.5 to 5.0 oz/A	myclobutanil	0	24	N
3	tebuconazole 3.6F	4.0 to 6.0 fl oz/A	tebuconazole	7	12	N
3	Rhyme 2.08SC[3]	5.0 to 7.0 fl oz/A	flutriafol	0	12	--
3 + 7	Aprovia Top 1.62EC	10.5 to 13.5 fl oz/A	difenoconazole + benzovindiflupyr	0	12	--
7	Fontelis 1.67 SC	12.0 to 16.0 fl oz/A	penthiopyrad	1	12	L
P05	Regalia (OMRI)	4.0 qt/A	Extract of *Reynoutria sachalinensis*	0	4	--
39	Magister 1.6SC[4]	24.0 to 36.0 fl oz/A	fenazaquin	3	12	H
7 + 12	Miravis Prime	9.2 to 11.4 fl oz/A	pydiflumetofen + fludioxonil	1	12	--
U06	Torino 0.85SC	3.4 fl oz/A	cyflufenamid	0	4	--

[1]Do not mix Vivando with horticultural oils. [2]A mild yellowing on leaf margins is sometimes seen following application of Luna Experience and Luna Sensation in cucurbits. [3]Do not use organosilicone adjuvants, or crop oil concentrate surfactants. Under certain environmental conditions, may result in phytotoxicity symptoms. FMC recommends the grower and/or user test this product to determine its suitability for use in watermelon. [4]Do not make more than one application per year of Magister.

Viruses (WMV, PRSV, ZYMV, and CMV)

The most prevalent virus in the Mid-Atlantic region is WMV followed by PRSV, ZYMV, and CMV. Plant fields as far away from existing cucurbit plantings as possible to help reduce the chances of aphid transmission of viruses from existing fields to new fields.

G. Resources

1. Vegetable Seed Sizes

Table G-1. Vegetable Seed Sizes
Use this table to estimate your seed requirements. Varieties and seed lots can differ in seed size.
Check with your seed supplier and the label on the container for more precise information.

Crop	Seeds/Unit Weight		Crop	Seeds/Unit Weight
Asparagus	13,000-20,000/lb		**Mustard**	15,000-17,000/oz
Beans: baby lima	1,150-1,450/lb		**Okra**	450-550/oz
Beans: Fordhook	440-550/lb		**Onions: bulb**	105,000-144,000/lb
Beans: snap	1,600-2,200/lb		**Onions: bunching**	180,000-200,000/lb
Beets	24,000-26,000/lb		**Parsnips**	7,500-12,000/oz
Broccoli	8,500-9,000/oz		**Parsley**	240,000-288,000/lb
Brussels sprouts	8,500-9,000/oz		**Peas**	1,440-2,580/lb
Cabbage	8,500-9,000/oz		**Peppers**	4,000-4,700/oz
Carrots	300,000-400,000/lb		**Pumpkins**	1,900-3,200/lb
Cauliflower	8,900-10,000/oz		**Radishes**	40,000-50,000/lb
Celery	60,000-72,000/oz		**Rutabaga**	150,000-192,000/lb
Collards	7,500-8,500/oz		**Spinach**	25,000-50,000/lb
Cucumbers	15,000-16,000/lb		**Squash: summer**	3,500-4,800/lb
Eggplants	6,000-6,500/oz		**Squash: winter**	1,600-4,000/lb
Endive, Escarole	22,000-26,000/oz		**Sweet corn: normal, sugary enhanced**	1,800-2,500/lb
Kale	7,500-8,900/oz		**Sweet corn: Super sweet (Sh)**	3,000-5,000/lb
Leeks	170,000-180,000/lb		**Tomatoes: fresh**	10,000-11,400/oz
Lettuce: head	20,000-25,000/oz		**Tomatoes: processing**	160,000-190,000/lb
Lettuce: leaf	25,000-31,000/oz		**Watermelons: small seed**	8,000-10,400/lb
Muskmelons	16,000-19,000/lb		**Watermelons: large seed**	3,200-4,800/lb

2. Plant Spacing and Populations

Table G-2. Plant Spacing and Populations
This table lists plant population size (plants per acre) at different combinations of between- and in-row spacing.

Between-Row Spacing (inch) ↓	In-Row Spacing (inch) →												
	2	**4**	**6**	**8**	**10**	**12**	**14**	**16**	**18**	**24**	**30**	**36**	**48**
7	448,046	224,023	149,349	112,011	89,609	74,674	64,006						
12	261,360	130,680	87,120	65,340	52,272	43,560	37,337	32,670	29,040	21,780	17,424	14,520	10,890
18	174,240	87,120	58,080	43,560	34,848	29,040	24,891	21,780	19,360	14,520	11,616	9,680	7,260
21	149,349	74,674	49,783	37,337	29,870	24,891	21,336	18,669	16,594	12,446	9,957	8,297	6,223
24	130,680	65,340	43,560	32,670	26,136	21,780	18,669	16,335	14,520	10,890	8,712	7,260	5,445
30	104,544	52,272	34,848	26,136	20,909	17,424	14,935	13,068	11,616	8,712	6,970	5,808	4,356
36 (3 ft)	87,120	43,560	29,040	21,780	17,424	14,520	12,446	10,890	9,680	7,260	5,808	4,840	3,630
42 (3½ ft)	74,674	37,337	24,891	18,669	14,934	12,446	10,668	9,334	8,297	6,223	4,978	4,149	3,111
48 (4 ft)	65,340	32,670	21,780	16,335	13,068	10,890	9,334	8,167	7,260	5,445	4,356	3,630	2,722
60 (5 ft)			17,424	13,068	10,454	8,712	7,467	6,534	5,808	4,356	3,485	2,904	2,178
72 (6 ft)			14,520	10,890	8,712	7,260	6,223	5,445	4,840	3,630	2,904	2,420	1,815
84 (7 ft)			12,446	9,334	7,467	6,223	5,334	4,667	4,149	3,111	2,489	2,074	1,556
96 (8 ft)			10,890	8,167	6,534	5,445	4,667	4,084	3,630	2,722	2,178	1,815	1,361

3. Frequently Used Weights and Measures

Table G-3. Frequently Used Weights and Measures
Frequently Used Weights and Measures and Approximate Metric Equivalents

Liquid				Dry			
Pint	**Liters**	**Gallons**	**Liters**	**Ounces**	**Grams**	**Pounds**	**Kilograms**
0.5	0.24	1	3.8	0.25	7.1	1	0.45
1.0	0.47	2	7.6	0.50	14.2	2	0.91
1.5	0.71	3	11.4	0.75	21.3	3	1.36
2.0	0.95	4	15.1	1.0	28.4	4	1.81
2.5	1.18	5	18.9	2.0	56.7	5	2.27
3.0	1.42	6	22.7	3.0	85.0	6	2.72
3.5	1.65	7	26.5	4.0	113.4	7	3.18
4.0	1.90	8	30.3	5.0	141.7	8	3.63
4.5	2.13	9	34.1	10.0	283.5	9	4.08
5.0	2.37	10	37.9	16.0	453.6	10	4.54

Length	Area
1 inch = 2.54 centimeters	1 acre = 0.405 hectares
1 foot = 30.48 centimeters	1 square mile = 2.59 square kilometers
1 yard = 0.914 meters	1 square yard = 0.836 square meters
1 mile = 1.61 kilometers	1 square foot = 0.0929 square meters
	1 square inch = 6.45 square centimeters

4. Making a Plant-Growing Mix

Many pre-mixed growing media products suitable for conventional and organic production are available commercially. A good, lightweight, disease-free, plant-growing medium can also be made from a mixture of peat and vermiculite. A formula for a very simple mix for conventional production is given in Table R-4, but a preferred formulation is shown in Table R-5. If plants are to be grown in a medium longer than 8 weeks, use the formula in Table R-5. Organic growing media differ from conventional media because all components used must be allowable under organic production standards. When mixing your own, it is important to verify with your certifier that the materials you are using will not compromise your certification. More information on growing media, including several formulations, can be found in:

- Potting Media and Plant Propagation: *https://extension.psu.edu/potting-media-and-plant-propagation*
- Potting Mixes for Certified Organic Production: *https://attradev.ncat.org/wp-content/uploads/2022/06/pottingmixes.pdf*

Regardless of which formula is chosen, unless good mixing procedures are used, the results will be less than optimal. For best mixing, use a horizontal-type paddle mixer that folds or blends the components, such as lime and fertilizer, evenly throughout the mix. With tilted or other types of mixers, the components tend to segregate or separate out, resulting in erratic performance of the mix.

Good procedures to follow when preparing a mix are:

1. Use a respirator to prevent inhalation of dust when mixing peat, vermiculite, and additives.
2. For small quantities of mix preparation (1 cubic yard or less) place 4 to 5 inches of vermiculite in the bottom of a 5-gallon pail. Add all the additives (lime, fertilizer, etc.) to the vermiculite in the pail and mix thoroughly.
3. Fluff the recommended amount of peat. Start mixing and begin blending the peat.
4. While blending, add water according to the dampness of the peat. You will need approximately 1 gallon of water per bushel of peat in the mix.
5. While blending, slowly pour the additives, which you have already mixed thoroughly with a small amount of vermiculite, into the mixer and blend for 3 to 5 minutes.
6. Add the recommended amount of vermiculite after the other ingredients and blend for 1 minute or less, depending on the consistency of the vermiculite. It should be mixed thoroughly without breaking down.
7. Use the mix for growing your plants soon after mixing. It is not good practice to stockpile the mix in large piles for long periods of time.
8. Read all labels of the ingredients used and heed all warnings that may be marked on the labels or bags.

Table G-4. Simple Plant-Growing Mix

This mix will only get the seedlings up. Supplemental fertilizing will be needed to grow plants to transplant size. About 3 weeks after seeding, begin liquid fertilizing the plants with a soluble fertilizer, such as a 20-20-20, at the rate of 2-3 tsp/gal water. This rate should be applied at least weekly. More frequent applications may be desirable. **Note:** Lettuce and cabbage transplants have been grown successfully on this mix diluted with an equal part of sand.

Materials	**One Cubic Yard (=22 Bushels)**	**(2 Bushels)**
Shredded sphagnum peat moss	11 bu	1 bu (10 gal)
No. 2, 3, or 4 domestic or African vermiculite[1] or horticultural grade (dust-screened)	11 bu	1 bu (10 gal)
Pulverized limestone - use *dolomitic* lime for mixes made with *domestic* vermiculite ***or*** - use *calcitic* lime mixes made with *African* vermiculite	10 lb ***or*** 6 lb	1 lb (1¼ cups) ***or*** 9 oz (3/4 cup)
- Superphosphate (20% P_2O_5) ***or*** **-** Triple superphosphate (46% P_2O_5)	2½ lb ***or*** 1¼ lb	4 oz (½ cup) ***or*** 2 oz (¼ cup)
Fertilizer (5-10-10)	5 lb	8 oz (1 cup)

[1]Vermiculite should be approximately pea sized and relatively free of fines and dust. The final mix should have a pH of 6.0-6.5.

Table G-5. Preferred Plant-Growing Mix

Note: Osmocote is a slow-release fertilizer. Use a formula that will release nutrients over a period of 8-9 months. **Mixes should be made just prior to seeding.** Plants grown in mixes containing Osmocote must be carefully watered, and the temperature must be carefully controlled prior to field planting. When using small cells, reduced Osmocote rates are suggested to control plant height.

Materials	**One Cubic Yard (=22 Bushels)**	**(2 Bushels)**
Shredded sphagnum peat moss	11 bu	1 bu (10 gal)
No. 2, 3, or 4 domestic or African vermiculite[1] or horticultural grade (dust-screened)	11 bu	1 bu (10 gal)
Pulverized limestone - use *dolomitic* lime for mixes made with *domestic* vermiculite ***or*** - use *calcitic* lime mixes made with *African* vermiculite	10 lb ***or*** 6 lb	1 lb (1¼ cups) ***or*** 9 oz (3/4 cup)
- Superphosphate (20% P_2O_5) ***or*** **-** Triple superphosphate (46% P_2O_5)	2½ lb ***or*** 1¼ lb	4 oz (½ cup) ***or*** 2 oz (¼ cup)
Sulfate or muriate of potash (50%-60% K_2O)	½ lb	1 oz (2 tbs)
Osmocote (18-6-12)	4 lb (tomatoes) 8 lb (eggplants) 8 lb (peppers)	6 oz (3/4 cup) (tomatoes) 12 oz (1½ cups) (eggplants) 12 oz (1½ cups) (peppers)
Micronutrient mix	Use according to manufacturer recommendations	
Wetting agent (such as Aqua-Gro granular)	1½ pt	1 oz (4 tbs)

[1]Vermiculite should be approximately pea-sized and relatively free of fines and dust. The final mix should have a pH of 6.0-6.5.