

Chapter 3

Transplants for Organic Vegetable Production

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Growing vegetable transplants for organic vegetable production is equivalent to growing vegetable transplants for conventional production. All vegetable transplants require clean growing conditions, adequate light and heat, as well as uncontaminated growing media and clean water. However, for organic vegetable production it is imperative to utilize growing substrate that has been approved by the Organic Materials Review Institute (OMRI). In addition, the source of seeds and/or plant material, fertilizers, and pest management tools must be OMRI approved.

Growing Substrates

Growing substrate is the foundation for healthy seedlings. A growing substrate that is clean, disease free and has spaces for both air and water will allow the seedling a chance to grow to its best potential. "Growing substrate" is also known as potting mix, potting soil, planting mix, or media. It is essential to match the correct type of substrate structure with specific containers. A flat or seed tray requires a heavier substrate; whereas, a tray with small growing cells requires a lighter substrate. The substrate must be well balanced and contain ingredients that provide absorbent materials for holding water and proper porosity for air spaces so that the roots will have adequate oxygen. The substrate should be kept light and airy in the seedling flats and cells due to the fact that compaction of the substrate will decrease the amount of space for air thus resulting in stunted root growth. Growers who pre-fill and stack their flats and plug trays should include a layer of cardboard between the flats to prevent compaction. It is recommended that growers fill the flats and cells to the top; once watered, they will reduce in volume. The substrate also will need to be kept sterile while mixing and during storage to prevent disease from impacting seedling and transplant growth.

Seeds need the right, amount of oxygen and water before they begin the germination process. Seeds begin by absorbing water, then sending out the radical which is the precursor to the root into the growing substrate. Once the radical enters the growing substrate, the radical becomes a root, develops root hairs and secondary roots and absorbs water and nutrients. The cotyledons open as soon as the radical enters into the growing substrate, providing a source of nutrients to the radical until the radical has developed into a root that is capable of absorbing water and nutrients. At that time, the first true leaves emerge from the tip of the stem and begin the process of photosynthesis, absorbing sunlight, carbon and hydrogen, changing it into sugars to promote growth for the plant and the roots.

Commercially available OMRI approved potting mixes are easily found online at <http://www.omri.org/omri-lists> and many greenhouse supply companies. To remain in compliance with the National Organic Program (NOP), growers must use an OMRI approved commercial substrate or a home-made mix that contains OMRI approved ingredients. Seed-starting substrates to propagate seeds differ from transplanting or potting substrates for transplants. Each of these products contains specific ingredients required for optimum shoot and root growth at different stages of plant growth. Most commercially purchased substrates previously have been sterilized to remove any harmful pathogens, and will contain lime to bring the substrate to a soil acidity of 6.5 - 6.8. Homemade substrates are preferred by growers who want direct control the quality of their final product. Numerous available homemade “recipes” can be found in Fern Bradley and Barbara Ellis’ *Rodale’s All New Encyclopedia of Organic Gardening*, Vernon Grubinger’s *Sustainable Vegetable Production from Start up to Market*, Smith and Henderson’s *The Real Dirt*, Eliot Coleman’s *The New Organic Grower*, and the *National Sustainable Agriculture Information Service*, which contains the organic variation of the Cornell Mix.

For growers who prefer to create their own substrate, care must be taken to ensure the substrate has been sterilized to remove any disease-causing pathogens and harmful insects. Sterilization removes both the beneficial and disease causing organisms, and there is always a race for re-establishment of both of them. Disease organisms often repopulate a substrate before the beneficial. Compost contains many beneficial organisms, some even fight off disease causing pathogens. Composted plant or animal manures do not need to be sterilized, because the high heat of sterilization removes many of the beneficial organisms. Peat moss is hydrophobic; therefore, any substrate made with peat moss should be well hydrated before it is mixed with the other ingredients. If the substrate is created days before planting, it should be kept evenly moist and not allowed to dry out.

Jay Martin Provident Organic Farms*	
Peat moss	15 gallon
Compost – plant based	5 gallon
Perlite	2 ½ gallons
Lime	8 ounces
Bloodmeal	8 ounces
Black rock phosphate	4 ounces
Cornell Mix – Organic	
Sphagnum Peat Moss	½ cubic yards
Vermiculite	½ cubic yards
Bonemeal	10 pounds
Lime – ground limestone	5 pounds
Bloodmeal	5 pounds
Jay Martin Basic Substrate	
Sunshine Basic Mix	2.8 cubic foot bag
Perdue agro recycling 7-1-1	8 ounces (NPK = 7-1-1)
Lime	8 ounces

*Established in 2001, Jay Martin Provident Organic Farms is a cooperative effort by farmers and shareholders to build a sustainable food system based on a socially and environmentally responsible business model.
http://www.providentorganicfarm.com/farmer_JayMartin.htm

As soil blocks became popular in the 1980's; Eliot Coleman wrote a block mix recipe in *The New Organic Grower*.

Soil Block Mix	
Peat moss	3 buckets
Lime*	½ cup
Mix together then add the sand or perlite	
Sand- coarse sharp or perlite	2 buckets
Base fertilizer**	3 cups
Mix all together	
Soil	1 bucket
Compost***	2 buckets

* The amount of lime should be adjusted depending on the crop to be grown, usually about pH 6.0-6.5.

** Base Fertilizer contains:

Bloodmeal

Crab-shell meal – slow release nitrogen

Colloidal phosphate – clay material with phosphorus

Green sand – some potassium and many micronutrients

***Compost should not exceed 40% of the mixture to prevent excessive moisture-holding capacity which can lead to a gummy substrate.

Organic nutrient sources can include many natural products. For a more complete list see <http://www.omri.org/home>.

Compost	
Nitrogen (N)	%
Bonemeal	2-6
Bloodmeal	12
Compost	1-3
Cottonseed meal	6
Alfalfa meal	4
Fish emulsion	5
Fish meal	14
Kelp	0.9
Potassium (P ₂ O ₃)	%
Colloidal phosphate	25
Greensand	1
Rock phosphate	20
Bonemeal	15-34
Bloodmeal	1.5
Compost	0.5-1
Cottonseed meal	2.5
Wood ash	1-
Phosphorus (K ₂ O)	%
Granite meal	3-5
Greensand	4-9
Cottonseed meal	1.7
Compost	1-2
Bloodmeal	.5
Fish emulsion	2
Kelp	4-13
Wood ash	3-7
Other	
Sul-po-mag	
Epson salts	

Fertilizer

For optimal plant growth and development, the seedlings and transplants require adequate macronutrients (e.g. nitrogen, phosphorus, and potassium) often referred to as N-P-K, and micronutrients (e.g. sulfur, iron, magnesium, boron, manganese, zinc, copper and molybdenum). Carbon, hydrogen and oxygen are all obtained by the plants from the atmosphere. Nitrogen, phosphorus and potassium are obtained from animal or vegetable products such as Bloodmeal, bone meal, fish emulsion, animal manures, kelp, cottonseed meal or wood ash. The micronutrients or trace elements are minerals and can be mined from the soil and added to the growing substrate. Blood meal and fish

emulsion are an organic source of micronutrients. Research has determined the ratios of N-P-K in many types of animal manure. Poultry manures N-P-K ratio is 1.0-0.8-0.4, horse manure N-P-K ratio is 0.7-0.25-0.55 and cow manure N-P-K ratio is 0.6-0.15-0.45. As the seedlings and transplants grow in the substrate for 4-6 weeks, these additional nutrients are the plants sole source of nutrients during this critical time.

Organic nutrient sources are often heavy and cumbersome, thus shipping may become expensive. Typically, nutrients are shipped in their raw form, such as rock phosphate instead of P_2O_5 . These raw forms of nutrients can be rather dusty and growers should use masks and safety glasses to prevent inhalation and eye irritation. Nutrients in their raw form are not always available for the seedlings and transplants if the substrate temperature is too cool or the root systems not fully developed. In order to determine the total amounts of macronutrients (N-P-K), available to the plants, an electrical conductivity (EC) meter and a pH meter should be used to test the substrate prior to use in either seeding trays or transplanting into larger containers. The substrate pH is a measure of acidity, with 0 being the most acid, 14 the most basic and 7 being neutral. The pH values are based on logarithms with 10 as the base, so a pH of 5 is 10 times as acid as a substrate testing at a pH of 6. A pH of 4 is 10 times as acid as a pH of 5 but 100 times as acid as a pH of 6. Most plants grow best with a neutral pH, 6.5 to 7.0. A neutral substrate pH allows the macro and micronutrients to be available to plants in a healthy amount or ratio. A more acid or basic substrate pH will allow the micro nutrients to be available in larger or more toxic amounts, or in such small amounts that the plants become deficient. Electrical Conductivity (EC) is the measure of the amount of salts in the substrate, or the concentration of macronutrients in the substrate. If the EC is too low, the substrate has too little macronutrients in the substrate; the plants will be deficient and will grow poorly and be more susceptible to diseases. If the EC is too high, the substrate has too much macronutrient in the substrate and can actually burn the roots, destroying the physical integrity of the plants growing system. Weekly testing of the substrate pH and EC will alert the grower to a trend of a lowering or rising of the substrates acidity and nutrient availability. The pH and Electrical Conductivity meters can be purchased through a greenhouse supply company. EC and pH meters vary in their instructions for testing but many use one part substrate and one part water, mixed together then allowed to sit for at least an hour before being tested. A sample of substrate can be gathered from newly mixed growing substrate before it is used, or samples can be gathered from seedling trays near the roots of growing plants. Nutrients in liquid form can be added to augment and/or replace the nutrients utilized by the seedlings and transplants. They can be added any time the seedlings are actively growing. It is especially helpful to add a liquid fertilizer as a spray on the foliage just before transplanting seedlings from a greenhouse environment into the field. Liquid fertilizers are more easily absorbed by the plants in cool growing conditions when the raw nutrients are unavailable.

Liquid fertilizers can be created by diluting any soluble fertilizer with water. Different strengths can be created by the addition of more or less water. An EC meter will be able to determine the strength of the liquid fertilizer. A liquid fertilizer is utilized by the organic grower as a maintenance nutrient source either as a "substrate drench", pouring on the

liquid fertilizer at the full strength to provide nutrients to the roots, or as a diluted spray applied to the foliage of the plants. Seeds dipped into a soluble fertilizer accelerate the germination process and can promote more vigorous growth of young seedlings. Plants that have been prepared for transplanting suffer fewer setbacks when sprayed with a liquid fertilizer up to three days prior to the actual transplanting. A substrate with compost will not require the application of a liquid fertilizer as a substrate drench for 3-4 weeks. A substrate without compost will require half-strength liquid fertilizer as soon as the first true leaves emerge, then weekly at full strength until the plants have hardened off.

Fish emulsion and kelp products are very conducive to mixing with water and used as a liquid substrate drench. Kelp products are the most effective for foliar spray mixes. Kelp provides the macro and micronutrients and should be applied during the evening or during a cloudy day to ensure maximum plant absorption. If applied during the heat of the day, the heat will evaporate the liquid too quickly and the residual fertilizer left on the leaves could burn the foliage. An ounce of an insecticidal soap per gallon of kelp spray aids the adhesion of liquid fertilizer, especially plants with slick surfaces or plants with very upright foliage. Compost tea also can be utilized as a foliar fertilizer. Compost tea can be made by adding approximately one cup of compost into a five gallon bucket for two days. The compost tea should be aerated during the two days while brewing to keep the beneficial organisms alive.

Foliar feeding should only be utilized as a supplementary feeding source and never used as a substitute for a substrate drench or root feeding. Plants have developed roots to absorb both water and nutrients from the soil or substrate to keep the plants growing and healthy. Leaves can absorb minor amounts of nutrients, but their main function is to absorb sunlight, carbon, hydrogen and create sugars that feed the plants various parts including the stems and roots.

Seed and Plant Material

To comply with the National Organic Program, a grower must purchase certified organic seeds or provide documentation that a genuine attempt was made to purchase organic seeds. This documentation must list at least three sources (e.g. organic catalogues, organic growers, stores, etc.) that were contacted prior to the selection of a non-organic seed source.

If necessary, seeds should be pre-treated prior to planting to insure that they will germinate. Research the seeds to see which varieties need special treatment before planting to see what their requirements are. Seeds with very hard coats must be scarified or scratched to allow them to absorb water. Other seeds will require a period of cold (called stratification) before they can germinate. This can be achieved by storing the seeds in a refrigerator. Many seeds germinate more effectively if they have been soaked in lukewarm water an hour before planting. These seeds should be drained and dried on paper towels shortly before planting.

Vegetative plant materials such as plant cuttings or plant slips should be taken from organically grown plants. This is a requirement of OMRI, and if non-organically grown vegetative plant material is not available, three sources must be listed. Vegetative plant material includes sweet potato slips (the growing ends of the sweet potato), white potato eyes, asparagus roots, rhubarb roots, fruit bearing trees, shrubs or vines.

Seeds come in different sizes, can germinate at different times and need different pre-treatments before germinating. All of these differences can make it difficult to keep the seedling growing at their best potential. Separating the seeds in categories may help the grower realize a better crop. A grower should plant seeds that germinate around the same time together. As the seeds all germinate around the same time, the watering schedule will be similar for the entire group. Another way to group the seedlings is by their nutrient needs. Plants with high nutrient needs that are grouped together can be fertilized separately from plants that have lower nutrient needs. Seedlings that need heat to germinate can be grown on heat mats to facilitate their germination.

Seedling Containers

Seeds can be sown directly into seed trays or various sizes of plug trays. The seed and plug trays must provide enough depth for the seedling to develop a superior root system. Containers (seed flats, plug trays) should have sufficient drainage and vent holes. Very small seeds should be started in plug trays, as they will require less water than larger seeds before and during germination. Seeds sown into a flat usually do not have root-bound problems. Because seeds are sown so closely together, their roots will often grow around the roots of seedlings beside them. Time can be lost disentangling the roots during transplanting. Some roots can also be harmed if the roots are too closely entangled. Seeds sown into cells are easily transplanted; however, the timing of transplanting is much more critical. Plants must have sufficient time to grow in the cells in order to develop an extensive root system, but not become too lengthy or root-bound.

Heating mats or heating units under the table will warm the substrate in the seed flats and plugs and stimulate faster seed germination. Once the seeds have germinated and the true leaves have sprouted, the seedlings can be moved from the heating mats. Containers should not be recycled as it is very difficult to clean and sterilize them to eliminate all plant and soilborne diseases. There are now machines available that will wash and sterilize the planting trays and plug trays so they can be reused. The machines are expensive to purchase and may only be practical for large operations.

Transplanting

Viable candidates for transplanting include seedlings that have had their first true leaves emerge just above the cotyledons. At this stage, seedlings can be transplanted into larger containers or directly into the prepared ground. Before the seedling has been transplanted, it must complete a process called "hardening off". The seedlings have been grown in a warm and humid greenhouse environment without excessive wind, hard rain, drought, or strong sunlight. Hardening off the seedlings allows the seedling to

become gradually acclimated to the harsher outdoor weather. The temperature in the seedlings greenhouse should be lowered to approximately 50° and the amount of water given to the seedlings should be slowly decreased. This process allows the seedlings to develop thicker cell walls and accumulate carbohydrates. After hardening, the seedlings should be moved outdoors to a sheltered area for a few days prior to planting. The ideal climate to transplant seedlings is cool, cloudy, and with no wind. If the ideal weather is not available, planting seedlings in the early morning and watering them into the soil will hydrate them and allow them to withstand the transplant shock better than planting them in the heat of the afternoon. All seedling transplants should be planted at the same depth in the soil as the seed flats except for tomatoes, which can be transplanted up to the top two leaves of the seedlings. Transplants should be watered and a liquid fertilizer applied after the first day to help the seedlings acclimate easier.

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