NRAES-145

Wine Grape
PRODUCTION GUIDE
for Eastern North America

Natural Resource, Agriculture, and Engineering Service (NRAES)
Cooperative Extension

APPENDIX 1

Target Soil and Petiole Values and Fertilizer Guidelines for Grapevines

Appendix 1 provides recommended response measures that are based on a range of soil and plant tissue analysis test results. The recommendations are presented for each essential element. The reader finds the target values that most closely match his or her own sample test results. The "AND" column may provide qualifying factors. The "THEN" column provides the recommended response. Footnotes provide additional information to tailor the grower's action.

NITROGEN

	Target Values				
	Soil[1]	Bloom Petiole	70–100 DAB*	AND	THEN
IF <		0.80 %	0.60 %	Inadequate vine size and/or other visual indicators of low N status (pronounced symptoms of N deficiency).	Apply heavy N application as indicated for rates, below.
IF <		1.00 %	0.60 %	Inadequate vine size and/or other visual indicators of low N status.	Apply moderate N application as indicated for rates, below.
IF <		1.20 %	0.80 %	Adequate vine size and/or other visual indicators of N adequacy.	Apply maintenance N.
IF =		1.2–2.2 %	0.80–1.20 %	Inadequate vine size.	Investigate other source of poor vine growth.
IF =		1.2–2.2 %	0.80–1.20 %	Adequate vine size and/or other visual indicators of N adequacy.	Apply maintenance N.
IF =		1.2–2.2 %	0.80–1.20 %	Excessive vine size.	Curtail "routine" or maintenance N applications; allow some weed competition for N.
IF >		2.2%	1.2%	Inadequate vine size.	Investigate other potential sources of poor vine growth. Otherwise no action.

Notes:

[1] Soil test results are generally not used to make N fertilization recommendations. *DAB = Days after Bloom

Sources:

Ammonium nitrate (32% N): acidic soil reaction (1 lb N = 1.8 lbs $CaCO_3$; It takes 1.8 lbs of lime to neutralize the acidic reaction of 1 lb of ammonium nitrate fertilizer), may be difficult to obtain due to explosive nature.

Urea (46% N): economical N source, acidic soil reaction (1 lb N = 1.8 lbs $CaCO_3$), subject to ammonia volatilization if not incorporated

Calcium Nitrate (15% N): more expensive, basic soil reaction.

Manure and other organic matter: variable N concentration, long-term, slow-release N.

Rates:

Rate depends on N need, desired vine size and soil conditions. Wine grapes rarely require more than 30-50 pounds actual N/acre/year. Use lower rate for grafted vines and higher rate for non-grafted. Heavily cropped V. labrusca may require up to 50-80 lbs N/acre as maintenance rate. Use experience to modify rates. Split applications or multiple applications via irrigation system (fertigation) may improve efficiency and allow a lower net use of N. Maintenance of elevated tissue levels of N can reduce the incidence of oxidant stipple and late-season bunch stem necrosis (BSN) on varieties susceptible to those disorders.

Heavy: 25 to 50 pounds actual N per acre between bud break and bloom, followed by an additional 25 pounds actual N between bloom and two weeks post-bloom. Apply 20 pounds of actual N per acre immediately after fruit harvest IF confident that rain or irrigation will infiltrate applied N at least 3 weeks prior to natural leaf senescence or frost.

Moderate: 20 to 30 pounds actual N per acre between bud break and bloom, followed by an additional 20 pounds actual N between bloom and two weeks post-bloom.

Light/maintenance: 20 to 30 pounds actual N per acre between bud break and bloom.

PHOSPHORUS

	Target Values				
	Soil[f]	Bloom Petiole	70–100 DAB	AND	THEN
IF <	20 ppm	0.17 %	0.14 %	pH adequate and/or leaf reddening observed on red-fruited varieties.	Apply P_2O_5 fertilizer as indicated in notes.
IF <	20 ppm	0.17 %	0.14 %	Acid soil and/or leaf reddening observed on red-fruited varieties.	Adjust soil pH for long-term correction and supplement with P_2O_5 fertilizer as indicated in notes for short term correction.
IF =	20-50 ppm	0.17–0.30 %	0.14–0.30 %	No visual disorders.	No action necessary; repeat sampling in two years.
IF >	> 50 ppm	> 0.30%	> 0.30%		Monitor for micronutrient metal deficiencies (such as zinc), particularly at soil pH > 6.8 .

Notes:

[f] Multiply parts per million (PPM) by 2 to obtain equivalent pounds/acre.

Target soil values are typical for Mehlich-3 and Bray extraction methods. There are 4 different P extractions methods (Mehlich 1 & 3, Bray, and Morgan). Mehlich-3 and Bray are similar in value; Mehlich is somewhat lower for low pH soils. Morgan is much lower than all three. Virginia Tech currently uses Mehlich-1 but may change to 3, Cornell and Northeast universities use Morgan, Penn State and other mid-Atlantic universities use Mehlich-3. If interpreting your own soil tests, it is important to know the P extraction method used by your analytical lab.

Vineyard P disorders are often associated with low soil pH. In established vineyards, raise soil pH with limestone applications. Supplement with P fertilizer until desired soil pH and phosphorus availability is achieved.

Sources:

Monoammonium phosphate (MAP) (48% P_2O_5), also contains 11% N, acidic soil reaction (1 lb N = 3.5 lbs $CaCO_3$).

Diammonium phosphate (DAP) (46% P_2O_5), also contains 18% N, acidic soil reaction (1 lb N = 4.1 lbs $CaCO_3$).

Triple superphosphate (approximately 46% P_2O_5); use only if additional N is undesirable.

10-10-10, 10-20-10, or other blends, but only if N and K are also required. Materials may be custom-blended to meet particular needs.

Rates:

Pre-plant:

Soil test results Low or Very Low (< 10 ppm), apply 100 lbs P_2O_5/acre.

Soil test results Mod (< 15 ppm), apply 50 lbs P_2O_5/acre.

If decision is based solely on petiole test, start with an under-trellis, banded application of 50 lbs P_2O_5/acre as soon as convenient and resample petioles at or following bloom-time. Use higher P rate if petiole test used to confirm a low soil analysis, and/or if leaf reddening observed with red-fruited varieties.

POTASSIUM

	Target Values				
	Soil	Bloom Petiole	70–100 DAB	AND	THEN
IF <	75 ppm	1.00 %	0.80 %	High soil Mg and K deficiency symptoms obvious.	Apply K fertilizer – Heavy rate.
IF <		1.50 %	1.20 %	Excessively dry or excessively wet.	Apply K fertilizer – maintenance rate or irrigate to increase soil K mobility.
IF =	75–100 ppm	1.50–2.50 %	1.20–2.00 %	Large crop.	Apply maintenance rate of K fertilizer.
IF =	75–100 ppm	1.5 –2.50 %	1.20– 2.00 %	Normal crop.	No action necessary; repeat sampling in two years.
IF >	100 ppm	2.50 %	2.00 %		Monitor for chronic Mg deficiency.

Notes:

Muriate of Potash (KCl) typically applied in the fall to allow K movement into the root zone and chloride leaching out of the root zone. Caution must be used on soil with a salinity problem (not common in the Northeast) or on shallow or poorly drained soils where the chloride cannot leach from the root zone.

Potassium is typically banded; however, broadcasting in vineyards with spreading root systems and no-till row-middle management is an option.

Factors to watch:

1. K-Mg competition, especially with changes in soil pH.
2. K demand, especially in high cropping systems.
3. K soil mobility, it decreases with decreasing soil moisture.

Sources:

Muriate of Potash (52% K, 62% K_2O), most common.

Sulfate of Potash (44% K, 53% K_2O), use if chloride toxicity is a potential problem.

Sulpomag (22% K_2O, 11% Mg), has both K and Mg, more expensive, considered organic.

Rates:

Preplant:

Desired soil K is 75–100 ppm. Soil should be amended with potash (K_2O) prior to planting to bring within this range, as follows:

Example:

(100 ppm K desired) – (50 ppm K from sample test) = 50 ppm K needed x 2.4 = 120 lbs K_2O/acre needed

(120 lbs K_2O/acre needed) x 1.67 (60% K_2O in KCl) = 200 lbs KCl/acre applied - or -

(120 lbs K_2O/acre needed) x 2 (50% K_2O in K_2SO_4) = 240 lbs K_2SO_4/acre applied

Existing vineyard (rates based on soil test, petiole test, visual observation, or combinations thereof)

Heavy: Apply up to 600 pounds/acre K_2O (see text for graduated response to deficiency symptoms)

Moderate: Apply up to 400 pounds/acre K_2O

Light/maintenance: Apply up to 150 pounds/acre K_2O

CALCIUM

	Target Values				
	Soil*	Bloom Petiole	70–100 DAB	AND	THEN
IF <		1.00 %	1.00 %	Acid soil	Increase soil pH with limestone; Use calcitic limestone if Mg is high; use dolomitic limestone if Mg is also low.
IF <		1.00 %	1.00 %	Alkaline soil	Rare—investigate soil conditions. Calcium can be increased without increasing pH with gypsum.
IF =	500–2000 ppm	1.00–2.5 %	1.3–2.5 %		No action necessary; repeat sampling in two years.
IF >		3.00 %	3.00 %		Very rare in mid-Atlantic. Could reflect poor sampling or elevated pH. Re-evaluate soil pH and reduce with sulfur if > 7.5; monitor plant tissue levels of other nutrients to avoid potential deficiencies.

Notes:

*Target soil calcium values are not listed because they will change based on soil CEC. For example, soil Ca levels of < 500 ppm may be adequate in low CEC soils as long as soil pH is > 6.0.

Low calcium availability typically associated with low soil pH. Adjust with limestone.

Sources:

Limestone (variable % Ca).

Gypsum (calcium sulfate, 22% Ca), not used to adjust soil pH.

Rates:

Acid soil: Adjust soil pH to 6.5 (see lime recommendation table in text). Because of interactions with potassium, no more than 2 tons limestone/acre/year is recommended in established vineyards.

MAGNESIUM

	Target Values				
	Soil	Bloom Petiole	70–100 DAB	AND	THEN
IF <	100 ppm	0.30 %	0.35 %	Acid soil	Adjust soil pH with dolomitic limestone and add MgO to soil as indicated in notes.
IF <	100 ppm	0.30 %	0.35 %	High K or wet season	High soil moisture (high K mobility) can cause transient Mg deficiency. Monitor and apply maintenance rate of Mg fertilizer if necessary.
IF <		0.30 %	0.35 %	Neutral or Alkaline soil	Deficiency rare in high pH soils. Adjust with Epsom salts if needed
IF =	150–250 ppm*	0.3–0.5 %	0.35–0.75 %		No action necessary; repeat sampling in two years.
IF >		0.50 %	0.75 %	Dry year	Low K availability in dry soil may inflate Mg readings — monitor.
IF >		0.50 %	0.75 %	Normal year — neutral soil	Monitor for K deficiency.

Notes:

*Influenced by soil CEC.

Low magnesium availability typically associated with low soil pH. Can be aggravated in acid soils with high K application. Adjust with dolomitic limestone in low pH vineyards. Use Epsom salts in neutral and high pH soils.

Excessive soil Mg (either natural or fertilizer applied) may cause K deficiency and vine size reduction. Monitor petiole K and Mg.

Sources:

Dolomitic limestone (variable % Mg), most common

Epsom salts (magnesium sulfate, 10% Mg)

Sulpomag (22% K_2O, 11% Mg), has both K and Mg, more expensive

Rates:

Acidic soil: Adjust soil pH to 6.5 (see lime recommendation table in text). Because of interactions with potassium, no more than 2 tons limestone/acre/year is recommended in established vineyards.

If pH acceptable: adjust Mg with $MgSO_4$

Example:

150 ppm desired – 50ppm on soil test = 100ppm desired x 2 = 200 pounds Mg/acre

200 pounds/acre x 10 (10% Mg in $MgSO_4$) = 2000 pounds/acre $MgSO_4$ (Epsom salts)

Foliar applications of Epsom salts (5–10 pounds/acre in 100 gallons water) can be used for short-term correction (see text).

BORON

	Target Values				
	Soil	Bloom Petiole	70–100 DAB	AND	THEN
IF <	0.3 ppm	20 ppm	20 ppm		Apply boron as recommended in notes.
IF =	0.3–2.0 ppm	25–50 ppm	25–50 ppm		No action necessary; repeat sampling in two years.
IF >	2.0 ppm	50 ppm	50 ppm		Monitor for Boron toxicity.

Sources:

Solubor (20% B), most common; can be applied to soil or to foliage
Borax (11% B)
Borate-46 (14% B)
Borate-65 (20% B)

Rates:

Soil application rates of 1 pound B/acre in medium to coarse textured soils to 2 pounds B/acre on heavy clay soils are recommended. Blending with other fertilizers (such as N) for broadcast application is suitable. Soluble B products can also be applied to the soil with an herbicide sprayer. Calculate sprayer rate based on actual area sprayed, as opposed to total vineyard acres sprayed. For example, assume we want 1 pound B per planted acre, or 5 pounds Solubor (20% B) per planted acre. If only spraying ⅓ of a planted acre (for example, a 36-inch herbicide band of 9 foot rows), use 1.7 pounds Solubor per planted acre.

Foliar applications of 0.2 pounds B/acre (1 lb. Solubor) are recommended and no more than 0.5 pound B/acre (2.5 lb. solubor) in one application. Spring foliar sprays are timed at 6–10 inch shoot growth and 14 days later. In California, fall (immediate post-harvest) foliar sprays have been more effective than spring foliar application in eliminating cluster and berry disorder.

To reduce the risk of foliar burn, do not apply boron sprays at less than 14-day intervals or tank-mixed with water-soluble packages, oil, or surfactants.

IRON

	Target Values				
	Soil	Bloom Petiole	70–100 DAB	AND	THEN
IF <	10 ppm	10 ppm	10 ppm	Alkaline soil and/or visual symptoms of Fe deficiency.	Lower soil pH to improve long-term iron availability and apply Fe foliar spray to correct current foliar deficiencies.
IF <	10 ppm	10 ppm	10 ppm	Waterlogged soil and/or visual symptoms of Fe deficiency.	Improve soil drainage to improve long-term iron availability and apply Fe foliar spray to correct current foliar deficiencies.
IF =	20 ppm*	30–100 ppm	30–100 ppm		No action necessary; repeat sampling in two years.
IF >	50 ppm			Acid soil	High soil Fe can limit P availability. Monitor and increase soil pH if needed.

Notes:

*Soil values between 11–19 ppm should be monitored for possible developing deficiency.

Iron deficiency is often associated with calcareous soils (high soil pH), low soil oxygen (waterlogging), and variety (*V. labrusca* more susceptible). Tissue standards for interpreting iron levels are not well defined. In the absence of visual deficiency symptoms, no corrective action is indicated.

Common deficiency treatments:

Lower soil pH by trenching in soil sulfur or using acidifying nitrogen fertilizers.
Improve soil drainage
Apply foliar iron sprays (only effective for existing foliage)
Apply iron chelates (expensive and short-lived)

MANGANESE

	Target Values			AND	THEN
	Soil	Bloom Petiole	70–100 DAB		
IF <	10 ppm	25 ppm	25 ppm	Manganese deficiency symptoms apparent.	Manganese deficiency is rare except on high pH soils. Apply Mn foliar spray if needed.
IF =	10 ppm	25–1000[f] ppm	25–1,000 ppm		No action necessary; repeat sampling in two years.
IF >	50 ppm			Acid soil	Manganese toxicity a potential problem at low soil pH. Adjust soil pH with limestone if needed.

Notes:

[f] Very high Mn levels may reflect contamination of tissue by Mn-containing fungicides.

High Mn in tissue can also be a result of wet soils.

Sources:

Manganese sulfate (32% Mn), Foliar spray.

Some fungicides (e.g., mancozeb) are also an effective source of Mn.

Rates:

Foliar spray: 2–3 pounds manganese sulfate/100 gal water.

COPPER

	Target Values			AND	THEN
	Soil	Bloom Petiole	70–100 DAB		
IF <	0.2 ppm	5 ppm	5 ppm		Deficiency rare, but possible on sandy soils or soils with very high organic matter content. Apply copper as indicated in notes.
IF =	0.5 ppm	5–15 ppm	5–15 ppm		No action necessary; repeat sampling in two years.
IF >		20 ppm	20 ppm		Potential toxicity reported when copper sprays repeatedly used, leading to copper accumulation in low soil pH vineyards. Symptoms similar to lime-induced chlorosis (iron deficiency).

Notes:

Apply foliar copper as Bordeaux mixture or other copper fungicide if grape variety is tolerant of foliar copper application.

If pre-plant situation, broadcast elemental copper at up to 5.0 pounds/acre.

Very high Cu levels may reflect contamination of tissue by Cu-containing fungicides.

ZINC

	Target Values				
	Soil	Bloom Petiole	70–100 DAB	AND	THEN
IF <	2 ppm	25 ppm	25 ppm		Apply Zinc to soil (pre-plant) or foliage as indicated in notes.
IF =	2 ppm	25 ppm	25 ppm		No action necessary; repeat sampling in two years.
IF >					(We lack experience with Zn toxicity.)

Notes:

If pre-plant situation: broadcast up to 5.0 pounds/acre of elemental zinc.

Zinc sulfate should be applied with equal amounts of hydrated spray lime (1–4 pounds/100 gal) at the 3- to 5-inch shoot stage. Repeat in 14 days as needed.

Zn-chelate may be used at manufacturer's recommended rates.

MOLYBDENUM

	Target Values				
	Soil	Bloom Petiole	70–100 DAB	AND	THEN
IF <	*	0.5 ppm	0.5 ppm	Vines chronically exhibit symptoms of millerandage ("hens and chicks" uneven berry size).	Apply molybdenum to foliage as indicated in notes.
IF >	*	0.5 ppm	0.5 ppm	No visual symptoms of poor growth or poor fruit set.	(We lack experience with Mo toxicity.)

Notes:

We lack evidence of molybdenum deficiency symptoms in eastern North America, although it has been reported in Australia, particularly with Merlot, where poor vine growth and poor fruit set are peculiar features of the deficiency. The 0.5 ppm action threshold is therefore a provisional threshold for eastern North America.

Apply sodium molybdate to canopy at 0.50 pound per acre in at least 100 gallons of water per acre. Apply at the 3- to 5-inch shoot stage and repeat in 14 days, or just prior to bloom.

* We lack specific knowledge of appropriate soil concentrations of molybdenum.