and soil pH is within desired range (4.5 to 5.0), apply 10 lbs/acre zinc sulfate to the soil surface in early spring.

High Zn (above 30). No application is necessary.

Recommendations for Grapes

Nitrogen (N)

Deficient (if N is below 0.70). (1) Apply 80 to 100 lbs. of actual nitrogen/acre (240 to 300 lbs. of ammonium nitrate) in early spring. Or: (2) Apply 0.8 lb. of actual nitrogen/100 sq. ft. of soil area (spread uniformly in an area approximately 4-feet wide beneath the trellis row). Or: (3) Make a foliar application of N as: (a) Urea fertilizer at 5 lbs/100gal., or 10 lbs/acre/application, (b) or use other commercial products, containing primarily N, at the recommended manufacturer's rate. Repeat applications may be necessary but generally will not supply total N requirement for the season.

Below Normal (if N is 0.70 to 0.90). (1) Apply 60 to 80 lbs. of actual nitrogen/acre (180 to 240 lbs. of ammonium nitrate) in early spring. Or: (2) Apply 0.7 lb. of actual nitrogen/100 sq. ft. of soil area spread uniformly in an area approximately 4-feet wide beneath trellis row). Or: (3) Make foliar application(s) of N as: (a) Urea fertilizer at 5 lbs/100 gal., or 10 lbs/acre/application. Or: (b) Other commercial products, containing primarily N, at the manufacturer's recommended rates. Repeat applications may be necessary but generally will not supply total N requirement for the season.

Normal (if N is 1.5 to 2.5). (1) Apply 40 to 60 lbs. of actual nitrogen/acre (120 to 180 lbs. of ammonium nitrate) in early spring. Or: (2) Apply 0.6 lb. of actual nitrogen/100 sq. ft. of soil area (spread uniformly in an area approximately 4-feet wide beneath trellis row). Or: (3) Make foliar application(s) of N as: (a) Urea fertilizer at 5 lbs/100 gal., or 10 lbs/acre/application. Or: (b) Use other commercial products, containing primarily N, at the manufacturer's recommended rates. Repeat applications may be necessary but generally will not supply total N requirement for the season.

High (if N is above 2.0). (1) A fertilizer application containing nitrogen is optional (may not be required next year) depending on the previous nutritional history of this vineyard, cultivar, or cultural practices. A token application rate would be 20 to 40 lbs. of actual nitrogen/acre (60 to 120 lbs. of ammonium nitrate) in early spring or 0.5 lb. of actual nitrogen/100 sq. ft. of soil area (spread uniformly in an area approximately 4-feet wide beneath trellis). (2) Foliage of young, nonbearing vines frequently have higher nitrogen content than mature vines.

Phosphorus (P)

Deficient (if P is below 0.13). (1) Apply 130 to 160 lbs. of P/acre (280 to 350 lbs. of 46% concentrated super phosphate). Or: (2) Apply 1.0 to 1.2 lb. of P_20_5/100 sq. ft. of soil area (spread uniformly in an area approximately 4-feet wide beneath trellis row). Or: (3) Make foliar application(s) of P as: (a) A soluble (20%) P fertilizer at 5 lbs/100 gal. Or: (b) Other commercial products, containing primarily P, at the manufacturer's recommended rates. Repeat applications may be necessary but may not supply the total P requirement for more than one season. (4). Low soil moisture may depress uptake of phosphorus.

Below Normal (if P is 0.13 to 0.15). (1) Apply 80 to 130 lbs. of P_20_5/acre (175 to 280 lbs. of 46% concentrated super phosphate). Or: (2) Apply 0.8 to 1.0 lb. of P_20_5/100 sq. ft. of soil area (spread uniformly in an area approximately 4-feet wide beneath trellis row). Or: (3) Make foliar application(s) of P as: (a) A soluble (20%) P fertilizer at 5 lbs/100 gal. Or: (b) Other commercial products containing primarily P at the manufacturer's recommended rates. Repeat applications may be necessary but may not supply the total P requirement for more than one season. Or: (4) Low soil moisture may depress uptake of phosphorus.

Normal (if P is 0.16 to 0.29). (1) No application of phosphorus is necessary at this time. (2) High to excess levels of this element may depress the uptake and concentration of one or more heavy metals such as zinc, copper, iron, or manganese.

Potassium (K)

Deficient (if K is 0.5 to 1.0). (1) Apply 300 lbs. K_20 (500 lbs. of sulfate or muriate of potash) per acre, any time. Or: (2) Apply 2.0 lb. of K_2O/100 sq. ft. of

soil area (spread uniformly in an area approximately 4-feet wide beneath trellis row). Or: (3) Make foliar application(s) of K as: (a) Sulfate of potash at 5 to 8 lbs/100 gal. Or: (b) Other commercial products, containing primarily K, at the manufacturer's recommended rates. Repeat applications may be necessary but may not supply the total K requirement for more than one season. (4). Low soil moisture and/or high Mg tends to depress uptake of K.

Potassium compounds tend to be fixed and unavailable to the vines, particularly in clay soils with a pH near 7.0, than in sandy soils with a pH near 5.0. Thus, potash applications may need to be greater on clay soils if the pH is above 6.5. Response to potash is greatest when the application is made in a 2-foot wide band beneath the trellis.

Below Normal (if K is 1.1 to 1.4). (1) Apply 240 lbs. K_20 (400 lbs. of sulfate or muriate of potash) per acre anytime. Or: (2) Apply 1.7 lb. of K_2O/100 sq. ft. of soil area (spread uniformly in an area approximately 4-feet wide beneath trellis row). Or: (3) Make foliar application(s) of K as: (a) Sulfate of potash at 5 to 8 lbs/100 gal. Or: (b) Other commercial products containing primarily K, at the manufacturer's recommended rates. Repeat applications may be necessary but may not supply the total K requirement for more than one season. (4) Low soil moisture and/or high Mg tends to depress uptake of K.

Normal (if K is 1.5 to 2.5). (1) Application of potash is optional depending on the previous history of the vineyard. A routine maintenance application is 120 lbs. K_2O/acre (200 lbs/acre of muriate or sulfate of potash or as a mixed fertilizer). (2) Commercial products containing maintenance rates of potassium may also be applied at the manufacturer's recommended rates.

Above Normal (if K is above 4.5). Applications of potassium are not required and should not be applied. Look for deficiencies of other elements, especially magnesium, caused by this abnormally high potassium level.

Calcium (Ca)

Deficient (if Ca is 0.5 to 0.8). (1) If soil pH is below the recommended level (6.5), then apply agricultural ground limestone at rates recommended by soil tests. Also correct other soil conditions, which can be associated with poor calcium uptake such as excessive, or deficient, soil moisture, poor drainage, or other nutrient elements present in excessive amounts. (2) Many commercial products containing calcium are available. Apply each according to manufacturer's recommendations. (3) For additional information, refer to Extension bulletins and state publications.

Below Normal (if Ca is 0.8 to 1.1). (1) If soil pH is below recommended level (6.5), then apply

Table 9-6. Specific Element Recommendations for Grapes from Petioles.

Element[a]	Deficient	Below Normal	Normal	Above Normal	Excessive
N (%)	0.3 - 0.7	0.7 - 0.9	0.9 - 1.3	1.4 - 2.0	2.1+
P (%)	0.12	0.13 - 0.15	0.16 - 0.29	0.30 - 0.50	0.51+
K (%)	0.5 - 1.0	1.1 - 1.4	1.5 - 2.5	2.6 - 4.5	4.6+
Ca (%)	0.5 - 0.8	0.8 - 1.1	1.2 - 1.8	1.9 - 3.0	3.1+
Mg (%)	0.14	0.15 - 0.25	0.26 - 0.45	0.46 - 0.80	0.81+
Mn (ppm)	10 - 24	25 - 30	31 - 150	150 - 700	700+
Fe (ppm)	10 - 20	21 - 30	31 - 50	51 - 200	200+
Cu (ppm)	0 - 2	3 - 4	5 -15	15 - 30	31+
B (ppm)	14 - 19	20 - 25	25 - 50	51 - 100	100+
Zn (ppm)	0 - 15	16 - 29	30 - 50	51 - 80	80+

[a] Values may differ among species for optimal growth. Values from leaves will vary significantly. For petioles taken between July 15 to August 15.

agricultural ground limestone at rates recommended by soil tests. Also correct other soil conditions, which can be associated with poor calcium uptake such as excessive, or deficient, soil moisture, poor drainage, and nutrient elements present in excessive amounts. (2) Many commercial products containing calcium are available. Apply each according to manufacturer's recommendations. (3) For additional information refer to Extension bulletins and other state publications.

Normal (if Ca is 1.2 to 1.8). Continue present cultural practices. Application of calcium is not required at this time.

Above Normal (if Ca is 1.9 to 3.0). Continue present cultural practices. Application of calcium is not required at this time.

Magnesium (Mg)

Deficient (if Mg is 0.14). (1) If soil pH is below the recommended level (6.5), then apply dolomitic limestone at rates recommended by soil tests. Or: (2) Apply agricultural grade magnesium sulfate to the soil at 300 to 400 lbs/acre, or foliar grade magnesium sulfate as a spray at the rate of 10 lbs/acre. Repeat applications may be necessary. Or: (3) Apply suitable commercial products containing magnesium and recommended for soil or foliar application.

Below Normal (if Mg is 0.15 to 0.25). (1) If soil pH is below the recommended level (6.5), then apply dolomitic limestone at rates recommended by soil tests. Or: (2) Apply agricultural grade magnesium sulfate to the soil at 200 to 300 lbs/acre, or foliar grade magnesium sulfate as spray at the rate of 10 lbs/acre. Repeat applications may be necessary. Or: (3) Apply suitable commercial products containing magnesium and recommended for soil or foliar application.

Normal (0.26 to 0.45). Continue present cultural practices. Application of magnesium is not required at this time.

Above Normal (if Mg is 0.46 to 0.80). (1) Continue present cultural practices. Application of magnesium is not required at this time. Look for deficiencies of other elements, especially potassium, caused by this abnormally high magnesium level.

Manganese (Mn)

Deficient (if Mn is 10 to 24). (1) Apply a commercial formulation of manganese sulfate (24% Mn) as a foliar spray at the rate of 5 lbs/acre, in early spring before growth starts. Or: (2) Commercial products containing manganese are also available. Apply according to manufacturer's recommendations.

Below Normal (if Mn is 25 to 30). (1) Apply a commercial formulation of manganese sulfate (24% Mn) as a foliar spray at the rate of 5 lbs/acre, in early spring before growth starts. Or: (2) Commercial products containing Mn are also available. Apply according to manufacturer's recommendations.

Normal (if Mn is 31 to 150). (1) Continue present cultural practices. Application of manganese is not required at this time.

Above Normal (if Mn is 150 to 700). (1) Application of manganese is not required at this time. (2) Contamination from or absorption of fungicides containing manganese may be the cause of this high level.

Iron (Fe)

Deficient (if Fe is 10 to 20). Apply commercial formulations containing iron in available forms, such as chelates, at recommended rates. Verify iron deficiencies by the presence of foliar symptoms.

Below Normal (if Fe is 21 to 30). Apply commercial formulations containing iron in available forms, such as chelates, at recommended rates. Verify iron deficiencies by the presence of foliar symptoms.

Normal (if Fe is 31 to 50). Continue present cultural practices. Application of iron is not required at this time.

Above Normal (if Fe is 51 to 200). Application of iron is not required at this time.

Copper (Cu)

Deficient (if Cu is 0 to 2). Apply a commercial formulation of copper sulfate (22% Cu) as a foliar spray in early spring before growth starts. An annual application rate should not exceed 4 to 6 lbs/acre.

Below (if Cu is 3 to 4). An application of a commercial formulation of copper sulfate (22% Cu) is optional. Make application as a foliar spray in early

spring before growth starts. An annual application rate should not exceed 4 to 6 lbs/acre.

Normal (if Cu is 5 to 15). Continue present cultural practices. Application of copper is not required at this time.

Above Normal (if Cu is 15 to 30). Application of copper is not required at this time.

Boron (B)

Deficient (if B is 14 to 19). Make two foliar spray applications of Solubor between bloom and first cover. Apply 0.4 to 0.8 lbs/acre of actual boron per application (2 to 4 lbs. Solubor/acre/application or 4 to 8 lbs. total Solubor/acre).

Below Normal (if B is 20 to 25). Make two foliar spray applications of Solubor between bloom and first cover. Apply 0.4 to 0.8 lbs/acre of actual boron per application (2 to 4 lbs. Solubor/acre/application or 4 to 8 lbs. total Solubor/acre).

Normal (if B is 25 to 50). Continue present cultural practices. Application of boron is optional or not required at this time.

Above Normal (if B is 51 to 100). Application of boron is not required at this time.

Zinc (Zn)

Deficient (if Zn is 0 to 15). Apply a commercial formulation of zinc sulfate (89%) as a foliar spray in early spring before growth starts, at a rate of 5.5 lbs/acre.

Below Normal (if Zn is 16 to 29). Apply a commercial formulation of zinc sulfate (89%) as a foliar spray in early spring before growth starts, at a rate of 5.5 lbs/acre.

Normal (if Zn is 30 to 50). Continue present cultural practices. Application of zinc is not required at this time.

High Zn (if Zn is 51 to 80). (1) Application of zinc is not required at this time. (2) Contamination from or absorption of fungicides containing zinc may be the cause of this high level.