HortFact—3104
UK COOPERATIVE EXTENSION SERVICE
UNIVERSITY OF KENTUCKY — COLLEGE OF AGRICULTURE
Horticulture Department

Fertilization of Grapevines

S. Kaan Kurtural, Viticulturist, John G. Strang, Extension Horticulturist
And
Christopher Smigell, Extension Associate

Vineyard fertilization practices aim to ameliorate the supply of available soil nutrients to the levels required for optimum grapevine growth and yield. Most soils will contain adequate amounts of micronutrients. However, nitrogen, phosphorus, potassium, and magnesium are the nutrients that usually limit grape production in Kentucky.

In order to determine the levels of plant available nutrients in the soil, growers need to conduct both soil analysis and plant petiole analysis to determine the actual amounts of nutrients taken up by the grapevine. The soil analysis and the plant petiole analysis need to be done each year to maintain the fertility in the vineyard.

Soil Sampling, Analysis, and Interpretation

Soil samples are taken either during fall or early spring. Soil samples taken in the fall can assist the grower in identifying potassium deficiencies and make the corrections when there is little other work to do in the vineyard. Soil samples can be collected with a soil probe, spade or shovel. To ensure adequate evaluation of soil fertility, samples should be collected at two depths: 0 to 8 inches and 8 to 16 inches along a Z- or X-shaped pattern within each block, beneath the grapevines in established vineyards. Growers must avoid sampling soil only in the middle or along the edges of the vineyard. Desirable pH, organic matter and element ranges for soil tests are presented in Table 1.

Table 1. Desirable range of pH, organic matter and elements from soil tests.

Chemical properties	Value range
Soil pH	5.5 to 6.8
Organic matter %	2 to 3
Phosphorus (P)	40-50 lbs/A
Potassium (K)	250-300 lbs/A
Magnesium (Mg)	200-250 lbs/A
Zinc (Zn)	8-10 lbs/A
Boron (B)	1.5-2.0 lbs/A

The only nutrients with a valid soil test in Kentucky are Phosphorus (P), potassium (K), Magnesium (Mg), Zinc (Zn) and Boron (B). To identify the deficiencies of other nutrients growers, have submit a petiole sample to a private laboratory. Instructions on how to sample and submit grape petioles are outlined in HortFact 3001 (http://www.uky.edu/Ag/Horticulture/foliar.pdf).

Cation Exchange Capacity (CEC) indicates the ability of the soil's particles to readily hold cations (e.g. H+, Ca++, K+) with the roots of the grapevine. As a rule of thumb, as the soil clay and soil organic matter content increase, there will be more exchange sites. The percent of organic matter and the clay content influence the CEC of vineyard soils and will determine the amount of element available to the plants. The

ranges of CEC depending on the classification of soils are as follows: sand (1 to 5), clay (20 to 30), and organic (30+).

Nitrogen (N)

Nitrogen is usually the most limiting element for grapevine growth and yield. It is customarily applied each growing season at a rate of 50 to 100 lbs of actual nitrogen per acre. Nitrogen applications must be completed around fruit set and not later than *veraison*. Late summer or fall applications of nitrogen are not recommended as they encourage the vines to put on vegetative growth late into the season when in fact they should begin to harden off prior to dormancy. When nitrogen is low in the vineyard, there is reduced shoot growth that leads to reduced canopy fill, reduced light interception (Figure 1), and reduced photosynthetic efficiency and ultimately reduced yields in the current season. When there is excess nitrogen in the vineyard the vines exhibit excessive vegetative growth leading to mutual shading within the grapevine canopy reducing fruit quality in the current season and bud fruitfulness in the upcoming year.

Figure 1. Nitrogen deficiency in 7-year-old 'Chambourcin' vineyard in central Kentucky.

Nitrogen application should be based on the petiole test results. Petiole samples should be taken before *veraison* from the youngest fully expanded leaf opposite the first cluster on a count shoot. The petiole test results should be used to correct the nitrogen fertility in the following season. Nitrogen is deficient in the vineyard if the petiole test is below 0.70%. In this case, 80 to 100 lbs of actual nitrogen per acre needs to be applied in the following season during spring. Nitrogen is below normal if the petiole test is 0.70%

to 0.90%. In this case 60 to 80 lbs of actual nitrogen needs to be applied in the following season during spring. Nitrogen is in the normal range if the petiole test is 1.5% to 2.0%. In this case 40 to 60 lbs of actual nitrogen per acre needs to be applied in the following season in spring. Nitrogen is high in the vineyard if the petiole test is above 2.0%. In this case, a nitrogen application maybe optional in the vineyard depending on cultivar and previous mineral nutritional history of the vineyard.

Growers need to split their nitrogen applications in Kentucky to avoid overstimulating the grapevines in early spring. The recommended amount of fertilizer needs to be applied in two stages: 1) One-half of the recommended amount needs to be applied no later than the 10" to16" growth stage. 2) If there is no damaging late spring frost, the remaining half needs to be applied no later than fruit set. The amount of nitrogen product to apply per vine and the formulas to calculate the amounts in for two commercial formulations of nitrogen fertilizers are presented in Table 2.

Table 2. Annual Nitrogen (product) application rates for grapes based on plant spacing and fertilizer formulation

		Ammonium nitrate		Urea	
Spacing in feet (Vine x Row)	Plants per acre	Pounds of 34-0-0 per plant at 70 lbs of actual N per acre	Grams of 34-0-0 per plant at 70 lbs of actual N per acre	Pounds of 46-0-0 per plant at 70 lbs of actual N per acre	Grams of 46-0-0 per plant at 70 lbs of actual N per acre
6 x 10	726	0.28	129	0.21	95
6 x 12	605	0.34	155	0.25	114
6 x 14	518	0.40	182	0.29	132
7 x 10	622	0.33	150	0.24	109
7 x 12	519	0.40	182	0.29	132
7 x 14	444	0.46	209	0.34	154
8 x 10	546	0.38	173	0.28	127
8 x 12	454	0.45	204	0.33	152
8 x 14	388	0.53	240	0.39	177

Calculating fertilizer amounts:

Example: 70 lbs of actual Nitrogen is recommended per acre to vines that are spaced 7 × 10. You have access to 34 – 0 – 0 fertilizer. There are 622 plants per acre (43560 / (7 × 10)).

Formula I: Pounds of fertilizer material per acre = (Pounds of Nitrogen recommended × 100) / % Nitrogen in fertilizer material.

70 × 100 / 34 = 205 lbs of 34-0-0 needs to be applied to the whole vineyard

To calculate the amount to apply per vine simply divide the resultant of Formula 1 by the number of plants per acre.

Formula II: Pounds of fertilizer material per acre / number of plants per acre 205/622 = 0.33 lbs of 34-0-0 per plant.

Phosphorus (P)
Generally adequate amounts of P are found in the central Bluegrass region, however P is often limiting in other regions of the state. If P is found to be deficient it needs to be corrected during site preparation. The pre-plant applications need to be based on the soil tests and 500 lbs to 1000 lbs per acre of superphosphate needs to be incorporated into the soil. Maintenance applications of P need to be based on petiole analyses. P is deficient if it is below 0.13% in the petiole and 130 to 160 lbs of actual P per acre needs to be applied. P is below normal if it is 0.13 to 0.15% in the petiole and 175 to 280 lbs of actual P needs to be applied. P is normal if it is between 0.16 to 0.30%. In this case no application of P supplying fertilizers is necessary.

Potassium (K)
Grapevines tend to show K deficiency when they are heavily cropped and maintenance applications of K have not been made in the vineyard (Figure 2). In mid- to late summer, leaves may have a bronze color, especially on the west-facing side of the trellis. Some leaves may have dark spots or blotches. Marginal chlorosis, browning, and dying may occur as the deficiency becomes more severe. Other possible symptoms include brown dead spots or areas throughout the leaf. In severe cases, more than half of the leaves on a vine may show these symptoms. Severe potassium deficiency reduces vine vigor, berry size, and crop yield. Symptoms of potassium deficiency generally develop in mid-shoot leaves followed by older basal leaves. Potassium fertilizers include potassium sulfate containing about 50% K_2O; potassium chloride (muriate of potash), containing about 60% K_2O; and potassium nitrate, with 44% K_2O.

Figure 2. Potassium deficiency in young 'Traminnette' leaf in Kentucky.

Potassium compounds tend to be fixed in the soil surface, although less so than phosphate. This fixation, which makes potassium unavailable to plant roots, generally is greater in a clayey soil with pH near 7.0 than in a sandy soil with a pH near 5.0.

Therefore, potash application rates may need to be greater and more frequent on clay than on sandy loam soils, especially if the pH is above 6.5. If foliar sprays are indicated, use a solution containing 6 to 10 pounds of either fertilizer per 100 gallons. Apply at a rate of 200 to 300 gallons per acre of mature vineyard. Foliage applications are of primary value, but they provide only a temporary solution to a potassium problem. Soil applications have a more lasting effect. Make one or more applications as soon as the need is determined. Avoid excessive rates of potash, which can lead to magnesium deficiencies in the vineyard and high pH must and wine. Potassium is deficient if the petiole test is below 0.5 to 1.0%. In this case 500 lbs of sulfate or muriate of potash needs to be applied per acre. Potassium is below normal if the petiole test is 1.1 to 1.4%. In this case 400 lbs of sulfate or muriate of potash needs to be applied per acre. Potassium levels are normal if the petiole test is 1.5 to 2.5%. In this case, potassium application can be optional but a maintenance application of 200 lbs of muriate of potash is recommended.

Kentucky Eden Shale soils in the northern portion of the state are an exceptional case for potassium application. These soils tie up potassium very tightly. Consequently, soil application rates of potassium are doubled.

Magnesium (Mg)

Magnesium tends to be deficient in vineyards if the soil pH is too low or excess applications of potash have been made. Symptoms of Mg deficiency tend to develop first on older leaves. Deficiency symptoms include yellowing that appears between the veins of the leaves while the veins remain green (Figure 3). As the vine becomes more severely affected, the interveinal chlorosis intensifies in older leaves and spreads to younger leaves toward the ends of the shoots.

Magnesium is deficient if the petiole test is below 0.14%. If soil pH is below 6.5 then dolomitic limestone application at the recommended rates can fix the problem. If the soil pH is within the normal range for the cultivar 300 to 400 lbs/acre of magnesium sulfate application to the soil, or 10 lbs/acre of foliar spray of magnesium sulfate is recommended. Magnesium is below normal if petiole test is 0.15 to 0.25%. In this case, if the soil pH is below 6.5 then dolomitic limestone application at the recommended rates can fix the problem. Or, application of magnesium sulfate to the soil at a rate of 200 to 300 lbs/acre or a foliar application of 10 lbs/acre is recommended. Magnesium in the vineyard is at normal levels if the petiole test is 0.26 to 0.45%. Application of Magnesium fertilizers is not required.

Figure 3. Magnesium deficiency in a Kentucky vineyard.