

Nutrient Management in Idaho Grape Production

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Most of the information currently available on the nutrient requirements of grapes relates to vineyards in California and Europe and does not apply to Idaho soil types and environmental conditions. This publication answers common questions posed by Idaho vine grape growers regarding soils and nutrients.

What soils are best for grapes?

The best grape soils are deep, well-drained loams, free from high concentrations of alkali, boron, or other toxic materials. Deeper soils produce the heaviest crops and are preferred for raisins, common wine grapes, and some varieties of table grapes. However, grapes are adapted to a wide variety of soil types and can be grown successfully on soils not suitable for many other crops.

What nutrients do grapes need?

Grape vines are less exacting than most other horticultural crops with respect to nutrient needs, and economical responses to fertilizers in vineyards have been limited. However, in some instances, deficiencies of nitrogen (N), potassium (K), zinc (Zn), boron (B), and iron (Fe) have been found that can be corrected by application of fertilizers.

Nitrogen

Nitrogen is critical for flower differentiation, rapid shoot growth, bud vigor, and fruit set. The complex physiology of nitrogen uptake and utilization has important implications for nitrogen

management in vineyards. Between bud break and bloom, grapes draw on stored reserves of nitrogen that were taken up during the previous season. Substantial N uptake from the soil begins at the 5- to 6-leaf stage. From bloom to veraison (color change or ripening), nitrogen is taken up from the soil and is largely partitioned to leaves and fruit. After veraison, N uptake continues through leaf fall. The fruit is a strong nitrogen sink, but as harvest approaches much nitrogen is obtained from other tissues. Late season N is increasingly partitioned to the roots. In seasons where there is a relatively long time between harvest and leaf fall, substantial amounts of post-harvest nitrogen uptake occurs, which is largely allocated to root reserves.

Symptoms of N deficiency include leaf yellowing (which shows up first on lower leaves), reduction of vegetative growth, and pink color in petioles, young shoots, and cluster stems. Berries on nitrogen-deficient vines mature early and fail to reach normal size.

Potassium

Potassium is responsible for energy transfer and storage. Adequate K improves cold-weather tolerance and fruit color. Potassium deficiency in grapes is not common, but when it does occur, it is manifested by leaf color fading beginning at leaf margins, marginal leaf burning, downward curling of leaf edges, premature leaf fall on vines carrying a heavy crop, and failure of fruit to ripen. Tight clusters of small, unevenly ripened berries may occur on vines with advanced potassium deficiency.

Deficiencies can usually be corrected with potassium sulfate applied as close to the root zone as possible. The greatest plant need for K is during fruit enlargement.

Excess K is a problem in the wine grape industry, since K is correlated with organic acids in the juice that reduce wine quality. The challenge of K management in wine grapes is to meet plant needs while avoiding the accumulation of high K concentrations in juice.

Zinc

Zinc is essential for uniform fruit maturity and seed formation. Deficiencies are occasionally encountered in vineyards, especially on sandy soils and where vines have been grafted onto nematode-resistant rootstocks. Deficiency symptoms include early appearing leaf chlorosis, widened petiole sinus, poor fruit set and berry development, and straggly clusters (some varieties). These symptoms show up in early summer as secondary shoot growth begins. Zinc has poor mobility in the plant and is hard to get into non-transpiring tissues such as reproductive structures. Since zinc remains in the leaf where it was applied, it is lost during leaf fall.

Boron

Boron aids the differentiation of meristematic cells. Grapes have a higher boron requirement than most other perennial deciduous fruit crops. Boron deficiency, the most common nutrient deficiency of grapes in the Northwest, is difficult to manage because of its complex physiology. Boron is required for flowering and fruit set. Localized deficiencies in reproductive structures may occur even when B content of the whole plant is sufficient. This occurs because the flower clusters are non-transpiring structures that are not easily supplied with B via the xylem. Boron management is further complicated by the fact that B can be toxic if excessive amounts are applied to correct a deficiency.

Boric acid can be applied based on accurate soil analyses for boron level. Deficiencies are most common in acid to slightly acid soils with high rainfall, and sandy soils irrigated with low-boron water. Deficiency symptoms include early apical expression, reduced fruit set caused by prevention of normal pollen development, and fruit set with a high proportion of shot berries that fail to elongate properly. In contrast, plants with zinc deficiency produce smaller berries of normal shape.

Iron

Iron is required for chlorophyll formation and aids in energy transfer in respiration. Iron-deficiency problems in high lime (CaCO_3) soils occur early and affect the entire apical region (new growth) with white interveinal chlorosis. To avoid this problem, use lime-tolerant rootstocks and fertilize with iron. Soil and foliar iron treatments often provide only a temporary and partial solution.

Soil mapping and testing

Since grapevines have lower nutrient needs than other crops, large amounts of fertilizer are usually not needed, and nutrient additions should be made with care. The starting point for a nutrient management program for grapes is the mapping of soils in the vineyard. County soil survey maps may be useful in providing general information about soil types on a site, but aside from a soil classification map, a detailed map should be prepared describing variations in soil texture, depth, drainage, water-holding capacity, and slope. You can create detailed maps by analyzing soil textures at different depths (1st foot, 2nd foot, and 3rd foot) and by referring to the NRCS soil texture and water-holding capacity chart.

After the mapping process is finished and before planting, soil samples should be taken to determine the nutrient-supplying ability of the soil and to identify potential soil problems. Different soils identified during the mapping process should be sampled separately. A recommended sampling procedure is to take a composite sample of 20-30 locations within each 5-acre block. Samples should be taken at the 1-, 2- and 3-foot depths. Care should be taken to mix subsamples well and to distribute the sample locations throughout the block. A soil analysis is only as good as the initial sample. The sample should receive a complete analysis, including macronutrients, micronutrients, pH, organic matter, soluble salts, base saturation, and cation-exchange capacity.

Soil and tissue samples should be taken again during the season to develop a database to evaluate the fertilizer program. Soil samples in an established vineyard can be taken annually or at 2- to 3-year intervals at 0-18 inches. Irrigation water should also be tested to identify possible toxicity problems and nutrients that are

present in the water source. The test should include pH, soluble salts, nitrates, potassium, and boron.

Tissue testing

Tissue testing is a valuable method for determining the nutrient status of plant tissue so that nutrient management decisions can be made. Tissue analysis is especially useful in deep-rooted perennial crops such as grapes, because soil samples of the entire root zone are difficult to collect and interpret. Also, plants accumulate and store nutrients at much higher concentrations than are found in soil. Often there is a very poor correlation between soil analyses and plant performance.

Tissue analysis includes diagnosis of poor crop growth, evaluation of fertilizer applications, management of crop quality, and diagnosis of multiple nutrient deficiencies. Tissue testing allows the grower to fine-tune the nutrient management program by establishing a database that serves as the basis for nutrient management decisions. Petiole samples taken at full bloom are useful for managing the current season growth, while samples taken at veraison are useful for follow-up or managing vine reserves.

In situations where more than one element is deficient, diagnosis by visual symptoms is difficult and petiole analysis provides the most accurate way to diagnose the problem. Results from petiole analysis will only be as good as the sample, and guidelines for petiole sampling in grapes are as follows:

- (1) take a separate sample of each variety and age;
- (2) do petiole sampling annually;
- (3) when doing diagnosis of the problem areas, do a paired comparison with separate samples from the problem area and a normal area for the same variety;
- (4) take petioles from leaves opposite the bottom flower clusters during full bloom, and from the second fully expanded leaf for samples taken at veraison;
- (5) take one petiole from each plant, and collect enough petioles to provide 30 grams dry matter (100-300 petioles);
- (6) discard the leaf blade;

- (7) avoid rows where the leaf surfaces may be contaminated, such as those on the outside and those sprayed with fertilizer; and
- (8) label each sample to identify the sampled area, and provide information that will help in sample interpretation, such as variety, age of plants, and relevant management factors.

Vineyard fertilization

Vineyard fertilization must be done in a systematic way, and large applications done with a “shotgun” approach should be avoided. The overall goal should be to supply the plant’s nutrient needs by correcting initial deficiencies and replacing nutrients removed from the soil by the crop. This can be done by knowing the yield from each block, soil tests from each block, and by observing the vines to ascertain their reaction to fertilizer from the previous season.

Nitrogen

In most vineyards, small applications of nitrogen (0-30 lb N/acre/year) are advisable, with amounts and timing dictated by N status of the soil, vine vigor, and yield goals. In vineyards with excessive vigor the grower may apply no N or may make small applications after veraison to ensure adequate storage reserves for the next season.

A new approach being investigated is to use foliar urea applied post-harvest to build N reserves in next year’s buds. For vines with adequate vigor, small N applications from veraison to harvest will load the plant with reserve N. In vineyards with low vigor the same amount of N should be applied in a split application, with the first application close to bloom and the second after harvest.

Phosphorus

Phosphorus deficiency in grapes is not common, but if deficiency is indicated by a petiole and soil test, it can be corrected by a banded application of a P fertilizer, or by applying compost with electrical conductivity (EC) of less than 4 mmho/cm, and a carbon/nitrogen ratio (C/N) of 20 to 1 or less. It is advisable to add no more than 2 tons of compost per acre unless there is a strong need for reclamation of the soil. In calcareous soils with high pH, it is very important to evaluate P level in soil and petiole and P mobility in the vine.

Zinc

Several methods have been developed to correct zinc deficiencies in grapes, and each is best adapted to certain viticulture situations.

“Daubing” is the application of a zinc sulfate solution to pruning cuts. Daubing should only be done on spur-pruned varieties. Cane-pruned varieties do not respond well to daubing because of the smaller number of cut surfaces and the lack of zinc mobility in the canes. Zinc uptake will be best if pruning is done on fully dormant vines. Use 1 pound of zinc sulfate per gallon of water—higher concentrations may damage the spurs. Two to 4 four gallons of this solution per acre should be adequate. Swab the zinc sulfate solution on cut surfaces with a stick padded on one end with an absorbent material. Daubing should be done the same day as pruning, and preferably within 3-4 hours. Daubing should be avoided when the upper 3 feet of soil has not been rewetted with winter rains or irrigation, and during prolonged periods of inclement weather including cold spells and cold, dry winds. These conditions may cause the vines to absorb zinc in toxic quantities.

Foliar zinc sprays are commonly used on cane-pruned varieties. In spur-pruned varieties, foliar sprays may be used instead of daubing for mild deficiencies, or in addition to daubing in severe cases. Best responses in terms of improved berry set have been observed from applications made from 2 weeks prior to bloom to full bloom. The spray should be directed toward the flower clusters and undersides of the leaves.

Foliar sprays can be made with zinc sulfate or zinc chelates. Zinc chelates are not as effective as zinc sulfates when compared on a cost per acre basis, but may be preferred because they are fully soluble. This is especially important when concentrated solutions for low-volume applications are being prepared.

A zinc sulfate solution for foliar application should include 4 pounds zinc sulfate and 3 pounds spray lime per 100 gallons of water. Spray lime prevents foliage burn. Research has shown that high-volume application of 100-150 gallons per acre results in better absorption than a low-volume application of 20-39 gallons per acre. The addition of other nutrients has not improved the effectiveness of zinc sprays, and growers should be cautioned against reducing an optimum quantity of zinc to include other elements that are not deficient.

Several other methods of zinc application have been investigated, but none was shown to be as effective as the methods described above. These other methods include direct injection into vine trunks, addition of zinc sulfate powder to dusting sulfur, dormant season sprays, and driving zinc points into vine trunks. Post-harvest foliar applications are not useful since zinc is not translocated out of the leaves.

Manure

Manure can be an integral part of a nutrient management program for grapes if the grower understands its benefits and limitations. Although manure is a source of phosphorus and potassium, its principal use as a fertilizer is as a source of nitrogen. Manure serves as a slow-release form of N because most of the N is present in organic compounds. As N-containing organic compounds are metabolized by soil organisms, inorganic N is released that can be used by the vine. About 50% of manure N is available the first year, and smaller percentages are released in the following years. However, this varies with the source and N content. For example, the rate of mineralization is faster with high-N poultry manure than lower-N dairy manure.

In addition to its benefit as a nutrient source, manure is a source of organic matter that improves soil physical properties. Manuring is especially useful on cut areas from land leveling, where soil fertility is low due to loss of topsoil during the leveling operation.

Disadvantages of manuring include weeds, salts, and induced zinc deficiency. Manure commonly contains 4-5% soluble salts on a dry-weight basis. In most vineyards, irrigation and rainwater are sufficient to prevent accumulation of damaging quantities of salt. Problems may occur on poorly drained soils and where high rates of manure have been applied near young vines. Induced zinc deficiency occurs where zinc fixation occurs following the application of high rates of manure, especially on sandy soils. This is usually not a problem with normal rates.

Composted manure has several advantages over raw manure. The heat released in the composting process kills weed seeds and pathogens, and composting produces humic substances that improve the physical properties of soil in addition to providing nutrients. Good quality compost should have a carbon to nitrogen ratio of 20:1 or less, and a soluble salt reading of less than 4 mmho/cm.

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