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Micronutrients for Grapevines

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Zinc and boron deficiencies are the most widespread micronutrient problems in California vineyards and thus have received the most attention in developing correction measures. Iron and manganese deficiencies are much less common and recommendations for their corrections are largely derived from experience in other viticultural areas and on other crops.

ZINC

Zinc deficiency is largely found in calcareous soils, sandy soils of low zinc content, and sites where corrals and poultry yards were located. Vines grafted onto the nematode resistant rootstocks with *Vitis champini* parentage -Dogridge, Ramsey (Salt Creek), Freedom, and Harmony - are also more susceptible. Correction is mostly accomplished by foliar sprays of zinc. Soil applications of zinc have not been very successful or economical as very high rates are required because of soil fixation of zinc. They are only recommended in localized, severely deficient areas where foliar sprays are not entirely satisfactory. Fairly successful soil-applied zinc rates are shown in Table 1. Generally, the best success with these recommended rates has been with young vines on sandy-textured soils. Also, concentrating the material at individual vines in hand-applied bands should improve success. These recommendations are based on furrow irrigation practices.

Table 1. Soil Application Rates for Vineyards

	Young vines (1-3 years)	Mature Vines (4+ years)
Zinc sulfate (36% Zn) injected or trenched to 6-10" depth	1 lb./vine	1½-3 lbs./vine
Zinc chelate, EDTA (14% Zn) banded in furrows near vine row and irrigated in	2-3 oz./vine	3-4½ ozs./vine

Soil application under drip irrigation would be expected to be more effective. It provides concentrated placement with more continuous wetting for zinc movement into the root zone. For example, in a drip trial good correction was demonstrated with rates of liquid zinc sulfate (12% Zn) at 4 to 9 oz. per vine and liquid zinc EDTA chelate (6.5% Zn) at .25 to 1.8 oz. per vine. The highest vine tissue (petioles) levels were achieved with zinc sulfate treatments. However, a foliar spray treatment in this moderately deficient trial vineyard was equal to the best drip soil treatments and would be considered the most economical treatment.

Considerable work has been conducted to find the most effective and economical foliar zinc spray methods for California vineyards. Many zinc compounds and products have been evaluated over the years including chelates and combinations with other nutrients. These studies have always shown the neutral zinc products containing 50-52% Zn to be the most effective on a label rate per acre basis. Most recently we evaluated zinc oxide (75-80% Zn) and found it to be equally effective to neutral zinc on an elemental zinc per acre basis. The success of neutral zinc and zinc oxide is probably due to the higher recommended rates per acre and higher zinc contents of these products as compared to many other products. Rates of 4-5 lbs/acre and 2-3 lbs/acre of neutral zinc and zinc oxide, respectively, or top label rates are commonly used where zinc deficiency is apparent.

Concentrate application with low water volume (20-30 gals/acre) has been compared to dilute application (100-150 gals/acre). The full-wetting dilute spray was found to be more effective with either neutral zinc or chelated zinc. However, a fully soluble zinc product such as a chelate may be preferred in concentrate application. Neutral zinc and zinc oxide are not very soluble and require good agitation and occasional flushing of sprayer lines because of possible settling of the material.

Spray timing studies have shown the period of 2 weeks prior to bloom up to bloom (60-70% caps off) to be the most effective in improving fruit set. Fall application as is practiced in some tree crops has shown very limited benefit in grapes. Daytime and nighttime applications are equally effective in grapes.

BORON

Boron deficiency is very geographical in occurrence, depending on rainfall, parent soil material, and its presence in irrigation water. Two forms of boron deficiency have been described in the literature -early season, temporary deficiency and spring to midsummer deficiency.

Early season, temporary boron deficiency appears during early shoot development and is usually outgrown by bloom. It is associated with droughty soil conditions in the fall and early winter and is now thought to be a droughtinduced disorder or deficiency. Symptom development has been prevented with B applications to the soil in the previous year or foliar sprays in the preceding season, including fall sprays. Symptom development can also be influenced by time and method of pruning, with late pruned and cane pruned vines being less affected.

The other type of boron deficiency occurs after the bud break period but usually before bloom and continuing through fruit set and up to midsummer. Thus, it has distinct effects on fruit set and berry development.

Boron is the least costly and easiest micronutrient deficiency to correct. Small vineyards can be treated by hand by sprinkling a boron fertilizer onto the soil at 25 to 30 lbs/acre (materials containing 11-15% B) or 20 lbs/acre (~20% B). This can be measured out in fractions of an ounce (1/2 to 1 oz., depending on material boron content and vine spacing) for application around each vine.

Boron is conveniently applied with solid or banded herbicide sprays by merely adding the correct amount of a soluble boron product to a calibrated herbicide sprayer. This can be done every 2 or 3 years with higher rates or annually with a lower rate. The longevity of these soil treatments depends on soil type and rainfall and should be monitored with leaf analysis.

Foliar sprays 2 to 3 lbs. per acre of a soluble boron product are also effective. Boron is also toxic at fairly low concentrations. Thus, recommended rates should never be exceeded and levels should be monitored with leaf analysis.

IRON

This is commonly referred to as iron chlorosis because of the striking chlorotic foliage symptoms it can produce. It is most commonly found in calcareous soils and can also be induced by cold, wet soils in the spring when the symptoms are usually temporary. Cultivars and rootstocks vary in their susceptibility to iron chlorosis, especially in calcareous soils. Thus, cultivar and rootstock selection can be used to avoid problems.

Correction is difficult and can be expensive. Foliar sprays with ferrous sulfate or iron chelate are only partially effective and must be repeated. Soil applications through a drip irrigation system have been effective but may also require expensive repeated applications in severe cases.

MANGANESE

This would appear to be a rare deficiency in Oregon. We mostly see it in sandy, calcareous or high pH soils with the Salvador cultivar. It is corrected with foliar sprays at 2-3 lbs/acre manganese sulfate.

LABORATORY DIAGNOSIS

Leaf petiole analysis can be effectively used to verify micronutrient deficiencies except for iron. Levels of iron in the leaves cannot be correlated with the presence of symptoms. It is the lack of **available** iron in the plant rather than the **total** amount that influences symptoms. Also, contamination of the samples from other iron sources is a common problem.

Critical levels have been established for most of the other micronutrients with cultivar differences being fairly minor. Samples are usually taken at bloom but should be timed to avoid contamination with foliar nutrient sprays.

TABLE 2: Symptoms of Micronutrient Deficiencies in Grapes

Nutrient	Fruit-berries	Shoots	Leaves
Zinc	Mostly a shot-berry effect with a range of small, green berries, intermediate size delayed-ripening berries, and some normal size and normal ripening berries.	Increased stunting (shorter internodes) with increased severity.	Smaller leaves with widened petiole sinuses (where petiole is attached to blade). The leaves on lateral shoots can be particularly small. Interveinal chlorosis of a pale, faded green color. Leaf veins will also be clear with a narrow band of darker green along their edges.
Boron	Drought-induced: small inflorescences, many of which dry up on the stunted shoots. Some small, round shot berries may appear after bloom along with normal berries.	Severely stunted and dwarfed after bud break with zig-zag growth and more profuse lateral development at the nodes. The early symptoms are usually outgrown by bloom.	Small, misshapened, cupped, wrinkled, and sometimes missing lobes, depending on cultivar.
	Spring, bloom: In severe cases some inflorescences will not set any berries and will dry up at bloom. Shot berries may persist in varying degrees and will all be of a similar size and shape (very round to pumpkin shape). They also ripen uniformly along with the normal berries in contrast to those with zinc deficiency.	The first growth is normal. As the deficiency develops prior to and during bloom internodes become shorter, shoot tips will die, and lateral growth may increase. Corky, swollen areas may develop in the internodes of severely affected shoots.	Yellow interveinal chlorosis, more often at the margin or in patches and often associated with some necrosis. Foliage symptoms usually do continue after mid-summer.
Iron	In severe cases the inflorescences themselves can be chlorotic and have reduced fruit set. No distinct effects are noted in mild cases of deficiency.	Can be chlorotic in severe cases. Overall growth is less or stunted depending on severity.	Distinct interveinal chlorosis of straw-yellow color with the veins themselves remaining green. Necrosis can occur in severe chlorosis.
Manganese	No distinct effects; not symptomatic.	Reduced growth in severe cases. Otherwise not symptomatic.	Chlorosis is a pale, faded green color developing between the primary and secondary veins in a herringbone shape. Basal leaves are affected first, usually past mid-summer.

