University of California Cooperative Extension • Tulare County

Grape Notes

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Mild Magnesium Deficiency Widespread This Year

Bill Peacock

Mild symptoms of magnesium (Mg) deficiency are common in vineyards this year. Mild symptoms (limited to a few basal leaves) have no effect on yield or vine growth and correction is not economically justified. Don't worry about it. However, correction may be necessary when 20% or more of the vine's leaf area is chlorotic, and this occurs over a significant area of the vineyard, persisting year after year. Magnesium deficiency can often be attributed to underlying problems such as soil chemistry, water quality, and fertilizer and amendment practices. Severe deficiency should be corrected by fertilization along with addressing the associated causes.

Symptoms

Magnesium is the centerpiece of the chlorophyll molecule and is required to maintain green leaves high in chlorophyll content. Magnesium is mobile within the plant and moves from older to younger tissue. When deficient, the basal, older leaves show the first signs of chlorosis. With mild deficiency only a few base leaves are affected, but leaves along the entire length of the shoot can be chlorotic with severe deficiency, see Photos 1, 2 and 3.

Chlorotic leaf symptoms first appear in May or June, and by late summer, these symptoms can be quite distinctive. The chlorosis is a general yellowing at the leaf edges, progressing between the primary and secondary veins. This chlorosis may become almost creamy white in color. The primary and secondary veins and surrounding tissue of the leaf remain green creating a "Christmas tree pattern".

Magnesium symptoms are sometimes confused with potassium (K) deficiency, since both are apparent in summer and fall. They are easily distinguished. Rather than the "Christmas tree pattern" as with magnesium, K deficient leaves produce a blotchier or irregular pattern of chlorosis, and leaves are often curled or cupped, some see Photos 4, 5.

In the southern San Joaquin Valley, magnesium deficiency symptoms are nearly always mild with only a few basal leaves showing symptoms by late summer. These basal leaves are shaded during summer, adding little to the vine's overall photosynthetic capacity, and yellowing of these leaves is not a great loss.

Symptoms are problematic when 20% or more of the vine's leaf canopy is chlorotic. This does represent a significant loss of photosynthetic capacity and correction may be necessary to maximize vine growth and yields.

Young grapevines are more susceptible until their root systems penetrate subsoil higher in magnesium. Magnesium deficiency also is more common in some grape varieties, including Thompson Seedless, Ruby Seedless, Redglobe and Grenache.

Soil Availability and Uptake

Soil magnesium is a moderately leachable nutrient and, as with calcium, greater amounts are in the subsoil than in upper parts of the soil profile, especially on older, highly weathered soils. In Tulare County, magnesium deficiency is more prevalent with vineyards planted on hardpan soils (old alluvium terraces) that are highly leached and weathered. These hardpan

soils (alfisols) include the Exeter, San Joaquin, Traver, and Madera soil series. Chemical analysis show low levels of magnesium and calcium in the upper portion of the profile where most of the root activity occurs and more concentrated concentration of calcium and magnesium deeper in the soil profile where roots are less active. Under irrigated agriculture, leaching and loss from crop removal seems to have further decreased the calcium and magnesium levels in the upper layers of these soils.

High levels of exchangeable potassium or ammonium can interfere with magnesium uptake by crops. Citrus growers have found that high rates of manure applied annually can induce magnesium deficiency on low magnesium soils, probably by increasing levels of potassium and ammonium relative to magnesium in the upper portion of the soil profile. In addition, high sodium in the soil profile can lead to magnesium deficiency problems.

A laboratory easily measures the magnesium concentration of soils, but it has been difficult to come up with critical levels. It is very difficult to accurately account for subsoil magnesium supply that may be available to the vine.

Exchangeable magnesium normally constitutes from 4% to 20% of the cation exchange capacity (C.E.C.) of the soil. The general consensus is that deficiency is likely when the magnesium saturation of the C.E.C. is less than 5%, or when the total exchangeable magnesium concentration drops below 25 milligrams (mg) of magnesium per kilogram (kg) of soil (25 mg kg^{1}). In addition, exchangeable magnesium should be two to three times as high as exchangeable potassium.

Tissue Analysis

Suspected magnesium deficiency symptoms can be verified by laboratory tissue analysis. The symptoms may be easily confused with those of potassium deficiency. In California vineyards, magnesium concentration in petioles usually increases as the growing season progresses. The critical levels shown below are for samples collected at bloom; these critical levels become less reliable when leaf petioles are collected later in the season.

Critical Levels in Leaf Petioles at Bloom	Total Magnesium (%)
Deficient	less than 0.2
Questionable	0.2 - 0.3
Adequate	over 0.3

Correction of Underlying Causes

Most of our southern San Joaquin Valley soils are alkaline in reaction, but in recent years, many soils have become acidic. This change in soil reaction has occurred after years of irrigation and fertilization. Acid soil conditions can lead to magnesium deficiency. This is corrected by applying and incorporating lime into the soil, thus neutralizing the acid and adding calcium and magnesium to the base exchange.

A laboratory analysis of the soil will indicate the lime requirement. Generally, it takes 2 to 5 tons per acre depending on soil texture, depth of correction, and initial soil pH. The soil pH should be 5.5 or higher to avoid magnesium deficiency and other problems associated with acidic soil.

Dolomite is the best choice as a liming material where there is both a potential magnesium deficiency and a soil acidic problem. It contains magnesium and calcium carbonate, which neutralize soil acidity while adding magnesium to the base exchange.

During drought years, sodium concentration increases in some vineyards (the result of less leaching and the necessity to use poor quality irrigation water). Reducing sodium concentration in the soil profile can help reduce or correct magnesium deficiency. Sodium reclamation requires the addition of a suitable amendment, which a laboratory analysis can determine, and then sufficient leaching to remove the sodium from the root zone.

Fertilizing Soil

The treatment of magnesium deficiency is probably not economical in most San Joaquin Valley vineyards. Usually correcting the underlying problems discussed above solves the problem. When a severe deficiency persists (more than 20% of the leaf canopy chlorotic) then fertilization may be necessary.

When furrow irrigating, magnesium is applied at 2 to 4 pounds of magnesium sulfate (Epsom salts) per vine placed in a deep furrow close to the vine. This would equal about 1000 to 2000 pounds of magnesium sulfate per acre, which is an expensive treatment. The vine response is usually slow, taking two years for correction, but the treatment is effective for up to eight years. Usually, a portion of the vineyard is severely deficient and only that portion requires fertilization.

We speculate that with a drip irrigation system, less magnesium fertilizer would be necessary to correct a deficiency than would be required with furrow irrigation. This is based on comparative research with potassium and other nutrients. We suggest that 0.5 to 1 pound of magnesium sulfate per vine (about 250 to 500 pounds per acre) would successfully correct a severe deficiency. Magnesium sulfate is injected into the drip system or, when only a small portion of vineyard requires treatment, it is applied by hand directly beneath each dripper. Magnesium sulfate is very soluble in water which is helpful when making solutions and injecting material into a drip system.

Foliar Treatment

Foliar sprays can be used for more immediate correction, although treatment will have to be repeated every year. Apply one or more foliar sprays using 4 pounds magnesium sulfate per 100 gallons water. Higher concentrations can cause leaf burn. Treatments should occur in the spring using 150 to 250 gallons per acre. Magnesium chelate and commercial foliar sprays containing magnesium are also available. These materials are convenient to apply, and should be used following label recommendations. However, they are lower in magnesium content and are more expensive.

Closing Remarks

Mild magnesium deficiency has been evident in vineyards the past few years. Growers have noticed chlorosis of the basal leaves and questioned the seriousness of the symptoms. Research suggests that a mild deficiency does not affect vine growth or yield, and correction is not necessary. However, in rare cases, severe deficiency occurs which requires correction. Usually, there is an underlying soil condition creating the problem such as soil that has become very acidic or sodic, or high potassium or ammonium concentrations relative to magnesium in the surface of the soil profile. If magnesium fertilization is required, apply to the soil, through drip irrigation, or by foliar sprays.

Photo 1. Magnesium deficiency first appears in May or June on base leaves. (Ruby Seedless). Note “Christmas tree pattern”.

Photo 2. Magnesium correction is necessary when 20% or more of the vines’ leaf is chlorolic and persists year after year.

Photo 3. Severe magnesium deficiency – Thompson Seedless.

Photo 4. Potassium deficiency. (Thompson Seedless). Note blotchy, irregular pattern of chlorosis, and leaves are often curled.

Photo 5. Sever potassium deficiency - Chardonnay grafted onto Ugni blanc.

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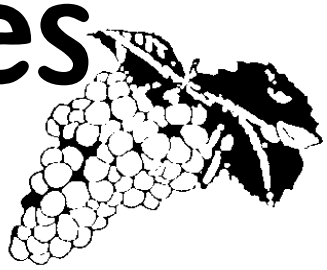

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