viti-notes
[grapevine nutrition]

Research to Practice

Trace elements

Viti-note Summary:

- Boron
- Copper
- Iron
- Zinc
- Molybdenum

Figure 1. Boron deficiency of Merlot causing zigsagged shoot growth and leaf cupping. Photo courtesy of Mardi L. Longbottom

Trace elements are nutrients required in low concentrations. They play varied roles in grapevine function but are important for healthy growth and yield. The trace elements include copper (Cu), zinc (Zn), manganese (Mn), iron (Fe), boron (B), and molybdenum (Mo). They have limited mobility within the vine.

Confirmation of a trace element deficiency or toxicity should be made with petiole analysis (see viti-note Petiole Analysis). Deficiencies can be corrected effectively via foliar sprays during the growing season.

Boron

The role of boron in grapevine function

Boron plays a role in the internal regulation of growth by plant hormones, pollen tube growth, sugar translocation and metabolism. Boron deficiency can potentially reduce crop yields because of poor fruit set. High levels of boron can cause phytotoxicity.

Mobility within the vine

Boron is phloem immobile, therefore under conditions of boron deficiency, stored boron cannot be mobilised by the vine to growing tips.

Symptoms of boron deficiency and toxicity

Boron deficiency

Deficiency symptoms may appear in early spring after dry winters (Figure 1). These symptoms include:

- Death of the shoot tip;
- Yellowing between the veins of recently matured leaves;
- Leaves with short, thick petioles;
- Rapidly expanding leaves may cup upwards and small areas between the veins become translucent;
- Shoots may have a zigzag appearance;
- Poor fruitset or berry formation;
- A high proportion of seedless berries which may be flattened.

In severe cases of boron deficiency:

- Longitudinal cracks develop along the canes;
- Tendrils may be necrotic;
- Dark, knobbly tendrils which may become necrotic.

Other topics in this Viti-Notes series include:

- Nitrogen fertilisation
- Phosphorus fertilisation
- Potassium fertilisation
- Petiole analysis
- Soil acidification
- Liming
- *Trace Elements*

Boron toxicity

Boron toxicity shows up first as a concave or convex cupping of the leaves near the shoot tip. This is followed by development of brown necrotic spots near the margins of leaves at the base of the shoot; the severity increases with time. Yellow streaks can appear between the veins of younger leaves. In severe cases, apical shoot growth is inhibited and shoots produce many lateral shoots (Figure 2).

Figure 2. Symptoms of boron toxicity including leaf cupping and leaves with burnt margins. Photo courtesy of Mardi L. Longbottom.

Copper

The role of copper in grapevine function

Copper plays an important role in, or is a component of:

- The enzymes of oxidation;
- Chlorophyll synthesis;
- The formation of lignin during cane ripening.

Mobility within the vine

Copper is relatively immobile within grapevines except in cases of severe deficiency.

Copper deficiency and toxicity

Copper deficiency has been recorded at Gingin and in the coastal and Margaret River districts of WA. Potential exists for deficiency to occur on leached sands elsewhere in Australia, and on alkaline soils such as in the Mallee of SA, Victoria and New South Wales.

Symptoms of copper deficiency include:

- Poor vine growth and yield;
- Short canes with shortened internodes;
- Small pale coloured leaves with only slight indentations (Figure 3).

Copper deficiency is most likely to be seen in young vineyards which have not yet received copper sprays in their disease management program.

There are no direct effects of copper deficiency or excess reported on wine quality, however copper contamination of must is undesirable, i.e. >20mg/L can exacerbate the risk of wine oxidation. These levels are rarely seen.

Figure 3 Symptoms of copper deficiency

Iron

The role of iron in grapevine function

Iron is an essential component of a number of proteins and enzymes and plays an important role in chlorophyll formation, photosynthesis and respiration.

Mobility within the vine

Iron is immobile within the vine causing deficiency symptoms in young leaves first.

Symptoms of iron deficiency

Iron deficiency results in:

- Diffuse yellowing of young leaves and new growth. In severe cases, total shoot chlorosis can give tissue a bleached appearance (Figure 3);
- When deficiency is not severe veins retain their green colour.

Severe iron deficiencies can result in reduced yield.

Iron deficiency is sometimes referred to as iron chlorosis or lime-induced chlorosis and is typically seen in soils with relatively high lime (Ca) content. In waterlogged soils, symptoms of iron deficiency often disappear if irrigation is withheld. Vines and weeds may be able to gradually reduce the quantity of water in the root zone and improve aeration.

Figure 4. Iron deficiency symptoms on grapevine leaves. Photo courtesy of Scholefield Robinson.

'Looks like'

Iron deficiency can be confused with manganese deficiency, however, iron deficiency always appears on the youngest leaves first, whereas manganese deficiency first occurs on older leaves. Symptoms similar to iron deficiency can also be caused by excessive uptake of the herbicide simazine.

Manganese

The role of manganese in grapevine function

Manganese plays an important role in chlorophyll synthesis and is an enzyme co-factor for metabolic reactions.

Mobility within the vine

Manganese is relatively immobile within grapevines.

Symptoms of manganese deficiency and toxicity

Manganese deficiency

Symptoms of mild manganese deficiency are often seen in vineyards in the Mallee areas of Australia (calcareous soils) and in some high rainfall areas. Symptoms are first seen on the older leaves as chlorosis in broad bands between the main veins (Figure 5). If the deficiency is severe, younger leaves may also be affected. Symptoms may be more severe on sun-exposed leaves. Severe manganese deficiency can affect vegetative and reproductive growth and may delay berry development.

Figure 5. Symptoms of manganese deficiency

'Looks like'

Manganese deficiency symptoms can be confused with those caused by zinc, magnesium or iron deficiency; however, symptoms of these deficiencies tend to appear on younger leaves first.

Manganese toxicity

The symptoms of manganese toxicity in grapevines have not been described. In other plant species necrotic spots appear on the older leaves, with chlorotic mottling near leaf tips and along margins. Brown spots or lesions occur on veins, petioles and stems.

Zinc

The role of zinc in grapevine function

Zinc is involved in the synthesis of plant growth substances (phytohormones), is a catalyst involved in cell metabolic reactions and plays a role in pollination and fruitset.

Mobility within the vine

Zinc is immobile in the plant so deficiency symptoms occur first on young leaves.

Zinc deficiency

Zinc deficiency is common in Australian viticulture. Symptoms may only occur once the deficiency is severe and include:

- Mottling of young leaves which, in severe cases, become necrotic;
- Widening of the petiolar sinus and sharp teeth giving leaves atypical shape;
- Stunted shoot growth which may show a zigzag growth pattern (Figure 6).

'Looks like'

Zinc deficiency may be confused with damage caused by phenoxy acid (2-4 D) and glyphosate herbicides. However, neither symptom is quite the same as that of zinc deficiency.

Figure 6. Zinc deficiency symptoms on grapevine leaves. Photo courtesy of Scholefield Robinson.

Influence of rootstock, variety and soil type on zinc

In regions such as the Riverland of South Australia, Muscat Gordo Blanco, Pedro Ximines and Zante Currant showed greater susceptibility to zinc deficiency before zinc treatment became routine. Some rootstocks are inferior in their ability to supply zinc compared with own-rooted vines.

Molybdenum

The role of molybdenum in grapevine function

Molybdenum is a co-factor to the enzyme nitrate reductase which converts nitrate-nitrogen to amine-nitrogen prior to its use in protein synthesis. In Australia, molybdenum has been associated with abnormal ovule development and poor pollen tube growth causing poor fruitset in own-rooted Merlot (Longbottom 2007).

Mobility within the vine

Molybdenum is mobile in grapevines if present in sufficient quantities (i.e. it is variably mobile).

Symptoms of molybdenum deficiency

In Australia, own-rooted Merlot is often difficult to establish in the first few years and can display vegetative symptoms (Figure 28) which have become known as the 'Merlot problem' (Robinson & Burne 2000). These symptoms include:

- Poor vine growth;
- Small leaves (size of a 50c coin or smaller);
- Leaf cupping and edge burn;
- Papery feel to leaves;
- Zig-zag shoot growth;
- Inky epidermis;
- Wood fails to mature;
- Rubbery feel to shoots.

Figure 7. A young Merlot vine showing symptoms of molybdenum deficiency. Photo courtesy of Mardi L. Longbottom.

These symptoms have been associated with excessively high nitrogen values in the petioles, a phenomenon that can be caused by molybdenum deficiency (Robinson and Burne 2000). In established own-rooted Merlot vines, molybdenum deficiency is distinct from the Merlot problem. Molybdenum deficiency in these vines is characterised by poor fruitset (Longbottom 2007) (Figure 8).

Figure 8. An extreme example of poor fruitset on Merlot bunches from molybdenum deficient vines (top) and typical bunches from vines with sufficient molybdenum (bottom). Photo courtesy of Mardi L. Longbottom.

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Further information

Training

For regional specific training in grapevine nutrition management, the AWRI is running *Research to Practice: Managing grapevine nutrition in a changing environment.*

Contact

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Useful references

Nicholas, P. 2004. *Soil, irrigation and nutrition.* Adelaide: Winetitles.

Articles about grapevine nutrition and viticulture in general are available to the Australian wine industry through the Australian Wine Research Institute library. Visit http://www.awri.com.au/information_services/jfml/ for details.

Product or service information is provided to inform the viticulture sector about available resources and should not be interpreted as an endorsement.

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