Micronutrients in No-Till

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Micronutrients, also known as trace elements, are those nutrients required in only small doses by plants. While the amounts of micronutrients required are around one tenth of the rate of macro nutrients, such as nitrogen, these nutrients are equally important for plant growth and maximum production.

The key micronutrients we are interested in for grain production in the Wimmera-Mallee are zinc and to a lesser extent copper, manganese and molybdenum.

Micronutrients and no-till

Zinc, copper, manganese and molybdenum are all highly immobile in the soil ie. they do not move far from where they are placed in the fertiliser granule. Crop roots take up the nutrients when they grow into the fertiliser band. In conventional systems cultivation mixes the nutrients evenly throughout the topsoil.

Removal of cultivation leaves the nutrients in the concentrated bands they were applied in at the time of fertilisation. However, even with the removal of cultivation, deficiencies of these immobile nutrients are rare due to the history of regular fertiliser applications on most farms.

Micronutrient use in the Wimmera-Mallee

Commercially in the Wimmera and Mallee zinc is the most important micronutrient due to the soils in the region being naturally deficient in this element. Copper deficiency is rarer than zinc and molybdenum and manganese deficiencies are very rare.

> Current and past management of cropping paddocks mean that it is rare to observe yield limiting deficiencies of zinc in the Wimmera-Mallee.

Application of micronutrients in no-till

Where a deficiency exists and fertiliser is required for correction, micronutrients are best applied as part of the soil applied starter fertiliser, as this method provides residual availability to subsequent crops.

Foliar sprays can be used to correct a deficiency but are effective for that season only.

Seed coated applications will also help correct a deficiency in the current season but will not provide the residual value of soil applied products. They are usually used in conjunction with a foliar spray in areas with a known deficiency and, while cheaper in the short term, are not as cost effective as soil applied products in the long term.

Work is continuing into the use of **fluid fertilisers** for application of micronutrients, ideally mixed with fluid phosphorus. Due to their highly immobile nature in soils, it would be expected that fluid fertiliser forms would improve plant root access to micronutrients and therefore provide greater yield responses when used on deficient soils. Current trial work has failed to demonstrate this so far in the Wimmera-Mallee, largely due to a lack of sites with obvious micronutrient deficiencies.

Fertiliser placement in no-till

No-till systems aim to apply seed and fertiliser in tight bands. This restricts the area of soil fertilised and therefore root access to these immobile nutrients. Sowing in between last season's crop rows separates the germinating crop from any residual fertiliser band that was laid down in the previous season's no-till crop.

> Sowing crops back on top of two or three year old crop rows will position the new crop on top of a residual fertiliser source and helps to make the most of prior investment in phosphorus and micronutrients.

Due to the lack of deficient soils without fertiliser history and the residual value from soil applied micronutrients, especially copper, trial work to date has not shown a clear method of placement to be better than another in a no-till system.

Trial work in Western Australia has shown higher concentrations of both zinc and copper in young wheat leaves, when fertiliser was banded below the seed, compared to drilled with the seed. However the highest concentrations were produced following a pre-sowing cultivation to mix residual nutrients through the soil (Bolland et al 2006). None of these differences were apparent in final yield.

It is thought the deeper placement keeps the fertiliser in moist soil where crop roots can access it (roots cannot access nutrients from dry soil) so this method may become important as residual fertiliser is used up.

Testing for deficiencies

Tissue testing is the most reliable way to detect a micronutrient deficiency. Your agronomist can take samples for analysis and the methods used are either: collection of youngest emerged leaf blades (YEB) (table 1) or whole plant tops (table 2).

Table 1. Guidelines to copper and zinc levels in youngest emerged blade (YEB).

YEB concentration		Status
Zinc ppm	Copper ppm	
Less than 12	Less than 1.3	Moderate – severe deficiency
10 – 14	1.3 – 1.6	Mild deficiency
	1.6 – 2	Marginal
Greater than 15	Less than 2	Healthy

Table 2. Guidelines to zinc levels in whole plant tops.

Zinc in plant tops (ppm)	Status
Less than 12	Noticeably deficient
12 – 16	Visual and growth effects
Greater than 18	Adequate

There are no fixed rules for interpreting micronutrient soil tests. Studies in glasshouse culture in south west Western Australia have shown that critical soil zinc for 90% maximum yield increases with pH, clay content and organic carbon. The range in values relevant to soils in west Victoria is likely to be 0.2 – 0.3 mg/kg zinc, but 0.6 mg/kg is often used as a critical value in practice. Similar studies on copper report critical values between 0.1 and 0.38 mg/kg copper (Brennan, R. F. 2006). Critical values for manganese are around 2.5.

ZINC

Zinc plays a role in many of the metabolic processes that occur within plants. Zinc is necessary for photosynthesis; efficient use of nitrogen; carbohydrate, cell and hormone production and it is also associated with disease resistance in plants (Hannam, 1994), for example the incidence of rhizoctonia can be worse in a crop grown in a zinc deficient soil. Zinc is required for pollen formation and so is often referred to as having a major role in seed set.

Deficiency symptoms

Zinc deficiency symptoms can appear on both old and new leaves. In wheat, plants will be stunted and a long pale green stripe appears on each side of the mid-vein of fully emerged leaves (Anderson, 2000). This tissue soon dies and turns pale brown. In some cases plants take on a 'water soaked' or 'diesel soaked' appearance (Wurst, 2001). Deficient legumes are more difficult to diagnose without a treated check plot and display general stunting.

In wheat look for dead lesions in the centre of the leaf as a sign of zinc deficiency.

Figure 1.
Zinc deficient wheat.
Photo from www.Hanafords.com

Yield response to zinc

Pulse crops tend to be more responsive to zinc than cereals, but large grain yield responses in cereals are possible in cases of severe deficiency. For example: in trials conducted on sandy, zinc deficient soils in South Australia in the early 1990s 2.5kg Zn/ha lifted wheat yield from 1.2t/ha to 2.6t/ha and barley yield from 1.1t/ha to 2.2t/ha (Hannam et al, 1994).

It is rare to see such severe deficiency and similar magnitude of yield loss in the Wimmera and Mallee due to the strong history of zinc fertiliser application on most farms, particularly since the 1990s.

BCG has conducted regular trials to investigate zinc response in the region since 1995. In this trial work yield responses to zinc have rarely been detected due to the regular history of use of this nutrient in most commercial cropping paddocks. Refer to www.bcg.org.au

Sandier soils in the northern Mallee tend to require more regular inputs of zinc to prevent deficiency than clay soils of the Wimmera, due to the lighter soil texture.

Zinc fertiliser recommendations

Zinc becomes unavailable over time on alkaline soils, so the recommendation of "2 – 3kg Zn/ha every 3 – 4years" was accepted practice for cropping in the Wimmera-Mallee until use of zinc coated fertilisers (such as Granulock®) became widespread. These products supply small amounts of zinc, usually 1%, and are designed for annual use. Blended products have higher zinc contents—around 3%—and do not need to be applied as regularly.

Despite the continued use of sowing fertiliser products containing zinc, there is little evidence from trial work to suggest that it is required so often on farms with a strong history of application.

Foliar sprays can be used to correct the foliar symptoms of zinc deficiency but will not repair roots that have been damaged by rhizoctonia or sulfonurea herbicides. Seed treatments are another option but do not provide a long lasting supply of zinc like granular fertiliser sources.

COPPER

Copper is essential for reproduction and lignification, which gives plants structural strength. Deficiency interferes with pollen development, resulting in sterile pollen causing poor grain formation and shrivelled grain (Anderson, 2000).

Copper deficiency occurs in only some parts of the Wimmera and Mallee and so is less commonly supplemented in fertilisers in these districts. Copper has a useful lifetime in soils of 20 – 40 years (Wihelm, pers. comm) and use appears to be increasing, particularly in the Mallee, perhaps as a result of a run-down of native copper levels.

Deficiency symptoms

Copper deficiency symptoms include weakened stems, wilting due to increased water loss, restricted grain filling (Anderson, 2000) or 'rats tail' twisting of heads and flag leaves—although these twisting symptoms aren't unique to copper.

If a foliar spray is used to correct copper deficiency it is important it is applied early in the crop's life (during tillering) as copper deficiency can affect pollen formation and therefore grain number per head.

Residual value

Soil applied copper will have long lasting residual activity. Trial work in Western Australia has suggested that a single application can last up to 20 – 35 years (Anderson, 2000). Research by WANTFA has shown the residual value of copper previously applied in a conventional system was still fully effective after 11 years of no-till cropping.

A single application of copper fertiliser can provide more than 10 years supply of copper to crops grown on deficient soils.

MANGANESE and MOLYBDENUM

Manganese is important for chlorophyll production which drives photosynthesis. Molybdenum is required for nitrogen uptake and grain formation.

Manganese and Molybdenum are the least commercially important micronutrient in the Wimmera-Mallee and deficiencies are rare and isolated. Deficiency is most likely on calcareous soils and gutless sands.

Molybdenum deficiency occurs throughout southwestern WA but is limited to patches usually less than 20ha.

References

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