GRDC Copper Management Trial

Author: **Nigel Wilhelm, SARDI, Waite Research Precinct, Adelaide**

Summary:

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Why do the trial?

Trace element disorders in cropping systems of the southern region are generally most common on the more infertile and lighter soils of the region. While management packages have been developed for many of these problems, the packages are old (20-40 years), were developed in different farming systems and used old application strategies (such as amended single super or combines for delivering fertiliser). Many have not been updated for current systems (including new crops such as lentils or mustard) or technologies and several new techniques and formulations are now available (such as fluid delivery at seeding into the furrow, synthetic and natural chelates and amended high analysis fertilisers). These old packages have to be tested under current cropping conditions to check if they are still relevant or need to be adapted and the new options compared for efficacy and cost to the existing approaches.

This article reports on a trial from a GRDC-funded project which is testing current guidelines for diagnosing trace element deficiencies with soil and plant testing and investigating management packages to make them more effective and cheaper for current cropping systems.

How was it done?

SARDI contracted Landmark to undertake a field experiment comparing a wide range of application strategies for treating copper (Cu) deficiency in wheat at a site near Edillilie which has had a strong history of Cu deficiency. Soil testing of the site prior to seeding showed DTPA Cu levels in the top 10 cm of 0.16 ppm which is considered very deficient by current guidelines. DTPA Cu was even lower in the subsoil, 0.03 ppm in the 10-50 cm layer, which gave us even more confidence to go ahead with the trial. Management details are summarised in tables 1 and 2.

Table 1. Site history and management details for Cu management trial in wheat at Edillilie, 2015.

Location:	Edillilie
Plot Size:	2 m x 8 m
Replicates:	4
Soil Type:	Loamy sand over clay
Sowing Date:	22 May
Harvest Date:	11 November
Rotation:	2014 - Canola
Seeding Density:	100 kg/ha Cobra wheat + 5L/T Wilchem Signature Zinc
Fertiliser:	Base of 35N + 28P/ha applied at sowing 20 L/ha Easy ATS + 80 L/ha UAN post emergent 130 L/ha UAN post emergent (126 kg/ha of N applied in total)
Pesticides:	Double Knockdown 2.5 L/ha Boxer Gold + 1.6 L/ha Avadex 670 ml Velocity + 75 ml Lontrel Adv + 150 ml Axial + 3 L/ha Wilchem Signature ZM + 0.5%

	Adigor 150 ml/ha Prosaro + 0.5% Uptake @ GS30 500 ml/ha Opus + 200 g/ha Piramor @ GS41

The trial was sown using a trial plot seeder with DBS tynes on 300 mm spacing in a randomised block design. Foliar copper treatments were applied at GS21 (early tillering) and at GS41 (flag emergence). Soil applied treatments (granular and fluid) were banded below the seed. Plots were harvested for grain yield and grain quality was analysed. See list of treatments in table 3 for more details.

Foliar sprays were applied 4 weeks prior to flowering to protect pollen development, which is a very sensitive stage for plants for Cu deficiency.

Table 2. Spray application details for the Cu management trial in wheat at Edillilie, 2015.

Spray Details		
Timing:	GS14/21	GS41
Spray Date:	1 July	31 August
Spray Equipment:	02LD nozzle, 150 L/Ha @ 2 Bar	02LD nozzle, 150 L/Ha @ 2 Bar
Weather conditions:	Temp: 9°C RH: 82% Wind: Light NW	Temp: 19°C RH: 55% Wind: Light N
Growing Conditions:	Excellent	Excellent

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What happened?

Growing conditions were excellent at this site until late spring when the crop became stressed from lack of water. Responses to effective Cu treatments became visible by late tillering as plots which were lighter green but this did not affect biomass production. All treatments had similar shoot biomass at first node stage, which is not unusual for Cu deficiency, even when it is severe.

Youngest fully emerged leaves, the most sensitive plant part for diagnosing trace element deficiencies were analysed for Cu at this first node stage to assess the effectiveness of soil-applied treatments. All levels were low (less than 2.5 ppm) but Cu applied as a fluid lifted YEB levels more than the Cu enriched granular fertilisers. Levels in the controls were 1.6 ppm which is considered very deficient for wheat.

As plants ran up to head, another symptom of Cu deficiency became obvious. Plants in all effective Cu treatments had heads which stood up straight but heads in low Cu treatments were bent over. This may have happened because Cu deficiency inhibits the production of lignin, which is the mortar holding plant cells together. With low lignin levels, plants are physically less robust.

After the scorching weekend in early October, plants in effective Cu treatments stayed green but all others were badly scorched. Despite looking spectacularly bad, it is difficult to know how much impact this scorching had on grain yield.

Table 3. Crop performance and Cu in youngest fully emerged leaves (YEBs) at first node for the Cu management trial in wheat at Edillilie, 2015.

	Cu in YEBs (ppm)	Yield (t/Ha)	Grain protein %
Nil Control	1.6	0.70	16.2
Coated granular fertiliser at seeding (0.5 kg Cu/ha)	1.6	0.99	16.5
Dry blend Granular fertiliser at seeding (kg Cu/ha)	1.4	0.31	16.1
Dry blend Granular fertiliser at seeding (2 kg Cu/ha)	1.2	0.31	16.9
Foliar spray sulphate (90 g Cu/ha)		2.09	14.0
Foliar spray chelate (90g Cu/ha)		1.73	14.8
Foliar spray sulphate x 2 (90 + 90g Cu/ha)		3.19	14.2
Luxury (1.5 kg fluid Cu + 2 kg granular Cu + 90 g foliar Cu)	2.0	2.98	13.9
Fluid at seeding (0.09 kg Cu/ha)	1.3	0.95	16.1
Fluid at seeding (0.19 kg Cu/ha)	2.0	0.99	16.6
Fluid at seeding (0.38 kg Cu/ha)	1.8	0.77	17.2
Fluid at seeding (0.56 kg Cu/ha)	2.5	1.13	16.7
Fluid at seeding (1kg Cu/ ha)	1.9	1.31	16.5
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LSD (P=0.05)	*0.4*	*0.43*	*0.7*

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Grain yield was severely reduced by Cu deficiency. Yields in the untreated controls averaged 0.7 t/ha (see table 3) and the best treatments yielded 3 t/ha or better. Treatments in which Cu was only applied to the soil at seeding as a fluid were beneficial but were very poorly effective compared to foliar sprays. Cu enriched granular fertilisers were little better than the untreated controls. The best yielding treatment was

the very cost effective option of two foliar sprays of 90 g Cu/ha as Cu sulphate , applied at first node and then 4 weeks prior to flowering. A chelated source of Cu proved to be no more effective at correcting Cu deficiency than a sulphate source. Grain size in this trial was poor, reflecting the tough finish to the season with hectolitre weight averaging 66 kg/hL and screenings 7%. However, grain size was no worse in the high yielding Cu treatments, even though proteins were lower (approx. 14% in the highest yielding treatments compared to 16% in the untreated controls).

Cu content in grain was also assessed and only treatments with a foliar spray had levels above detection for the lab (1 ppm). Of these, sulphate foliar sprays lifted grain Cu higher than the chelated source. Despite these very low levels of Cu in grain, germination in both untreated controls and the luxury Cu management were similar and well above 90% (note: only grain from these two treatments.

Messages from the trial.

- The site was severely deficient in Cu for wheat so growers in this district with similar soil types should heed the warning provided by this trial.
- Under these severely deficient conditions, soil applications of Cu were poorly effective compared to foliar sprays but fluid applications performed better than Cu enriched granular fertilisers. However, soil applications of Cu can persist for decades so we hope to re-seed this trial in 2016 to assess residual benefits of the treatments applied in 2015.
- There was no evidence that a chelated source of Cu as a foliar spray was more effective than a sulphate source and less Cu seemed to end up in the grain with the chelated source.
- A single foliar spray of Cu prior to flowering is often sufficient to protect a cereal crop from Cu deficiency but under the severe deficiency encountered in 2015, two foliar sprays were necessary to overcome the problem completely (one at first node, the second prior to flowering).
- Cu deficiency can make a crop more sensitive to adverse conditions. In this trial, the hot drying conditions of the early October weekend, severely scorched all plots with no or poorly effective Cu management strategies.
- The soil and leaf tests taken during this trial support that the current guidelines for Cu deficiency are still relevant to modern farming systems and varieties. A DTPA Cu level in soil of less than 0.3 ppm in the top 10 cm is considered deficient, and 1.3 ppm Cu in YEBS is considered very deficient for wheat.

Many thanks to Patrick Head and his team for conducting the trial and to Terry Blacker and Sjaan Davey (SARDI) for assisting with operations and analysis of samples.