Managing micronutrients in cropping systems of Western Australia

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What do we have:?

- Cu, Zn, Mn, Mo, B
- B & Al toxicity,
- Range of plant species
- Plant tests [young or whole tops] and
- Soil tests; extractants, methods etc

- A large combination!
- Hence some generalisation and principles.
What do we know?
Mostly: -
  • Immobile in the soil
  • Mostly immobile in the plant when deficient
  • Plants need continuous supply
  • even distribution in soil is essential
  • good fertiliser residual
  • less available at high pH

Factors which affect the plant availability

  • Root interception
  • Placement geometry
  • Soil reactions
  • Differential response of plant species
Root interception

Grain yield (%) of the recommended Cu [5.5 kg Cu sulphate]

<table>
<thead>
<tr>
<th>Past Cu application</th>
<th>kg CuSO4/ha 0</th>
<th>2.75</th>
<th>5.5</th>
<th>8.25</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>58</td>
<td>76</td>
<td>77</td>
<td>83</td>
</tr>
<tr>
<td>2.75</td>
<td>95</td>
<td>98</td>
<td>95</td>
<td>99</td>
</tr>
<tr>
<td>5.5</td>
<td>100</td>
<td>102</td>
<td>103</td>
<td>100</td>
</tr>
<tr>
<td>8.25</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11+0.5 yrly</td>
<td>102</td>
<td>102</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

Copper concentration in plant

<table>
<thead>
<tr>
<th>Past Cu application</th>
<th>kg CuSO4/ha 0</th>
<th>2.75</th>
<th>5.5</th>
<th>8.25</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.7</td>
<td>1.2</td>
<td>1.5</td>
<td>1.7</td>
</tr>
<tr>
<td>2.75</td>
<td>1.7</td>
<td>2</td>
<td>2.4</td>
<td>2.4</td>
</tr>
<tr>
<td>5.5</td>
<td>2.9</td>
<td>3.3</td>
<td>3.5</td>
<td>3.7</td>
</tr>
<tr>
<td>8.25</td>
<td>3.7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>4.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11+0.5 yrly</td>
<td>5</td>
<td></td>
<td></td>
<td>5.5</td>
</tr>
</tbody>
</table>
Root interception

The efficiency of Cu fertiliser improves:

• If placed in soil regions of high root activity
• No. of granules of Cu per soil volume increases
• Drilling with the seed << topdressed
• Therefore: number of Cu particles and distribution in soil determines the effectiveness of Cu fertiliser

Re-application

How to determine if TE's required

• Soil test
• History: how long since the last
• Plant test
• Plant symptoms: helpful but not the best method
Studies with a range of different soil test Mn procedures, and for plant species are usually poorly related.

Why?

The critical soil test values of Mn for a soil growing a crop are influenced

- by the methods of soil collection and drying,
- the effects of organic reactions and
- inorganic reactions of Mn in soils.
Soil Testing Summary

• Soil tests are not definitive and should only be considered as a guide.

• Zinc (DTPA soil test) is the most reliable soil test. DTPA test - guide for critical levels for Zn (mg Zn/kg): 0.2(sand), 0.3(loam), 0.45(clay)

• Copper (DTPA soil test) > ~0.35 mg/kg likely to be sufficient, but there is little calibration.

• Best diagnosis method is to plant tissue test.

Micronutrient re-application

Application of TE in minimum tillage situations

• Cu and Zn are now concentrated in drilled bands at shallow depth in mostly dry soil and intercepted by too few roots

• There has been little TE reapplication work in these situations

• However, much is known about the factors which affect the availability of TE for plants
Micronutrient re-application

The effect of placement of copper and zinc fertiliser on the concentration in young wheat leaves at the boot stage.

Copper and Zn concentration (mg/kg)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Nil Cu</th>
<th>Cu (1.0)</th>
<th>Nil Zn</th>
<th>Zn (1.0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drilled</td>
<td>2.5</td>
<td>2.8</td>
<td>15</td>
<td>24</td>
</tr>
<tr>
<td>Banded below</td>
<td>2.5</td>
<td>3.6</td>
<td>14</td>
<td>34</td>
</tr>
<tr>
<td>Cultivated</td>
<td>2.8</td>
<td>4.5</td>
<td>16</td>
<td>37</td>
</tr>
</tbody>
</table>

Cu as CuSO4; Zn as ZnO.

Ammonium oxalate soil extractable Cu in placement

N. Jeramungup

(a) In rows

(b) Half in and half between rows
Possible solutions

- Place fertilizer Cu and Zn below seed while sowing
- Cultivate top about 10 cm soil once every 5-7 years
- Sow, and drill or band fertilizer, at diagonal across old sowings
- Soil Test 1:1 is suggested.

Re-application?

**Residual value:** how long are TE available in the soil?

- Little is removed in agricultural products
- Soil immobile :- held by soil components
- Little/ no leaching from soil- root profile.
- Small additions in fertilisers [ e.g. Zn in super]
- Hence last a long time?
Re-application: methods

Re-application: foliar sprays

Cu Foliar @ Gs 47
Summary: Micronutrients

- Immobile in the soil
- Mostly immobile in the plant when deficient
- Plants need continuous supply
- Even distribution in soil is essential
- Good fertiliser residual
- Less available at high pH, except Mo more available
- Soil test mostly unreliable or poor calibration
- Plant tests reliable; Cu, Zn, Mo and Mn

If liming, and no micronutrients application for > 15 years then consider reapplication.

Collaboration & funding

Managing micronutrient deficiencies in cropping systems of WA
A new project funded by GRDC.

Western Region team:
- James Easton, CSBP, Kwinana
- Richard Bell, Murdoch Uni, Murdoch
- Andreas Neuhaus, CSBP, Kwinana
- Neville Chittleborough, DAFWA, Albany Regional Office

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Thank you
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“Micronutrients should not be applied until tissue testing has shown there is a need. Applying a micronutrient, especially copper because 10 years are up since the last application, or because it gives you a warm feeling, could be very wasteful.”

Corollary: What if it’s undiagnosed

<table>
<thead>
<tr>
<th>Area Cu def. soil in WA</th>
<th>8 million ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>10% cropped annually</td>
<td>0.8m ha</td>
</tr>
<tr>
<td>Avg. wheat yield</td>
<td>1.5 t/ha</td>
</tr>
<tr>
<td>Avg. wheat yield decrease to undiagnosed Cu deficiency</td>
<td>5%</td>
</tr>
<tr>
<td>Wheat loss: (t)</td>
<td>60000</td>
</tr>
<tr>
<td>Wheat price: ($/t)</td>
<td>275</td>
</tr>
<tr>
<td>Wheat industry loss; ($)</td>
<td>~16 million</td>
</tr>
</tbody>
</table>