Nutrition Management in Broadacre Cropping

Macro Nutrients

There are 10 macronutrients required by plants (table 1). Of these, South Australian soils often supply nitrogen, and phosphorus, in particular, in quantities insufficient for optimum crop development.

Micro nutrients/Trace elements

There are 7 micronutrients or trace elements that plants require for growth. (table 1). A deficiency of any trace element in the soil can limit plant growth even when all other essential elements are present in adequate amounts. In South Australian soils, zinc, manganese and copper are often deficient or insufficiently available. In acid soils, molybdenum availability is reduced often resulting in crop deficiency.

Table 1: List of nutrients essential for plant growth.

Macro Nutrients	Micro Nutrients
Carbon (C)	Boron (B)
Oxygen(O)	Cobalt (Co)
Hydrogen (H)	Copper (Cu)
Nitrogen (N)	Iron (Fe)
Potassium (K)	Manganese (Mn)
Phosphorus (P)	Molybdenum (Mo)
Calcium (Ca)	Zinc (Zn)
Magnesium (Mg)	
Sulphur (S)	
Chlorine (Cl)	

Table 2 gives an indication of the amount of each of these essential nutrients which is removed from the soil profile in the process of growing and harvesting a crop which produces grain yields of one tonne per hectare.

Table 2: Nutrients removed by 1 tonne of grain.

Crop Group	Nitrogen	Phosphorus	Sulphur	Zinc	Manganese	Copper
Cereals	17 - 23 kg	2.7 - 3 kg	1.5 - 1.6 kg	14 - 20 g	11 - 40 g	3 - 5 g
Legumes	33 - 60 kg	3.2 - 4.0 kg	1.5 - 2.4 kg	28 - 35 g	14 - 60 g	5 - 10 g
Oilseeds	25 - 41 kg	4.3 -7 kg	4 -10 kg	26 - 40 g	13 - 40 g	4 - 14 g

NITROGEN

Broadacre crops require more nitrogen than any other nutrient and deficiency in this nutrient is therefore the most common limitation to realising the potential yield.

Main sources of nitrogen (other than fertiliser nitrogen):

1. Nitrogen fixation by legumes.

   The amount of nitrogen symbiotically fixed by legume crops usually ranges from 60 to 120 kg of N/ha/year. This varies according to the crop. Lucerne is able to fix much more nitrogen than grain legumes which generally utilise about the same amount of N that they produce.

2. Decomposition of plant and animal residues.

   Legume pastures supply about 12 kg of mineral N per tonne of dry matter produced by the pasture and a grassy pasture can supply about 4 kg/tonne of dry matter. Cereal stubbles, on the other hand, generally supply very little nitrogen and may even cause a temporary decrease in available N.

3. Carry-over of unused nitrogen from previous years. (Usually low levels)

Deficiency symptoms

General yellowing in the older leaves of cereals (nitrogen is quite mobile in the plant). NB by the time visual symptoms are evident some yield potential has been lost. Nitrogen deficiency in pasture and grain legumes can be difficult to diagnose. Symptoms include shortening of the internodes and incompletely expanded leaves.

Tools for assessment of nitrogen pools and crop demands:

- Primary Industries SA Nitrogen Calculator
- Deep Soil Nitrogen Test
- Sap Nitrate Test
- Near Infra-red (NIR) Nitrate Test

Nitrogen applied at seeding has been found to be generally more effective than that applied either at tillering growth stage or in a split application at seeding and tillering. Nitrogen applied later in the growing season (eg at flowering) will tend to influence grain protein development rather than yield. Trial work suggests that 6 to 7 kg of nitrogen per tonne of grain per hectare will increase grain protein levels by one percent.

The adoption of direct drill/no tillage cropping methods has led to difficulties in nitrogen application. To overcome inherent problems such as nitrogen toxicity to the seedling, an increasing number of farmers are moving towards deep placement of fertiliser. (More than 20kg/ha of nitrogen placed in the seed row can cause seedling damage). The use of liquid fertilisers may also have a place in this situation as it allows for easier manipulation of P:N ratios in one-pass seeding operations.

PHOSPHORUS

Phosphorus is also required in large amounts, principally in the early stages of plant growth. It is very immobile in the soil and is readily “locked up” with iron and aluminium complexes in acid soils and with lime in alkaline soils.

Deficiency Symptoms

Often difficult to detect in the field because all plants are affected. Poor growth, low plant vigour and delayed maturity are the main effects. Phosphorus deficiency in pasture legumes may present as a reddish tinge to the leaves.

Tools for assessment of phosphorus pools and crop demands:

- 0-10 cm paddock soil P monitoring
- Primary Industries SA Phosphorus Calculator

While granular fertiliser application to crops and pastures is the most common source of added P, recent research suggests that the use of liquid fertilisers may confer cost savings and increased application efficiencies, particularly in lower rainfall areas with highly calcareous soils.

SULPHUR

Sulphur is essential for the formation of plant proteins and for nitrogen fixing in legumes.
Sulphur deficiency can cause significant production losses in cereal crops but legumes are more sensitive. Historically, however, cereal farmers in South Australia have not had problems with sulphur deficiency. It has become more of an issue since the widespread use of high analysis fertilisers (which have low levels of sulphur), and with the increasing areas of canola being grown.

Table 3: Sulphur requirements for cereal, pulse and Canola crops.

Crop	Required for crop growth (kg Sulphur/tonne grain produced)	Removed in grain (kg Sulphur/tonne grain produced)
Cereals	5	2
Pulses	8	3
Canola	20	10

Deficiency Symptoms

Similar to nitrogen deficiency in cereals but the younger leaves are affected.

Tools for assessment

- Deep soil testing (0-60 cm) is now commonly used.
- Plant analysis

(Soil sulphur in the top 10cm is generally a poor indicator of sulphur fertiliser requirements).

The application of gypsum, or the use of sulphur enriched fertilisers are the main strategies for sulphur nutrition.

For cereal and grain legume crops, supply what is likely to be removed in the grain.
For canola crops, supply what is likely to be removed in the grain plus an extra amount for crop growth requirements.

ZINC

Zinc deficiency in agricultural crops is one of the most common micronutrient deficiencies. It is deficient in a wide range of soil types. Soils with less than 0.3 mg/kg of zinc are likely to require added zinc for optimum crop production. (With highly alkaline soils, the critical level may be up to 0.8 mg/kg).

Deficiency Symptoms

Difficult to diagnose in grain legumes and pastures. Cereals may not present any symptoms other than reduced top growth production. Visual symptoms often appear in the middle-aged leaves. Longitudinal pale green stripes appear on one or both sides of the mid-vein of the leaf. These develop into necrotic patches, which ultimately result in collapse of the leaf in the middle region.

Tools for assessment

- Plant analysis
- 0-10 cm paddock soil zinc monitoring

Long-term correction of zinc deficiency can be achieved by means of a soil spray of zinc sulphate, or by use of zinc enriched fertilisers. As zinc is quite immobile in the soil, adequate incorporation is required for effective uptake of zinc in the year of application by soil spray. 2.5kg/ha of elemental zinc (equivalent to 10 kg/ha of zinc sulphate will correct most deficiencies and the effect will persist for 3-10 years, depending on soil type.

Strategic correction of crops exhibiting visual deficiency symptoms may be achieved by means of a foliar spray of zinc sulphate applied at a rate of 250 to 350 g per hectare.

COPPER

Copper deficiency in South Australia is most commonly found on highly calcareous or ironstone soils as well as in siliceous sandy soils with low organic matter levels. High soil concentrations of other metals such as iron, magnesium and aluminium can induce copper deficiency.

Deficiency Symptoms

Large losses in production from crops and pastures can be incurred in the absence of any visual deficiency symptoms. Visual symptoms in cereals include a general wilting (unrelated to moisture status) of the plant at tillering stage. Copper is required for cell wall structure so that deficiency can result in reduced stem strength. Withering of the tips of leaves and incomplete head and grain formation characterises more severe deficiencies. Significant reduction in grain production can be incurred from crops suffering from copper deficiency late in the season because pollen production is affected.

Tools for assessment

- Plant analysis
- 0-10 cm paddock soil Cu monitoring

Copper deficiency is best corrected by soil applications of copper sulphate at a rate of 10 kg/ha (equivalent to 2.0 kg/ha of elemental copper). Alternatively homogenous, copper enriched fertilisers may be used. Strategic correction of crops exhibiting visual deficiency symptoms early in the season may be achieved by means of a foliar spray of copper sulphate applied at a rate of 0.40 kg per hectare.

MANGANESE

Manganese deficiency is most common in alkaline and calcareous soils and is particularly severe in crops and pastures grown on highly calcareous sands (60-85% free lime). It also occurs on slightly acid sandy soils, lateritic soils, peat soils and poorly drained soils.

Deficiency Symptoms

Manganese deficient cereal crops often have a patchy appearance with areas of poor growth. Severe deficiency can result in the death of the plant, thus severely reducing crop yields. As manganese is relatively immobile in the plant, symptoms appear initially on the young leaves. Affected leaves turn pale green and have a limp or wilted appearance.

Manganese deficiency can cause split or shrivelled grain in lupin pods and will delay maturity of deficient plants.

In canola the whole of the deficient plant becomes paler. This yellowing is most prominent on the older leaves. The interveinal areas gradually turn yellow while the veins remain green.

Tools for assessment

- Plant analysis

Manganese deficiency in the tested crop can usually be corrected by a foliar application of manganese sulphate at rates of up to 3.5 kg/ha. On highly calcareous soils two foliar applications in conjunction with manganese seed dressings and/or homogenous manganese-enriched fertilisers may be necessary to completely correct the deficiency. As manganese is rapidly tied up, soil applications confer little or no residual benefits.