Critical Growth Stages for Maintaining Sound Nutrition of Crops on Upper EP

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INFORMATION

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General Principles

- Wheat requires fourteen essential elements to grow normally and complete its life cycle, which in the case of all annual crops is to produce viable grain.
- Wheat has evolved to be extremely efficient at accessing nutrients from its environment, and generally it is very successful. However, upper EP soils are, in general, very infertile and so present a serious challenge to wheat's ability to acquire nutrients.
- Soils provide the vast majority of nutrients to crops and it is only when the supply is below what is required for optimum performance that fertilisers are used to supplement the soil's reserves.
- Wheat requires a supply of all the essential elements for almost the entire time the plant is growing. It is only during the very first and last stages of development, germination and grain fill, respectively, that it can perform well on the nutrient reserves within itself.
- While a supply of all nutrients nearly all of the time is necessary for the optimum performance of wheat, there are critical times for supply of some elements to ensure healthy growth and grain production.
- For commercial crops, the economically optimum rate to supplement supply of a nutrient is to just below adequacy. However, it is rarely possible to achieve that level of precision in reality.
- There are four ways that the supply of a nutrient to a wheat crop can be supplemented by a fertiliser in a broad-acre, rainfed situation; boosting nutrient levels in the seed, adding nutrients around the seed as a dressing, adding the nutrient to the soil for the crop to find or spraying the nutrient directly onto the shoots of the crop.
- Wheat can only extract nutrients from damp soil.

This paper focuses on critical stages for particular nutrients during the life cycle of a wheat plant and will not deal with most of the issues around rates and dates of using fertilisers in commercial situations. It is constructed in such a way that each nutrient, which may require supplementation via fertilisers on the upper EP, is discussed separately in terms of critical stages of demand and when intervention can be most effective. Nutrients which are supplied in adequate to abundant amounts in upper EP soils for wheat will not be covered.

The primary purpose of this paper is to highlight particular stages in a wheat's life cycle when nutrient supply is most critical or when supplementing the nutrient is most effective (or not). For details sufficient to manage the nutrition of individual wheat crops, follow ups with your normal advisory sources will be necessary.

Nitrogen (N)

- Nitrogen is required in the largest amounts by wheat. It performs many functions within the plant but is best known for its effect on tillering. Without adequate N, wheat will not tiller well, or will even abort existing tillers. Adequate N supply is essential for satisfactory protein levels in grain.
- N can be quite toxic to germinating seeds, although the rates of N normally used at seeding on upper EP rarely cause such problems in wheat.
- If the supply of N from the soil drops below adequate levels, wheat can make use of supplementary N right up, to and including, early grain fill. Thus, the effectiveness of supplementary N is dictated more by environmental conditions (i.e. suitable conditions for applications) than the physiology of the crop, particularly in low rainfall environments.
- In crops yielding above 2 t/ha, maintaining good N supply from late tillering to head emergence is important to preserve the extra tillers required to reach such yield targets. Since this period generally coincides with increased release of N from soil organic matter in spring; N fertilisers are only required if this increased supply is still inadequate.
- Wheat can take up N directly through its shoots, but in most circumstances, most of the N applied as a foliar application still enters via the soil and the root system.
- As N is applied later in crop development, more and more of the extra N that gets into the plant is used to produce extra protein, rather than extra grain yield.

Phosphorus (P)

- Phosphorus is required in large amounts by wheat and since nearly all southern Australian soils are too low in P reserves for acceptable wheat performance, it is a very important nutrient in the economics of wheat production. P is a central component in the energy capturing molecules of plant cells and also assists in many defence pathways of wheat. A supply of P is required by wheat throughout nearly all of its life cycle but it is particularly damaging to the plant if its supply is poor early in the season (up to about stem elongation).
- Using seed high in P is a good way to ensure sound germination, rapid emergence and vigorous establishment.
- The most efficient way to supplement wheat with extra P (after boosting the seed content) is to apply P fertiliser in or near the seed row of the crop.
- When applying P fertiliser to wheat at seeding, the first 5-10 kg P/ha should be applied with the seed. If any more is to be applied, just under the seed row is the preferred position for maximum benefit.
- P can be applied to the shoots of wheat but this technique is proving too unreliable so far to be recommended.

Sulphur (S)

- Sulphur is required in moderate amounts by wheat but few southern Australian soils are deficient in S for wheat. S is important in protein metabolism and also assists in many defence pathways of wheat. A supply of S is required by wheat throughout nearly all of its life cycle but wheat is very adept at moving S around within the plant so supplies later in the season are not so critical.
- Like N, the effectiveness of supplementary S is dictated more by environmental conditions (i.e. suitable conditions for applications) than the physiology of the crop, particularly in low rainfall environments.
- Also like N, S in its available form to wheat (sulphate) is very leachable, so applications at seeding or soon after are vulnerable in this respect.

Zinc (Zn)

- Zinc is the most common and widespread of the three trace elements which occur on upper EP. Its most obvious role in the plant is to help maintain the integrity of cell membranes. When it is in deficient supply, many capabilities of the plant start unravelling (e.g. disease resistance, water use efficiency, rapid grain fill and haying off).
- Seed rich in zinc can really boost early growth in deficient soils.
- Foliar sprays on wheat are effective but best benefits are realised at the 2 leaf stage. The impact of a foliar spray gradually declines at later growth stages.
- To boost the content of seed, a foliar spray can be applied during grain set and early fill.
- Zinc moves very slowly in the soil so applications at seeding time are best in or very near to the seed row. Fluid applications near the seed row give the plant a solid band of Zn to intercept more easily.

Copper (Cu)

- Copper deficiency has been widespread on upper EP but was largely overcome with widespread applications of bluestone super mixes during the 1950s and 1960s. However, these historical applications are probably starting to wear out now and the string of dry springs we have been having make Cu deficiency worse.
- Copper is vital to the production of the building blocks for plants but it causes its most obvious problems at flowering. Copper is essential for the production of fertile pollen so if it is in deficient supply at flowering, flowers will not set, heads will not form normally and grain production can be severely reduced.
- A foliar application within 4 weeks of flowering will protect flowering and seed set.
- While soil reserves of copper can be boosted with applications into the soil at seeding, if springs are dry, Cu deficiency can still occur during flowering.
- With the proviso that they cannot guarantee protection during flowering, soil applications are the most cost effective strategy because they can last for decades.
- Stock grazing on feed low in copper can run into problems with Cu deficiency.

Manganese (Mn)

- Manganese is a trace element whose availability in soil drops rapidly with increasing pH. On upper EP it can occur on the very calcareous soils, on limestone ridges or in white infertile sands (where there is little total Mn in the profile). Mn is vital to maintaining disease resistance pathways in plants and for the production of the mortar which holds plants upright.
- Seed rich in Mn can really boost early growth in deficient soils.

- Foliar sprays on wheat are effective but providing that seed with reasonable Mn content is used, mid tillering timing is probably the most effective; sufficiently early to avoid major growth setbacks but late enough to prolong the benefits through to late in the crop development. Unless you are very experienced at detecting the onset of Mn deficiency, plant tests are the most reliable early indicator of a deficiency for predicting the need for a foliar spray.
- To boost the content of seed, a foliar spray can be applied during grain set and early fill.
- Mn moves very slowly in the soil and is rapidly fixed in calcareous soils so applications at seeding time are best in or very near to the seed row. Fluid applications near the seed row give the plant a solid band of Mn to intercept more easily. Applying with an acidic fertiliser (e.g. MAP) can prolong availability.

As far as we can reliably ascertain, all the other 8 essential elements required for normal wheat growth are supplied by EP soils in adequate amounts under most circumstances. For nutrients such as boron and salt (sodium and chloride) these supplies can be so "generous" that toxicities can occur. Since these nutrients are quite mobile in soils, over time they have been washed down through soil profiles and have tended to accumulate at the bottom of the long term wetting front of upper EP soils (40-80 cm). Where this has led to toxic amounts in these subsoils, B and salt toxicity can start occurring as lots of roots reach these deeper layers (often in spring as crops rely more and more on subsoils for a supply of water).