Nutrient considerations for the 2017 crop - what to worry about

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Take home messages

- The wet 2016 may have leached the more mobile nutrients, such as nitrogen (N), sulphur (S), boron (B) and possibly potassium (K) deeper into the profile which suggests at sowing, rates may need to be raised for these nutrients to ensure they remain at adequate levels in the developing root zone.
- The dry start to winter is not all bad as subsoil moisture levels are reasonable. The rest of winter needs to wet the topsoil and get the roots to tap that moisture, so set yield potentials conservatively in the light of the unfolding season and make N decisions in the light of that yield potential.
- When comparing N sources, the rate, the timing and the placement all interact so that efficiency options vary and no single source is a 'silver bullet' to all situations.
- Getting the right nutrient source at the right rate, right time and right place is the basis of good nutrient management. To find out more about the 4R's approach, visit http://www.ipni.net/4r.

What is a good nutrition program?

A good nutrition program is part of a whole agronomy package and cannot – or should not – be considered in isolation from soil type, region, the way paddocks are prepared, the crop type and cultivar, crop protection, equipment available, the yield potential and other agro-climatic issues. A good program will look to at least maintain fertility and this goes closely with soil physical and biological health. A good nutrition program will aim to supply what is required to meet the productivity expected and balance risk and return.

In the current season, the most important aspect is to assess where you are and consider where you want to be. Deal with what you know and plan for what you do not know. **Nobody really knows what comes next, but we do need to take stock of the story so far.** Building flexibility into an agronomy program is the first consideration. So, the story so far is about coming off a wet season with mostly good yields, although like the 'curate's egg' (http://www.phrases.org.uk/meanings/163300.html) – it was good in places. Good yields meant high removals, the wet conditions could have moved N, S and B down the soil profile and higher than normal N losses by denitrification were likely. Big stubble loads meant more draw down on N and so the starting recommendations were to

- soil test shallow for P and K, deep for N and S.
- supply a little more N at seeding – use an N-Rich strip to monitor.
- balance P removal if soil tests were at or near critical values.
- Take a look at S either at seeding or with early ammonium sulfate applications.

The crop is now probably 30-40% into the season and so the nutritional interventions that can be imposed are limited largely to N and S, some K and some micronutrients. It is really too late to do anything about P – the work undertaken over the past few years has shown that while some P can be taken up through the leaves, there is little benefit in terms of grain yield (McBeath et al., 2015). If you are tissue testing for P there are often low values over winter as the roots grow slowly and so can only acquire small amounts of P. When the season warms, root activity and P uptake will recommence. Zinc (Zn) in tissues follows a similar trend.

N strategy going forward

The first aspect of any N strategy is to do the sums on yield potential, N supply and N demand to see what – if any – is the N gap. All these have uncertainties but there are some ways that these uncertainties can be approached. For example, using soil probes or modelled soil moisture values to assess the current amount of available soil moisture – if moisture is likely to be the limiting factor. The situation for the spring will largely determine if the potential is realised, but poor establishment (for example, mice, weeds and diseases) will reduce the capacity of the crop to channel soil water to grain yield. Given that, there are some indicators that can be considered around effective and efficient N use:

Right time

Timing relative to growth stage

The earlier N is applied, the larger the yield increase, while the later the N is supplied, the larger the protein increase. Basically, the N supplied will most affect the tissue that is actively growing at that time. Early N stimulates shoots or tillers, while later N can increase stem growth. Once active stem growth slows, later N can be used in grain filling (Table 1).

Timing relative to rainfall

Most growers would try to time application of urea ahead of rainfall so that the losses of N as volatilised urea are reduced. The amount of N lost from surface applied urea has been a topic of significant research over the past few years. Experiments in cropping systems in the Wimmera and Mallee showed losses of up to 23% from urea, and this loss can halve where there was rain within a day of application (Turner et al. 2012). Soil texture, wind-speed, crop cover, stubble load, soil organic matter and temperature all affect the rate of volatilisation. The detail of how much N is lost due to a particular rainfall event probably causes more grief than a Collingwood grand final win, but addressing ammonia losses is only one part of the actual efficiency. The poor response of crops to applied N in season is more often a result of the N being stranded in the dry topsoil rather than being all lost through volatilisation.

Right rate

The key question here is if the crop is actually N limited, and unless this is the case there will be no response and so a low efficiency. Nitrogen budgets are developed from yield estimates (demand) against supply from deeper in the soil or from mineralised N which will also be important (but often estimated). The rate can be determined based on having adequate N in the crop by anthesis to match the yield and protein target. A 3.5t/ha grain yield will probably come from a biomass at anthesis of 7t/ha and to meet a 11% protein target should have around 120kg N (for your own situation do the maths up or down). If the post-anthesis conditions are better than the target, then N will be diluted by the extra growth and grain protein will decline. If conditions are worse, then grain protein will increase. So, the actual yield response will depend on the N rate meeting the gap between the target demand and expected supply (neither of which we know in advance). So there is some luck here in what outcome occurs. N-rich strips offer an opportunity to make in-season N assessments that integrate the prior N supply with demand to assist in determining the degree of N limitation.

Right place

Isolating N from losses due to ammonification, denitrification and leaching means that – if the crop

Table 1: Responses of wheat (cv Yitpi[d] 2001, Longerenong) to 20kg N/ha applied at different crop stages, relative to nil added N.

Responses		N applied at:				
	Nil N	DC31	DC42	DC65	DC72	LSD p>0.05
Yield (t/ha)	3.31	3.94	3.23	3.29	3.14	0.31
Protein (%)	8.6	9.4	10.4	9.8	8.9	0.4
N recovered (kg N/ha)	50	65	59	57	49	
% Recovery		75%	44%	33%	-4%	

(DC = Zadok's decimal code for the growth stages of cereals) really needs the N – it can access it with minimal loss. Putting all the N up-front would suggest a good efficiency, but this is when seasonal conditions are least known and so demand is still being formed, the N is exposed to loss processes for longest, and the decision on rate can only be adjusted up – not down. It is also important to caution about fertiliser – especially urea – placed in a seed-row. Poor establishment due to damage to germinating seeds can be significant with wide rows, narrow points, light soils and dry conditions (http://anz.ipni.net/article/ANZ-3076). A 3-5cm separation between fertiliser and seed is adequate to minimise damage.

Inter-row banding pre-crop or even in-crop (side-banding) is an attractive option as it buries the N but the technologies around this require more refinement. There more recent results from work in NSW and older work in Victoria were encouraging but it is still limited because of its early timing. Newer work with mid-row banding in-crop is very encouraging (Wallace, pers. comm.)

However, in most situations, the placement for in-crop application will be over the top of the crop. For dry fertilisers, most will end up on the soil and the fate for urea is to become either ammonia which can be lost, or as plant available ammonium or nitrate. Leaves can absorb inorganic and organic nitrogen sources. Small pores within leaf cuticles can take up urea, ammonium and nitrate. These pores are lined with negatively charged molecules. Therefore, uptake of cations (such as ammonium) is faster than anions (such as nitrate). Uptake of small, uncharged molecules, like urea, is fast. Urea is commonly used for foliar fertilisation because it's uncharged, has high solubility and can be rapidly and efficiently absorbed by leaves (Fernandez et al. 2013).

For fluid fertilisers, such as urea or urea/ammonium nitrate solutions, depending on the application equipment used, some proportion of the material will intercept the crop canopy and some will hit the soil. Once on the soil, the loss processes are the same for dry fertilisers, but the N on the canopy can be taken up through the leaves.

Foliar applied N has been proposed as the most efficient method to present N, and urea is rapidly and effectively taken directly through the leaf surfaces. For highest efficiency, coverage should be good, but crops are susceptible to damage both from urea itself as well as the salt effect of the solution. This urea toxicity will dictate the upper level for effective N uptake, and it is probably around 10-15kg N/ha depending on crop cover, ambient conditions, and application technology. Streaming nozzles likely place fluids on the inter-row rather the canopy, and while reducing canopy damage, they do expose the material to soil surface losses under the canopy.

Right source

Many of the comparisons of N sources (products) confound the source with both the placement and timing effects, but where N for N comparisons at similar timings are made, differences in recovery of applied N and yield responses are small (Gooding et al. 2007). However, there are quite large differences in cost (Doyle 2013) that need to be balanced against benefits gained.

For surface applied N, two experiments showed losses to ammonification as urea (23%), urea/ammonium nitrate (12%) and sulfate of ammonia (12%) for 9 days between application and light rainfall on an alkaline vertosol (Turner et al. 2012). In a similar earlier experiment, the loss of N from urea can be reduced from 10% to 1% of applied N through the use of a urease inhibitor (Turner et al. 2010), although the efficiency of this reduction was reduced at higher temperature and higher soil organic C content (Suter et al. 2011).

At Birchip in 2013 (McClelland, pers. comm.) showed that N uptake from both UAN (50% urea, 50% ammonium nitrate) (streaming nozzles), urea solution (flat fan nozzles) and dry urea (top-dressed) was similar 10 days after application (DC31). However, by anthesis the UAN (streaming nozzles) and dry urea had more N in the crop than the urea solution. By maturity there were no yield differences, although the UAN and dry urea had higher grain protein contents than the urea solution.

Fluid fertilisers offer the opportunity to combine two operations, and therefore, reduce paddock traffic, as well as giving options for additional nutrients such as S or micronutrients to be applied. There are also many other factors at play rather than just selecting a N source to get more N into the crop, and then achieving a profitable yield response. However, in my opinion there would need to be compelling circumstances where expected losses are high to justify moving away from top-dressed urea, provided as the season unfolds. An important issue with using fluid fertiliser and tank mixing with micro-nutrients and crop protection chemicals is to ensure compatibility – I have included a link to some important information on this within the 'Useful resources and reference' section.

Potassium and sulphur

Low levels of potassium (K) and Sulphur (S) can show up under certain conditions. Low K is often associated with leached acid soils where K supply is low. The key diagnostic here is to look for better growth under old windrows and then tissue testing the good and bad areas. Interventions in-crop with muriate of potash (KCl) are generally successful but relatively high rates (for example, 50kg K/ha) are needed compared to using K at seeding. For sulphur, interventions with ammonium sulphate or fluid products are useful, and there is some evidence that pulses on light soils after wet years may be responsive to added S. For cereals and canola, ammonium sulphate itself supplies relatively insufficient N if the rate is set to supply S (for example, at 10kg S/ha) or relatively too much S if the rate is set to supply N (for example, 50kg N). Solid and fluid blends with N:S ratios around 10:1 will have a better balance of these nutrients

Tissue testing

In season plant nutrient status can be assessed through the use of tissue tests. These tests are most often calibrated for the youngest explanted leaf for micronutrients as this is the most sensitive tissue. The critical aspects of tissue testing and interpretation are:

- Soil and environmental conditions can affect tissue concentrations – drought, compaction, frost/cold, overcast, waterlogged, etc. Take care with interpreting low B and Zn values because they in particular can be influenced by these conditions.
- The right timing according to plant growth stage – as nutrient concentration tends to decline as plants age.
- Nutrients interact and can give false negatives or positives – so look at the whole nutrient program and not just the tissue value in isolation.

In general, tissue tests provide useful information on the nutrient status at a point in time. Best results come from an assessment of the comparative nutrient status of samples taken from good and bad patches of growth. The critical values in the literature are largely supported by recent research through the GRDC Micronutrient project led by Dr Wilhelm (DAS00146).

Useful resources and references

Doyle (2013) http://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2013/03/Liquid-Nitrogen-pros-and-cons-of-different-formulations

Extension AU Crop Nutrition community of practice - http://extensionaus.com.au/crop-nutrition/

Fernandez et al. 2013. Foliar Fertilization, Scientific Principle and Field Practices. International Fertilizer Industry Association. (http://www.fertilizer.org/HomePage/LIBRARY/Our-selection2/Fertilizer-use.html/Foliar-Fertilization-Scientific-Principles-and-Field-Practices.html

Getting chemistry in the spray tank right - https://grdc.com.au/news-and-media/news-and-media-releases/south/2015/01/getting-chemistry-in-the-spray-tank-right

Gooding and Davies. 1992. Fertilizer Research, 32, 209-222.

Gooding et al. 2007. Field Crops Research, 100, 143-154.

Micronutrient topics – IPNI ANZ http://anz.ipni.net/topic/micronutrients

McBeath et al., 2015 https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2015/02/topping-up-wheat-with-foliar-phosphorus

Suter et al. 2011. Soil Research, 49, 315-319.

Turner et al. 2010. Agriculture, Ecosystems and Environment, 137, 261-266.

Turner et al. 2012. Nutrient Cycling in Agroecosystems,93, 113-126.

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