When and how to use nitrogen fertiliser

SUMMARY

Nitrogen use has resulted in great improvements in crop yield in favourable seasons. In dry seasons too much applied nitrogen can result in haying-off and lower yields. Good guidelines are now available for nitrogen use to reduce the risk of crop failure resulting from applying too much fertiliser nitrogen.

The critical factors are:

- Stored soil water (control summer weeds)
- Measure how much nitrogen is in the soil prior to sowing
- Calculate nitrogen requirement from the target yield
- Do not pre-drill more than 60 kg/ha of urea in the 350mm rainfall zone (100kg/ha in the 450mm zone)
- Split applications are safer
- Topdress with urea if the soil test indicates a need, the crop is healthy, and the outlook is for an average to wet season

What happens to nitrogen fertiliser? Nitrogen inputs comprise a large component of total expenditure on fertilisers every year. Nitrogen fertiliser has enabled many farmers to boost their production but we have also found that in many years we do not get the yield response from nitrogen fertiliser we hoped for. In some cases crop yields are reduced as a direct result from too much applied nitrogen. How do we manage nitrogen fertiliser to optimise yield without the risk of crop failure?

Applying nitrogen to crops in the low to medium rainfall zone, on alkaline soils with subsoil limitations is always a risk. What have we learned to reduce our exposure to this risk?

METHOD

For the last three years the BCG has undertaken trials investigating the response nitrogen fertiliser on wheat. A demonstration trial with no-predrilled urea, pre-drilled urea (100kg/ha), urea broadcast prior to sowing (100kg/ha) and topdress application (100kg/ha) was sown to Frame wheat at Birchip, Sea Lake and Charlton. Each site had detailed soil analysis down the soil profile, including soil nitrate, other nutrients such as phosphorous, and limiting factors such as sodicity and boron. Soil nitrate tests were taken at the end of tillering and at harvest. Crop samples were taken during the season for dry matter production and at harvest for yield and protein.

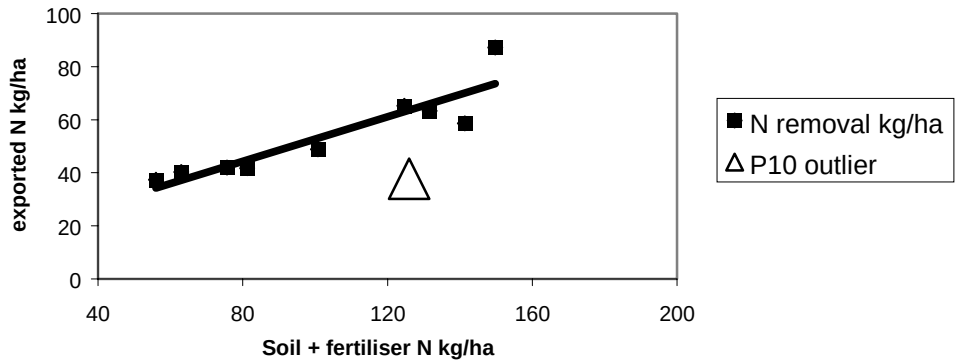
RESULTS

Farmer experience

Many farmers are now using deep soil nitrate testing prior to sowing to help with making fertiliser decisions. A successful example of deep soil nitrate testing is presented in Figure 4.2. These results are from one farm in the Southern Mallee in 1999 where ten wheat and barley paddocks were tested prior to sowing. There was an excellent correlation between available nitrogen (deep soil nitrate plus fertiliser nitrogen applied) and the amount of nitrogen removed from the paddock (calculated from the yield and protein content of the grain). One paddock (P10) did not perform and at this stage it is still not clear why this was the case.

Unfortunately, deep soil nitrate testing is not always so reliable. In some paddocks and in some years interpreting soil nitrate tests for a yield outcome does not work. In the following sections some of the reasons for this are explained and some possible solutions are provided.

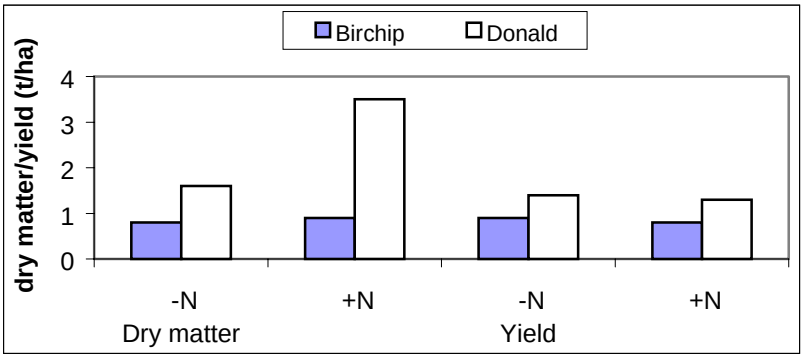
Figure 4.2 Nitrogen removal (yield x protein) plotted against available soil nitrogen for ten wheat and barley paddocks on one farm in the Southern Mallee, 1999



INTERPRETATION

A good example of how sub-soil limitations can have an influence on nitrogen uptake was seen in 1997 (Figure 4.3) at Birchip and Donald (in cooperation with the Avon-Richardson Cropping Group).

Figure 4.3 Dry matter production at flowering and grain yield for control (no nitrogen fertiliser) and predrilled wheat at Birchip and Donald.



Soil available nitrogen in the soil at Birchip was 95 kgN/ha (relatively high) and at Donald 47 kgN/ha (low for that region). 1997 was a very dry season (GSR at Birchip and Donald was 190 and 239mm respectively).

At Donald there were no subsoil limitations to growth. There was a large increase in growth under the fertilised plots, which resulted in a tripling in dry matter production at flowering. The large amount of dry matter growth dried out the soil profile by flowering. Furthermore, a dry finish to the season meant there was a large loss in potential yield under the pre-drilled treatment.

At Birchip the high soil nitrate level resulted in no response to fertiliser nitrogen in either dry matter or yield, and little uptake of soil water. The soil at Birchip contained toxic levels of boron and sodicity at 30 cm depth (B=22ppm and

sodicity=32% as ESP). Soils with high boron and sodicity restrict root growth, which in turn reduces water and nutrient uptake.

Crops grown on soils with moderate levels of available nitrogen and subsoil limitations, are unable to take full advantage of applied nitrogen in most average to below average seasons. Only in very favourable seasons with a constant water supply would extra fertiliser nitrogen benefit these crops.

At the two sites in 1998 (Birchip and Sea Lake) there were no subsoil limitations and the low nitrogen site at Birchip (42 kgN/ha) responded favourably to pre-drilled nitrogen compared to the control (2.6 versus 1.6t/ha).

At Sea Lake the site had 109kg/ha of available soil nitrogen and there was no yield response to predrilled nitrogen (2.5 and 2.3t/ha for pre-drilled and no fertiliser nitrogen respectively).

In 1999 the results of the trials indicated that there was sufficient nitrogen supply at all three sites Birchip, Sea Lake and Charlton for the crop to reach their target yields, and no yield responses to applied nitrogen were observed.

BEST BET MANAGEMENT PRACTICES FOR APPLYING NITROGEN FERTILISER

Table 4.10 Best management practices for applying nitrogen fertiliser

Criteria	Notes	Example
Target yield	Calculate target wheat yield prior to sowing based on average GSR plus stored soil water *Yield kg /ha = (GSR + Stored water – 110 evaporation) x WUE for crop*	Target yield =3.0 t/ha *Average GSR=240mm,* *Stored water=20mm,* *WUE for wheat=20kg/mm/ha*
Nitrogen requirement	Calculate the nitrogen supply requirement for the target yield from Figure 4.4	70kg N/ha
Paddock selection	Crops can only respond to nitrogen favourably if they do not suffer from weed competition or disease	
Deep soil nitrate test	Test paddocks for soil available nitrogen (late March onwards) to a depth over which the roots grow in the soil (ie. be aware of subsoil limiting factors such as boron).	50 kg available N/ha
Urea requirement	Calculate the amount of urea required *Urea required (kg/ha) = {N required (kgN/ha) - deep soil N test result (kgN/ha)} * 2*	(70 – 50) x 2 = 40 kg/ha urea required
Summer rain	For the 300 to 450mm rainfall zone calculate above average monthly summer rain. If there has been more than 50mm it is then safe to assume that there will be some stored soil water if summer weeds controlled (reducing haying-off potential)	Total of 50mm rain above monthly averages. Summer weeds were controlled in the paddock. Risk of urea resulting in haying-off is relatively small.
Split application	If the urea requirement is above 60kg/ha in the 300-350mm rainfall zone or above 100kg/ha in the 350-450mm rainfall zone – consider a split application. Pre-drill half and topdress the other half if the season is above a decile 4 by late July.	The amount of urea required to produce the target yield is below the risk level (60 kg/ha of urea), so pre-drill the full amount.
Topdress nitrogen	A crop in the 5-6 leaf stage is at its optimum stage for topdressing. Only consider topdressing if : (1) it is a decile 4 season or wetter; (2) there is some stored soil water in the profile; (3) the deep soil nitrogen test undertaken prior to sowing indicates that there will not be enough nitrogen in the soil to reach the target yield;	By mid July the season is wet (decile 7), the crop is growing well with no disease and weeds are controlled. Yield potential has increased to 3.5t/ha.Topdress with urea at 40kg/ha to reach this new target

	and (4) the crop is healthy and not suffering from disease or weed competition.	yield.

Figure 4.4 Nitrogen requirement for wheat