Nitrogen fertiliser for wheat – assessing price and weather risks

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The urea price has doubled recently and at the time of writing (mid June 2008), it costs about $1000 per tonne delivered on farm. When the cost of application is added, the total comes to at least $1100 per tonne. Since urea contains 46 per cent N, the cost of nitrogen is $2400 per tonne. With the current grain price at about $350 per tonne, the price ratio of N:grain is 6.8 – which is a little higher than the long-term average in Australia of 5.6 (Figure 1). The current ratio means that fertiliser has to return 6.8 tonnes of grain to cover the cost of one tonne of N.

A useful profit target for applying nitrogen is that the gross returns from extra grain should be twice the cost of the fertiliser plus application. So at present, grain-growers need to aim for an extra 14 tonnes of grain for each tonne of N applied. This target is feasible when all (or most) conditions are favourable for a response.

The maximum possible grain response to nitrogen is 30–40 tonnes of grain per tonne of N (depending on grain protein), but few crops give such responses.

In the late 1980s, CSIRO conducted experiments on 62 wheat crops on farms in the eastern Riverina (southern NSW) where 40–50 kg N per hectare as urea was topdressed, generally before rain. The average response was four tonnes of grain per tonne of N and only one in six experiments gave responses greater than the target of 14 to 1 (one in three experiments gave responses greater than 10 to 1).

Those proportions are probably still a guide to the proportion of crops that will give profitable responses.

NITROGEN AFTER A DROUGHT

Some previous droughts finished with good summer rains leading to rapid mineralisation and little need for fertiliser for the following crop. In many parts of eastern Australia there was reasonable rain during the 2007–08 summer. Where weeds were controlled over summer and autumn, there are higher levels of soil water and mineral N than we have seen for several years.

Checks for nitrogen response

The conditions in which wheat gives the most profitable yield responses to nitrogen are well known:

- Adequate water status;
- Early sowing;
- Minimum root and foliar disease;
- Low crop-N status;
- Adequate levels of other nutrients such as phosphorus and zinc; and,
- Reasonable plant density, good weed control and so on.

If any one of these conditions is not met, the chance of a profitable response to N is reduced. If more than one is not met, nitrogen fertiliser will probably be unprofitable.

The most obvious risk is water status. This means rainfall during the crop and stored water in the profile. It also means the ability of the crop to extract water from the whole profile. If the subsoil contains high concentrations of salt or boron, extraction of subsoil water will be limited and N response may well be low.

It's possible to estimate the N fertiliser: water supply interaction using computer models, but a simple and adequate rule of thumb may be to adapt the practice of a

TABLE 1: Examples of nitrogen budget for wheat with reasonable assumptions (left) and incorrect assumptions (right)

		Assumptions bulk density = 1.5 ammonium included	Assumptions bulk density = 1.2 ammonium excluded
		kg N/ha	kg N/ha
Crop N demand			
	Target yield 3.5 t/ha		
multiplied by	Target protein 12%		
multiplied by	Correction factor 2.34*	98	98
Soil supply			
Deep soil test at sowing			
	Nitrate-N 10 ppm		
	Ammonium-N 1 ppm		
multiplied by	Number of 10 cm layers		
multiplied by	Soil bulk density	99	72
add	In-crop mineralisation	80	80
equals	Gross N supply	179	152
less	Assuming 50% not recovered	90	76
	Net N supply	89	76
Fertiliser N requirement			
Crop demand less soil supply	Net extra N needed	9	22
	Fertiliser N needed (assuming 50% recovery)	18	44

*The correction factor of 2.34 is calculated from (10 x 1.33/5.7) where 10 accounts for the percentage and the conversion from t/ha to kg/ha; 1.33 accounts for the around 1/3 of N in the straw; and, 5.7 converts protein to N.

John Angus advocates a realistic appraisal of crop response to any applied nitrogen.

wheatgrower in the central west of NSW who topdresses N fertiliser only when seasonal rainfall is twice the average.

Getting nitrogen budgets right

A simple way to calculate the balance between crop-N demand and soil-N supply is with a nitrogen budget. Versions of this approach have been used in Australian cropping for at least 15 years. It is worth revisiting this approach because of the possibility of compounding errors.

In the example in Table 1, you can see how two small errors on the input side can lead to a 100 per cent error in calculating N fertiliser requirement.

One error is to underestimate bulk density, which is the weight of dry soil in a known soil volume. It is important to get this value right because it is multiplied by the concentration of mineral N in calculating kg per hectare.

Some N budgets use a value of bulk density of 1.2 g per cm^3 but many Australian topsoils have a bulk density of at least 1.3–1.4 g per cm^3 in the topsoil and at least 1.5 g per cm^3 below 20 cm.

A less serious error is to ignore the amount of ammonium in soil. Ammonium is formed as an intermediate step in the process of mineralisation of organic matter to nitrate. In most soils it is present at about 10 per cent of the nitrate concentration. For on-farm tests, it is adequate to just add 10 per cent to the nitrate-N value rather than pay for a separate ammonium analysis.

But ammonium data can be useful because high values show problems that may indicate that samples are from urine patches or that the samples were left to stew in plastic bags on the back of a ute for a few days. The answers are to take plenty of samples, avoid stock camps and keep the samples cool.

In the example in Table 1, the combined error in estimating kg per hectare of available N is about 25 per cent. When expressed as the fertiliser-N requirement this error balloons to over 100 per cent.

Nitrogen fertiliser in context

The use of N fertiliser on wheat shot up during the 1990s, partly because of the favourable seasons and also because of the improved responses when root disease was controlled by break crops. After the recent droughts, few growers have been tempted to topdress N on wheat crops.

If or when there is a good season, it may be profitable to apply N fertiliser again but only when all conditions favour large responses. ■

FIGURE 1: Nitrogen cost and grain price (in year 2000 dollar values) and the nitrogen/grain price ratio