

Monitoring nitrogen use efficiency in cotton crops

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Increasing nitrogen (N) fertiliser costs and increased focus on greenhouse gas emissions have prompted greater attention to the efficient use of N fertilisers. Cotton growers and consultants recognise the importance of these issues as well as

the need to optimise fertiliser inputs to meet the nutritional requirements of high-yielding cotton crops. Recent studies have shown that N fertilisers can be used much more efficiently within the Australian cotton industry than they are currently being used.

For the second season, the Cotton Nutrition Research Group and the Soils and Nutrition Priority Team (made up of members of the National Cotton Extension Team) monitored nitrogen use efficiency in several regions during the 2007–08 cotton season.

We determined crop N use efficiency (NUE) in 23 commercial cotton crops within in six valleys in the 2007–08 season. We compared these measurements using a relationship formulated over the past five seasons in a cropping systems experiment at Narrabri.

Crop Nitrogen Use Efficiency (NUE)

This is determined by dividing the lint yield by the crop N uptake (for example, kg lint produced per kg N uptake). This indicates how effectively a crop produces

lint yield from the N that it has accumulated. The crop NUE does not discriminate between soil N or fertiliser N sources but it does give some insight into whether inadequate, sufficient or excessive amounts of N fertiliser were applied.

Crop N uptake refers to the amount of N (kg N per hectare) taken up and contained in the crop. Measuring crop N uptake involves taking one square metre of crop (whole plants) after cut-out and approximately three weeks before defoliation (about 20–25 per cent bolls open) and before leaf starts to drop. These plants are then dried, weighed, milled and analysed for N content. This process is very time-consuming and labour-intensive.

NUE – what value are we aiming for?

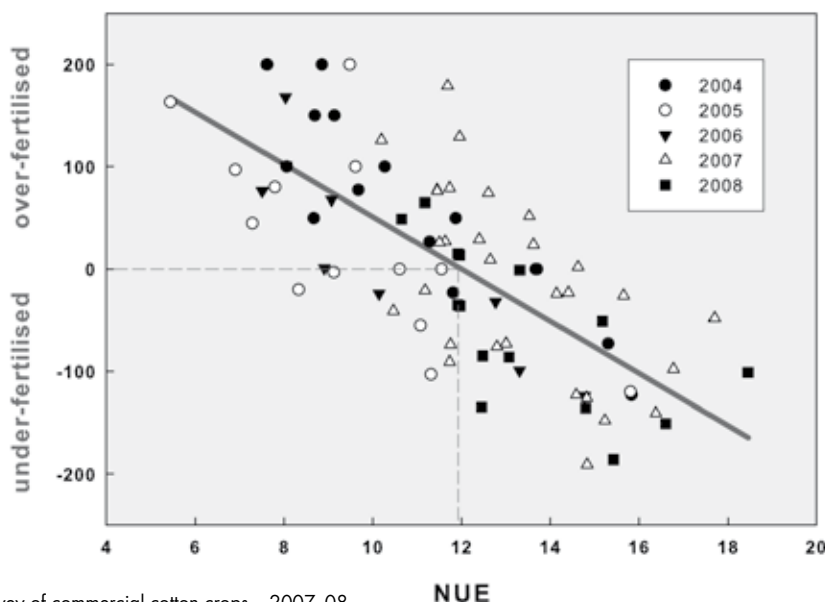
A relationship between N fertiliser use and NUE (Figure 1) has been determined from the past five years' data of a long-term cropping systems experiment at ACRI. Earlier results were published in *The Australian Cottongrower* magazine in December 2006 and August 2007.

Crop NUE of between 10.9 and 12.9 indicate that N fertiliser rate was sufficient. Values less than 10.9 indicate excessive rates of N fertiliser may have been applied. Values greater than 12.9 indicate

SUMMARY

- We measured crop N use efficiency in 23 cotton crops in six regions.
- N use efficiency was high in one crop (under-fertilised), optimal in 11 crops and low in 11 crops.
- Low N use efficiency is a consequence of excessive N fertiliser application.
- About 50 kg N/ha too much N fertiliser was applied, averaged over all crops monitored.
- Half the crops examined were over-fertilised by an average 90 kg N/ha.
- Growers can avoid over-fertilising high fertility fields by testing soil before N fertiliser is applied: the NutriLOGIC program can help determine the optimum N fertiliser rate.

FIGURE 1: Crop N use-efficiency (NUE) measured in a crop rotation experiment at Narrabri where numerous N fertiliser rates (0–200 kg N/ha) were applied to identify the optimum N fertiliser rate – over-fertilised crops have low NUE whereas under-fertilised crops have high NUE



Survey of commercial cotton crops – 2007–08



The average crop was over-fertilised by 50 kg N per hectare.

insufficient N fertiliser may have been applied, that the crop was drought-stressed or another nutrient deficiency limited crop growth.

We determined the crop NUE and estimated the N fertiliser requirement for each commercial cotton crop, as shown in Table 1. We used the relationship in Figure 1 to determine whether the crop was under or over-fertilised with N.

N use efficiency (NUE)

As in 2007, most of the commercial crops surveyed were to some degree over-fertilised with N. Only those crops deliberately unfertilised showed high NUE. Compared with 2007, crop DM and N uptake were 16 per cent higher, yield was nine per cent higher but NUE was five per cent lower, indicating that in 2007–08, crops were more over-fertilised than in 2006–07. Several crops exceeded the ideal crop N uptake figure (200–250 kg N per hectare) that is sufficient for maximum lint yield.

N fertiliser excess or inadequacy

This survey indicated that there is scope to improve N use efficiency industry wide: we can safely reduce N fertiliser inputs by 15–25 per cent. One-half of the crops surveyed had excessive amounts of N applied (90 kg N per hectare too much on average). The lowest NUE indicated the crop was over-fertilised by 125 kg N per hectare. This would add more than \$200 per hectare to the grower's input costs. By reducing N fertiliser inputs to cotton crops, we may improve yields while reducing costs and substantially improve gross margins.

Excessive N fertiliser application in-

FIGURE 2: Cottonseed N content is related to crop N use efficiency – excess N taken up by the crop can be stored in the seed

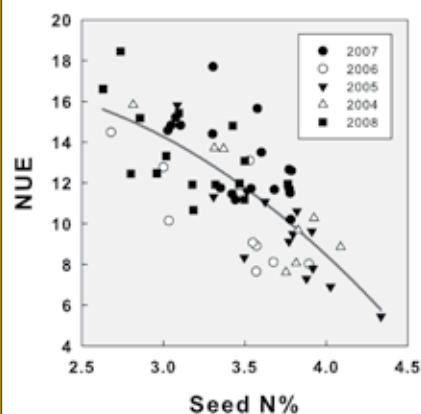


TABLE 1: Crop dry matter (DM), crop N uptake, lint yield, N use efficiency (NUE) and estimated amounts of N fertiliser (kg N/ha) applied in excess (or insufficiency) for 23 cotton crops examined in 2008

Valley	Crop DM t/ha	N uptake kg N/ha	Lint b/ha	Lint kg/ha	NUE kg/kg	Fertiliser excess
Emerald	14.2	241	9.4	2125	8.8	81
	8.0	184	8.4	1901	10.4	41
	13.9	312	9.8	2215	7.1	125
	10.5	261	9.8	2215	8.5	89
	10.9	244	9.4	2131	8.7	82
	8.5	130	6.1	1385	10.7	33
	8.0	158	9.4	2124	13.5	-39
	12.6	281	8.4	1906	6.8	133
(unfertilised)	9.2	133	8.4	1906	14.4	-63
Macintyre	14.4	256	10.5	2378	9.3	68
	16.0	320	11.8	2681	8.4	92
	13.9	250	12.0	2732	10.9	26
	15.4	182	10.9	2468	13.6	-42
(unfertilised)	10.0	134	9.9	2244	16.8	-125
	13.9	266	13.1	2965	11.1	21
Gwydir	13.7	303	11.3	2565	8.5	90
Namoi	10.5	183	8.08	1834	10.0	49
	9.6	212	8.32	1889	8.9	78
	11.4	255	12.85	2917	11.4	13
	13.0	284	12.40	2814	9.9	52
	12.0	224	11.80	2679	12.0	-1
Macquarie	13.1	255	10.8	2445	9.6	61
	13.1	338	13.1	2977	8.8	81
Murrumbidgee	14.3	268	12.9	2928	10.9	26
All sites	12.4	244	10.4	2366	10.0	51
2007	10.6	211	9.5	2166	10.5	39

creases the emission of greenhouse gases (especially nitrous oxide) from fields. In the near future, the price of N fertiliser may include a 'carbon tax' to account for greenhouse gas emissions.

The appropriate N fertiliser rate for cotton can be predicted by soil testing and using a tool such as NutriLOGIC. Your local extension officer can help if you are not familiar with this technology. It is critical to determine if soil N levels have built up over time, especially where high N fertiliser rates have been used in the past.

FUTURE RESEARCH

Because the measurement of crop NUE is time-consuming and labour-intensive, we have investigated alternative means of determining NUE. Fortunately, the N concentration in cotton seed is closely related to crop NUE (Figure 2).

If it was possible to test fuzzy seed (at the gin) for N concentration, NUE could be very quickly and easily estimated and growers informed of their apparent use of N fertiliser. No commercial laborato-

ries are currently able to offer this service – they would first need to gin a sample of seed cotton.

Alternatively, use could be made of satellite imagery. A collaborative effort is being made to correlate our data with satellite images taken through the growing season. This research is in its infancy but shows some promise.

The NUE monitoring program is continuing through the 2008–09 cotton season in most areas. This data will be published later in 2009. If you are interested in this nitrogen use efficiency assessment program, please contact your local Regional Cotton Extension Officer.

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Thanks to Jo Price, Merry Errington and Kellie Gordon for technical assistance, the many cooperating consultants and growers who allowed access to their crops and to CRDC and CRC for funding this research.