

# Monitoring nitrogen use efficiency in your region

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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 nitrogen fertilisers. These issues and the need to optimise fertiliser inputs to meet crop requirements have also increasingly been identified as priorities in feedback from cotton growers and consultants. So, how efficiently are nitrogen fertilisers currently being used in the Australian cotton industry?

The Cotton Nutrition Research Group and the Soils and Nutrition Priority Team (made up of members of the National Cotton Extension Team) initiated a nitrogen use efficiency monitoring program in several regions during the 2006–07 cotton season to gain some understanding of current nitrogen use efficiencies.

## WHAT DID WE DO?

At various sites in the Namoi, Gwydir, Macintyre and Central Queensland regions, we measured the crop N uptake, crop N use efficiency and N fertiliser recovery, as described below. These measurements were compared using a relationship formulated from separate cropping systems experiments.

Crop N uptake refers to the amount of N (kg N/ha)

## SUMMARY

- We measured N use efficiency in 34 cotton crops in 5 valleys.
- N use efficiency values were high in 2 fields, optimal in 8 fields and low in 17 fields.
- Low N use efficiency values were a consequence of excessive N fertiliser application.
- Averaged over all sites, about 40 kg N/ha too much N fertiliser was applied.
- The data indicated that there is considerable scope to reduce N fertiliser inputs to cotton fields without reducing yields.
- It is important to determine the appropriate N fertiliser rate using soil testing and a tool such as NutriLOGIC.

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 (at about 10–15 per cent bolls open) and before leaf starts to drop. These plants are then dried, weighed, ground and analysed for N content.

## Crop nitrogen use efficiency (NUE)

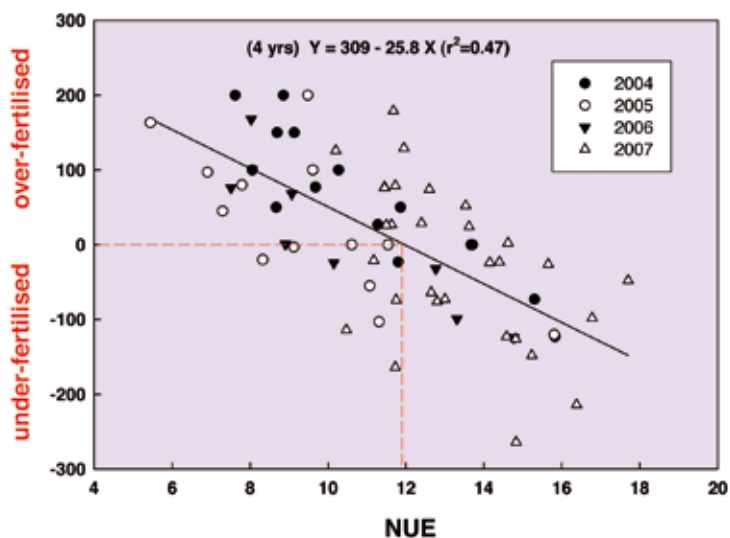
This indicates how effectively a crop produces lint yield from the N that it has accumulated. The crop NUE measurement does not discriminate between soil N or fertiliser N sources and is therefore independent of how much N fertiliser was applied. It indicates how efficiently the cotton crop uses all N sources available to it.

It is measured by dividing the lint yield by the crop N uptake (that is, kg lint produced per kg N uptake). So crop N uptake and crop yield must be determined. This is a detailed way of assessing how efficiently N is used by cotton and can indicate where inadequate, sufficient or excessive amounts of N fertiliser have been applied.

## Nitrogen fertiliser recovery (NFR)

This indicates how well a crop uses the N fertiliser that has been applied. This is the proportion of the applied N fertiliser that is taken up by the crop, expressed as a percentage of that applied. It is calculated by taking the difference in crop N uptake between fertilised and unfertilised cotton, divided by the rate of fertiliser applied. This requires a zero-N fertiliser strip (plot) in the field being monitored.

**FIGURE 1: Crop N use-efficiency (NUE) measured in a separate crop rotation experiment where numerous N fertiliser rates were applied — over-fertilised crops have low NUE whereas under-fertilised crops have high NUE**



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**TABLE 1: Crop dry matter (DM), crop N uptake, lint yield, N use-efficiency (NUE) and N fertiliser recovery (NFR – where different N rates were applied) and estimated amounts of N fertiliser (kg N/ha) applied in excess (or insufficiency) for 34 cotton fields, of which seven were Pima crops**

Valley	N rates applied	Crop DM t/ha	N uptake kg N/ha	Lint b/ha	Lint kg/ha	NUE kg/kg	NFR %	Fertiliser excess
<b>EMERALD</b>		18.5	289	11.5	2611	9.0		76
		16.8	359	11.2	2542	7.1		126
		9.4	208	10.4	2361	11.3		16
		13.8	238	9.6	2179	9.2		72
		9.6	144	9.9	2247	15.6		-95
		11.2	268	8.3	1884	7.0		127
		11.6	151	8.3	1884	12.5		-13
		9.2	163	9.3	2111	13.0		-26
	<b>mean</b>	<b>12.5</b>	<b>227</b>	<b>9.8</b>	<b>2227</b>	<b>10.6</b>		<b>36</b>
<b>MACINTYRE</b>		10.9	190	10.1	2297	12.1		-2
<b>GWYDIR</b>	0 N	10.3	219	8.6	1952	8.9	-	
	160 N	12.6	217	8.6	1953	9	-2	77
	320 N	8.7	210	9.6	2173	10.4	-3	42
		6.2	162	7.9	1790	11.1		24
		13.6	261	13.4	3051	11.7		7
		13.7	276	12.5	2847	10.3		43
	0 N	4.0	60	5.5	1256	20.9	-	
	180 N	6.8	144	5.5	1243	8.6	47	87
		10.4	250	7.5	1696	6.8		134
	<b>mean</b>	<b>9.6</b>	<b>200</b>	<b>8.8</b>	<b>1996</b>	<b>10.9</b>		<b>59</b>
<b>Pima</b>		14.1	318	5.0	1132	3.6		?
		9.1	155	4.3	975	6.3		?
		9.1	211	5.8	1325	6.3		?
		11.3	235	6.0	1354	5.8		?
		14.3	346	7.8	1771	5.1		?
		19.5	349	8.6	1950	5.6		?
		10.3	236	8.6	1950	8.3		?
	<b>mean</b>	<b>12.5</b>	<b>264</b>	<b>6.6</b>	<b>1494</b>	<b>5.9</b>		
<b>NAMOI</b>		10.5	218	10.1	2292	10.5		38
		9.5	180	8.7	1976	11		26
		7.0	166	7.4	1668	10		50
		11.7	241	9.8	2225	9.2		71
		12.3	256	9.8	2225	8.7		85
		13.0	246	11.1	2520	10.2		45
		6.1	105	9.1	2066	19.7		-199
		11.1	208	11.8	2679	12.9		-24
	<b>mean</b>	<b>10.2</b>	<b>203</b>	<b>9.7</b>	<b>2206</b>	<b>11.5</b>		<b>12</b>
<b>MACQUARIE</b>		13.8	258	12.7	2883	11.2		21
		15.4	311	12.0	2724	8.8		83
		10.7	237	9.0	2043	8.6		87
		14.2	259	12.2	2769	10.7		33
	<b>mean</b>	<b>13.5</b>	<b>266</b>	<b>11.5</b>	<b>2605</b>	<b>9.8</b>		<b>56</b>

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### NITROGEN USE-EFFICIENCY — WHAT IS OUR TARGET?

It is important to outline our targets for NUE before we discuss the results of our survey. Results from the past four years of a long-term cropping systems experiment at ACRI have been used to develop a relationship between fertiliser use and nitrogen use-efficiency (Figure 1).

Earlier results were published in *The Australian Cottongrower* magazine in December 2006. Crop NUE values between 11 and 13 indicate that N fertiliser rate was sufficient. Values less than 11 indicate excessive rates of N fertiliser may have been applied. Values greater than 13 indicate insufficient N fertiliser may have been applied, that the crop was drought stressed or another nutrient deficiency limited crop development.

### WHAT DID WE FIND?

We determined the crop NUE and NFR and estimated the N fertiliser requirement for the commercial cotton crops, as shown in Table 1. We used the relationship in Figure 1 to predict the N fertiliser requirement from the crop NUE value.

Our survey fields covered a wide range of yield levels. Many crops yielded well as they were planted in fallowed fields and the growing season was long. But some important trends in N fertiliser use have emerged.

#### N uptake

Research over many years has shown that 200–250 kg N/ha crop N uptake is sufficient to maximise lint yields. But N uptake beyond this level will reduce NUE. Many of the crops in our survey exceeded 250 kg N/ha N uptake.

#### N use efficiency (NUE)

Obtaining the optimum NUE value of 11.8 kg lint/kg N uptake can be difficult, given the variability in growing conditions between seasons. About two-thirds of the crops had NUE values less than 11 (some as low as 6.8), but only seven per cent had NUE values more than 13. Eight of the 27 crops had optimum NUE values (11–13). The crop with very high NUE in the Namoi showed symptoms of poor P nutrition and slow crop growth — it took up inadequate amounts of N because of this.

#### N fertiliser excess or inadequacy

This survey indicates that nine sites had sufficient N, two had inadequate N and 16 sites had excessive amounts of N. Averaged over all the sites (excluding the zero N plots), about 40 kg N/ha was applied in excess of the amount required by cotton. This will add about \$50 per hectare to the grower's input costs. So there is scope to improve N use efficiency industry wide, and possibly reduce N fertiliser inputs by about 15 per cent.

Most of the cotton fields chosen by the extension team were either adequately or over-fertilised with N. Excessive N application results in N losses and waste of

money as N not used by the crop may be lost from the soil. By reducing N inputs to fields with poor N use-efficiency, we may improve yields while reducing costs and substantially improve gross margins.

Low NUE results from excessive N fertiliser application which increases the risk of enhancing greenhouse gas emissions (especially nitrous oxide) from cotton fields. This can be corrected by determining the appropriate N rate by soil testing and using a tool such as NutriLOGIC to predict the appropriate N fertiliser rate for cotton.

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, especially where high N fertiliser rates have been used in the past.

#### N fertiliser rate trials

The N rate trials in the Gwydir valley show different responses to N fertiliser. In the first trial, crop N uptake was not increased with the addition of N fertiliser (there was already enough N in the soil) and lint yield was not increased by N addition. So N fertiliser recovery (NFR) was very low in this trial — the N applied was not used and much of this N may have been lost from the soil.

The second N rate trial in the Gwydir was affected severely by limited water. But crop N uptake was increased with N fertiliser and about 47 per cent of 180 kg N/ha applied was recovered by the crop, although lint yield was unchanged.

#### Pima crops

The Pima crops took up more N than most of the up-land cotton crops, but yielded considerably less. So the NUE values were substantially lower for Pima and there needs to be a separate NUE calibration for this species.

### WHERE TO FROM HERE?

We plan to continue nitrogen use efficiency monitoring during the 2007–08 cotton season and obtain data for each region so that the best N management practices are identified and extended to the rest of the industry. We will be conducting on-farm experiments to achieve this. If you are interested in this nitrogen use efficiency assessment program, please contact your local Regional Cotton Extension Officer. We are also working on a revised methodology to allow growers to assess NUE on each field at a small cost.

Reinvestment into regional cotton extension by the Cotton Research and Development Corporation has resulted in the recruitment of Regional Cotton Extension Officers for most cotton-growing regions.

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**Gwydir: Julie O'Halloran 02 6750 6308**

**Macintyre: Rod Gordon 07 46716711**

**St George: Dallas King 0427 635 621**

**Darling Downs: Kate Charleston 07 4669 0815**

**Central Queensland: Doug Sands 07 4983 7403**

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