GETTING NITROGEN BUDGETS TO MATCH COTTON CROP REQUIREMENTS

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PHOTO: **Block B at the IREC Field Station, 4 March 2022. The photo shows where the crop is greener (in the centre of the photo) as a result of a slow-release nitrogen trial last season. The nitrogen applied last year is becoming available this season and benefitting the crop.**

QUICK TAKE

- **Know your soil and conduct pre-season soil tests.**
- **Set a realistic yield target and do a simple nitrogen budget.**
- **Split applications of nitrogen show the highest gross margins.**
- **Over-supply of nitrogen after cut-out, leads to a lint yield penalty, delays maturity and reduces fibre quality.**

The More Profit from Nitrogen project showed that only 17% of nitrogen taken up by the cotton crop was derived from fertiliser and the remaining 83% was supplied by the soil. Doing a nitrogen budget for individual fields is critical to set up cotton to reach potential yields and achieve better fertiliser use efficiency.

NITROGEN fertiliser is one of the key production drivers in irrigated cotton production in Australia, with an average application rate of 275 kg N/ha across the industry and some fields receiving as much as 500 kg N/ha. With the cost of urea trebling in recent months, nitrogen now represents a significant proportion of growing costs. Ensuring the efficient use of this expensive input is critical for profitability.

Losses from the system

Good nitrogen management starts with understanding how nitrogen can be lost from the field. These pathways include:

- *leaching* below the root zone
- *volatilisation* through gaseous loss of fertiliser to the atmosphere
- *denitrification* through gaseous loss due to prolonged waterlogging
- *runoff* from heavy rainfall and long irrigation run times.

Nitrogen losses can be minimised to a large extent through good irrigation management practices and correct timing and placement of nitrogen fertiliser. Tracking of nitrogen levels in the plant through petiole sample from early squaring to peak flowering to establish trendlines also helps to make topdressing decisions.

The More Profit from Nitrogen project also looked at the interaction between nitrogen and phosphorus. Applying nitrogen pre-plant vs in-crop improved the phosphorus response, potentially due to improved early root exploration. It is best practice to apply phosphorus and potassium early before the crop is planted and mix thoroughly in the plant line.

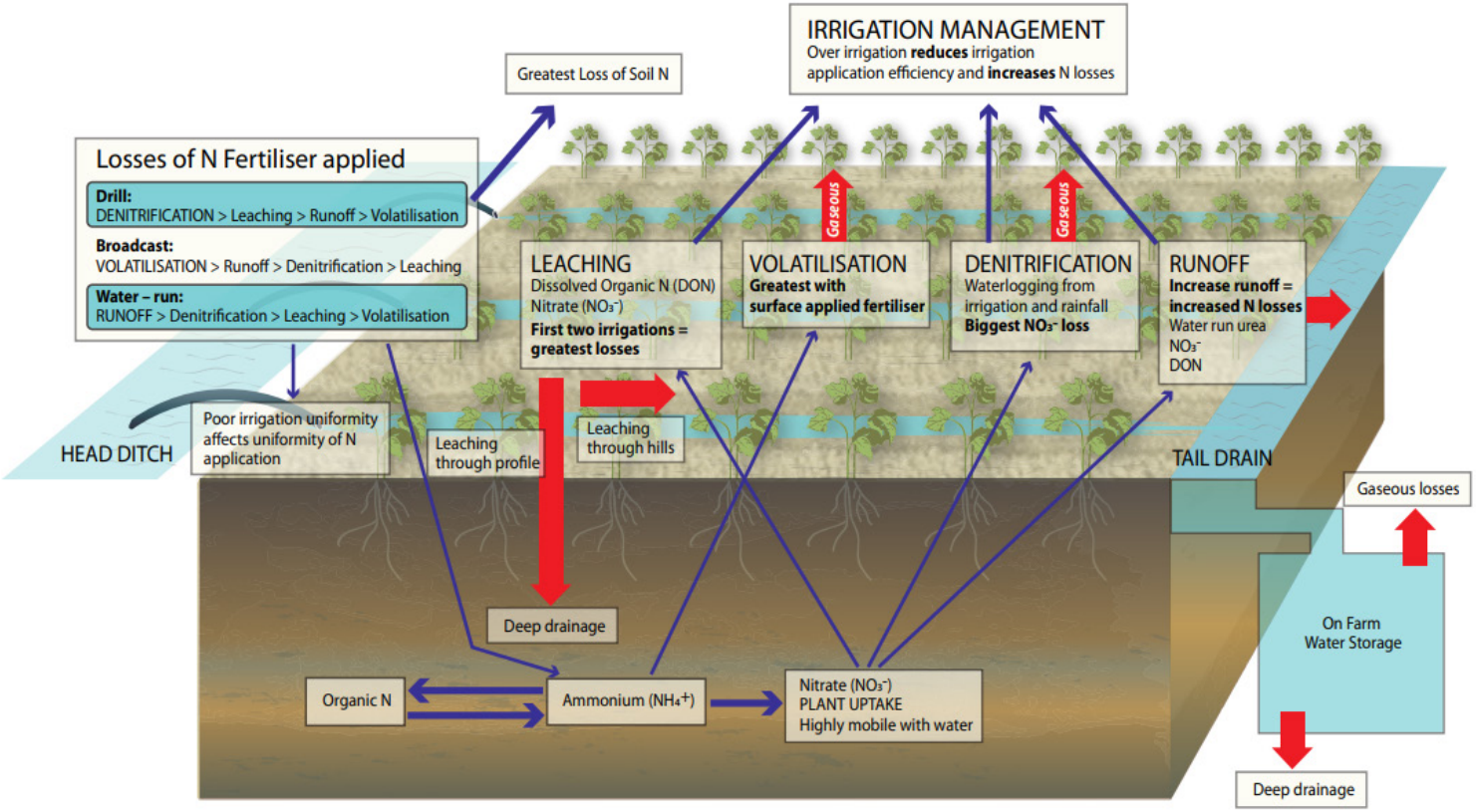

Figure 2. Potential loss pathways of nitrogen from the field. SOURCE: CottonInfo

The nitrogen budget sheet

The first step to efficient use of nitrogen fertiliser is to conduct soil tests (0 to 30 cm and 30 to 60 cm), with adequate core samples, before fertiliser decisions are made. Research by Queensland University of Technology, as part of the More Profit from Nitrogen project, indicated that on-farm sampling techniques could be improved. Often the number of cores taken from a paddock was inadequate to properly account for variability in the paddock. Variability across the paddock leads to large differences in soil characteristics and is likely one of the root causes of a general lack of trust in soil testing – with a poor sampling technique, the soil sample may not be 'typical'.

Growers frequently plan their nitrogen fertiliser program for the season based on a standard 'recipe' rate of nitrogen fertiliser, which has not discounted the nitrogen already in the soil. Often, these 'recipe nitrogen rates' are well in excess of that needed by the crop yields being achieved, and it is likely that the farm yields are not being constrained by a deficiency of nitrogen but rather, other soil, plant, disease or weather-related factors.

Once a realistic target yield is set for individual fields a simple calculator spreadsheet (Table 1) can be used to determine the amount of fertiliser nitrogen to apply to meet demand.

Table 1. A nitrogen budget spreadsheet for 3 blocks of irrigated cotton, IREC Field Station, Whitton, 2021.

Crop and soil details		Field		
		B block	C block	D block
Yield target (NSW)	bales/ha	11	12	12
Nitrogen removal rate	kg N/bale	12	12	12
Total nitrogen removal	kg N/ha	132	144	144
Nitrogen required (efficiency)	kg N/ha	**330**	**360**	**360**
Shallow soil NO_3 (0–30 cm) (soil sampled 12 Aug 21)	mg/kg	3.7	4	35
Shallow soil bulk density	g/cm³	1.35	1.35	1.35
Deep soil NO_3 (30–60 cm) (soil sampled 12 Aug 21)	mg/kg	3.9	3.9	51
Deep soil bulk density	g/cm³	1.35	1.35	1.35
Organic carbon	%	0.8	0.8	0.9
Starting moisture	mm	100	100	100
Water applied to end Feb	mm	800	800	800
In-crop rainfall to end Jan	mm	150	150	150
Soil nitrogen present	kg N/ha	31	32	348
Mineralisation	kg N/ha	118	120	134
Total soil nitrogen available	kg N/ha	**149**	**152**	**482**
Nitrogen surplus (deficit)	kg N/ha	(-181)	(-208)	122
Fertiliser nitrogen required	**kg N/ha**	**181**	**208**	**0**

Timing of application

The majority of nitrogen (55%) taken up by the cotton plant is during the flowering stage (Figure 1) so the timing of the fertiliser application should ensure that nitrogen is available by this stage.

The More Profit from Nitrogen project looked at different timings of applying fertiliser nitrogen. Measured over two seasons, the research found no significant yield difference between different combinations of pre-plant and in-crop nitrogen applications. However significant yield differences were found between all up-front timings and the 70:30 split and the 30:70 split in the second year. The 100:0 timing yielded less than the 70:30, 30:70 and 0:100 timing.

Partial budget gross margin analysis indicated a $544/ha gain from both the 30:70 and 70:30 split (Table 2).

Table 2. Partial gross margin budget of 4 separate fertiliser application treatments, which were combinations of up-front and split in-crop nitrogen (N) applications.

Treatment	Lint yield (bale/ha)	Revenue ($/ha)	N application cost ($/ha)	Lost N from field ($/ha)	Partial budget GM ($/ha)
100% up-front	15.2	$7,600	$40	$53	$2,825
70:30	16.3	$8,150	$58	$42	$3,368
30:70	16.3	$8,150	$70	$29	$3,369
100% in-crop	15.7	$7,850	$18	$21	$3,123

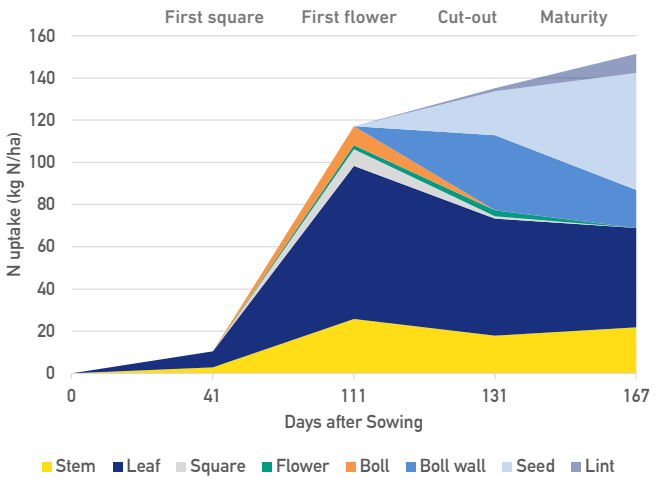

Figure 1. The uptake of nitrogen by different components of the crop

While in-crop nitrogen applications can reduce fertiliser losses compared with pre-plant applications, growers should not over-apply fertiliser nitrogen late in the developing crop. Two research field experiments and a commercial farm case study all showed that when fertiliser nitrogen was applied after cut-out there was a lint yield penalty and nitrogen uptake by the cotton was very low. There was no improvement in boll retention higher in the plant and no increase in boll weight compared to treatments where nitrogen fertiliser was applied earlier in-crop (by early bolls) or pre-plant. Application of nitrogen fertiliser late in-crop delayed plant maturity, increased trash load of picked samples and reduced lint fibre quality.

Conclusion

While difficult to predict yield and conditions prior to the season, nitrogen fertiliser rates should be aligned with realistic yield potential, nitrogen already in the soil and long-range seasonal forecasts. Nitrogen fertiliser rates of more than 200–240 kg N/ha do not increase yields – other factors are limiting yields.

Nitrogen fertiliser use efficiency gains can be made by improved nitrogen timing, better nitrogen budgeting to account for residual soil nitrogen and soil nitrogen mineralisation from organic matter.

References and further reading

This article draws from the following references:

Spotlight magazine - Autumn 2022 | CRDC | pp 12-16

More profit from nitrogen – Enhancing nutrient use in cotton (final report)

Note – A simple N budget spreadsheet is available from the author

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