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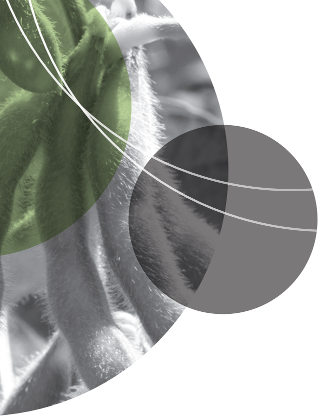

# Cotton

## Effects from nitrogen fertiliser timing and irrigation deficit on irrigated cotton – Narrabri 2017/18

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### Key findings

- Spilt application of nitrogen (N) fertiliser increased lint yield in cotton for two differing irrigation deficits compared with the entire amount of N being applied pre-plant.
- Applying the total N fertiliser pre-plant increased N loss from the field via the tail water.
- The 70 mm irrigation deficit had a greater effect on lint yield than the 50 mm deficit.
- The 70 mm deficit with a split N application had the highest irrigation water use efficiency (IWUE).

### Introduction

The experiment investigated management strategies to improve nitrogen use efficiency (NUE) within Australia's cotton industry. Yield, N uptake, plant growth response and N loss in tail water were compared under various N fertiliser application timings.

### Site details

| | |
|---|---|
| **Location** | Australian Cotton Research Institute, Narrabri |
| **Soil type and nutrition** | The soil type at the Narrabri research site is a self-mulching grey vertosol with low sodicity<br>Pre-season N was applied as urea at 30 cm under the plant line. In-crop N was applied as broadcast urea followed by irrigation 1–2 days after broadcasting<br>The plant available water content (PAWC) was 220 mm to 120 cm deep, which is representative of northern Australia's cotton growing soils. While the trial site had low sodicity, it is common for northern NSW cropping soils to be sodic at depth, which can affect PAWC |
| **Seasonal weather** | The 2017/18 growing season received 2338 day degrees (cumulative temperature >15 °C and <35 °C) and 210 mm rainfall from November 2017 to March 2018<br>There were six 'cold shock days' (min temp <11 °C) and 62 'hot days' (max temp >36 °C). This is approximately half the long-term site average number of cold days per season (10) and twice the long-term average of hot days (32) |
| **Trial design** | Randomised split-plot design; with irrigation deficit the main plots and N fertiliser timing as the sub-plots with three replications. Each plot was 8 m wide (8 rows) and 130 m long |

| | |
|---|---|
| Sowing date | 28 October 2017 |
| Fertiliser | Each N treatment received 244 kg/ha of urea (46% N). The N rate was chosen after pre-season soil testing to give a total available N of 200 kg N/ha (0–90 cm depth) |
| Cultivar | Cotton Seed Distributers (CSD) Sicot 748B3F |
| Plant population | Plant establishment14 plants/$m^2$ |
| Insect management | 15 January 2018: Transform® (240 g/L sulfoxaflor) 300 mL/ha<br>20 February 2018: Admiral® Advance (100 g/L pyriproxyfen) 500 mL/ha |
| Harvest date | 14 April 2018. The central four rows were picked using a 4-row picker fitted with calibrated weigh-scales |

## Treatments

### N fertiliser application timings

- 100% pre-plant: applied in August 2017
- 70:30% split: 70% applied August and 30% applied in December 2017
- 30:70% split: 30% applied in August and 70% applied in December 2017
- 100% in-crop: applied in December 2017

### Irrigation schedule deficits

- 50 mm deficit: 9.8 ML/ha (11 irrigations applied)
- 70 mm deficit: 8.4 ML/ha (8 irritations)

## Results

### Lint yield

Both the irrigation deficit and the N timing treatment affected lint yield. The 50 mm irrigation deficit increased cotton lint yield by 0.81 bales/ha compared with the 70 mm irrigation deficit. Lint yield was also affected by N fertiliser application timing. Where 100% of the N was applied up front, the crop yielded was lower than the other three N treatments, which did not differ from each other (Figure 1). There was no interaction between irrigation deficit and N timing treatments.

The high day degrees accumulated in 2017/18 provided optimal long season growing conditions for the intensive irrigation deficit (50 mm) and the in-crop N application treatments. Cooler seasons that have low day degree accumulation or have earlier seasonal frosts can reduce the yield potential of the intensive deficit and the later in-crop N application treatments.

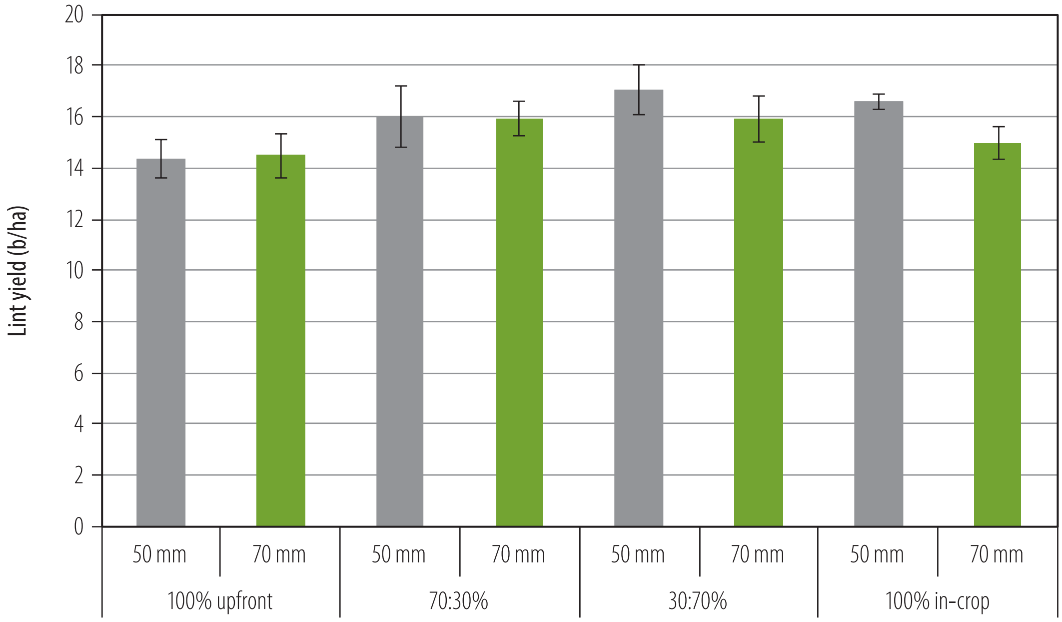


Figure 1. Lint yield for the various N applications at Narrabri. Error bars signify standard error about the means. The l.s.d. for the deficit treatment was 0.58 bale/ha, and for N timing it was 1.41 b/ha.

### Water use efficiency

The crop water use (= applied water + rainfall + starting moisture – ending moisture) of the two irrigation deficits were monitored regularly throughout the growing season. Measurements were taken using an EM38 MkII, an electromagnetic device, where soil moisture is calibrated using soil core samples and neutron probe recordings.

The 50 mm deficit had a greater crop water use and a lower irrigated WUE (applied water/lint yield) However, there was no difference in production or economic WUE due to the higher lint production from the 50 mm deficit treatments (Table 1)

Table 1. Experiment water use efficiency.

| Deficit treatment | Irrigations applied | Applied water (ML) | Crop water use (mm) | Irrigated water use efficiency (bales/ML) | Production water use efficiency (bales/ML) | Economic water use efficiency ($/ML) |
|---|---|---|---|---|---|---|
| 50 mm | 11 | 9.8 | 994 | 2.3 | 1.7 | 725 |
| 70 mm | 8 | 8.4 | 868 | 2.9 | 1.9 | 875 |
| Probability | | | <0.05 | <0.05 | ns | ns |

### Plant growth response

The two irrigation deficits had no statistically significant effect on plant height, however, applying all nitrogen pre-plant increased plant height compared with split N or 100% in-crop treatments (Table 2). Increasing cotton plant height did not necessary equate to higher yields. These results show that delaying some or the entire N application meant more plant energy was used in reproductive lint production rather than growing excessive vegetative matter.

There was no effect from the irrigation deficit or N timing treatments on fruiting nodes or the total bolls produced by the plants However, the treatment affected boll retention in the first position of a branch.

Table 2. Cotton plant response to nitrogen application treatments and irrigation deficits.

| Nitrogen treatment | Irrigation deficit | Plant height (cm) | Nodes | Fruiting nodes | 1st position boll number | Total boll number/plant |
|---|---|---|---|---|---|---|
| 100% pre-plant | 50 mm | 103.7 | 23.9 | 16.5 | 8.4 | 10.4 |
| | 70 mm | 84.6 | 22.2 | 15.5 | 7.6 | 10.4 |
| 70:30% split | 50 mm | 94.0 | 22.5 | 15.5 | 7.6 | 10.3 |
| | 70 mm | 83.7 | 21.6 | 14.7 | 8.1 | 10.5 |
| 30:70% split | 50 mm | 90.5 | 23.8 | 17.0 | 8.1 | 11.1 |
| | 70 mm | 79.1 | 21.3 | 14.4 | 7.2 | 10.2 |
| 100% in-crop | 50 mm | 92.9 | 23.1 | 16.1 | 8.4 | 10.9 |
| | 70 mm | 79.0 | 22.3 | 15.3 | 7.3 | 10.2 |

Nitrogen application timing significantly affected plant height ($P<0.05$) and N timing × irrigation deficit affected the first position boll retention ($P<0.05$)

### Tail water N loss

Nitrogen fertiliser timing had a significant effect on the amount of N lost from the field via the tail water across the season. The majority of N runoff from furrow irrigated fields occurs during the first 2–3 irrigations. The in-crop N timing treatments reduced the cumulative N losses as there was less N fertiliser in the field during the first three irrigations. Applying N fertiliser in crop results in a greater amount of available N in the field at the optimum period of plant N uptake – between flowering and the boll fill stage (90–100 days after sowing) This is opposed to having a higher amount of N available early in the season when plant N uptake is low (Table 3).

Table 3. Cumulative N losses from tail water in an irrigation field (kg N/ha).

| Irrigation deficit | Cumulative N loss (kg N/ha) | | | |
|---|---|---|---|---|
| | 100% upfront | 70:30% | 30:70% | 100% in-crop |
| 50 mm | 38 | 26 | 18 | 13 |
| 70 mm | 37 | 35 | 21 | 17 |

N timing significantly affected the amount of N lost from the irrigated field over the season ($P<0.001$).

## Conclusions

The experiment found that in-crop N timing reduced N loss in irrigation water runoff and improved lint yield, compared with applying all N fertiliser pre-plant. Previous studies have found that too much in-crop N, or applying in-crop N too late in the growing season, can have no benefit on yield. Growers who do apply N in crop need to ensure it is not applied too late (post January) in the growing season as this would increase the probability of regrowth and late vegetative matter rather than reproductive growth.

The intensive irrigation strategy of 50 mm, did produce a greater yield compared with the 70 mm deficit, however, with the higher amount of applied water, the 50 mm deficit resulted in lower WUE Interestingly, the higher yield of the 50 mm deficit meant that there was no difference in $/ML. The higher yield produced by the 50 mm deficit compared with the 70 mm deficit was driven by the long growing season and high day degree accumulation. In shorter seasons with an earlier plant maturity, the yield potential could be limited by the treatments, which had late in-season N applications and lower irrigation deficits.

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