Reducing N runoff during irrigated cotton production

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Abstract

Nitrogen (N) fertiliser is applied both pre-plant and in-crop for high-yielding Australian irrigated cotton. Runoff during flood-furrow irrigation can be a major N loss pathway, particularly during the first two irrigations following pre-plant N application. Over three seasons, we assessed the impacts of N fertiliser products, placement and application timing on N runoff from irrigated cotton grown on Vertisols. Greatest N runoff came from in-crop fertigation. N runoff was reduced by split N application, applying pre-plant urea with a nitrification inhibitor or polymer-coating and by optimising fertigation practice.

Keywords: runoff, cotton, irrigation, urea, enhanced efficiency fertiliser

1. Introduction

In Australia, an industry average of 336 kg N/ha fertiliser is applied to produce high-yielding irrigated cotton (2018 average: 2547 kg lint/ha) (CRDC 2019). Formerly, most farmers applied all N fertiliser from 1–9 months before sowing, but in-crop N application is becoming a more common strategy. In an industry dominated by flood-furrow irrigation, loss of applied N fertiliser in runoff water can be a major pathway for N loss (Macdonald *et al.* 2017). Our research aimed to find N application strategies to reduce N runoff but maintain lint yield.

2. Methodology

Three field experiments on Vertisols compared N runoff from field-length plots where N fertiliser was applied either 100% pre-plant (100:0), 100% in-crop (0:100) or as a split (70:30, 50:50, 30:70). Pre-plant N was applied as either urea, polymer-coated urea or nitrification-inhibitor [DMPP]-coated urea. In-crop N applications were either side-dressed (urea), broadcast (urea, urease-inhibitor [NBPT]-coated urea) or fertigated (urea, urea ammonium nitrate, ammonia). Irrigation water entering the paddock and exiting each plot was manually sampled every 30–60 min and analysed for ammonia, nitrate and urea concentrations. Total incoming and outgoing water volumes were measured using flow meters and automatic flow sensors, respectively. Sampling of every irrigation event during 2016–17 showed that, after the first two irrigations, only plots where in-crop N was applied produced measurable runoff N, so later irrigations in the following two seasons were not sampled.

3. Results

During the 2016–17, 2017–18 and 2018–19 growing seasons, 8.9, 9.0 and 9.5 ML/ha were applied in 9, 8 and 11 irrigation events, respectively. Irrigation application efficiency (outflow / inflow) (Table 1) varied due to antecedent soil moisture, crop water use and in-season

weather. Highest runoff N losses occurred from fertigation applications in all seasons.

Table 1. Runoff N (nitrate + ammonium + urea) loss for season.

N-timing (pre:in-crop) & N forms	In-crop method	Runoff N loss (kg N/ha) 2016–17 (+f 260 kg N/ha) (+w 15 kg N/ha) (37% runoff)	2017–18 (+f 112 kg N/ha) (+w 4 kg N/ha) (42% runoff)	2018–19 (+f 155 kg N/ha) (+w 17 kg N/ha) (16% runoff)
nil N		8.7	12.7	4.5
100U:0	-	-	39.8	12.9
100pcU:0	-	-	20.3	9.7
70U:30U	bc	20.2	38.7	-
70niU:30U	bc	11.8	27.0	-
50U:50U	bc	-	-	10.1
30U:70U	bc	13.6	20.7	-
30U:70uiU	bc	15.9	22.9	-
30U:70U	sd	13.8	27.1	-
30U:70UAN	fg	63.7	38.7	-
30U:70A	fg	75.2	32.7	-
30U:70U	fg	86.1	43.1	18.0
30U:70U	opt-fg	-	-	10.7
0:100U	bc	12.0	20.0	10.5
l.s.d		16.2	10.5	2.3

* +f, N added in fertiliser; +w, N added in irrigation water; U, urea; pcU, polymer-coated urea; niU, nitrification inhibitor-coated urea; uiU, urease inhibitor-coated urea; UAN, urea ammonium nitrate; A, ammonia; bc, broadcast; fg, fertigation; opt-fg, optimised fertigation.

In 2016–17, N runoff from non-fertigated treatments was no greater than the nil N control. In 2017–18, N runoff from 30U:70U and 30U:70uiU broadcast splits, 0:100U and 100pcU:0 was similar to the control. More N was lost from 100U:0, 30U:70U side-dressed and 70U:30U, although DMPP reduced the N loss. In 2018–19, 100pcU:0 and 0:100 reduced N runoff compared to 100:0. Less N was lost during optimised fertigation where N input to the water ceased once runoff began.

4. Conclusions

Nitrogen runoff during fertigation can be high, particularly when irrigation application efficiency is low. Runoff N loss can be reduced by ceasing N input once runoff begins. Runoff losses from pre-plant N can be reduced using either less N (split), nitrification inhibitor-coated urea or polymer-coated urea.

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