Effect of application rate on nitrogen fertilizer recovery in an irrigated cotton cropping system

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Abstract

Irrigated cotton in Australia on heavy textured clay soils (Vertiol) is typically described as inefficient with respect to nitrogen, due largely to significant gaseous N losses through denitrification. We investigated the effect of different N rates (100N, 200N, 300N) on fertilizer recovery in furrow irrigated cotton. There was no significant effect of the different fertiliser rates on yield, with an average lint yield of 2,52 t ha^{-1}. Total fertiliser losses ranged from 28% to 49% of the fertiliser applied with the highest losses in the 300N treatment. The results demonstrate that N losses can significantly be reduced by avoiding excessive N application rates in irrigated cotton systems.

Keywords: vertisol, cotton, nitrogen, irrigation

1. Material and methods

A field experiment was established in September 2017. The cotton was sown on the 18th October 2018 and ^{15}N-labelled urea applied on the 9th November 2018. The experimental setup consisted of four N fertiliser treatments arranged in a randomised block design:

0N – i.e. no added nitrogen fertiliser.

100N – 100 kg N ha^{-1} urea basal application at planting

200N – 200 kg N ha^{-1} urea basal application at planting

300N – 300 kg N ha^{-1} urea basal application at planting

The recovery of N fertiliser in the soil and plant was assessed by applying ^{15}N-labelled urea to micro-plots.

2. Results

The average lint yield in the fertilised treatments was 2,5 t ha^{-1} with no significant effect of different fertiliser rates on lint yield, while applying no N fertiliser reduced lint yield by 20%.

There was no significant difference in total N uptake between the fertilised treatments with an average uptake of 204 kg N ha^{-1}.

56% to 73% of crop N was derived from the soil demonstrating the importance of N supplied from the soil and the relatively lesser reliance on the N fertiliser applied.

Nitrogen fertiliser use efficiency (NFUE) was consistently low, with 32% to 43% of the applied fertiliser taken up by the plant and 28% to 49% completely lost over the season.

Highest losses were observed in the 300N treatment indicating an non-linear exponential response of N losses to N fertiliser rates once the capacity of the plant-soil system to store N is exceeded, similar to what has been observed for N_2O emissions in fertilized cropping systems (Shcherbak *et al.*, 2014).

2. Conclusions

The results show that high N losses can be expected under current on-farm management strategies, where N rates exceed the crops demands. We conclude that an optimised fertiliser strategy can be adopted in cotton to substantially reduce N losses without affecting yield potential.

Treatment	0N	100N	200N	300N
Total biomass (t/ha)	10.1 ±0.5^{a}	13.7 ±0.5^{b}	14.0 ±0.5^{b}	13.3 ±1.0^{b}
Lint yield (t/ha)	1.9 ± 0.1^{a}	2.5 ± 0.1^{b}	2.6 ± 0.1^{b}	2.5 ± 0.2^{b}
Total N uptake (kg/ha)	116 ± 8^{a}	184 ± 16^{b}	209 ± 4^{b}	215 ± 11^{b}
N derived from soil (kg/ha)	116 ± 8^{a}	135 ± 14^{a}	124 ± 7^{a}	120 ± 13^{a}
Fertilizer N recovered in plant (kg/ha)	-	41 ± 2^{a}	85 ± 9^{b}	95 ± 11^{b}
Fertilizer N recovered in soil (kg/ha)	-	26 ± 7^{a}	59 ± 7^{b}	59 ± 10^{b}
Fertilizer N lost (kg/ha)	-	33 ± 6^{a}	56 ± 14^{a}	146 ± 34^{b}

Table 1: The biomass, yield, Total-N uptake and recovery during the 2017/18 cotton season. (a & b indicate statistical differences observed).

Shcherbak, I., Millar, N., Robertson, G.P., 2014. Global metaanalysis of the nonlinear response of soil nitrous oxide (N2O) emissions to fertilizer nitrogen. Proceedings of the National Academy of Sciences 111, 9199-9204.