ALTERNATIVE N APPLICATION STRATEGIES FOR REDUCED N₂O EMISSIONS IN FLOOD-FURROW IRRIGATED COTTON

Graeme Schwenke¹, Annabelle McPherson¹

Research Question
Can alternative fertiliser nitrogen (N) management reduce soil nitrous oxide (N₂O) emissions in irrigated cotton cropping on Vertosols in northern Australia?

Introduction
On average, more than 240 kg N/ha of nitrogen fertiliser is applied to Australian irrigated cotton crops. Lint yields average 10 bales/ha (2.3 t/ha), but can exceed 15 bales/ha (3.5 t/ha). The combination of high N fertiliser rates and temporarily saturated soil conditions from flood-furrow irrigation creates the potential for large soil emissions of N₂O during nitrification and denitrification. In a bid to reduce soil N₂O emissions we varied N fertiliser timing and placement in an on-farm trial on a Vertosol (65% clay, 26% silt, 9% sand) near Gunnedah, NSW, Australia.

Treatments
T1: 100 kg N/ha as anhydrous ammonia injected into the non-irrigated side of the hill before sowing, then 2 x 30 kg N/ha as urea applied during irrigations 2 and 3 (total of 8 irrigations).

T2: As for T1 except the pre-plant anhydrous ammonia was injected into the irrigated side of the hill.

T3: 160 kg N/ha as anhydrous ammonia injected into the non-irrigated side of the hill before sowing. No in-crop N applications.

Treatments randomised x 3 reps. Plots 8 x 560 m.

Measurements

[a] An automated chamber system sampled soil N₂O emissions in 2 reps each of T1 and T2 at 9–10 am biweekly from fertiliser application until harvest.

[b] 4 manual chambers in each of the 9 plots:
(1) on the irrigated side of the hill,
(2) on the non-irrigated side of the hill,
(3) in the irrigated furrow, and
(4) in the non-irrigated furrow.

Emissions were measured from 9–11 am at 1, 2, 4 and 7 days after the first 5 irrigation events. Crop N uptake was measured using quadrat cuts at peak biomass and total N analysis. The middle 6 rows (of 8) were harvested with a commercial cotton picker, baled, weighed and ginned to give lint yield.

Results: Automated Chambers

In T1, N₂O emission activity occurred after each of the first 3 irrigations – where N was applied – but was negligible for the rest of the season, with little response to rainfall events (Fig. 1).

In T3, which had the larger initial N rate, N₂O fluxes were high after the first irrigation and continued for longer than those in T1, which had subsided within a week.

However, there was no statistically significant difference on cumulative N₂O loss (688 g N₂O-N/ha) or N₂O emission factor (0.43%) between the two treatments.

Results: Manual Chambers

Maximum N₂O was emitted from the fertiliser band position of all treatments after the first irrigation. Fluxes had not fully returned to baseline levels 7 days after irrigation (Fig. 2). Changing the location of the pre-plant fertiliser band in relation to the irrigated furrow increased N₂O loss in T2 compared to T1 on day 2 of irrigation 1, but not afterwards. In T1 and T2, temporary N₂O fluxes occurred in response to the water-run urea applied in irrigations 2 and 3. In T1, N₂O fluxes were higher from the non-fertilised hill position (next to the irrigated furrow). By contrast, chamber positions did not affect N₂O flux in T2. N₂O flux was negligible after irrigations 4 and 5 (T1 and T2) and irrigations 2–5 (T3).

Cumulative N₂O emissions summed across the 5 sampling events showed no significant difference between the three treatments due to the large variation in N₂O flux results.

Conclusions

Splitting N application between pre-plant and water-run reduces the loss of N₂O during the first irrigation. However, emission of N₂O following water-run N in irrigations 2 and 3 resulted in a similar N₂O loss overall. Irrigating the furrow near the fertiliser band rather than the opposite side of the hill from the fertiliser band initially increased the intensity of N₂O loss after the first irrigation, but the seasonal loss of N₂O was no different. Lint yield (14 bales/ha) was unaffected by N application treatment, despite significantly greater crop N uptake when all N was applied pre-plant (T3) than when split-applied (T1).

1 NSW Department of Primary Industries, Tamworth Agricultural Institute

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