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ALTERNATIVE N APPLICATION STRATEGIES FOR REDUCED N_2O EMISSIONS IN FLOOD-FURROW IRRIGATED COTTON

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Research Question

Can alternative fertiliser nitrogen (N) management reduce soil nitrous oxide (N_2O) 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 N_2O during nitrification and denitrification. In a bid to reduce soil N_2O emissions we varied N fertiliser timing and placement in an on-farm field 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 N_2O emissions in 2 reps each of T1 and T2 at 9–10 am bi-weekly 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, N_2O 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, N_2O 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 N_2O loss (688 g N_2O-N/ha) or N_2O emission factor (0.43%) between the two treatments.

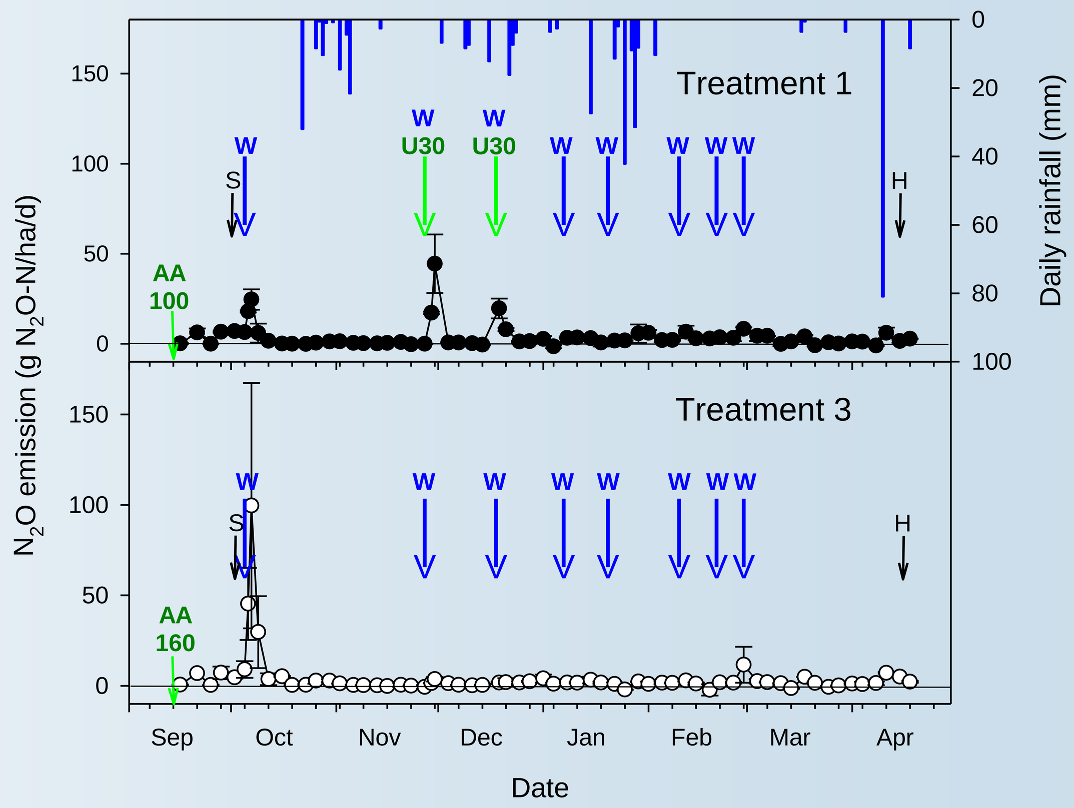

Figure 1. Daily N_2O flux measured bi-weekly using auto chambers in T1 and T3. Bars indicate daily rainfall; arrows indicate sowing (S), harvest (H), irrigation (W), and N fertiliser application (AA = anhydrous ammonia, U = water-run urea).

Results: manual chambers

Maximum N_2O 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 N_2O loss in T2 compared to T1 on day 2 of irrigation 1, but not afterwards.

In T1 and T2, temporary N_2O fluxes occurred in response to the water-run urea applied in irrigations 2 and 3. In T1, N_2O fluxes were higher from the non-fertilised hill position (next to the irrigated furrow). By contrast, chamber positions did not affect N_2O flux in T2. N_2O flux was negligible after irrigations 4 and 5 (T1 and T2) and irrigations 2–5 (T3).

Cumulative N_2O emissions summed across the 5 sampling events showed no significant difference between the three treatments due to the large variation in N_2O flux results.

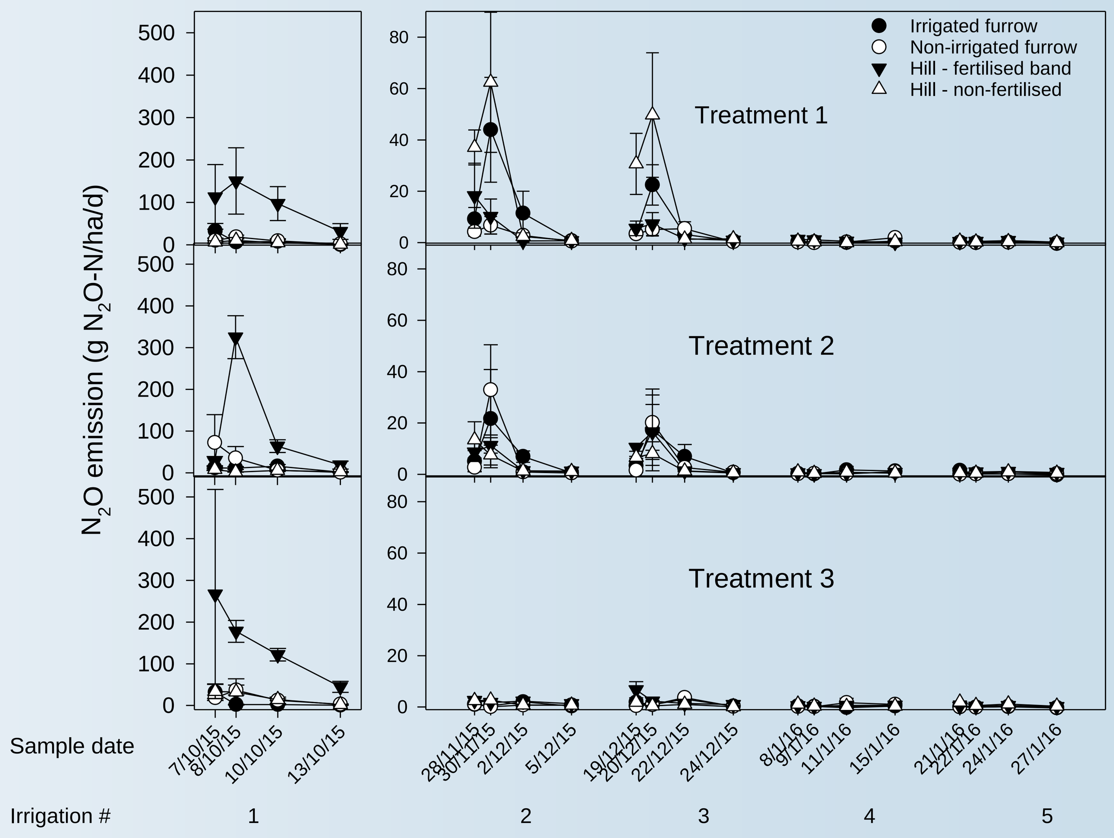

Figure 2. Daily N_2O emissions during the week after each of the first 5 irrigation events (note difference in scale for irrigation 1). Mean ± standard error is shown for each of the 4 sampling positions within a plot. Urea was water-run in irrigations 2 and 3 of treatments 1 and 2.

Conclusions

Splitting N application between pre-plant and water-run reduces the loss of N_2O during the first irrigation. However, emission of N_2O following water-run N in irrigations 2 and 3 resulted in a similar N_2O 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 N_2O loss after the first irrigation, but the seasonal loss of N_2O 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).

Anhydrous ammonia applied pre-planting.

Flood-furrow irrigation. Every second furrow is irrigated, with water percolating through the bed into the non-irrigated furrow.

Manual GHG emissions sampling was carried out in furrow and hill positions (2 of each in each plot). Chambers were removed from the bases in between sample times

The middle 6 rows of each 8-row plot were harvested with a commercial cotton picker and the resulting round bales weighed.

This research is supported by funding from the Australian Government (Department of Agriculture), the Cotton Research and Development Corporation, and the NSW Department of Primary Industries.

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