

IMPACT OF NITROGEN FERTILISER LOSSES FROM COTTON

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SUMMARY

We measured the emission of nitrous oxide (N₂O) from irrigated cotton that had been fertilised at four rates of N.

Cotton that received N fertiliser applications at or below the economic optimum for lint production emitted relatively small quantities of N₂O.

Excessively high N fertiliser application increased N₂O emissions exponentially.

INTRODUCTION

The application of nitrogen fertiliser is the direct cause of nitrous oxide (N₂O) emissions from cropping systems. Nitrous oxide is a powerful greenhouse gas (GHG) and has a warming potential 310 times greater than carbon dioxide (CO₂). Should agricultural producers choose to take advantage of carbon trading initiatives, they will need to target and reduce the emission of greenhouse gases, especially N₂O emissions.

We have set out to examine the relationship between N fertiliser application rates, achieving maximum lint yield and with minimal N₂O emissions in an irrigated cotton system at Narrabri.

METHODS

GHG monitoring equipment was installed in an existing nitrogen fertiliser rate experiment. We measured nitrous oxide (N₂O), carbon dioxide (CO₂) and methane (CH₄) concentrations; this allowed us to determine GHG emissions on an hourly basis. We commenced measuring GHG emissions from the cotton phase of a cotton-faba bean-fallow system in September 2011. The N₂O data presented here are up to the time the field flooded in late January 2012.

We monitored N₂O emissions from a randomised field trial where urea was applied at 4 rates (0, 120, 200, 320 kg N/ha). The 0, 120, 200 N rates represent the range of optimum N rates determined for this rotation in past 3 years, whereas the 320 N rate is more typical of the N fertiliser management in some commercial cotton crops.

Twelve automatic chambers, coupled to a gas chromatograph, were used to measure emissions from the field (Figure 1). Three replicate chambers were installed in each N fertiliser treatment. At the beginning of each hour, the chamber lids were closed on one chamber in each N treatment. Over the hour, the concentration of N₂O in each chamber was measured four times. The emission was then calculated from the linear increase in concentration over time. This approach has been used for a number of studies funded by the federal Department of Agriculture Forestry and Fisheries.



Figure 1. Chambers deployed in the spring of 2011. In the background is the trailer which houses the gas chromatograph and computer system used to measure the GHG concentrations in the chambers

The emission factor (EF) was calculated according to equation 1. This factor indicates how much N₂O is emitted per unit of fertiliser N applied.

$$EF = \frac{N_2O.N \text{ (treatment)} - N_2O.N \text{ (control)}}{\text{Fertiliser applied (kg N/ha)}}$$

In this case the 0 fertiliser rate plots were used as the control

The cost of the emission per hectare was calculated assuming the eCO₂ price of \$23 per tonne. In a free market situation this price will fluctuate according to demand.

RESULTS

The amounts of N_2O measured at each N fertiliser rate are shown in Table 1.

Table 1. Nitrous oxide (N_2O) emissions at four N fertiliser rates, the emissions factor and cost of those emissions from a cotton crop.

N applied	N_2O lost	Emission Factor	\$/ha
0	0.47	na	3.22
120	0.59	0.10	4.04
200	1.03	0.28	7.06
320	4.07	1.13	27.90

The emissions factor indicates that relatively more N from the fertiliser is lost as N_2O as the N fertiliser rate increases. So, not only does the total N loss increase, so does the proportion on N_2O , relative to N_2 .

The point at which lint yield was maximised was ~200 kg N/ha, i.e. the economic optimal N fertiliser rate. Similarly, crop N uptake was maximised at this level of N fertiliser. There was no agronomic benefit to apply more N fertiliser than the optimal 200 kg N/ha.

Table 2. Crop N uptake (kg/ha) and lint yield (kg/ha) measured at four N fertiliser rates.

N applied	Crop N	Lint yield
0	148	2570
120	201	3110
200	244	3120
320	239	3100

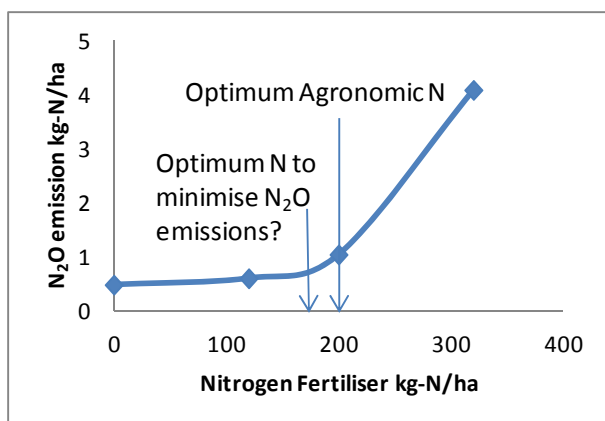


Figure 2. Nitrous oxide emission as approximated to N fertiliser application.

Figure 2 shows that N_2O emissions did not increase above the background emission level until

approximately 170 kg-N/ha which is below the agronomic optimum N fertiliser rate.

DISCUSSION

This research confirms the idea that excessive N fertiliser application results in large emissions of N_2O . This is costly in terms of wasted N fertiliser and damaging to the environment. Further work is needed to validate the optimum fertiliser rate to minimize N_2O emissions under different environmental conditions. Additionally once the eCO_2 is measured from the complete crop rotation it will be possible to calculate the gross margin and the economic optimum N fertiliser application.

The economic optimum N fertiliser rate is quite readily estimated by soil analysis prior to fertiliser application, and adjusted through the season where tissue analyses indicate deficient levels of N in the crop.

Over use of N fertiliser is common within the cotton industry (Rochester 2012) and profits are reduced because of reduced production and wasted N fertiliser. Under current policy settings N costs are likely to rise as energy costs increase and this will result in further economic penalties due to inefficient fertiliser use.

Nitrous oxide emissions increased after each irrigation or rain fall, thus management of irrigations to minimise water-logging and promote better drainage will reduce those emissions.

CONCLUSIONS

Excessively high N fertiliser application exponentially increases N_2O emissions.

Those crops that have received N fertiliser applications at or less than the economic optimum N fertiliser rate emit relatively small quantities of N_2O .

ACKNOWLEDGMENT

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REFERENCES

Rochester IJ (2012). It pays to optimise N fertiliser inputs. Australian Cottongrower magazine, pp 40-42 April-May 2012.