Gaseous nitrogen losses from a subtropical sugarcane cropping system

Daniel I. Warner[1], Clemens Scheer[1,2], Johannes Friedl[1], David W. Rowlings[1] and Peter R. Grace[1]

[1] Institute of Future Environments, Queensland University of Technology, Brisbane, QLD 4000 Australia,
[2] Institute for Meteorology and Climate Research (IMK-IFU) Karlsruhe Institute of Technology (KIT) Garmisch-Partenkirchen, Germany.

E-mail: clemens.scheer@kit.edu

Abstract

Sugarcane is typically produced under conditions that are known to stimulate gaseous nitrogen losses via denitrification. These losses illustrate a highly inefficient use of N fertilisers on sugarcane farms but total denitrification losses are virtually unknown. This field study investigated the efficacy of different management strategies to reduce N_2 and N_2O emissions from a sugarcane field. The results demonstrate that sugarcane systems in Australia are a hotspot for denitrification where high gaseous N losses can be expected. Cane trash retention stimulated denitrification increasing total N losses by 60%, while the use of a nitrification inhibitor (DMPP) reduced losses by 70%.

Keywords: term, term, term

1. Material and methods

A field experiment was established on a sugarcane farm at Bundaberg, QLD, Australia. The experimental setup consisted of three treatments arranged in a randomised block. All the treatments began with the application of 145 kg of N ha^{-1} of 60 atom % enriched ^{15}N urea fertilizer solution applied in a band, buried 10 cm deep beside each sugarcane row.

i) **DMPP:** Urea fertilizer with 0.6% DMPP solution (w/w) and sugarcane trash retained in the field.

ii) **Standard Grower Practice (CONV)**: Urea fertilizer and sugarcane trash left in the field.

iii) **Trash Removed (TR)**: Urea fertilizer with sugarcane trash removed from the surface.

The static closed chamber and ^{15}N gas flux methods method were used to measure N_2 and N_2O emissions by quantifying the increase in ^{15}N-labelled gases in the chamber headspace over time.

2. Results

Over the 50 days measuring period 13 to 46 kg-N ha^{-1} were lost as N_2 and N_2O from the fertiliser band of the different treatments. The use of the nitrification inhibitor DMPP reduced N_2 and N_2O losses by 54% and 98%, respectively. Removal of the cane trash blanket reduced N_2 and N_2O losses by 28% and 52%, respectively.

The majority of gaseous N losses occurred as N_2 in all treatments. The average $N_2/(N_2 + N_2O)$ product ratio in the CONV and TR treatments was 0.60 and 0,69, respectively. The use of DMPP did not only reduce total denitrification losses but significantly increased the (N_2/N_2+N_2O) product ratio (0.97), most likely due to a reduced NO_3^- build up in the soil profile limiting the suppression of the N_2O reductase while enabling complete denitrification to N_2.

2. Conclusions

The study highlights that sugarcane systems in Australia are a hotspot for denitrification where high gaseous N losses can be expected. Denitrification is stimulated by the retention of sugar cane trash, most likely due to an increased availability of labile carbon and increased water holding capacity of the soil. DMPP proved to be highly efficient in reducing gaseous N losses by reducing the nitrate availability for denitrification. Moreover, DMPP was even more effective in mitigating N_2O emissions by reducing the $N_2/(N_2 + N_2O)$ product ratio. Our findings highlight the significance of fertilizer and trash management for gaseous N losses in sugarcane systems and demonstrate that the nitrification inhibitor DMPP can be used as an effective N_2O abatement strategy.

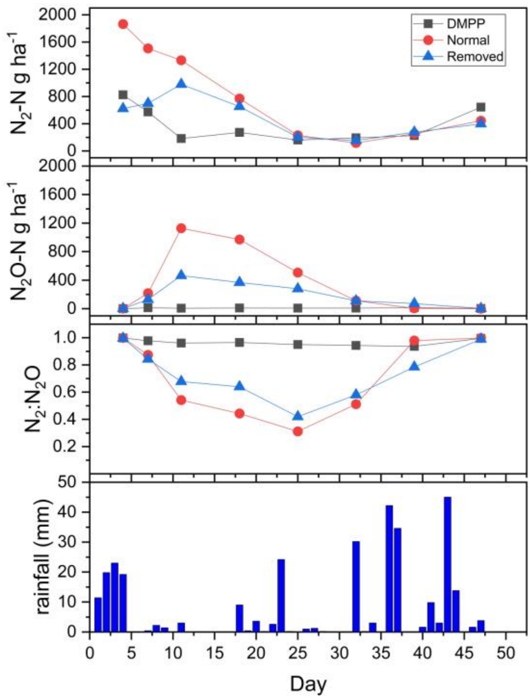

Fig. 1: Average daily N_2 and N_2O fluxes and the corresponding $N_2/(N_2+N_2O)$ product ratio.