Nitrification inhibitors - a tool to reduce N_2O-N emissions in winter wheat?

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Introduction

N fertilization increases N_2O-N release from soil, contributing to greenhouse gas emissions in arable farming.

The use of nitrification inhibitors (NI) during N fertilization is presented as a way to reduce fertilizer-induced N_2O-N emissions (Fig. 1), but their suitability as a climate protection measure is the subject of controversial debate (emission time shift).

Aim

Evaluation of NI in terms of their greenhouse gas reduction and agronomic effects.

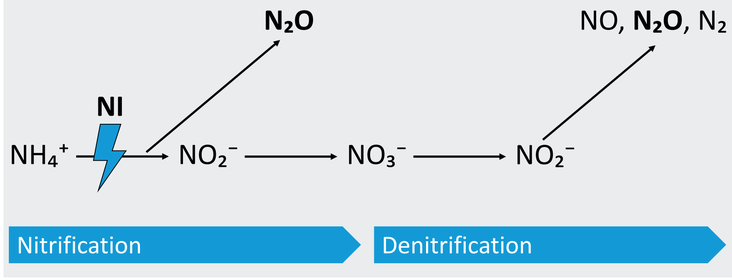

Figure 1: NI inhibit the transformation of ammonium to nitrate in the soil.

Figure 2: Measurement method (left: static N_2O-N chamber and different applied N fertilizers, right: spacer for the N_2O-N measuring system).

Methods

N_2O-N measurements weekly throughout the year and additional measurements after emission events in a winter wheat (RGT Reform A) plot trial in Northern Germany in 2023 with a chamber system (Fig. 2). One as well as two factorial analysis was performed.

Experimental factors (4 repl. per variant):

- Urease inhibitor (UI): without / with
- Nitrification inhibitor (NI): without / with (varieties: DCD, DMPP, MPA)
- Two N fertilizer forms: Ammonium sulfate nitrate (ASN) / Urea
- Total N fertilization: 190 kg N ha^{-1} applied in two doses in inhibited variants and in three doses in non-inhibited variants.

Results

- Fertilizer induced N_2O-N release ranged between 0.17 and 0.69 % of total fertilizer-N.
- ASN application in three N doses emitted less N_2O-N than ASN in two doses (Fig. 3 A).
- NI addition to ASN decreased N_2O-N emission compared to ASN application in two doses, especially for DMPP (Fig. 3 A).
- NI addition to urea slightly decreased N_2O-N emission compared to urea application in three doses (Fig. 3 A).
- Grain yield was on average 10 % (urea treatments) to 20 % (ASN treatments) higher with NI (Fig. 3 B).
- Over both N forms, NI significantly reduced N_2O-N release (-0.5 kg N ha^{-1}) and increased grain yield (+1.0 t ha^{-1}) compared to treatments in two doses without NI (data not shown, two-factorial analysis (N form x NI))

Conclusions

- Higher N rates and wet conditions for the first doses and dry conditions around the third N dose probably caused the differences in N_2O emissions between N doses.
- Results will be further verified in the upcoming experimental years.

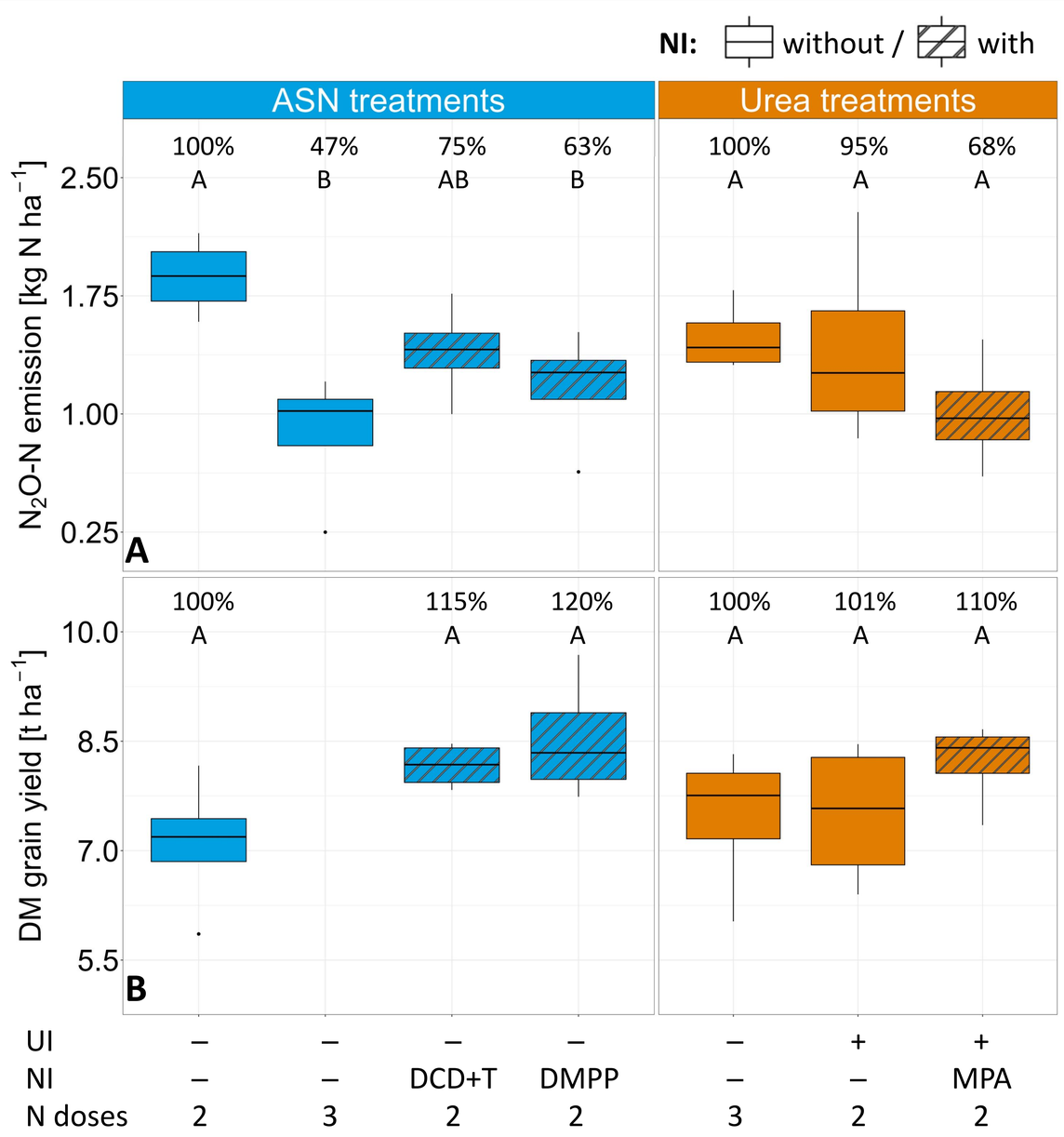

Figure 3: Treatment effects on (A) N_2O-N emissions and (B) grain yield (harvest year 2023). N_2O-N emissions were cumulated over the measurement period (March 28, 2023 to February 28, 2024). Percentages refer to the respective base scenario (ASN in 2 N doses/ Urea in 3 N doses). N total = 190 kg N ha^{-1} (2 N doses: 100/90 kg N ha^{-1}, 3 N doses: 70/70/50 kg N ha^{-1}). Capital letters indicate significant differences ($p < 0.05$), one-factorial analysis per fertilizer.

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