N_2O emission reduction after long term application of nitrification inhibitor DMPP

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~ 80 % nitrous oxide (N_2O) emissions by **agriculture** (Germany) → Main source from **nitrogen fertilizer** → **Nitrification inhibitors (NI)** possible tool for **emission reduction** → **Affects** the **long-term use** of the **NI DMPP (3,4-dimethylpyrazole phosphate):**

- **1. N_2O emission**
- **2. Efficacy of DMPP**
- **3. Microbiome**

→ **?**

Dynamic Chamber - Pot - Experiment

Legend

M1	
M2	
M3	
M4	
N0	
T1	
T2	
T3	

Field Management (history of fertilizer types applied to same soil)

2007 (year)	2016	2023
Ammonium Sulphate Nitrate (ASN)		
Entec26® (ASN+DMPP)		
ASN	Entec26®	
Entec26®	ASN	

Incubation Treatment (n=4)

N0	(unfertilized Control)
ASN	(Ammonium Sulphate Nitrate)
ASN+DMPP	(+ 3,4-Dimethylpyrazole Phosphate)
ASN+NP	(+ Nitrapyrin)

Soil: Loess

pH	~ 7
Sand	2.50 %
Silt	73.80 %
Clay	23.70 %

Incubation Parameters

Temperature	15	°C
Water filled pore space	50	%
Bulk Density	1.3	g cm^{-3}
Amount of fertilizer	120	kgN ha^{-1}
Straw addition	1.4	g kg^{-1} dry soil
Duration	85	days

Measurement

Nitrous Oxide	Continuously by gas chromatography
Ammonium	Continuous Flow Analysis after soil extraction (KCl)
Gene abundance	qPCR of two soil samples from each pot

1. N_2O emissions - from management-treatment combinations

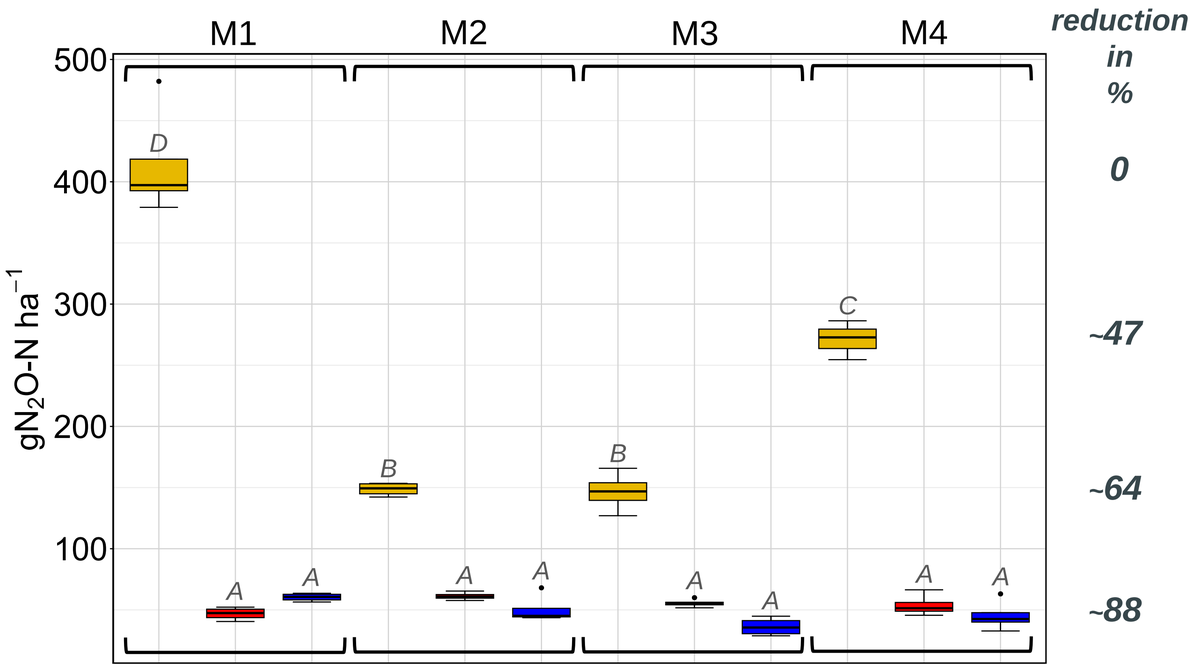


Fig. 1: Cumulative N_2O emission (85d) grouped by field management histories (M1-4) for all fertilizer treatments (T1-3), values of unfertilized treatment (N0) subtracted from fertilizer treatments (T1-3).

2. Efficacy of DMPP - Ammonium dynamic

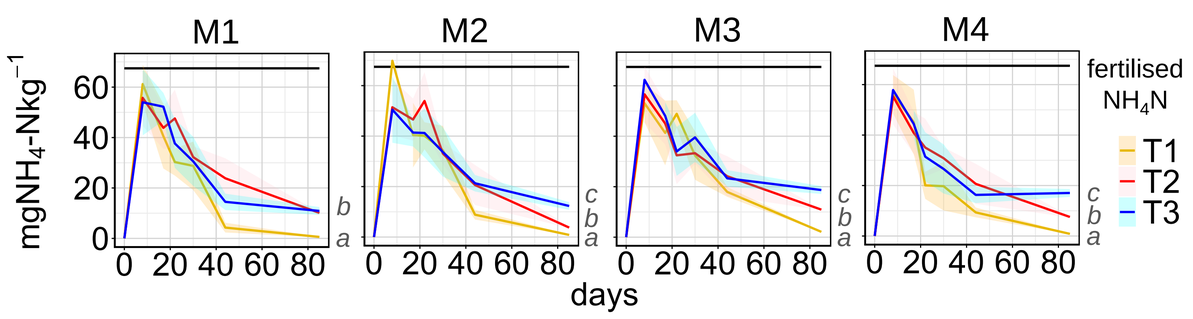
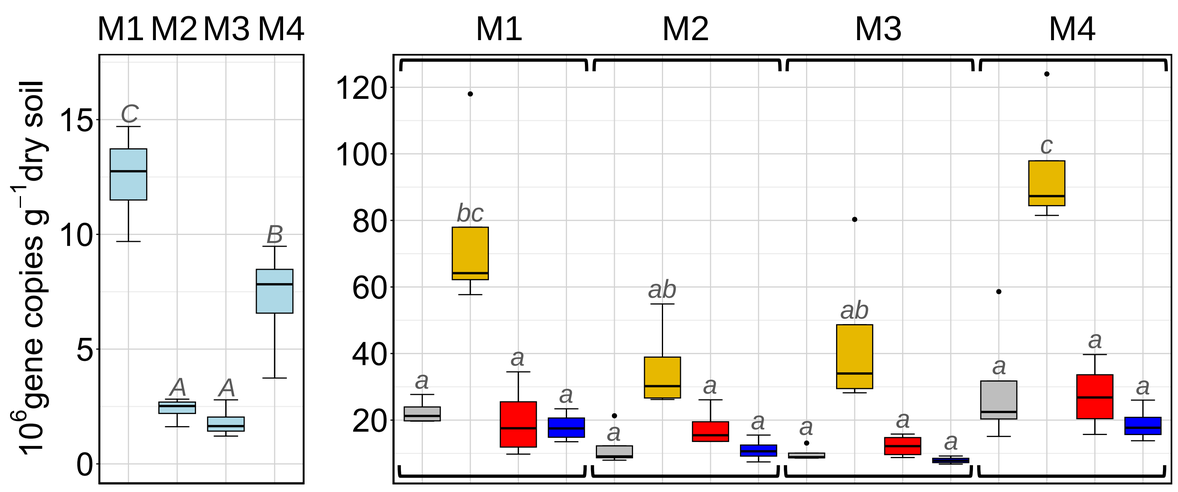


Fig. 2: Ammonium dynamic along the incubation experiment grouped by management (M1-4), values of unfertilized treatment (N0) subtracted from fertilizer treatments (T1-3).

- Effect of management (M1-4) on N_2O emission in ASN treatment (Fig. 1)
- Effect of NI treatment (T2-3) on N_2O emission in all managements (Fig. 1)
- Effect of management-treatment interaction on N_2O emission (Two Way ANOVA: $Pr(>F) = < 2 \cdot 10^{-16}$)
- Lower final ammonium content T2 (+DMPP) in DMPP managements (M2-4) than T3 (+NP) (Fig. 2)

  → Possibly lower efficacy of DMPP after DMPP Management
- Effect of managment (M1-4) on bacterial amoA gene abundance (Fig. 3, before Experiment)
- ASN increased bacterial amoA gene abundance (smaller increase with NI's) (Fig. 3, after Experiment)
- Shape of response on management and treatment identical for N_2O emission (Fig. 1) and bacterial amoA gene abundances (Fig. 3, before and after Exp.)

3. Microbiome - Abundance of bacterial amoA gene



before (applying T1-3) (Management) — **after** Experiment (Management+Treatment)

Fig. 3: ***before:*** Abundance of bacterial amoA gene of field managements without experimental fertilizer treatment („before Experiment"), ***after:*** abundance of bacterial amoA gene of all management-treatment combinations („after Experiment").

Conclusion

The **long-term use** of the **NI DMPP affects:**

→ **N_2O emission,** but reduction to almost same emission in all NI treatments (small effect)

→ **Microbiome,** for bacterial amoA gene

→ Possibly the **efficacy of DMPP**

Next Steps

- Identification of organsims by amplicon sequencing
- Calculation of Net + Gross nitrification rates from ^{15}N data

Outlook

- Which Organisms are affected by long-time use of DMPP?
- Are Residues of DMPP or DMPP-metabolites in the different managed soils?

NitriKlim — Bewertung von Nitrifikationsinhibitoren als Klimaschutzmaßnahme

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