Response of soil N_2 and N_2O fluxes to denitrification control factors in two agricultural soils

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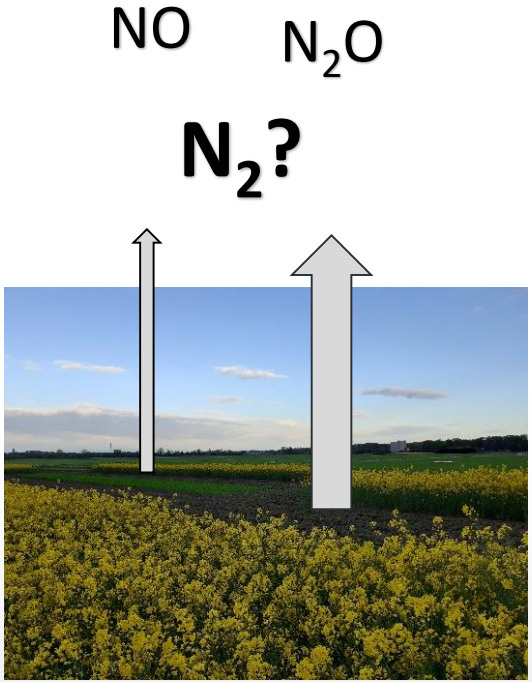
Introduction

Controlling soil nitrogen (N) cycling to mitigate N-oxide emissions and optimize N use efficiency is an important aspect of agricultural soil management.

Denitrification models can be used to support decision-making but are limited by a lack of soil N_2 flux data.

Measurements of soil N_2 fluxes are challenging due to methodological limitations and the spatial/temporal heterogeneity of denitrification in soils.



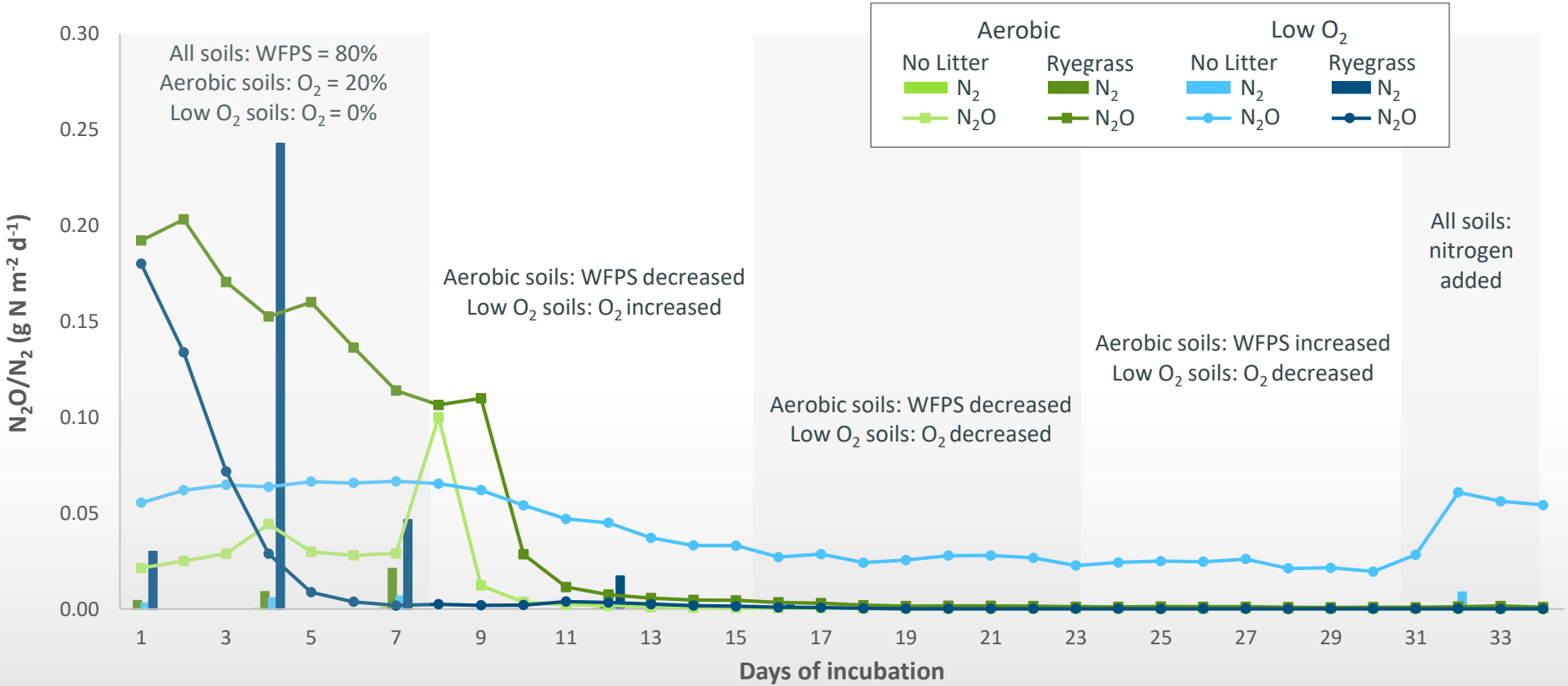
Materials and methods

Laboratory incubations

- Soil origin: Germany; Fuhrberg (sandy Podzol) and Rotthalmünster (silty loam Luvisol)
- Soil preparation: sieved, air-dried, pre-incubated, added nitrogen (with and without ^{15}N label), packed into cores (see left)
- Incubation: flushing with helium to create a low-N_2 atmosphere*
- Soil treatments during incubation:
  - type and amount of plant litter (ryegrass or maize)
  - variable low oxygen (O_2) or aerobic (20% O_2)
  - changing soil moisture (water-filled pore space; WFPS)

* Well R, Burkart S, Giesemann A, Grosz B, Köster JR, Lewicka-Szczebak D. Improvement of the 15N gas flux method for *in situ* measurement of soil denitrification and its product stoichiometry. *Rapid Commun Mass Spectrom*. 2019;33:437–448. https://doi.org/10.1002/rcm.8363

Preliminary results – sandy Podzol (time series)



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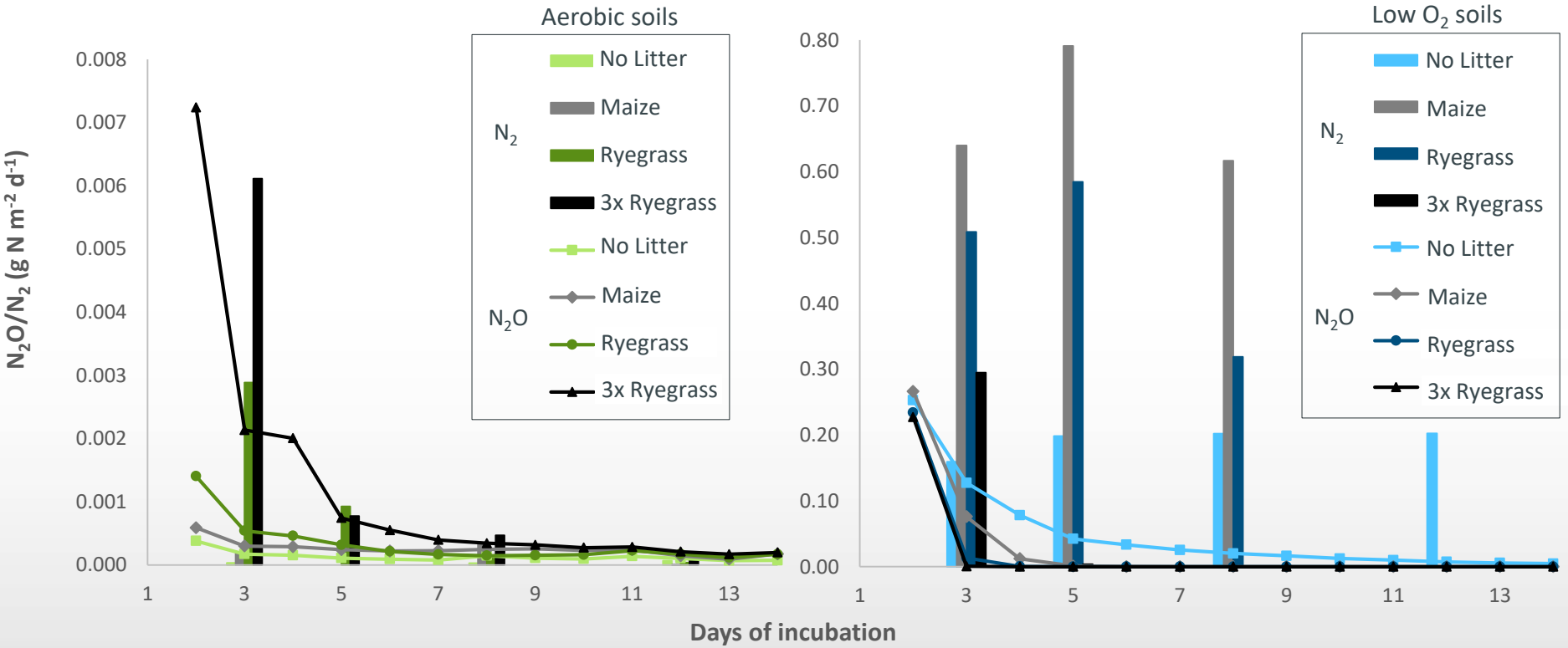
Preliminary results – silty loam Luvisol (litter treatments)



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Points to note

Total denitrification (N_2+N_2O) vs N_2O measurement alone

- Denitrification activity can be significantly underestimated if based only on measurements of N_2O emissions

Complex interactions depending on controlling factors over time

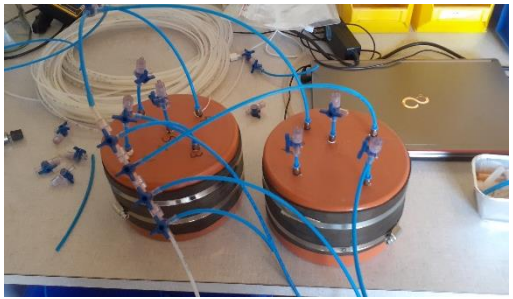
- Differences in denitrification between soil type, litter type, length of incubation, etc.
- Time series data for N_2 needed to fully understand responses

How do laboratory incubations compare to field measurements?

Next steps

Laboratory incubations

- Ongoing analysis of results from previous incubations
- Testing improvements in methods for sample analysis and evaluation
- Assessing optimal sample sizes and number of replicates



Establish and test field measurement system

- Test variations of the flushing technique* to achieve lowest possible background N_2 during *in situ* field measurements

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