N_2O emissions from timothy grassland on mineral soil under different fertilization regimes in boreal climate

VIISAS TYPPI-KIERTO
N-Teho

Sanni Semberg[1], Hem Raj Bhattarai[1], Maija Marushchak[2], Maarit Termonen[1], Perttu Virkajärvi[1]
[1]Natural Resources Institute Finland (Luke), [2]University of Eastern Finland (UEF)
Contact information: sanni.semberg@luke.fi

Background

Cultivated grasslands can be significant sources of nitrous oxide (N_2O). Using cattle slurry as a fertilizer is a common grassland management practice, and it can also improve soil organic carbon stock and fertility. Slurry application has been found to cause higher N_2O emissions compared to mineral fertilizer, although current knowledge on the effect of different fertilizer types and rates on N_2O emissions is still incomplete.

Methods

We measured N_2O emissions from a mineral soil cultivated with timothy in Central Finland from May 2024 to May 2025. The experiment consisted of six treatments; combining two slurry regimes ("no slurry" and "30 t ha^{-1} of slurry for the first harvest and 30 t ha^{-1} for second harvest") with three mineral N application rates (0, 250 and 350 kg soluble N ha^{-1} year^{-1}) divided by three harvests in proportions 44%-36%-20%. Total applied N in each treatment is given in Table 1.

We used closed chamber method with a portable analyzer in snow-free period and the snow gradient method during snow-cover.

Preliminary results

We found that slurry application increased the N_2O flux rates compared to plots that received only mineral fertilization in the first and second fertilization events. In the third fertilization, when only mineral fertilizer was used to all treatments (except 0N), the emission rates were similar across treatments.

Non-growing season started with smaller emission rates in all plots. Slurry treated plots showed occasionally higher emission rates compared to the mineral N fertilized plots and those increased emissions coincided with fluctuating freezing temperatures.

Annual N_2O emissions were lower from mineral fertilized plots compared to slurry treated plots. In addition, mineral fertilized plots tented to produce higher yields compared to slurry plots, resulting in lower yield-scaled N_2O emissions. Although the N_2O emissions from the non-fertilized treatment (0N) were the lowest from all treatments, it produced remarkably lower yields compared to other treatments, making the yield-scaled emissions relatively high.

Conclusions

This study suggests that using cattle slurry as a fertilizer leads to higher N_2O emissions compared to mineral N fertilizer from grassland on mineral soil. However, our results demonstrate that mineral N fertilization could also increase N_2O emissions under favorable conditions, e.g. with enough moisture.

Assessments of climatic impact of agricultural management strategies should incorporate also economic viability and agronomic performance. Emission reductions that compromise productivity may not be beneficial for farmers in the long term.

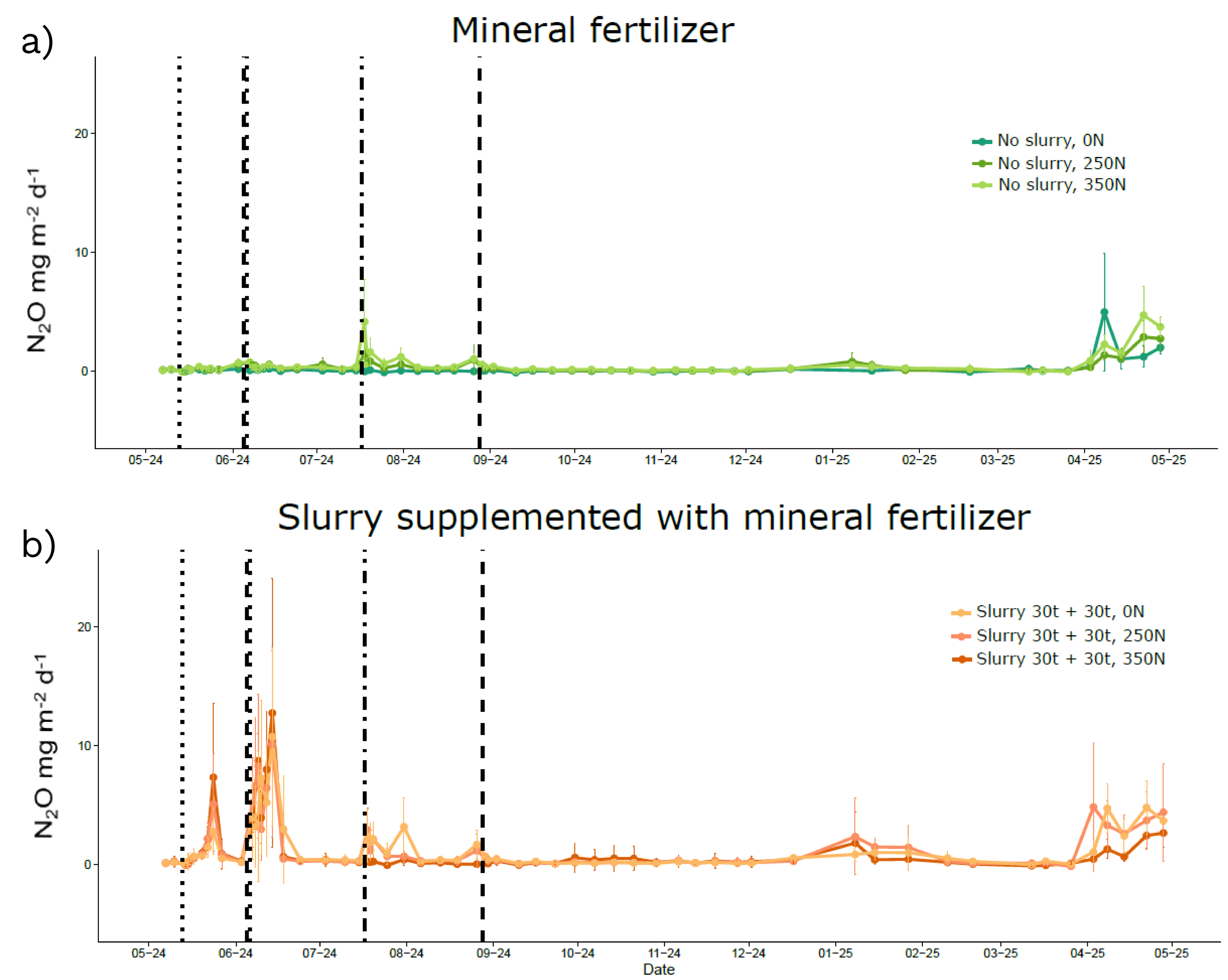

Figure 1. N_2O flux rates (N_2O mg m^{-2} d^{-1}) from mineral fertilizer (a) and slurry supplemented with mineral fertilizer (b). Vertical lines indicate management events during the growing season: fertilization (dotted), harvest (dashed), harvest and fertilization (dotdashed).

Treatment	Yield (kg ha^{-1})	Annual N_2O emission (kg N_2O-N ha^{-1} y^{-1})	Yield-scaled N_2O emissions (kg N Mg^{-1})	Total N applied (kg ha^{-1})	Total soluble N applied (kg ha^{-1})
No slurry, 0N	2520	0.50	0.22	0	0
No slurry, 250N	9250	0.85	0.09	250	250
No slurry, 350N	9710	1.18	0.12	350	350
Slurry 30t + 30t, 0N	5760	1.65	0.30	203	107
Slurry 30t + 30t, 250N	9040	2.44	0.27	333	237
Slurry 30t + 30t, 350N	8150	2.29	0.28	433	337

Table 1. Yield, annual N_2O emissions, annual yield-scaled emissions and total N and soluble N applied during the measurement year.

Figure 2. Closed chamber method with a portable analyzer was used for measuring N_2O emissions during snow-free period.

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www.luke.fi/viisastyppikierto

Maa- ja metsätalousministeriö
Luke LUONNONVARAKESKUS
UNIVERSITY OF EASTERN FINLAND