Methane uptake in fertilized soils - effect of NH_4NO_3 at different soil O_2 levels

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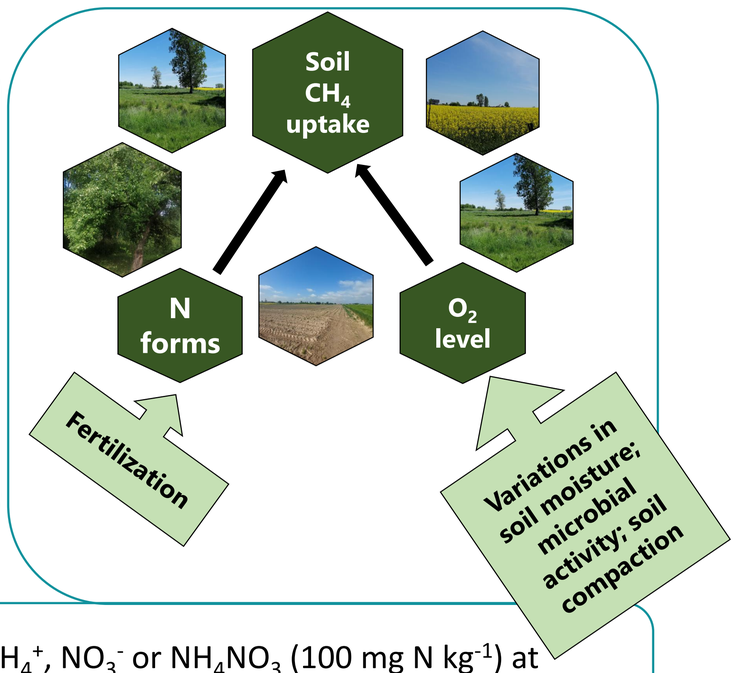
RATIONALE

Soil participates in global warming e.g. as a source or sink for greenhouse gases (GHGs). Given the mitigation potential, its capability of **methane (CH_4) uptake** is often under scientific considerations. Methanotrophs can consume atmospheric CH_4 (especially in forests and grasslands) or oxidize CH_4 produced in deeper soil layers or in anaerobic microsites, thus reducing its emission from soil.

Land use influences the CH_4 uptake capacity and is often changed by **nitrogen (N) fertilization**, and ammonium nitrate is a very widely used fertilizer. Nitrogen is highly dynamic in soil and addition of ammonium (NH_4^+) may result in nitrate (NO_3^-) accumulation due to nitrification.

The **O_2 concentration** is a dynamic parameter altered by natural soil moisture changes as well as root and microbial activity.



The aim of the study was to determine CH_4 consumption (1%) in three arable soils of different types incubated with NH_4^+, NO_3^- or NH_4NO_3 (100 mg N kg^{-1}) at different O_2 levels (2, 5, 10, and 20 % v/v). Moreover, the concentrations of mineral N forms under different aeration were measured.

RESULTS

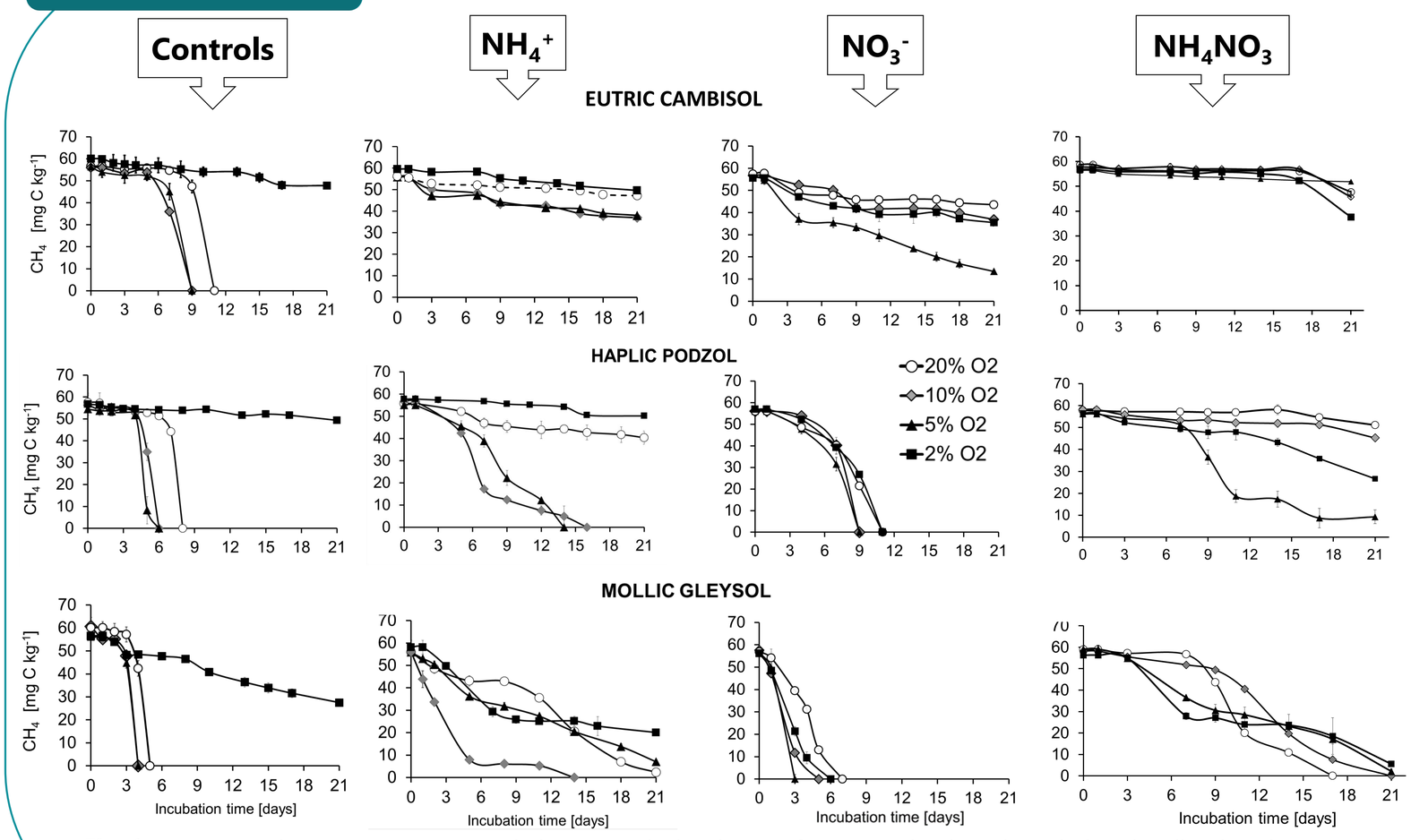


Fig. 1. Decrease in the CH_4 concentration with the time in the headspace of Eutric Cambisol, Haplic Podzol, and Mollic Gleysol incubated with CH_4 (1% v/v), without and with addition of 100 mg N kg^{-1} in form of NH_4^+; NO_3^- and NH_4NO_3. Soil samples were incubated under different O_2 levels (20%, 10%, 5%, 2% O_2 v/v).

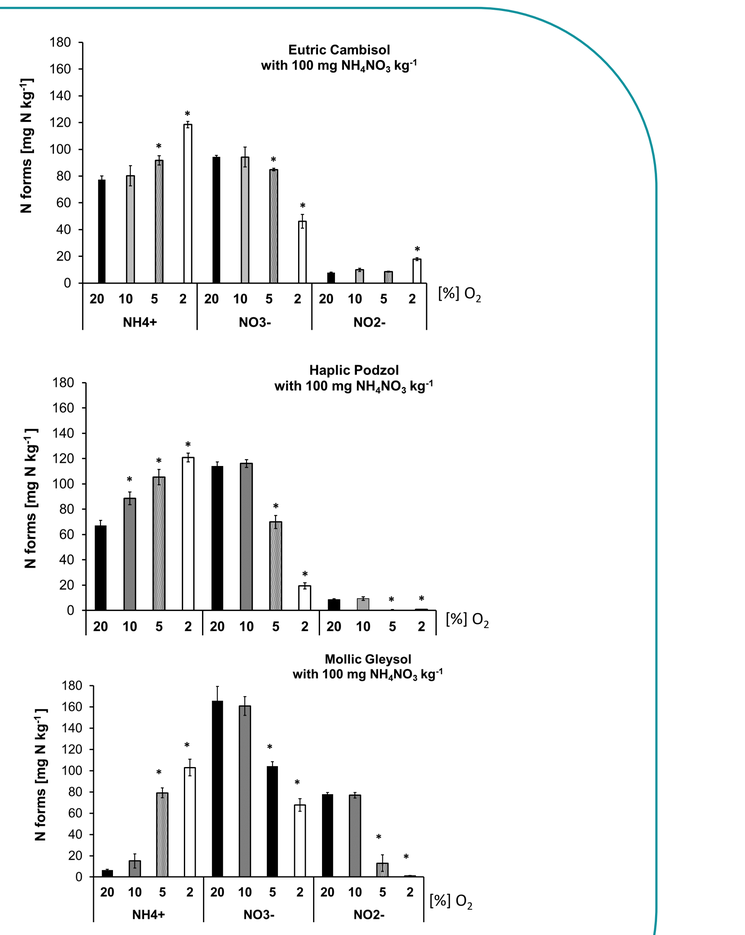


Fig. 2. Concentration of mineral N forms in Eutric Cambisol, Haplic Podzol, and Mollic Gleysol enriched with 100 mg NH_4NO_3 kg^{-1} at the end of incubation at different O_2 levels (20%, 10%, 5%, 2% v/v). The asterisk indicates significant difference in relation to 20%O_2 ($p<0.05$).

SUMMARY AND CONCLUSIONS

- ✓ Mineral arable soils completely oxidized added CH_4 (1%) under oxia and hypoxia.
- ✓ Hypoxia (5%; 10%O_2) was optimal for CH_4 uptake in all controls.
- ✓ Hypoxia (5%; 10%O_2) was optimal for methanotrophy in Podzol and Gleysol with NO_3^-.
- ✓ All factors (N enrichment, soil type, oxygen level) may be significant and regulators of methanotrophy.
- ✓ Negative effect of NH_4^+ was the strongest at oxia (20%O_2) and microoxia (2%O_2).
- ✓ A negative NO_3^- effect on methanotrophy was noticed in Cambisol at oxia and hypoxia.
- ✓ Nitrates stimulated CH_4 consumption in all soils under 2%O_2.
- ✓ Addition of NH_4NO_3 resulted in reduction of CH_4 consumption, with the exception of the variant with 2%O_2, where a lower N dose resulted in faster CH_4 oxidation than in the control.
- ✓ NH_4NO_3 addition may differently affects CH_4 uptake than separately NH_4^+ or NO_3^-.
- ✓ In all tested soils, the final NH_4^+ concentration increased, whereas the level of NO_3^- decreased with the reduction of the O_2 level from 20% to 2%, due to nitrification.

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