Biological Nitrification Inhibition (BNI) activity of temperate catch crops: a promising strategy to reduce nitrification in fertilized soils

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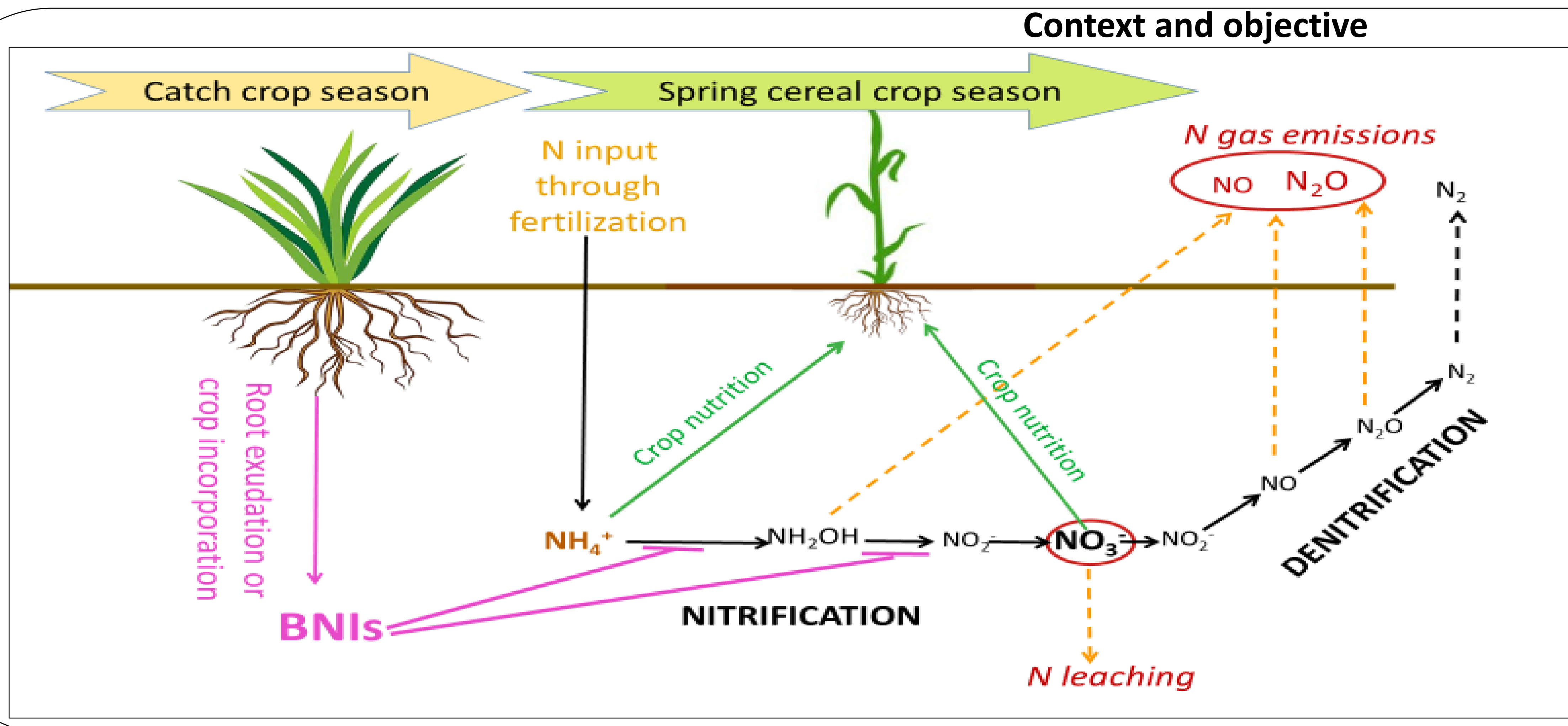
Aude Mancia (aude.mancia@uliege.be) [a] ; Hervé Vanderschuren [a] ; Cécile Thonar [a,b] , Hugo Murillo[b]

a LIÈGE université Gembloux Agro-Bio Tech b ULB Université Libre de Bruxelles

CATCH-BNI

Project CATCH-BNI : https://www.suscrop.eu/projects-second-call/catch-bni

Context and objective



- About 70% of N inputs in agroecosystems are lost (N_2O emissions, NO_3^- leaching, NH_3 volatilization) so importance to increase N use efficiency of crops
- Nitrification inhibitors (NIs) such as DMPP can be used to reduce nitrification in agricultural soils but are associated with many drawbacks (cost, environmental impact, public acceptance).
- Attention is now turned onto a promising alternative: Biological Nitrification Inhibition (BNI), i.e., the ability of some plants to naturally produce Nis

Main objective: This research, within the European project CATCH-BNI, aimed to identify BNI-based approaches to stabilize N-fractions of fertilizers applied to target crops.

Fig. 1 Schematic representation of the effect of BNIs on N cycle and crop nutrition

Materials and methods

- Short-term soil incubation experiment.
- Optimal conditios for nitrification (20°C, 60% WFPS)
- Five soil treatments: soil ot treated, soil treated with DMPP, rhizospheric soils from white mustard cultivar « Verdi » and cultivar « Pole Position » and rhizospheric soil from spring wheat cultivar « Persia 44 » (a benchmark for its BNI property).
- Three fertilization treatments: ammonium sulfate (AS), Orgamine 7 (Fayt-Carlier s.a., Belgium), and liquid digestate (Biogaz du Haut Geer, Belgium). Application at 100 mgN kg^{-1} DW soil
- Negative control : non-treated soil + no fertilization
- Non destructive measurement of N_2O fluxes with gas analyzer
- Destructive sampling at Day 0 (just after fertilization), Day 7 and Day 21 for determination of mineral N concentrations

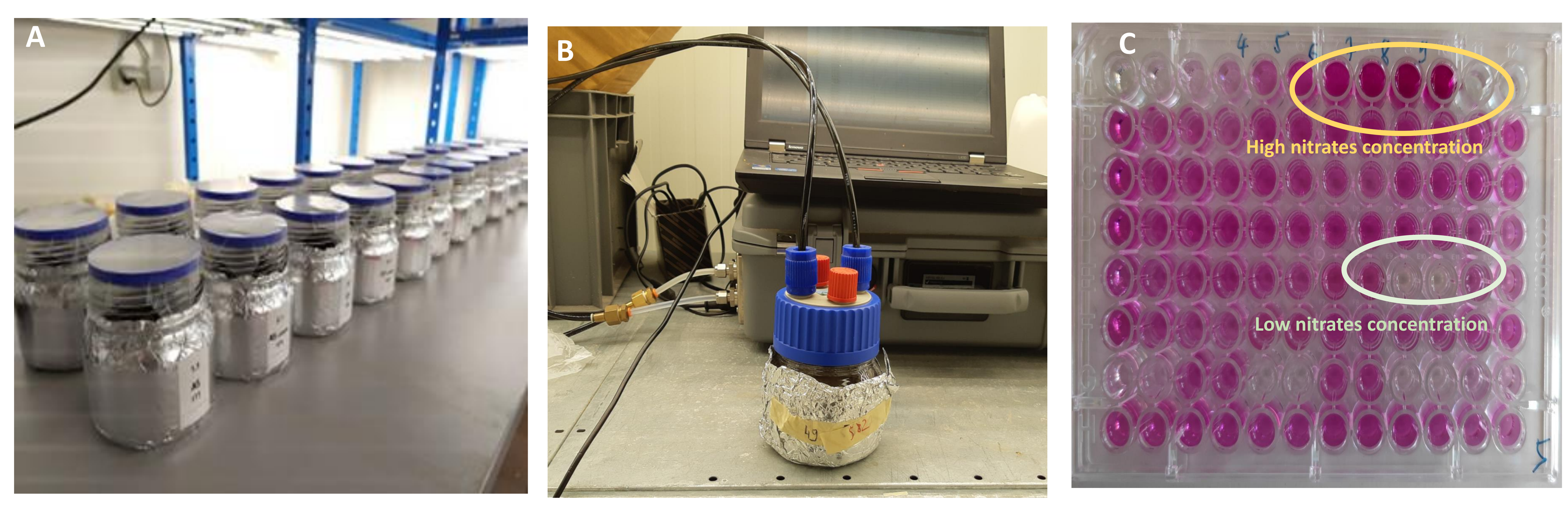


Fig. 2 Soil incubation experiments to assess stabilization of organic fertilizers with BNI material (catch crops tissues or rhizospheric soil): A/Pots containing incubated soil B/ Measurement of N_2O emissions with an infrared gas analyzer C/Results of the test for NO_3^- concentration determination

Key findings

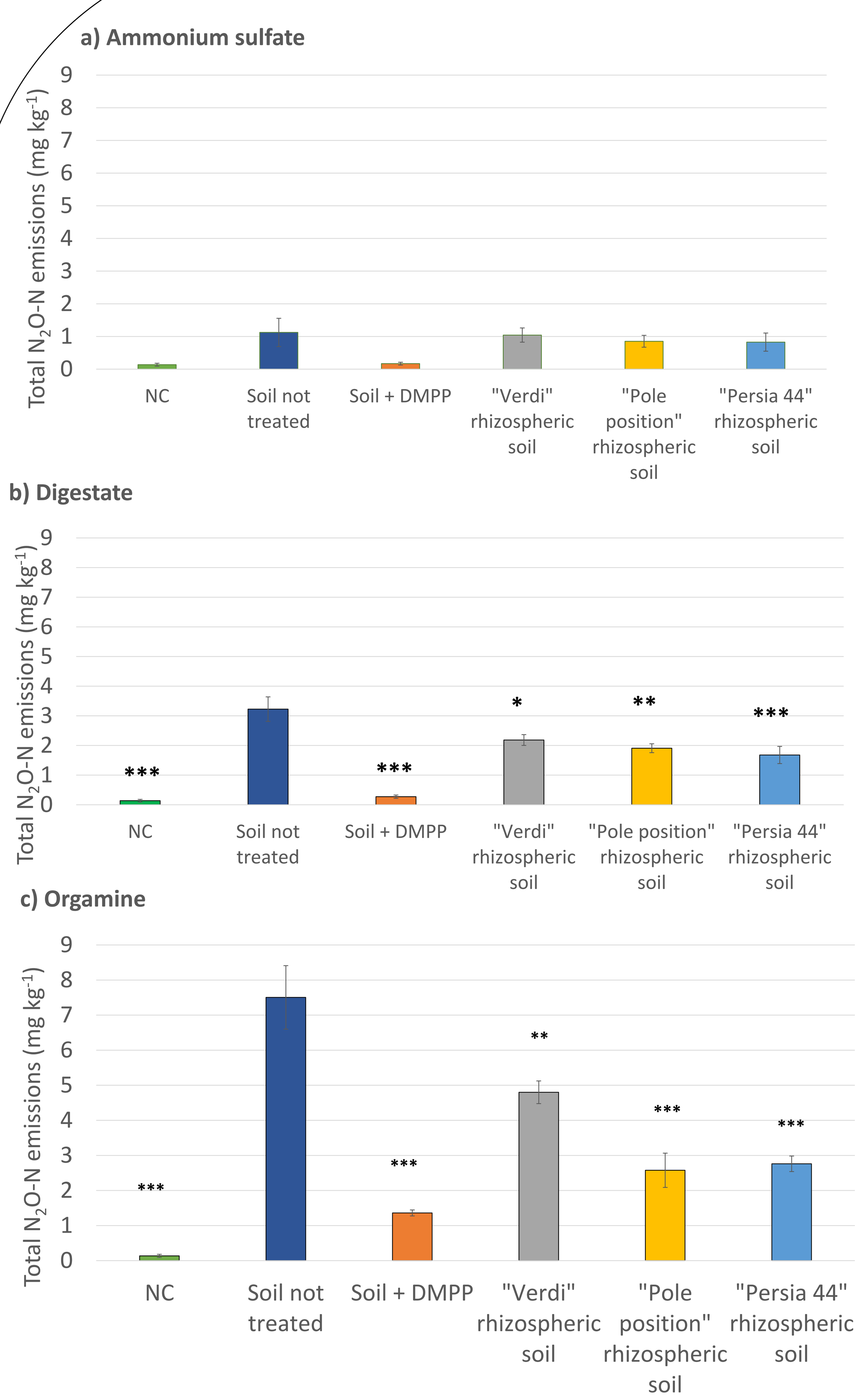


Figure 3. Total N_2O emissions (mg kg^{-1}) calculated 22 days after fertilization with ammonium sulfate (a), digestate (b) and orgamine (c) for each soil treatment. Units are expressed on a dry soil weight basis. NC refers to negative control. Black asterisks indicate a significant difference with the "Soil not treated" (Dunnett's test) . Significance codes are: * p<0.05 ; ** p< 0.01 ; *** p<0.001

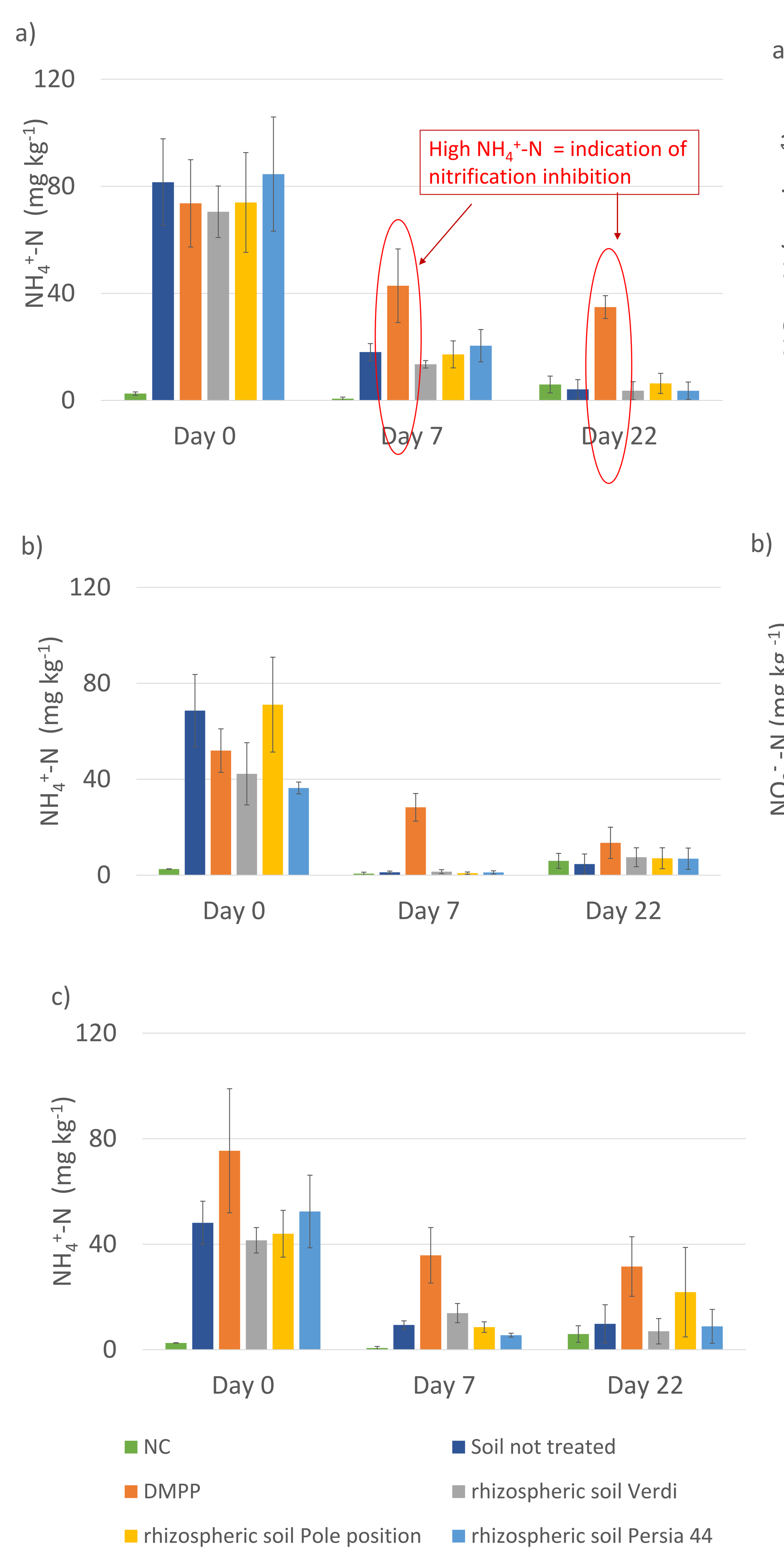


Figure 4 . Average concentrations of NH_4^+-N (mg kg^{-1} ; n=4) measured for each soil treatment at each destructive samplings following fertilization with AS (a), digestate (b) and orgamine (c) . Units are expressed on a dry soil weight basis. NC refers to negative control (standard soil receiving water instead of fertilizer).

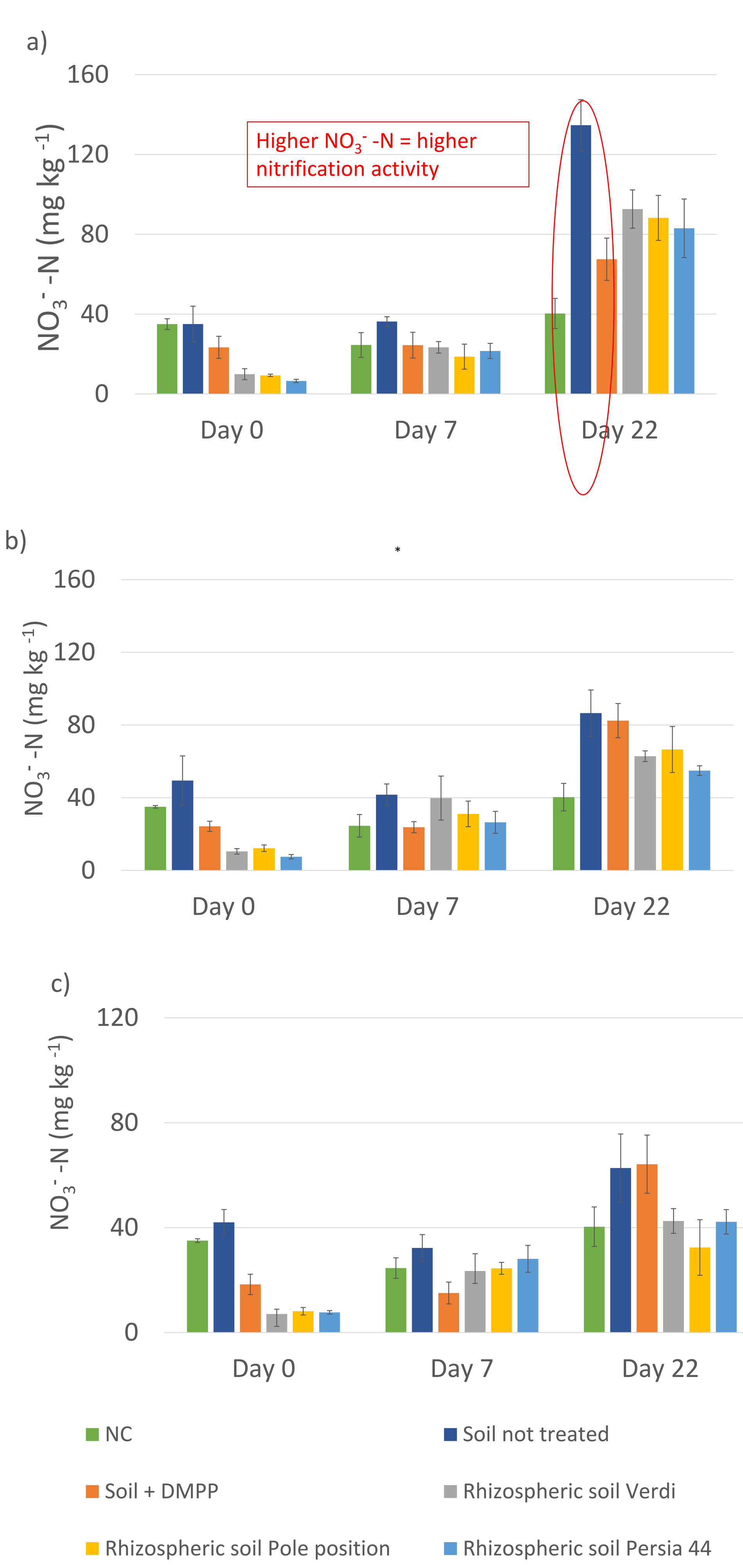


Figure 5. Average concentrations of NO_3^--N (mg kg^{-1} ; n=4) measured for each soil treatment at each destructive samplings following fertilization with AS (a), digestate (b) and orgamine (c) . Units are expressed on a dry soil weight basis. NC refers to negative control (standard soil receiving water instead of fertilizer).

After AS fertilization:

- No significant reduction of N_2O emissions with rhizospheric soils or soil + DMPP compared to soil not treated.
- However, mineral N showed higher nitrificatoin activity in soil not treated
- Therefore absence of difference of N_2O emissions could be due to globally low emissions for all soil treatments

After digestate and orgamine fertilization:

- Reduction N_2O emissions with rhizospheric soil and Soil+DMPP compared to Soil not treated.
- Mineral N profiles show not obvious nitrification inhibition activity for rhizospheric soil
- Lower N_2O activity in rhizospheric soils could be attributed to BDI (Biological Denitrification Inhibition) activity in rhizospheric soils, associated with higher NO_3^- increase between Day 0 and Day 22.

Rhizospheric soil from white mustard cultivars « Verdi » and « Pole Position » represent a promising stategy to reduce N_2O emissions after organic fertilization

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