GEORG-AUGUST-UNIVERSITÄT GÖTTINGEN

EBERHARD KARLS UNIVERSITÄT TÜBINGEN

The role of maize root exudates to availability of N source in different forms in top- and subsoils

Juanjuan Ai[1,2], Callum C. Banfield[1,2], Guodong Shao[2], Kazem Zamanian[3], Sandra Spielvogel[4], Michaela A. Dippold[1,2]

[1] Biogeochemistry of Agroecosystems, Department of Crop Sciences, University of Göttingen

[2] Geo-Biosphere Interactions Department of Geosciences, University of Tübingen

[3] Department of Soil Science of Temperate Ecosystems, University of Göttingen

[4] Institute of Plant Nutrition and Soil Science, Christian-Albrecht-University of Kiel

Biochemistry of Agroecosystems

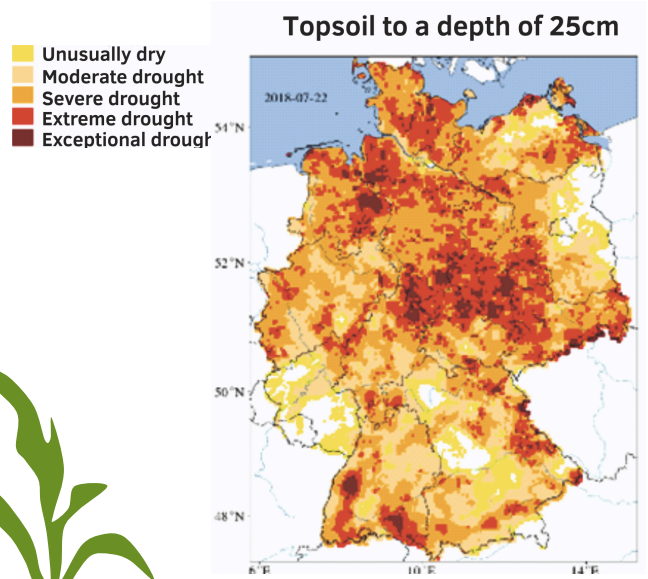
ROOT WAYS

BONARES Zentrum für Bodenforschung

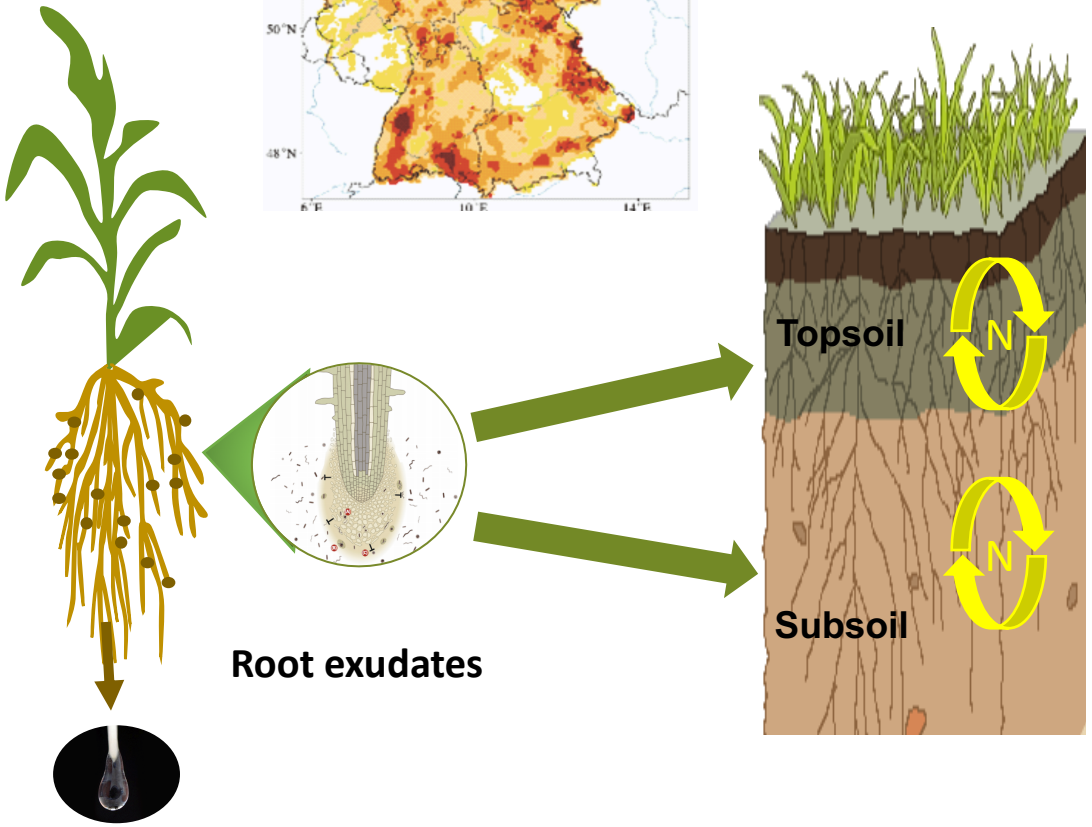
EGU General Assembly 2022

EGU22-4304

Introduction



In Germany, predicted increasing drought frequencies and intensities will reduce nutrient availability in dry topsoils and hamper water access for cash crop production



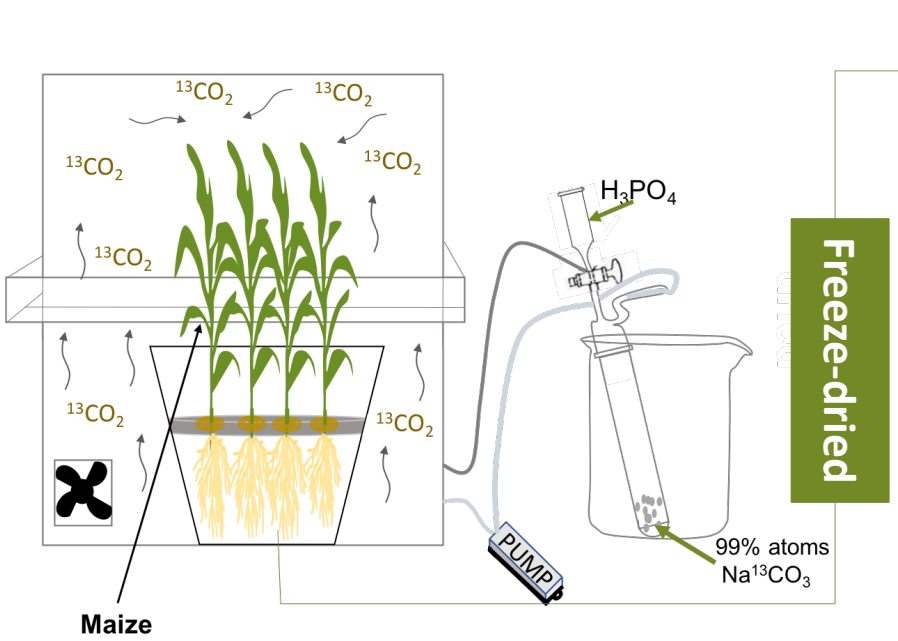
- Main driver of element and nutrient cycling in the rhizosphere
- Effect of root exudates on nutrient release by rhizosphere microorganism may vary depending on: nutrient form; nutrient availability; root environment
- Subsoils of particular importance due to hampered nutrient cycling in topsoils?

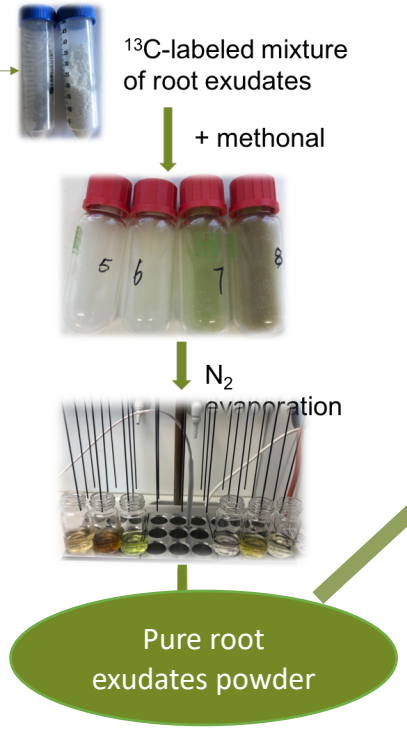
Source: https://en.wikipedia.org; https://www.emsland-group.de

Methods

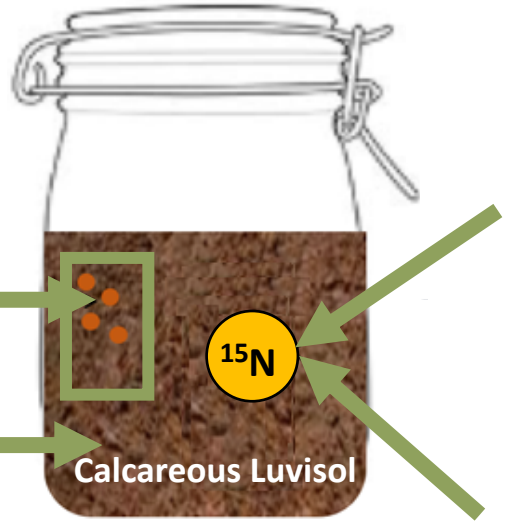
Objective

To investigate the specific processes how root exudates interact with distinct N forms altering their subsoil mobilization by ^{15}N isotopic labelling, and disentangle key rhizosphere strategies for N mobilization





Freeze-dried



Soil sources

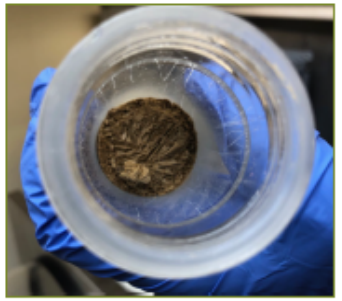
Topsoil 5% $CaCO_3$

Subsoil 32.1% $CaCO_3$

Organic ^{15}N sources

urea vs. plant litter

Inorganic ^{15}N sources



NH_4^+: free vs. sorbed

Root exudate production and sampling from maize plants

Incubation experiment (^{15}N forms of different availability)

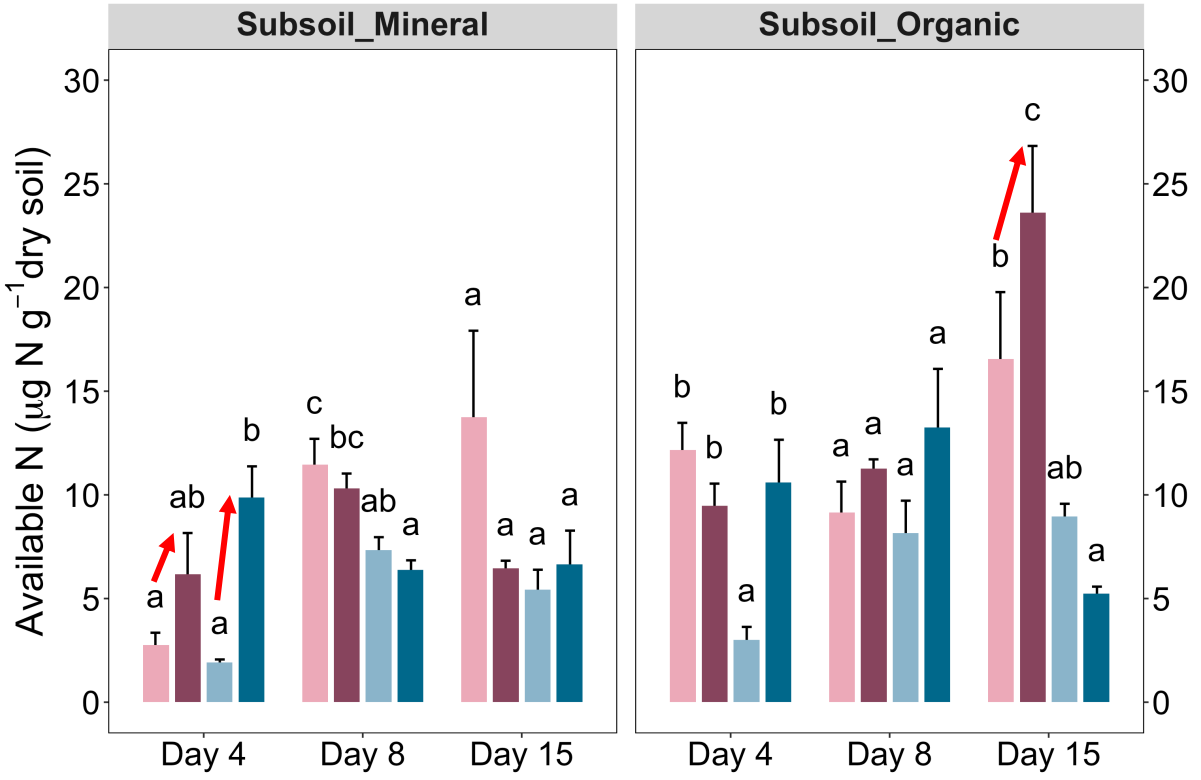
Results

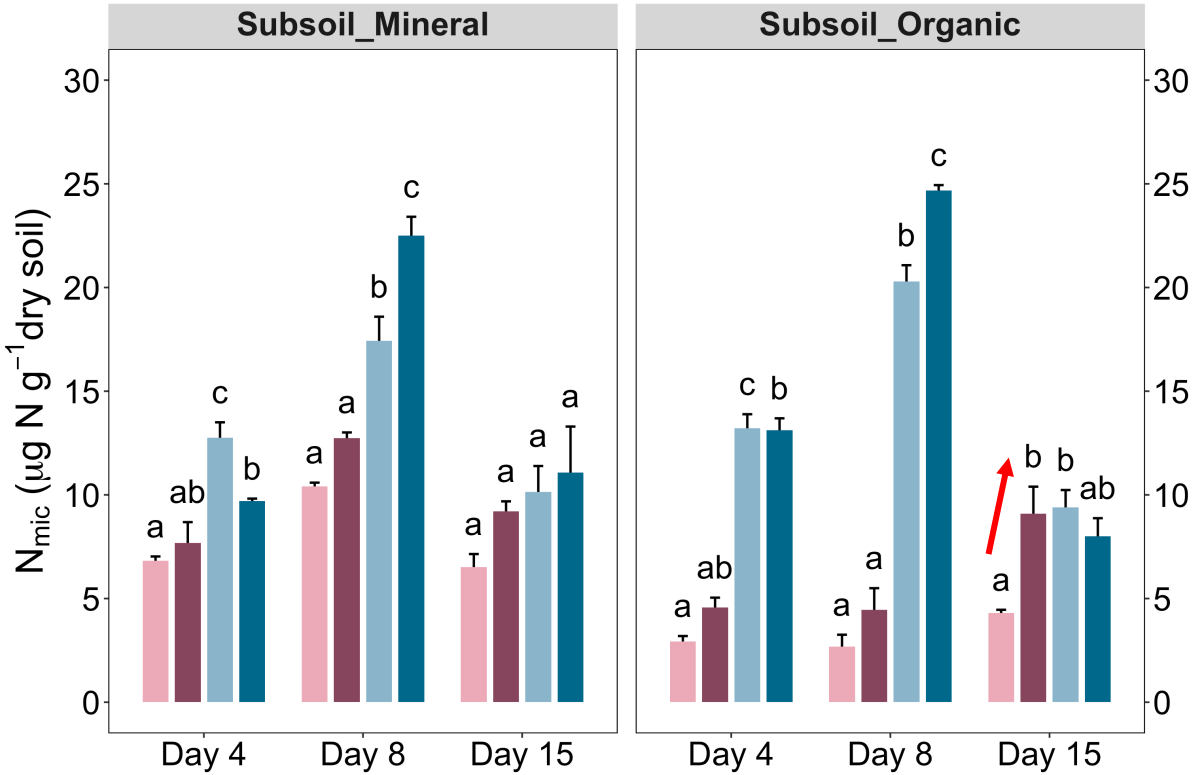
^{15}N-labelled chicory shoots / sorbed $^{15}NH_4^+$ source – root exudate

^{15}N-labelled chicory shoots / sorbed $^{15}NH_4^+$ source + root exudate

^{15}N-urea / Free $^{15}NH_4^+$ source – root exudate

^{15}N-urea / Free $^{15}NH_4^+$ source + root exudate



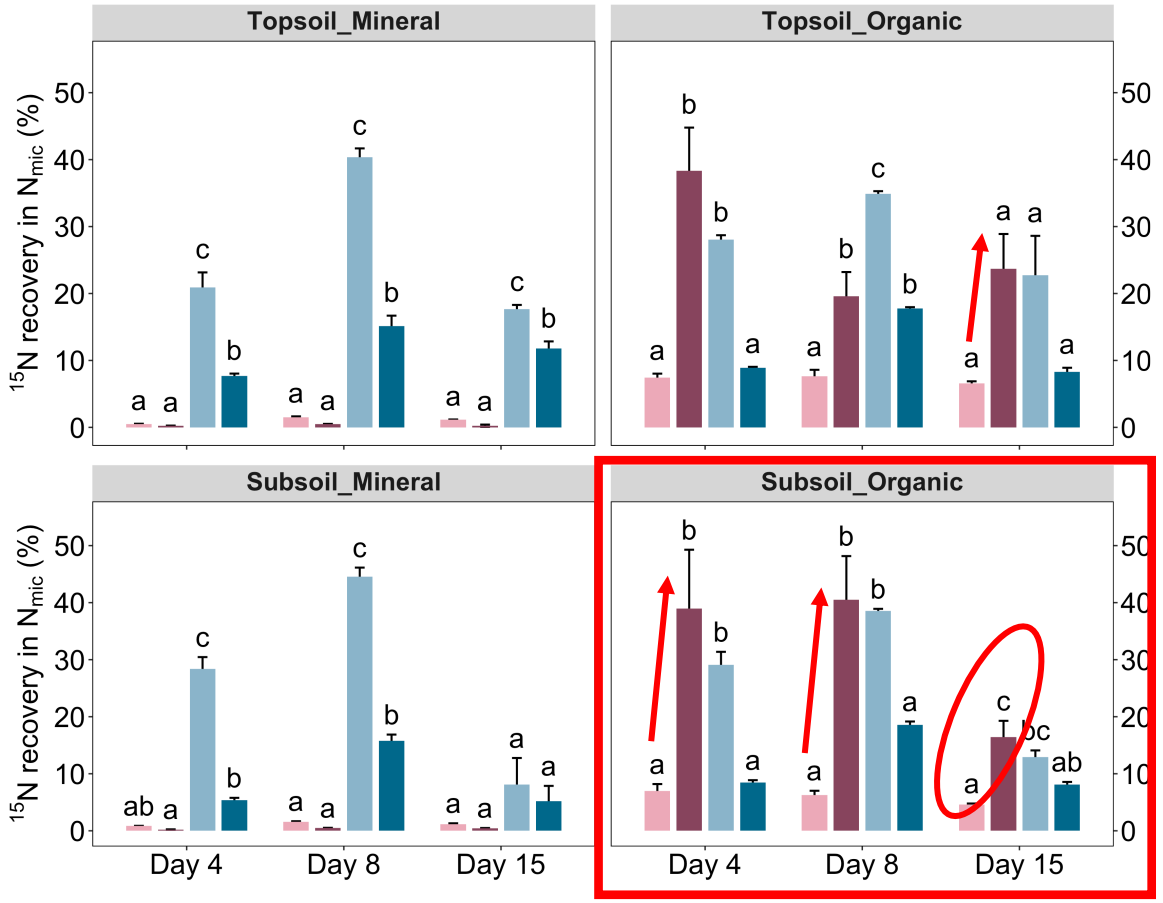


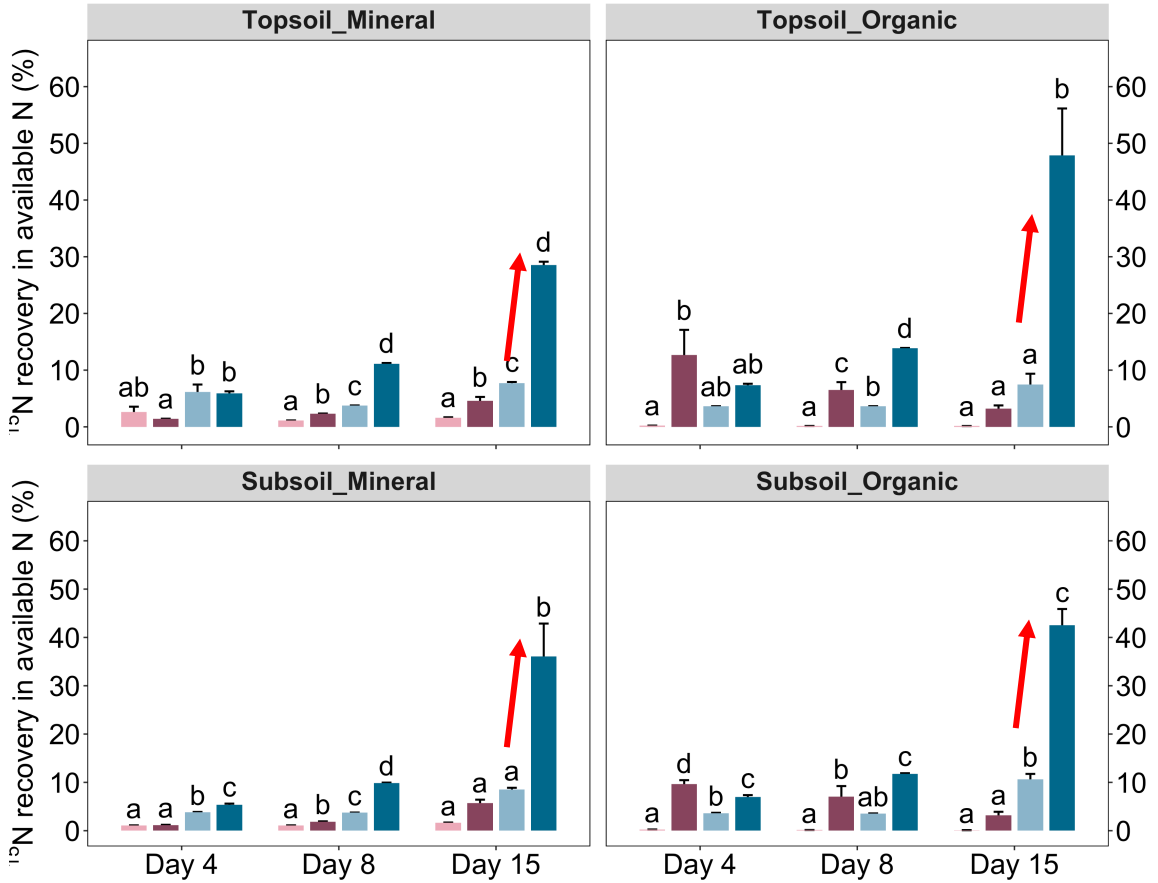
→ Root exudate induced an increase in subsoil solution (available N) with sorbed and free NH_4^+ supply

→ Root exudate enhanced the capacity of subsoil microbial communities to use complex litter-derived N.

Results

- ^{15}N-labelled chicory shoots / sorbed $^{15}NH_4^+$ source – root exudate
- ^{15}N-labelled chicory shoots / sorbed $^{15}NH_4^+$ source + root exudate
- ^{15}N-urea / Free $^{15}NH_4^+$ source – root exudate
- ^{15}N-urea / Free $^{15}NH_4^+$ source + root exudate

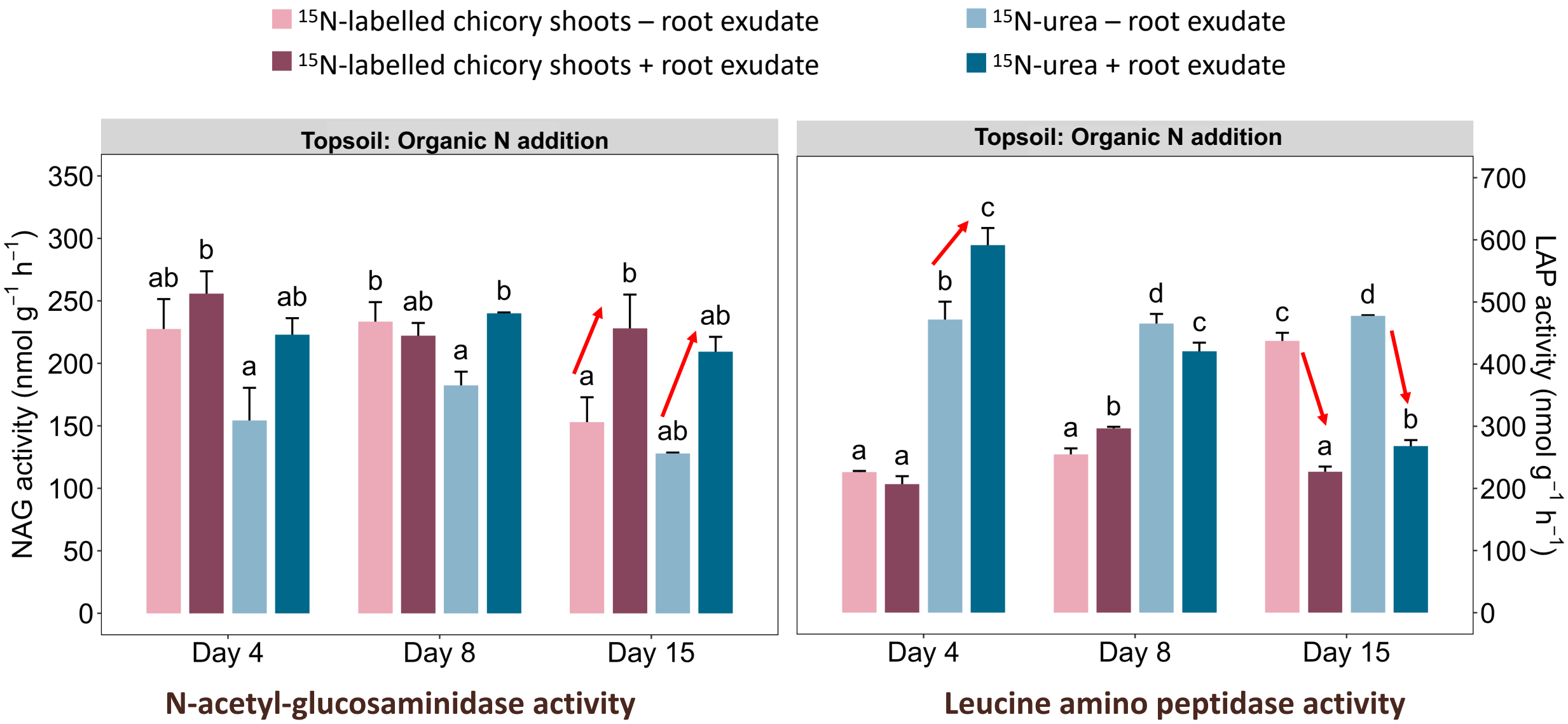




→ Root exudates stimulated N release into soil with residues-derived N

→ Root exudates might regulate easily available N mobilization and immobilization

Results

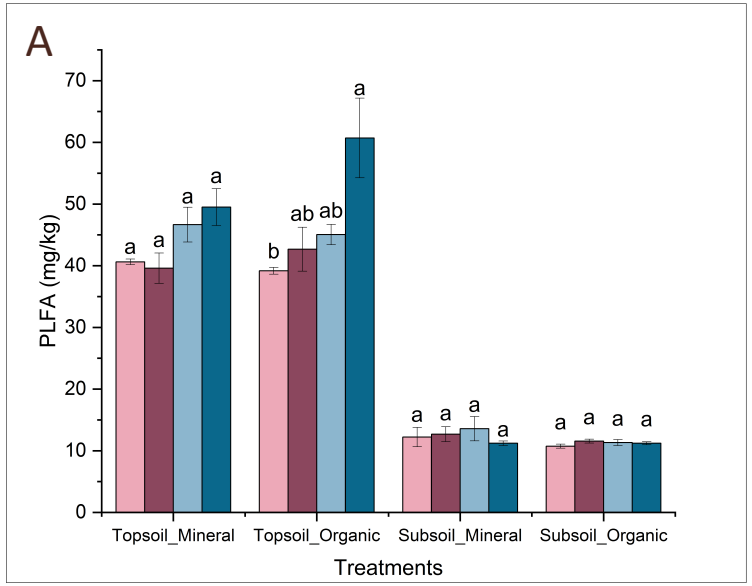


N-acetyl-glucosaminidase activity

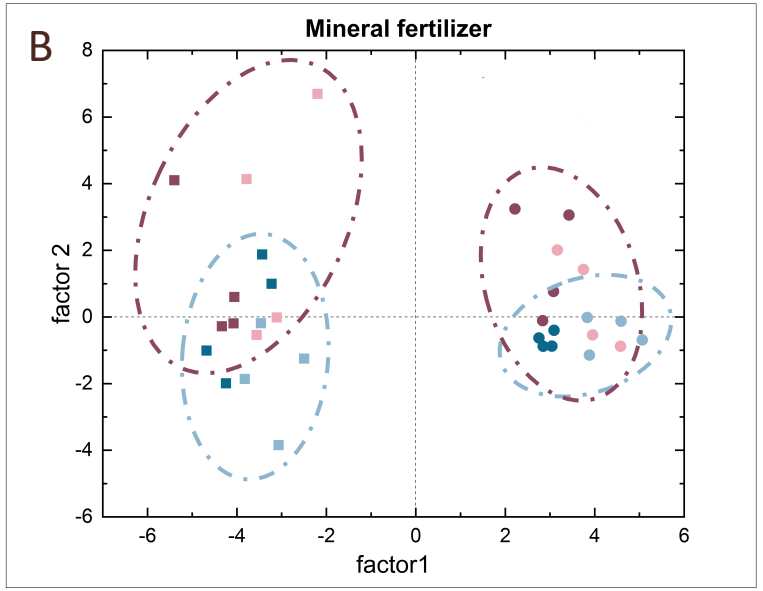
Leucine amino peptidase activity

Results

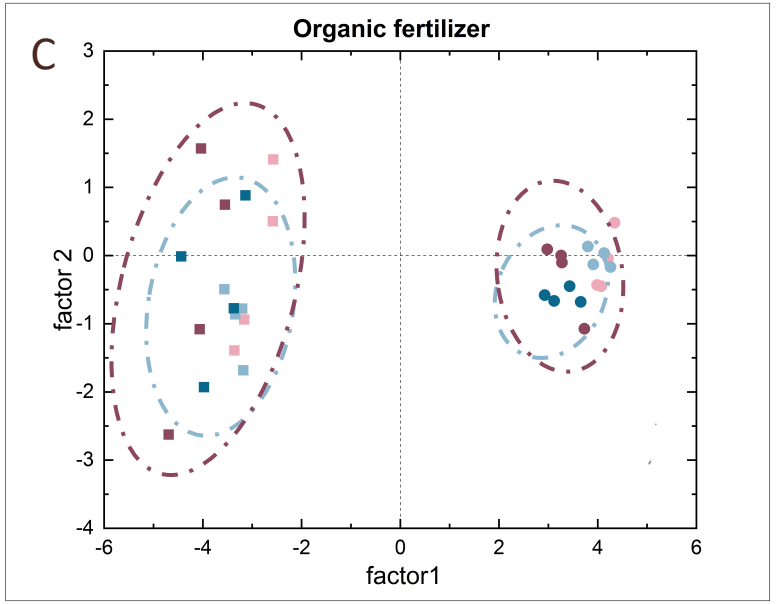
PLFA (mg kg^{-1})



PLFA: mineral N sources addition



PLFA: organic N sources addition



- Sorbed $^{15}NH_4^+$ / ^{15}N-chicory – RE
- Sorbed $^{15}NH_4^+$ / ^{15}N-chicory + RE
- Free $^{15}NH_4^+$ / ^{15}N-urea – RE
- Free $^{15}NH_4^+$ / ^{15}N-urea + RE

- Sorbed $^{15}NH_4^+$ – RE
- Sorbed $^{15}NH_4^+$ + RE
- Free $^{15}NH_4^+$ – RE
- Free $^{15}NH_4^+$ + RE

- ^{15}N-chicory – RE
- ^{15}N-chicory + RE
- ^{15}N-urea – RE
- ^{15}N-urea + RE

Topsoil Subsoil

RE: root exduate

Conclusions

- Root exudates lead to a shift in microbial N source in presence of organic N
- Subsoil communities were well capable of using litter-derived N, especially if root exudates accelerate overall activity and N cycling in subsoils
- N incorporated from plant litter is successively recycled in microbial biomass following the initial degradation
- Principal component analysis of phospholipid fatty acid demonstrate that the observed alterations with root exudate addition were not caused by changes in microbial community composition but rather by an altered microbial activity and N metabolism

Thanks for your kind attention

Federal Ministry of Education and Research

China Scholarship Council
www.csc.edu.cn