# Microbial carbon use efficiency of plant root exudates depends on the substrate and carbon and nitrogen availability

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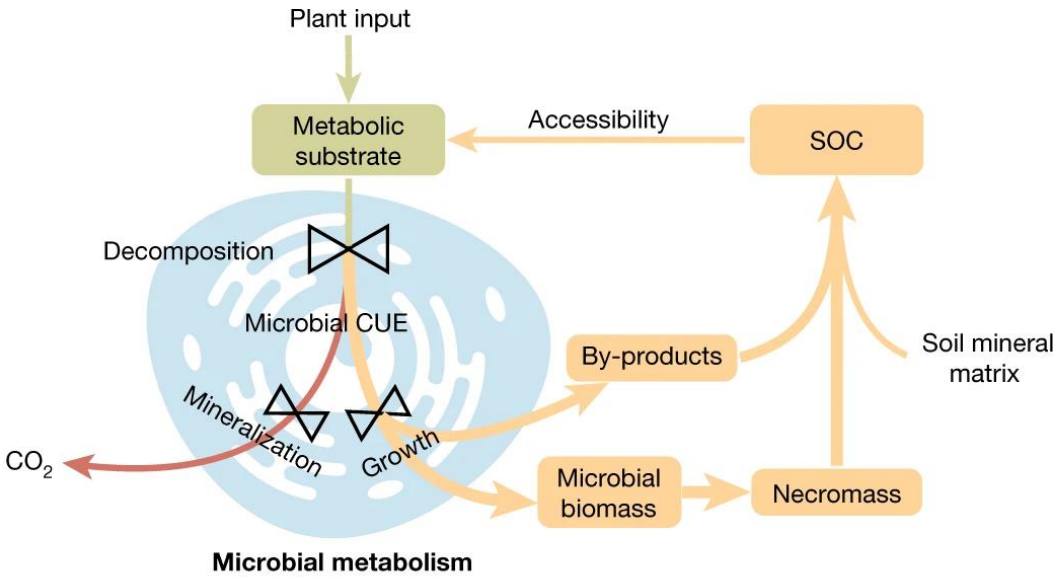
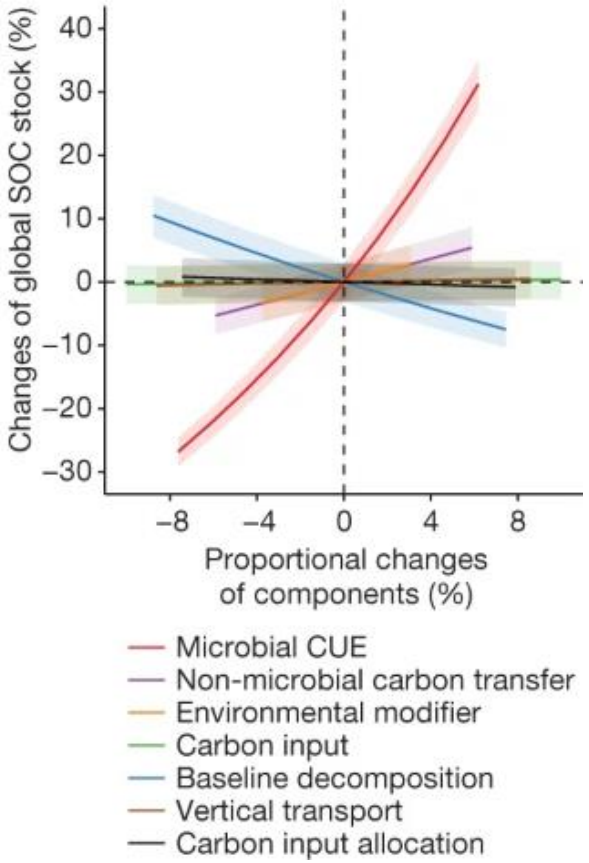
EJP SOIL has received funding from the European Union's Horizon 2020 research and innovation programme. Grant agreement No 862695

# Microbial Carbon Use Efficiency (CUE) is an Important Factor of Soil C Storage

CUE = C for growth / C uptake



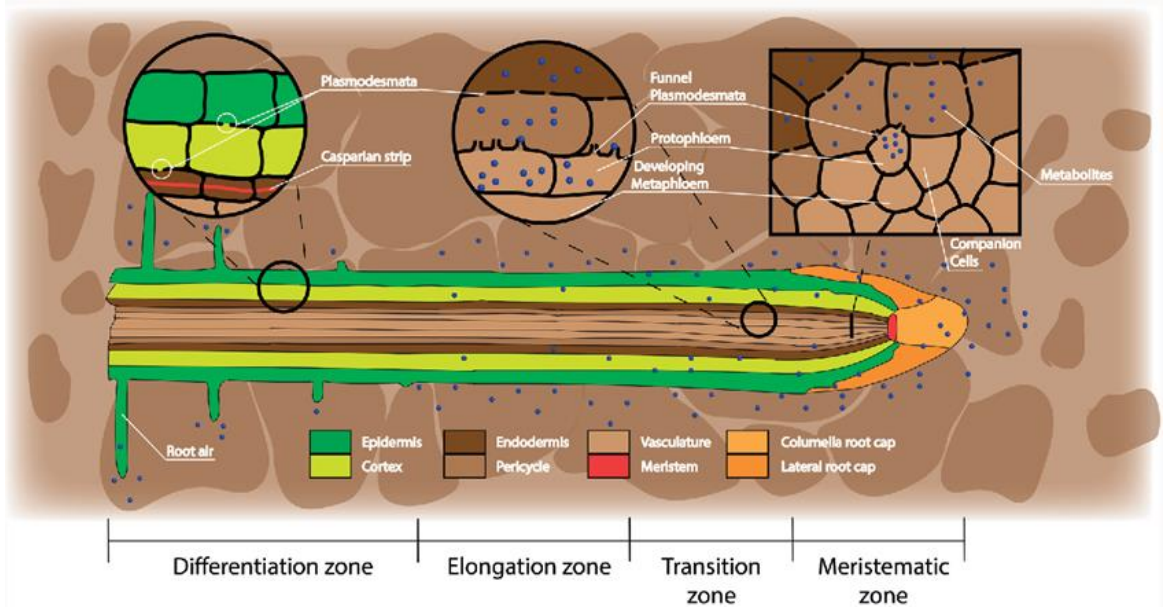

Source: Tao et al. (2023)




Source: Tao et al. (2023)

# Root Exudates Potentially Contribute to Soil C Sequestration

Root exudation: release of primary metabolites (sugars, organic acids, amino acids) from roots




Source: Canarini et al. (2019)

Studies have pointed out the importance of

- labile compounds (Cotrufo et al., 2013),
- living root inputs (Sokol et al., 2014; Villarino et al., 2021),

for C sequestration

⬇

Potential contribution by root exudates

However…

## Knowledge gap:

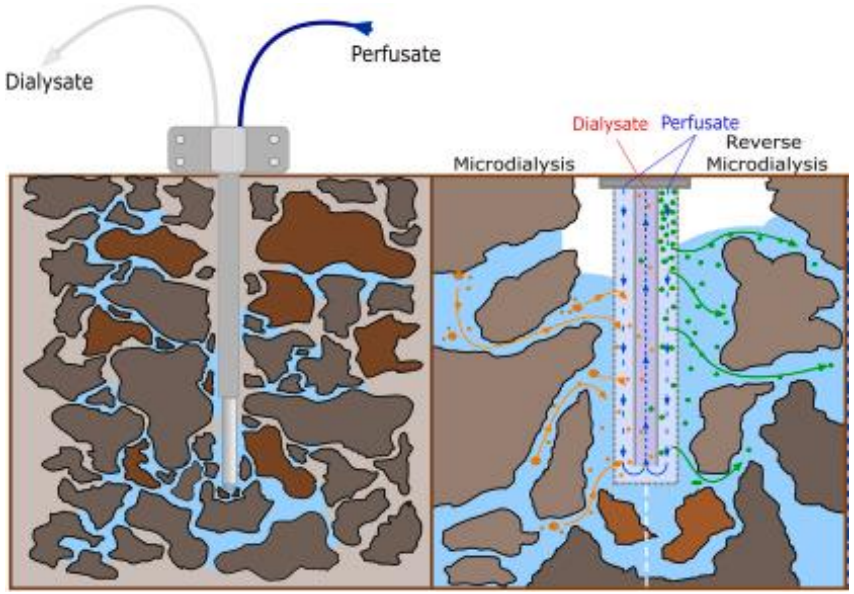
How CUE of root exudates are controlled?

## Overall aim:

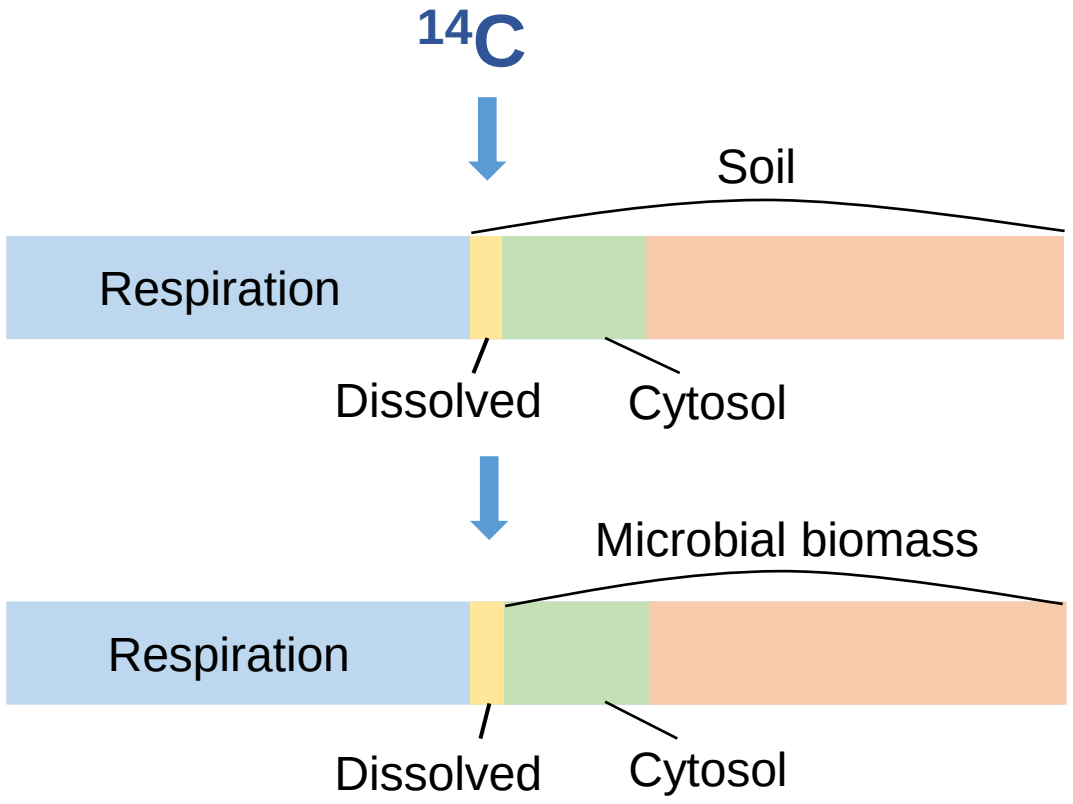
Improve our understanding of CUE of root exudates,
for potential management of agricultural systems for more efficient C sequestration through root exudates

# Microdialysis experimental setup to simulate exudation

Microdialysis
- allows slow release of substrates by passive diffusion




Source: König et al. (2022)



## Experiment 1

Pure solution of  five individual compounds (glucose, sucrose, acetic acid, alanine, aspartic acid)

Objective:

Investigate the difference between the pulse-addition and microdialysis method

Investigate the difference in CUE between compounds

## Experiment 2

Compound mixtures

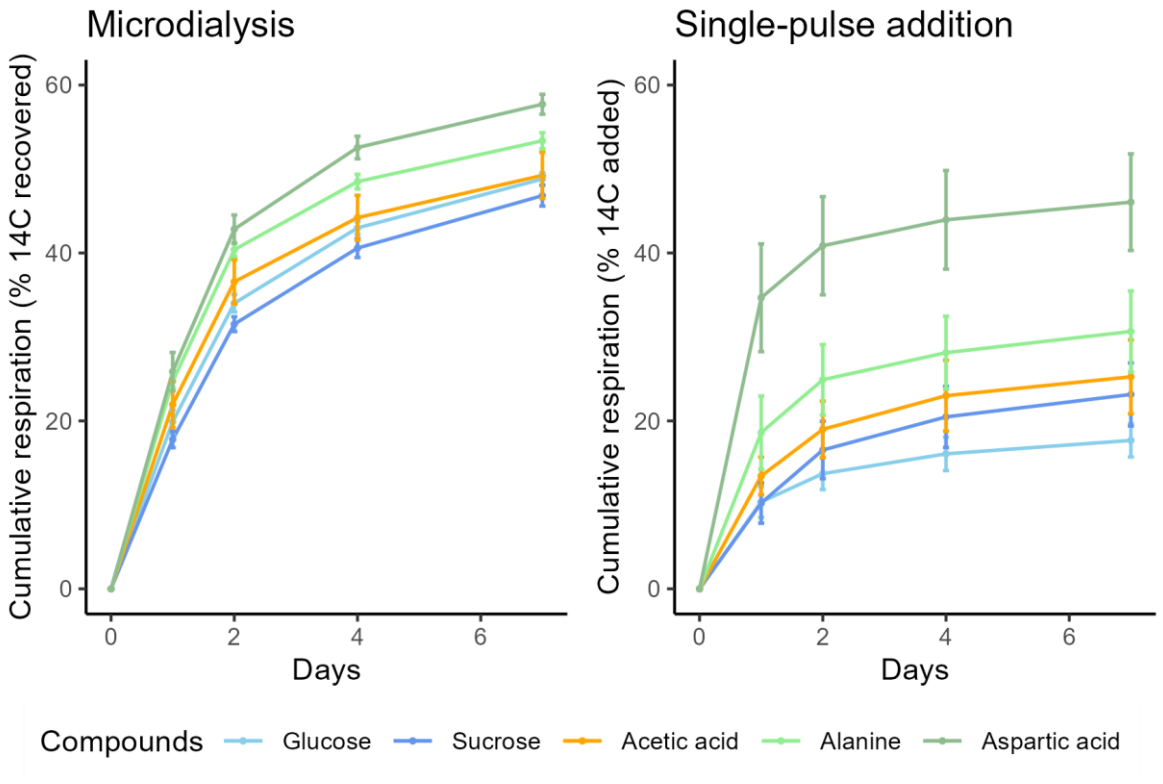
Objective:

Investigate the effect of the presence of other compounds

| | Compound Mixture Treatments | | | |
|---|---|---|---|---|
| 14C-labeled Compound | Control (N/C: 0) | Low N (N/C: 1/27) | High N (N/C: 1/9) | Control (N/C: 1/3) |
| Glucose | Glucose: 1 mM C | Glucose: 1 mM C<br>Acetic acid: 1.666 mM C<br>Alanine: 0.333 mM C<br>(3 mM C in total) | Glucose: 1 mM C<br>Acetic acid: 1 mM C<br>Alanine: 1 mM C<br>(3 mM C in total) | |
| Acetic acid | Acetic acid: 1 mM C | Glucose: 1.666 mM C<br>Acetic acid: 1 mM C<br>Alanine: 0.333 mM C<br>(3 mM C in total) | Glucose: 1 mM C<br>Acetic acid: 1 mM C<br>Alanine: 1 mM C<br>(3 mM C in total) | |
| Alanine | | Glucose: 4 mM C<br>Acetic acid: 4 mM C<br>Alanine: 1 mM C<br>(9 mM C in total) | Glucose: 1 mM C<br>Acetic acid: 1 mM C<br>Alanine: 1 mM C<br>(3 mM C in total) | Alanine: 1 mM C |

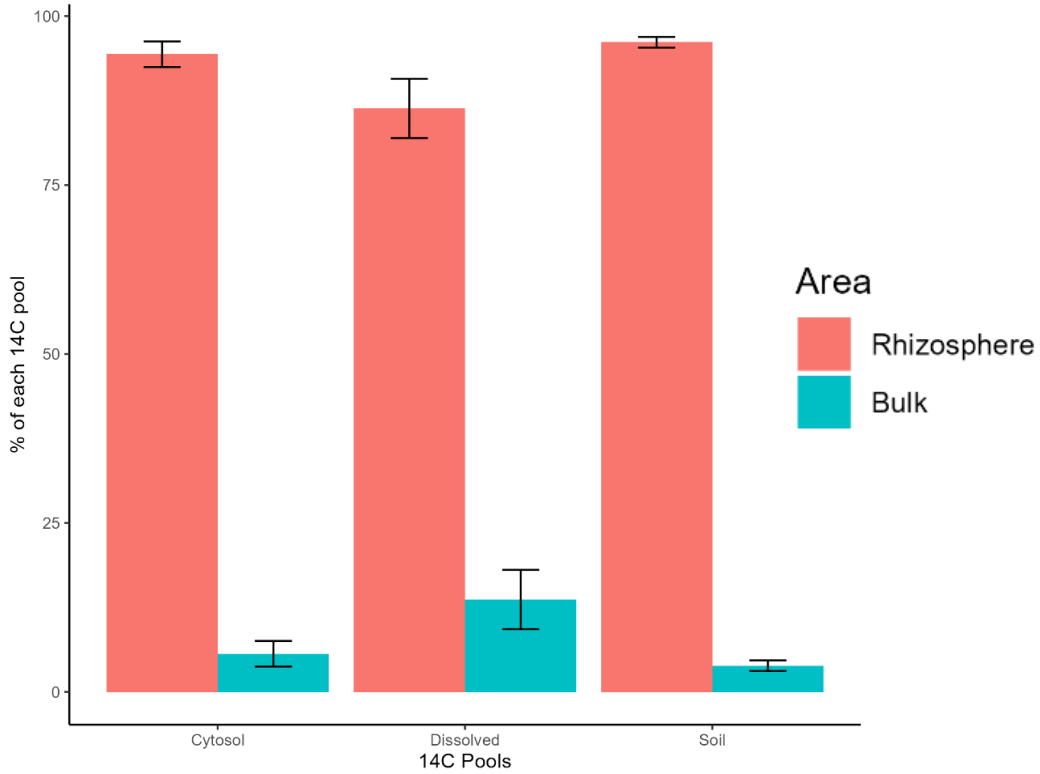
# Microdialysis vs. single-pulse addition

Lower respiration observed in the microdialysis method



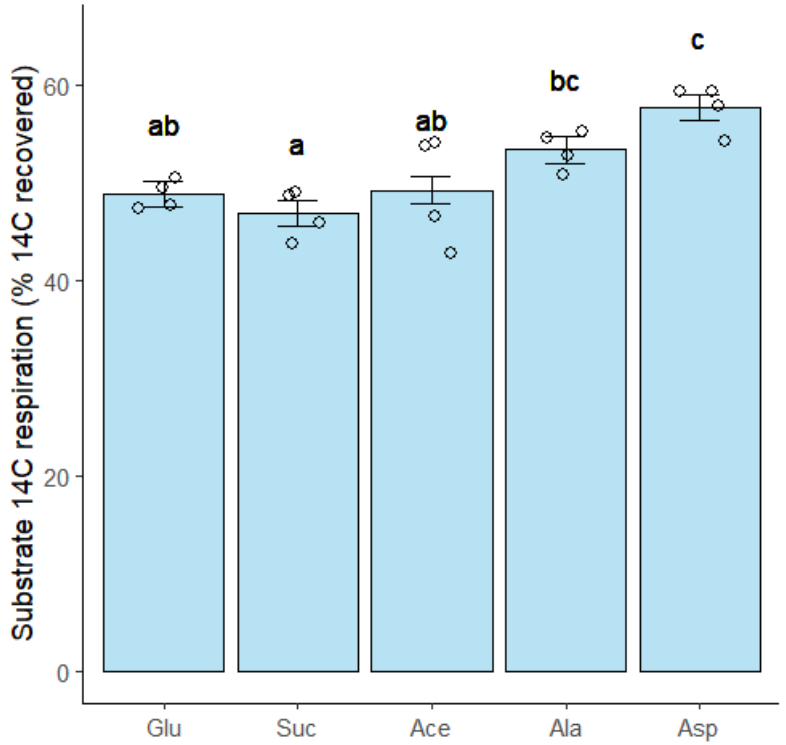

# Spatial substrate distribution

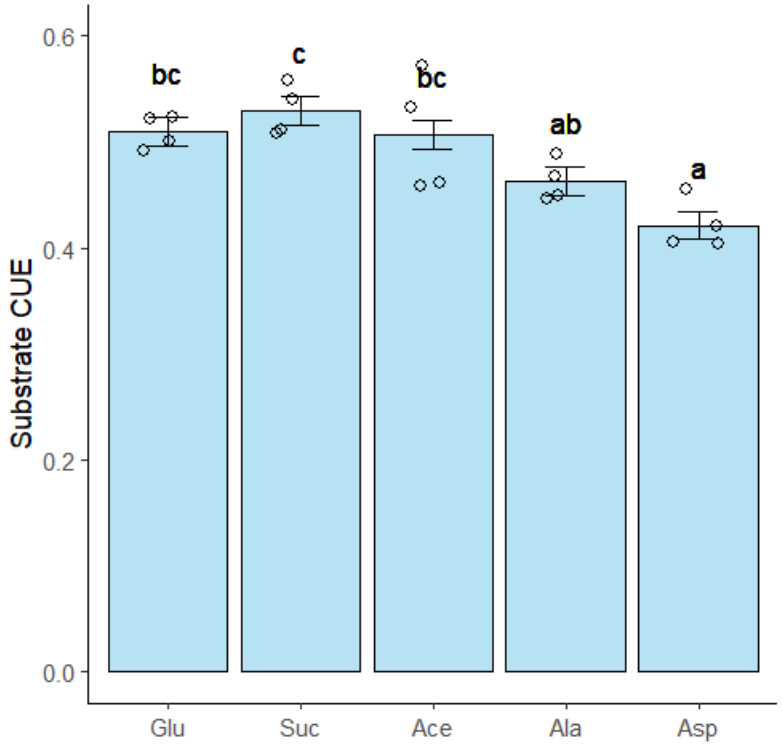
The microdialysis method effectively simulated the root exudation of primary metabolites



# Comparison between individual compounds

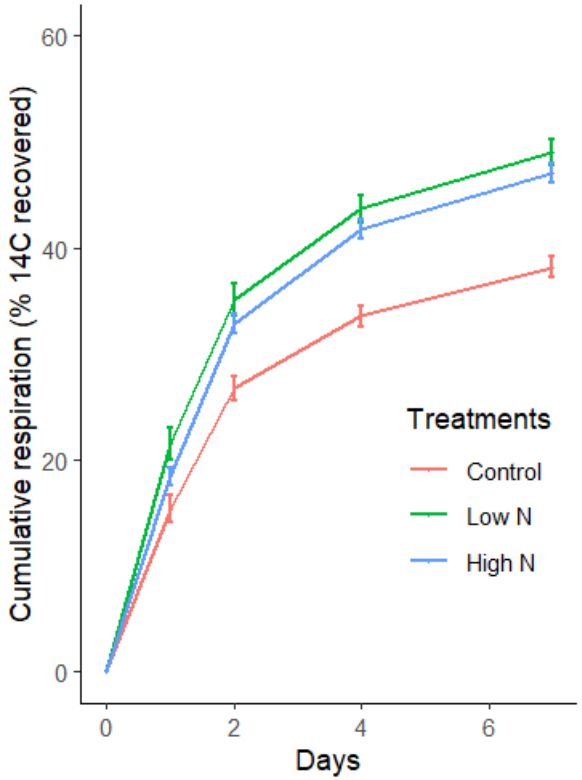
CUE:
Sucrose > Glucose, Acetic acid > Alanine > Aspartic acid

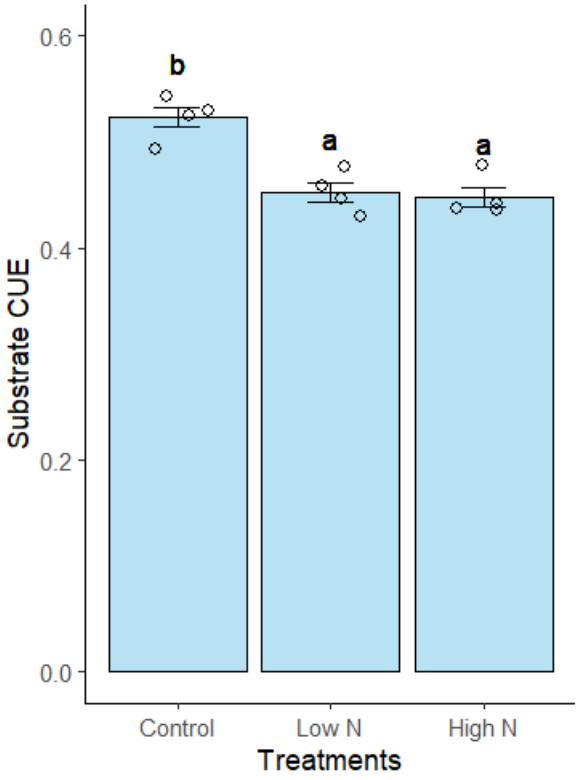


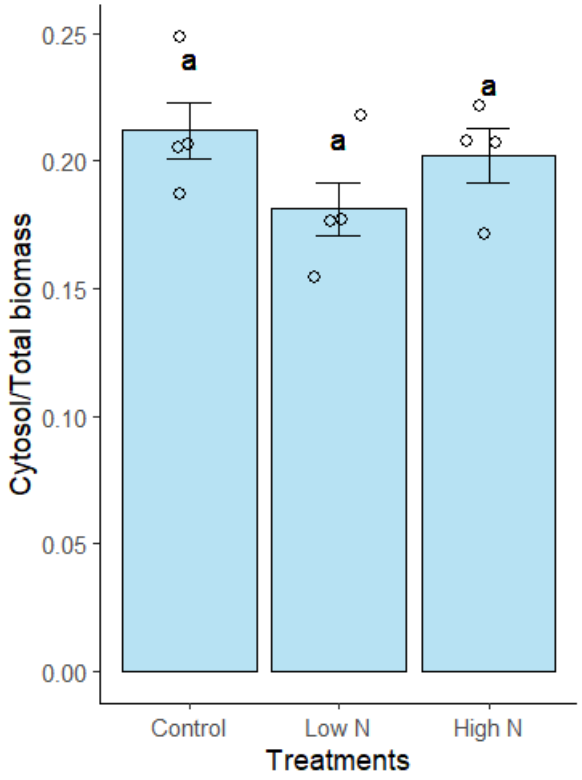



# Glucose

- Mixture treatments lowered CUE

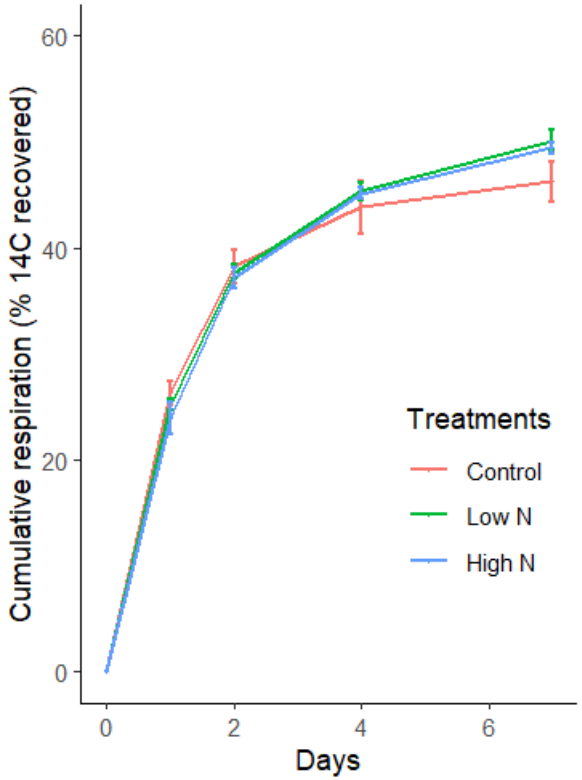


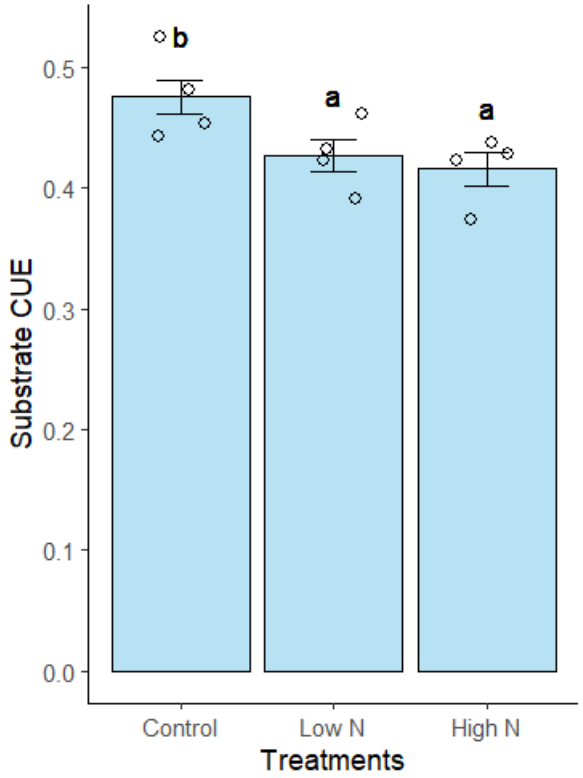



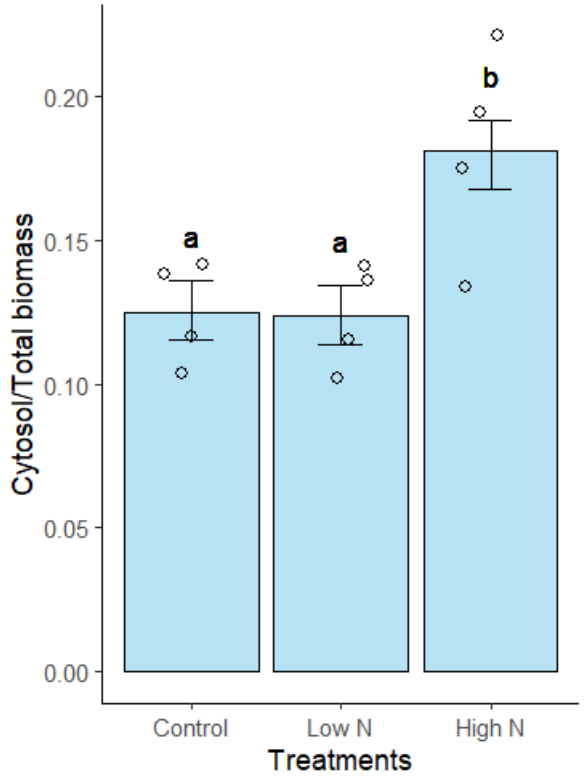



# Acetic acid

- Mixture treatments lowered CUE
- High N mixture (N/C: 1/9) slowed microbial metabolism



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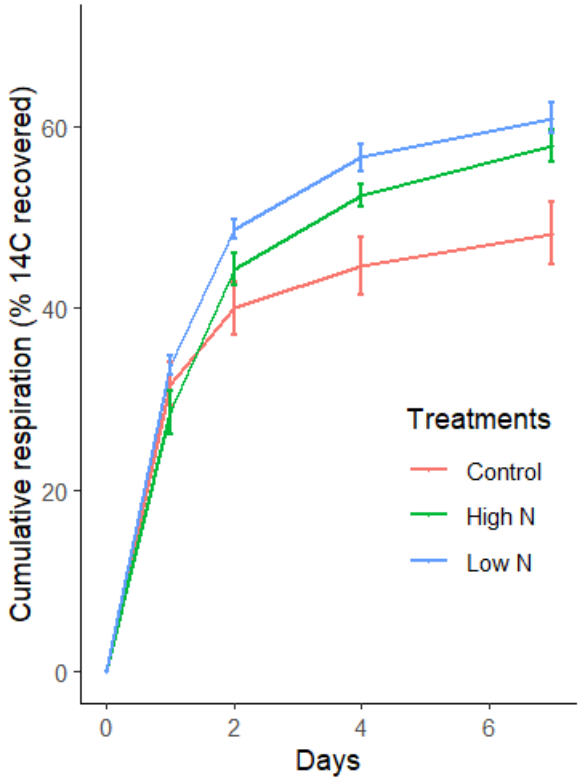


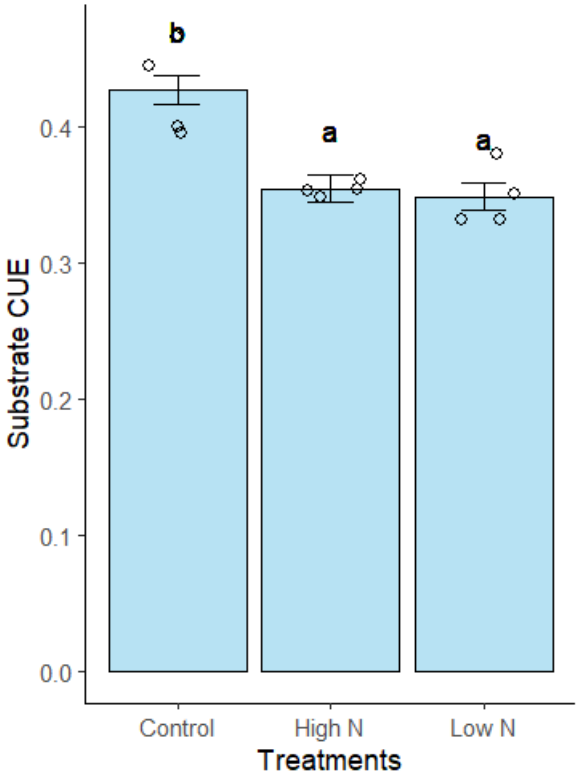


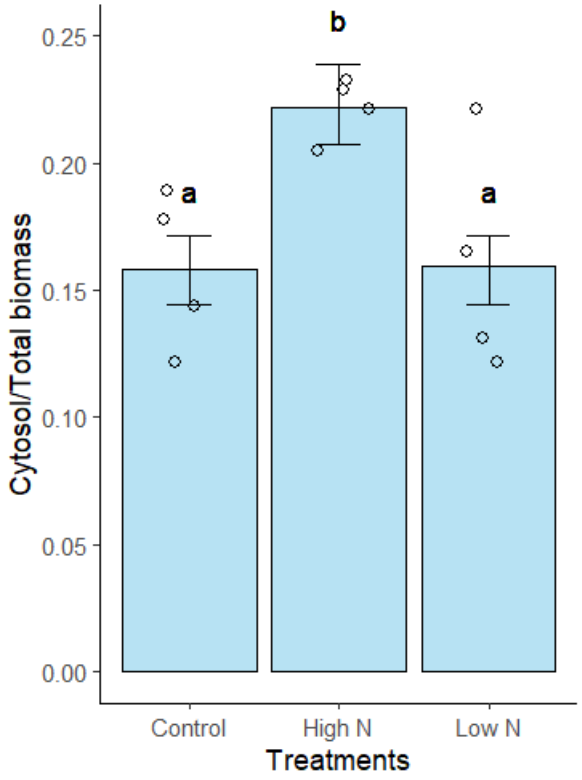

## Concluding remarks

Microbial utilization of low-molecular-weight compounds varies between

- Individual compounds
- carbon and nitrogen availability

Possibility to select plant species/variety for efficient C sequestration by root exudates

Further work is needed e.g. in

- Compound- and condition-specific priming effects

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