Soil microbial communities influence plant carbon cost to acquire nutrients

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Introduction

How does the carbon cost to acquire nutrients change between sterilized and natural soils compared to an increase in nutrients and how does that impact photosynthetic capacity?

Physiological results

Maximum, RedBeeCo-limited, photosynthetic capacity, \( \text{V}_{\text{cmax}} \), increases with nutrient addition, with an significantly negative effect of soil sterilization compared with natural soils.

Structural carbon cost for nutrient acquisition shows and inverse effect to \( \text{V}_{\text{cmax}} \), lowering in the highest nutrient treatments and in the natural soil.

Plant growth

Dry weight increases with nutrient addition, with a strong positive effect of soil sterilization compared with natural soil.

Plants grown in natural soils underperformed compared to plants grown in sand with similar available nutrients.

Plants grown in sterilized soils outperformed compared to the same, sand grown, plants.

Methods

Two species native to the Netherlands were chosen: Holcus lanatus (C3, grass) and Solanum dulcamara (C3, potato). Per treatment combination 10 individual plants per species were planted (total n = 120).

Plants were measured for photosynthetic capacity after 7 weeks and destructively harvested after 8 weeks of treatment.

Methods

Substrate Treatments

- Low N+P
- Medium N+P
- High N+P
- Sterilized Natural

Soil: 36mg N + 2.40mg P

Both soils: 36mg N + 2.04mg P (readily available)

Conclusion & discussion

In this particular setup, natural soils provided a rather costly environment for the plants compared to the same, sterilized, soil. This is however only visible in biomass production. Total biomass was significantly higher for plants in sterilized soils compared to natural soils, but the structural carbon cost to acquire nutrients was also higher.

There are rather remarkable inverted relations between photosynthetic capacity, carbon cost to acquire nutrients, and dry weight when comparing plants grown in pure sand to plants grown in natural soils, sterilized or not.

- The presence/absence of a rich microbiome does not compare, in combined physical and physiological terms, to sterilized sand with added nutrients.
- In nutrients in sand we see an increase in dry weight correlated with an increase in \( \text{V}_{\text{cmax}} \), and a decrease in carbon cost to acquire nutrients.
- In sterilized and natural soils we see an increase in dry weight correlated with a decrease in \( \text{V}_{\text{cmax}} \) and an increase in carbon cost to acquire nutrients.

Further analyses on isolate inferred \( \chi \) (c : s ratio) will enable us to test the optimality framework, and the effect the microbiome has on the modelled optimization of \( \text{V}_{\text{cmax}} \) and \( \chi \) to the environment.

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