Plant regulation of microbial enzyme production in situ

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Introduction

Element limitation of microbial enzyme production has been described within the framework of multiple element co-limitation- microbes will increase enzyme production in response to addition of a complex limiting nutrient (i.e. protein nitrogen (N)) only when carbon (C) limitation has been relieved (Allison and Vitousek 2005, Koch 1985).

microbes + Organic N substrate ——— No change in N-degrading enzyme activity

microbes + Organic N substrate with labile C ——— Increased N degrading enzyme activity

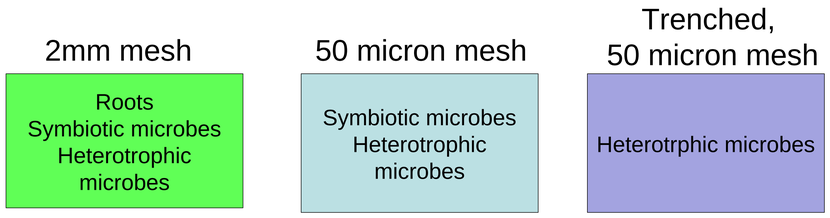
These relationships are well supported by lab incubation data, however in the field roots fundamentally alter the microbial resource environment. Plant C allocation to microbes via mycorrhizal symbiosis and root exudation may relieve C limitation, allowing microbes in the field to respond directly to complex organic N substrate addition via enzyme synthesis.

H1- *Addition of complex organic N (protein) in the presence of roots increases the production of N-degrading enzymes; and*

H2- *In the absence of roots and mycorrhizae, complex organic N addition does not stimulate enzyme production due to C limitation of enzyme synthesis.*

Methods

Mesh exclusions treatments were used to isolate the effects of roots and specific members of the microbial community.

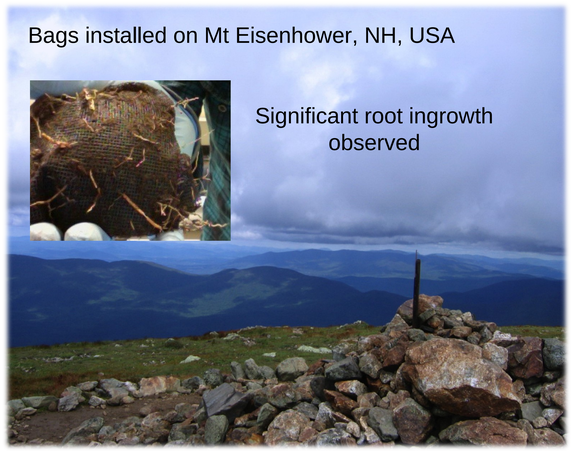


Bags were fertilized with protein- a complex organic N source, inorganic P, or protein and inorganic P in combination.

Placed at the interface of the soil organic horizon and mineral soil in June 2009.

Bags fitted with tubing and pulsed monthly with nutrients- 11 ug protein N / g soil, and 20 ug P / g soil

Pulses were delivered during the first weeks of June, July and August, then harvested the first week of September.



Results

- Significant increases in N degrading enzyme activity were only observed in root bags fertilized with complex N (Figure 1A).
- Ergosterol- a fungal biomass marker- also increased in root bags fertilized with complex N (Figure 1B).
- C degrading enzymes polyphenol oxidase and peroxidase responded differentially within root bags (Figures 1C and 1D).
- Increases in acid phosphatase activity in response to N addition were limited to the trenched- heterotrophic microbial ingrowth bags (Figure 1E).

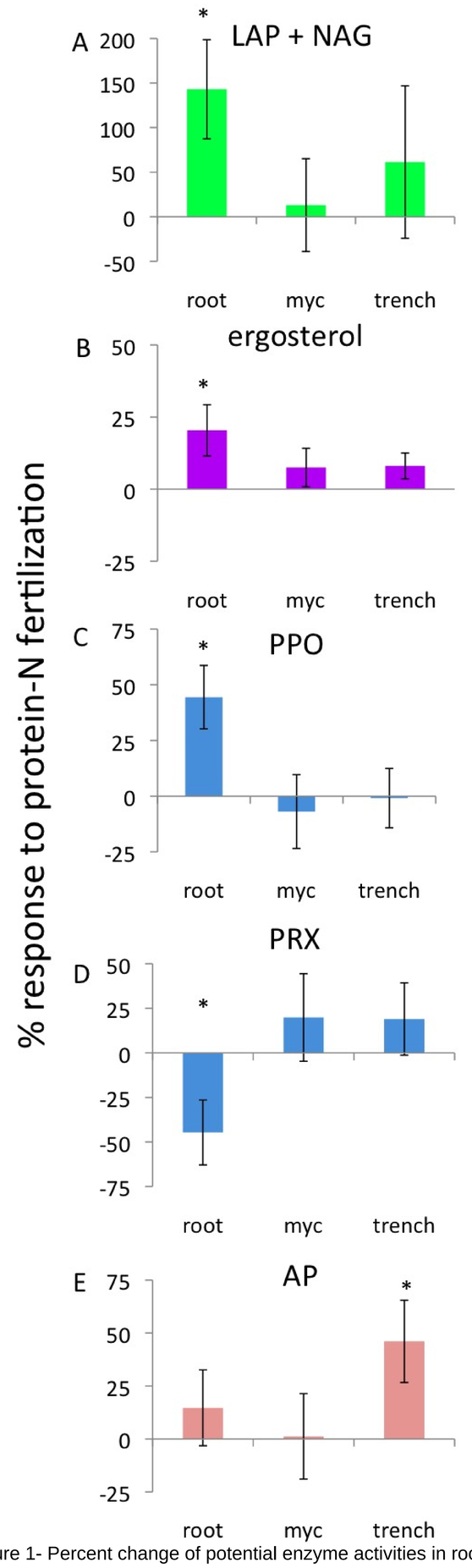


Figure 1- Percent change of potential enzyme activities in root, mycelia and trench bags to complex organic nitrogen addition, relative to controls. Error bars show standard error of each response, asterisks are used to denote significance. Specific enzyme names are abbreviated- leucine aminopeptidase (LAP), ß-N acetylglucosaminidase (NAG), polyphenol oxidase (PPO), peroxidase (PRX), acid phosphatase (AP).

Conclusions

Both H1 and H2 were supported, reinforcing the role of roots as a microbial C pathway and the idea that economic rules govern microbial enzyme production.

The findings show that plant roots fundamentally alter the microbial resource environment, suggesting lab incubation data may not be easily generalizable to field settings.

Differential responses of carbon degrading enzymes in root bags, as well as the acid phosphatase response in trench bags suggest possible community mechanisms driving variation in the data.

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