Depth Differential Colonization by Mycorrhizal Fungi in Prairie Grasses

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Abstract

A research was conducted in field plots to evaluate types of mycorrhizal fungi colonization in monocultures of green needlegrass (G), switch grass (S), western wheatgrass (W), Russian wild rye (R), crested wheatgrass (C) or mixtures of grasses. A root sampling strategy based on different soil depth (0-15, 15-30 and 30-45 cm) revealed a significant effect of depth on root colonization by different types of micorrhizal fungi, but no significant differences were found between plant communities.

Introduction

The symbiosis between plant roots and arbuscular mycorrhizal fungi (AMF) is probably the most ancient and widely distributed symbiosis in terrestrial ecosystems. In addition to influence P uptake capacity and growth, long term plant diversity and coexistence, are defined by specific plant AMF associations (Mummey et al, 2005).

Despite the fact that prairie grasses usually have an extraordinary deep root system, research on AMF is mostly focussed on the first 15 or 20 cm of the soil. The purpose of this project is to define the distribution and role of AMF in some native and introduced prairie grasses.

The next research questions were addressed**:** Are prairie grasses colonized by AMF? Do they differ in AMF colonization levels? Is root colonization restricted to the upper layer of the soil?

Experimental setup

Soil samples were taken at tree different soil depths from monocultures of green needlegrass (G), switch grass (S), western wheatgrass (W), Russian wild rye (R), crested wheatgrass (C) or mixtures of WGS or CRS. The origin and seasonal activity of these plants is included in Table 1.

Soil cores 45 cm long were divided in three sub-samples (0-15, 15-30 and 30-45 cm). Roots from every sample were stained (Vierheilig et al, 1998) and AMF colonization was assessed under the microscope by the line intersect method (Giovanetti and Mosse, 1980).

Based on hyphal diameter, two types of AM hyphae were scored separately, as previously described by Rillig and Field (2003). A fine, vesicle and arbuscule forming mycelium was distinguished from a coarse, coil forming mycelium. They will be called Type A and Type B mycelia respectively in this paper (Figure 1).

Statistical analysis: The experiment was established in four complete randomized blocks. Colonization values were square root transformed to normalize data and analyzed by an ANOVA procedure, introducing depth, blocks, plant species and the interaction plant species*depth as independent variables in the model. For comparisons, untransformed means with their confidence intervals were recalculated again after the ANOVA, as suggested by Sokal and Rohlf (1995).

Table 1. Origin and seasonal activity of prairie grasses included in this research.

Origin	Common name	Scientific name
	Cool season	
Native	western wheatgrass (W)	*Agropyron smithii* Rydb.
	green needlegrass (G)	*Stipa viridula* Trin.
Eurasia	crested wheatgrass (C)	*Agropyron desertorum* (Fisch. ex Link) Schult.
	Russian wild rye (R)	*Elymus junceus* Fisch.
	Warm season	
Native	switch grass (S)	*Panicum virgatum* L.

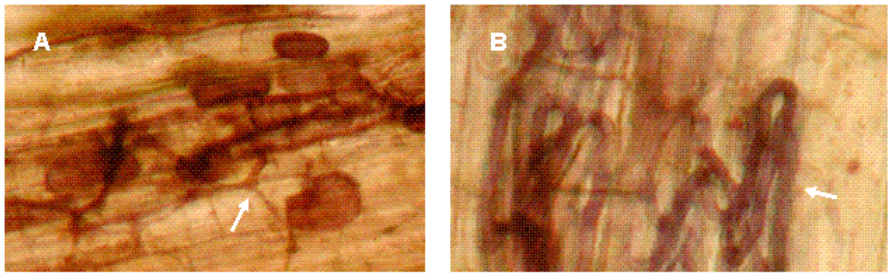

Figure 1. Morphology of mycorrhizal colonization. **Type A** is a thin mycelia associated with spores and vesicles. **Type B** is a coarse mycelia, non-associated with those structures (Arrows showing both types of mycelia).

Results and discussion

Colonization by mycorrhizal fungi was significantly influenced by soil depth. Colonization did not differ between plant species and no plant species*soil depth interaction was found. The highest values of colonization were observed at a depth 0-15 cm, but measures of type A and type B colonization were differentially affected by depth.

In the upper layer of the soil, root colonization was shared by both types of mycelia, but in deeper layers, colonization was dominated by coarse, coil forming type B mycelia. (Table 2). Additionally, Type A or B mycelia were mutually exclusive, in roots.

Table 2. Values of colonization by type A and type B mycelia as influenced by sampling depth.

Depth cm	**Colonization (%)**	**95% confidence intervals**	
		Lower	**Upper**
		Type A	
0-15	28.3	23.8	32.8
15-30	5.2	0.7	9.7
30-45	5.8	1.3	10.3
		Type B	
0-15	37.3	31.4	43.1
15-30	26.3	20.4	32.1
30-45	24.8	19.0	30.7

Research about AMF is usually restricted to the first 15 or 20 cm of the soil profile, but the presence of a coarse coil-forming endophyte in deeper layers has been reported by Rillig and Field (2003) in *Bromus hordeaceus* L. and *Lotus wrangelianu* Fischer & Meyer. In the latter study, variation in root colonization in response to elevated levels of atmospheric CO2 varied with plant species. Recent studies also revealed variation in the composition of the microbial community with soil depth in Mediterranean environments suggesting the occurrence of a less diverse, but similarly active microbial community as deep increases (Goberna et al 2005).

In the prairies, the contributions to plant performance of soil microbial communities residing in deeper layers in the soil needs to be better understood. Many of these plants often have root systems that can be several meters deep, and depending on the season, it is possible to have extreme fluctuation in temperature and water content, in surface horizons. The activity

of deeper resident communities should be more uniform than that of these microbial groups living in the surface. However, how these unknown microbial communities contribute to plant fitness or how short-term changes in the environment affect them is unknown.

Conclusions

All plant species included in this research are colonized by mycorrhizal fungi.
Colonization levels are not different between these plants.

Different type of AMF structures are present in plant roots. While both thin and vesicule and arbuscule forming, and coarse coil forming mycelia are abundant in root of the 0-15 cm soil layer, coarse coil-forming mycelia dominate at deeper depths.

Next step in the research

Molecular and biochemical techniques will be used to investigate mycorrhizal diversity and activity in these plant species.

References

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