MYCORRHIZAL OCCURRENCE IN WILLOWS IN A NORTHERN FRESHWATER WETLAND

by PAUL E. MARSHALL and NANCY PATTULLO

School of Natural Resources, University of Michigan,
Ann Arbor, MI 48109

KEY WORDS

Ectomycorrhiza Flooding Michigan Peat Phosphorus Salix

SUMMARY

Willows growing in a north central Michigan wetland were found to be ectomycorrhizal throughout the 1978 growing season on each of two sites (one water-saturated, one relatively drier). Each site was dominated by a mix of sedges (Carex spp.) and willows (Salix spp.). On both sites, phosphorus was added at two levels (20 or 200 kg P ha⁻¹) to simulate potential inputs from the disposal of secondarily-treated municipal wastewater. The intensity of willow root infection was determined by scoring root tips on a 0 to 4 scale based on mantle-, intercellular hyphae-, and root epidermal cell characteristics.

Infection on the wet site remained uniformly heavy in July and August when P was added, but it declined significantly during August for control plants at both sites. When water levels increased during September, the intensity of mycorrhizal infection increased on control plants on the wet site. On the drier site, mycorrhizal intensity decreased on controls and on plants exposed to the highest P levels. Between August and September samplings, mycorrhizal intensity increased considerably on dry-site controls but did not change on plants exposed to added P.

INTRODUCTION

The nutrient dynamics in freshwater wetland ecosystems have been of increasing interest since it was suggested that wetlands may function as nutrient traps to prevent eutrophication⁵,⁶ and since wetlands have become sites for disposal of secondarily-treated sewage effluent¹⁹. Phosphorus (P) dynamics in wetlands have been of particular interest since P is involved in a complex biogeochemical cycle which is poorly understood. Wetland plants may play an important role in P cycling and numerous studies have described parts of phosphorus cycles in wetlands based in part on observed changes in P concentrations in plant tissues, plant uptake of P, and biomass changes⁵,¹⁶. Other studies have described wetland plant responses to applied P¹²,²⁰, however, very few studies of wetland nutrient dynamics have considered the occurrence or role of mycorrhizas. Others have suggested that as phosphorus concentrations increase in soils, the intensity...
of mycorrhiza formation decreases\(^7\). Since willows are one of the major woody plants in northern freshwater wetlands, and since little is known about wetland willow mycorrhizas, this study was initiated to observe seasonal changes in the occurrence and structure of willow mycorrhizas and to determine the effects of added phosphorus on wetland willow mycorrhizas.

**METHODS**

*Site description*

The study sites were located in a 716 ha fen southwest of Houghton Lake in Roscommon County, Michigan. This wetland was chosen as it has been the object of considerable ecological study\(^2\),\(^3\),\(^6\),\(^7\),\(^11\),\(^15\),\(^16\),\(^18\),\(^19\),\(^20\) and it is currently being used as a disposal site for secondarily-treated municipal wastewater. The vegetation and hydrologic characteristics of this wetland (fen) have been extensively described in the above references. A sedge and willow vegetation cover predominated on the sites used in this study, and peat soils ranged from 0.5 to 1.5 m in depth. The peat was underlain by sand and clay. Throughout the study, the pH of interstitial water ranged from 5.7 to 6.9 at a 25 cm depth and redox potentials ranged from \(-160\) to \(+10\) mV at 25 cm depths.

One study site was located in a relatively wet area where peat remained water-saturated throughout the summer. A second site was located at a slightly higher elevation and was somewhat drier such that water levels dropped to an average of 5 cm below the peat surface in mid-summer. Neither site was affected by other studies in progress on the wetland (sewage effluent additions, mainly).

Table 1. Effects of season, site, and phosphorus \([20\text{ (low)} \text{ or } 200\text{ (high)}\text{ kg P.ha}^{-1}]\) on wetland willow mycorrhizas*

<table>
<thead>
<tr>
<th></th>
<th>Wet site</th>
<th>Dry site</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control  Low P  High P</td>
<td>Control  Low P  High P</td>
</tr>
<tr>
<td>July</td>
<td>2.71\textsuperscript ab  2.79\textsuperscript ab  2.83\textsuperscript ab</td>
<td>2.96\textsuperscript ab  3.11\textsuperscript ab  3.20\textsuperscript b</td>
</tr>
<tr>
<td>August</td>
<td>1.86\textsuperscript a  2.60\textsuperscript a  3.00\textsuperscript ab</td>
<td>1.25\textsuperscript a  2.20\textsuperscript a  2.00\textsuperscript a</td>
</tr>
<tr>
<td>September</td>
<td>3.30\textsuperscript b  3.25\textsuperscript b  3.30\textsuperscript b</td>
<td>3.30\textsuperscript b  2.44\textsuperscript a  2.67\textsuperscript ab</td>
</tr>
</tbody>
</table>

* Numbers represent mean scores of mycorrhizal intensity \((n > 20)\). Scoring was based on the following scheme:
0 = No intercellular or external hyphae observed in light- or electron microscopy. Roots determined to be non-mycorrhizal.
1 = Some external hyphae but very little intercellular penetration observed in light- and electron microscopy, but other indications of ectomycorrhiza not observed.
2 = Definite mantle observed in electron microscopy. Some intercellular hyphae visible in light microscopy, but not extensive.
3 = Definite mantle observed in electron microscopy. Considerable intercellular hyphae and slight epidermal cell elongation noted in light microscopy. Many more cortical cells surrounded by hyphae than in specimens given a 2 rating.
4 = Very organized mycorrhizas observed in light- and electron microscopy. Observations include thick and extensive mantle, extensive intercellular hyphae, and pronounced epidermal cell elongation.

Numbers with the same superscript letter are not significantly different \((p \leq 0.05)\).