Stunting of White Spruce (Picea glauca (Moench) Voss) Associated With Ectomycorrhizal Deficiency

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*Stunting of 1-0 white spruce (*Picea glauca *(Moench) Voss) was associated with poor mycorrhizal development.* Tree Planters' Notes 38(1):22-23;1987

Stunting of 1-0 white spruce (*Picea glauca* (Moench) Voss) in Lake States nurseries has been considered a serious problem for the last decade *(1,2,4).* Although this condition has little effect on growth and survival when third-year stock is outplanted, the cull at nurseries due to small seedlings results in substantial dollar losses *(2).* The early cessation of growth in the first growing season, purple discoloration of foliage, low foliage phosphorus (P) concentration without a soil P deficiency *(3,4),* and scatter pattern of stunting within the nursery beds strongly suggest that stunting of white spruce in Lake States nurseries results from a mycorrhizal deficiency.

Mycorrhizal deficiency on hardwood and conifer seedlings in forest tree nurseries is common in nurseries on prairie soils or after soil fumigation *(7,8,12).* In addition to killing harmful pests, fumigants kill beneficial organisms such as mycorrhizae. To verify our theory, we designed a study to find out if stunted white spruce seedlings did indeed have fewer ectomycorrhizae than nonstunted seedlings from fumigated nursery soils.

Samples of fall-sown first-year seedlings were taken on August 12, 1984, at the Hayward State Nursery, Hayward, WI, and the J.W. Tourney Nursery, Watersmeet, MI, from beds that were fumigated the previous year with dazomet (Mylone 50D, 400 pounds per acre) and methyl bromide + chloropicrin (Dowfume MC-33, 350 pounds per acre) respectively. Five stunted and 5 nonstunted white spruce seedlings were collected at 10 randomly selected positions in affected seedling beds. Seedlings that demonstrated the extremes of stunted and nonstunted conditions were selected-that is, seedlings with purple foliage, small shoots, and bud set and seedlings with deep green foliage, long shoots, and active shoot elongation. Samples were frozen for later evaluation.

The percent ectomycorrihizal infection was calculated for each seedling. The entire root system was cleared and stained for Hartig net demonstration according to methods reported by Nylund and others *(9).* Each growing point on an individual squash-mounted root system was examined with 200 x conventional light microscopy. The root tip was considered ectomycorrhizal if a Hartig net was present. A nonpooled Student's *t*-test was used to compare percent root tip infection of the stunted and nonstunted seedlings.

Results

The percent mycorrhizal root tips of stunted seedlings was significantly less than that found on nonstunted seedlings at both nurseries (table 1). Many stunted seedlings were nonmycorrhizal.

Discussion

Stunting of 1-0 white spruce seedlings at both nurseries was associated with low ectomycorrhizal colonization of growing tips. This poor development of mycorrhizae explains the foliage P deficiency that occurs in the absence of soil P deficiency previously observed in stunted white spruce seedlings *(3-5),* because mycorrhizae aid in the uptake of P *(6).*

We thank John Borkenhagen, manager of the Hayward state Nursery, and Thomas Emerson, assistant nursery manager of the J.W. Tourney Nursery, for their assistance and cooperation.

Table 1—*Percent ectomycorrhizal root tips on 25 stunted and 25 nonstunted 1–0 white spruce seedlings at the Hayward State Nursery, Hayward, WI, and the J.W. Toumey Nursery, Watersmeet, MI*

	Percent ectomycorrhizal root tips	
	Stunted	Nonstunted
Hayward Nursery	7	44*
Toumey Nursery	2	79**

*Significantly different at $P = 0.05$ (Student's *t*-test).
**Significantly different at $P = 0.01$ (Student's *t*-test).

Soil fumigation reduces or eliminates mycorrhizal fungi *(11).* The scattered pattern of stunting within nursery beds reflects the pattern of reinoculation of mycorrhizal fungi following fall fumigation *(8).* Ectomycorrhizal fungi produce mushrooms in the areas surrounding the fumigated beds. The spores from these mushrooms are airborne and reinoculate the beds in a random pattern. Mycorrhizae form only on seedlings in inoculated areas of the bed. The volume of spores available for reinoculation of beds is reduced if there are extremely dry or wet periods in late summer and fall, when mushrooms are produced. The dry periods reduce the overall numbers of mushrooms produced, while excessive rains wash the spores from the air and prevent transport to the nursery beds *(10).*

In the Lake States we see stunting primarily in the northern nurseries. This is probably due to the rather short period between late summer fumigation and the first snows. Consequently, there is less time for mycorrhizal fungi to reinoculate fumigated areas.

Stunting occurs in both conifer and hardwood beds in many Lake State nurseries. Further work is underway to determine if mycorrhizal deficiencies exist on species other than white spruce and to study the effects of various cultural practices on mycorrhizal development.

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