The Effects of White Spruce Stunting on Seedling Growth

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*Stunting of white spruce (*Picea glauca *(Moench) Voss) seedlings in northern Lake States tree nurseries continues to be a common occurrence. In this evaluation the cull percentage was seven times greater in stunted 3+0 white spruce stock than in nonstunted stock. Stunting of white spruce did not adversely affect seedling growth after outplanting.*

Stunting of white spruce and red pine (*Pious resinosa* Ait.) seedlings in Lake States tree nurseries is a common phenomenon. This condition is characterized by arrested seedling growth midway through the first growing season, with foliage that becomes purple in late summer. The following spring, stunted seedlings resume growth and the foliage turns green. Berbee et al. (1) examined several possible causes for this condition, including mycorrhizal deficiency and fungal infection but found no relationship between stunting and those factors.

In 1977, stunting affected from 13 to 30 percent of the total production of white spruce and red pine in five nurseries in Michigan, Wisconsin, and Minnesota (1). A later evaluation (2) indicated that 28 percent of the white spruce at the Eveleth Tree Nursery, Eveleth, MN, were stunted in 1979. I have observed similar levels of white spruce and red pine stunting in many of the region's northern nurseries and also that the percentage of stunted stock varies from year to year in any one nursery.

Croghan and LaMadeleine (2) found that the average height of stunted white spruce seedlings was 22 percent less than the height of nonstunted seedlings at the end of 3 years in the nursery. However, this was not a true indication of the comparative size of the seedlings because the nursery beds had been top pruned. The stunted seedlings had attained 78 percent of the top pruned height, not the actual height. It was not known if the growth of stunted seedlings continued to lag behind nonstunted seedlings after outplanting. If it did, the dollar losses associated with white spruce stunting were greater than those attributed to culling seedlings alone. This evaluation was designed to assess losses of white spruce in the nursery due to stunting and to determine if the growth differential persists after planting.

Methods

Nursery. In September 1980, seven plots of stunted and seven plots of nonstunted 1+0 white spruce seedlings were marked in the Eveleth nursery. In April 1982, these seedlings were hand-lifted as 3+0 stock.

Nursery personnel used the specifications developed by USDA Forest Service, region 9 for class B white spruce planting stock (13 to 23 centimeters shoot height and 3 to 8 millimeters stem caliper) to place seedlings in one of the following grading categories: 1) stunted culled, 2) stunted accepted, 3) nonstunted culled, and 4) nonstunted accepted. Height and root collar caliper measurements were taken for all seedlings. Student's t-test was used to test for differences between the stunted and nonstunted groups.

Outplanting. Sixty-two seedlings were randomly selected from each of two grading categories (2 and 4, above) and outplanted on the Superior National Forest. The nonstunted seedlings were planted in a single row at approximately 2.4-meter (8-foot) intervals. A parallel row of stunted seedlings planted at the same spacing was installed 2.4 meters from the nonstunted row. Height and stem caliper of the outplanted seedlings were recorded at the time of planting. At the end of the second growing season (October 1983), shoot growth, stem caliper, mortality, and pest damage were recorded. Based on the assumption that planting in separate rows had no effect on seedling growth, Student's t-test was used to test for differences between the stunted and nonstunted groups.

Results

Nursery. Mean percent cull in the stunted plots was significantly greater than in the nonstunted plots (table 1). Height and caliper were significantly greater in nonstunted seedlings than in stunted seedlings for both accepted and culled categories.

Table 1—*Cull, shoot height, and stem caliper for stunted and nonstunted 3+0 white spruce at the Eveleth Nursery (April 1982)*

	Stunted	Non-stunted
Number accepted [a]	90	202
Number culled	121	16
Mean percent plot cull [b]	57	7*
Mean seedling height (cm)		
Accepted	20.23	26.37*
Culled	12.41	15.38*
Mean stem caliper (mm)		
Accepted	2.63	3.78*
Culled	2.27	2.56

* Significantly different from paired value at P = 0.05 (Student's *t*-test).
a Accepted = seedling met USDA Forest Service region 9 planting stock specification.
b Mean of 7 stunted seedling plots and 7 nonstunted seedling plots.

The mean height of seedlings from stunted plots was only 62 percent of the height of seedlings from nonstunted plots. However, it should be noted that the beds were top-pruned during the second nursery growing season. The corresponding comparison of mean stem caliper shows that the stunted group was only 66 percent as large in caliper as the nonstunted seedling group.

Outplanting. There were significant differences for initial and final mean shoot height for the outplanted stunted and nonstunted white spruce (table 2). Similarly, initial mean stem calipers for the stunted and nonstunted seedlings were significantly different. However, by the end of the second growing season no statistically significant caliper difference was found. Similarly, no differences in shoot and caliper growth or growth rate (growth/initial size) were observed.

Twice as many of the outplanted stunted seedlings died (10 percent) as did nonstunted seedlings (5 percent). Mortality was due to dessication and did not result from insect or disease activity.

Discussion

The cull rate in 3+0 stunted seedlings was 57 percent whereas the cull rate in nonstunted seedlings was 7 percent, a difference of 50 percent. This value is almost twice the amount observed in an earlier evaluation (2). Although the exact amount

Table 2—*Shoot height and stem caliper for 62 stunted accepted and 62 nonstunted accepted 3+0 white spruce stock on the Virginia Ranger District, Superior National Forest, Minnesota, at outplanting (April 1982) and after 2 growing seasons (October 1983).* [a]

Measurement	Stunted	Nonstunted
Total seedling height (cm)		
April 1982	20.1	24.32*
October 1983	29.30	34.61*
Shoot growth since outplanting (cm)	9.50	10.04
Shoot growth rate [b] (cm)	.52	.45
Total stem caliper (mm)		
April 1982	2.77	3.74*
October 1983	4.19	5.13
Caliper growth since outplanting (mm)	1.46	1.39
Caliper growth rate (mm)	.59	.43

* Significantly different from paired value at P = 05 (Student's *t*-test).
a Accepted = seedling met USDA Forest Service region 9 planting stock specifications.
b Growth rate = total 1982 and 1983 growth/initial size.

of 1+0 stock stunted in 1979 is not known, based on my past observations, the nursery probably had from 10 to 35 percent white spruce stunting. If we use the 10 percent figure, the cull due to stunting for the nursery's entire 3+p white spruce crop for 1982 would be 5 percent. In 1982 the nursery shipped 2.1 million 3+0 white spruce seedlings. With a 10-percent stunting rate, 105,000 seedlings would be lost; with a 35-percent rate, 367,500 seedlings would be lost.

Comparisons of the four seedling classes showed that the stunted seedlings remained smaller than the nonstunted seedlings for both shoot height and stem caliper throughout the third nursery growing season.

At planting and at the end of two growing seasons, stunted stock had significantly smaller mean shoot heights than did nonstunted stock. However, the initial difference in mean caliper disappeared by the end of the second growing season. Although the final mean shoot height of the stunted group was smaller by 5.13 centimeters, this difference should not increase over time, as there were no significant differences between the stunted and nonstunted groups for shoot growth or shoot growth rate. Clearly, a 5-centimeter difference would not be of consequence at rotation age.

Excellent survival rates were observed for both the stunted and nonstunted groups of seedlings, 90 and 95 percent, respectively.

Conclusions

Although stunted 3+0 white spruce stock is smaller than nonstunted stock, the stunted seedlings that pass the region 9 specifications grow at rates comparable to those of nonstunted seedlings when planted out. Based on these results, it appears that economic losses due to stunting of white spruce are limited to the nursery. The need to understand the phenomenon of stunting in the nursery continues, however.

Literature Cited

1. Berbee, J.G.; Zarnstorff, J.; LaMadeleine, L.A. Stunting of first-year conifer seedlings in Lake States nurseries. Rep. NA-FR-13. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Area State and Private Forestry; 1980.8 p.
2. Croghan, C.F.; LaMadeleine, L. A. Impact of stunting of white spruce at Eveleth Nursery. Tree Planters' Notes 33(4): 19-22; 1982.