Performance of Fall- and Spring-Planted Bareroot and Container-Grown Red Pine (*Pinus resinosa* Ait.)

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*Red pine (*Pinus resinosa *Ait.) styro-plug, 2-0, 3-0, and 2-2 seedlings were planted in the fall and spring. After four field seasons for the spring-planted seedlings and three for the fall-planted seedlings, survival and height growth of the container seedlings was similar to that of the 2-0 and 3-0 seedlings. The 2-2 transplant stock generally outperformed all the other stock classes. Planting season had no significant effect on survival of container stock. Average annual height growth was better on spring-planted trees than on fall-planted trees, irrespective of stock class.* Tree Planters' Notes *37(2):24-26; 1986.*

Recent symposia on artificial regeneration and intensive management in the Lake States, plus projected needs for softwoods, have stimulated interest in intensive management of red pine (*Pinus resinosa* Ait.) plantations *(2).* Research needs include documentation of the survival and growth of bareroot and container seedlings on various sites. There is also renewed interest in the prospect of fall planting to widen the existing reforestation window. This paper compares the performance of bare-root and container red pine seedlings planted in the spring and fall in east central Minnesota.

Materials and Methods

Three types of nursery-grown bareroot stock *(2-2* transplants and *3-0* and *2-0* seedlings) and styro-plug container-grown seedlings were planted in spring and fall *1980.* These results include four growing seasons for spring-planted trees and three growing seasons for fall-planted trees.

The prior cover type on the study site consisted of quaking aspen (*Populus tremuloides* Michx.), paper birch (*Betula papyrifera* Marsh.), and red maple (*Acer rubrum* L.). After the harvest of commercial trees in *1979* the area was scarified by root raking. The soil is a moderately well-drained Ahmeek-Ohmega sandy loam underlain by a fine, sandy loam fragipan.

The styro-plug containers *(35* cubic centimeters rooting volume) were seeded in November *1979,* grown in a greenhouse, and placed outside in May *1980* until planted. Both spring- and fall-planted containers were from the same greenhouse crop. Spring-planted bareroot trees were lifted from the nursery and stored for about 1 week under refrigeration before being planted. Spring planting of bareroot stock was on May *14* and container stock on June *3, 1980.* Fall-planted bareroot stock was planted on the same day it was lifted from the nursery. All fall planting was done on September *23, 1980.* Container stock was planted using a Potti-putki planting tube. The bareroot stock was planted using a standard planting bar.

Measurements taken of sample seedlings at time of planting indicated that the quality of all stock was within acceptable standards except the high shoot to root ratio of fall-planted *3-0* stock (table 1).

A randomized block design was used with four replications of each treatment combination (stock x season). Each treatment combination had *50* trees per replication for a total of *1600* trees in the entire study.

Evidence of browse damage by snowshoe hares (*Lepus americanus* Erxleben) was noted in October *1980.* To reduce further browse damage, mesh plastic netting was placed around each seedling.

Primary vegetative competition on the site was quaking aspen and balsam poplar (*Populus balsamifera* L.), various willow species (*Salix* spp.), grasses, and sedge. The trees were chemically released in August *1982.*

Survival and height measurements are summarized in table 1. Height growth was calculated as the average per growing season.

Results

Planting season comparisons. Spring-planted bareroot stock had significantly greater survival and

[1] The authors thank the Potlatch Corporation, Minnesota Wood Products Division, for its help in conducting this study. This article is University of Minnesota Agricultural Experiment Station Science Journal Series Paper No. 1989.

height growth than stock planted in the fall. Season of planting had no significant effect on survival of container stock but, similar to bareroot stock, mean annual height growth was less on fall-planted trees (table 2). Heights at the end of the measurement period are also shown in table 2 but keep in mind that the spring-planted stock had an additional growing season in the field.

Table 1—*Physical characteristics of stock at time of planting (N = 20)*[1]

Stock type	Stem diam. (mm)		Shoot ht. (cm)		S/R ratio[2]	
	Spring	Fall	Spring	Fall	Spring	Fall
Container	1.6 d	2.1 d	9.5 c	9.7 b	2.3	1.1
2–0	3.0 c	3.1 c	7.5 d	6.1 c	3.6	3.1
3–0	3.7 b	4.0 b	16.7 b	23.2 a	4.1	6.7
2–2	5.5 a	7.1 a	20.1 a	24.7 a	4.3	3.9

[1]Means within a column and planting season with the same letter are not significantly different (P = 0.05).
[2]Shoot to root ratio based on ovendry weight.

Table 2—*Comparisons of mean survival, mean height, and mean annual height growth of spring- and fall-planted red pine stock types*[1]

Planting season	Container	2–0	3–0	2–2	Average
Mean survival (%)					
Spring	82 ay	91 axy	82 ay	97 ax	88
Fall	73 ax	74 bx	51 by	85 bx	71
Mean height (cm)					
Spring	59 az	76 ay	72 ay	102 ax	81
Fall	33 by	36 by	34 by	59 bx	43
Annual height growth (cm)					
Spring	12 ay	17 axy	17 axy	22 ax	17
Fall	4 by	10 bx	6 by	12 bx	8

[1]Bareroot seedlings were planted in the spring on May 14, 1980; containerized seedlings on June 3, 1980. Seedlings were planted in the fall on September 23, 1980. Means within a column (a, b, c) or across a row (x, y, z) followed by different letters differ significantly (P = 0.05).

Planting stock comparisons. Survival of the container and bareroot stock was similar, with two exceptions. Survival of spring-planted 2-2 stock was significantly higher than the 3-0 and container stock. Survival of fall-planted 3-0 stock was significantly lower than the other types of stock (table 2).

Height differences were not consistent between spring- and fall-planted seedlings. Average height of spring-planted container stock was significantly shorter than that of the spring-planted bareroot stock. But, the height of fall-planted container stock did not differ significantly from that of the 20 and 3-0 stock. The 2-2 stock was significantly taller than all other stock types at the end of the measurement period, as it was at the time of planting; however, it did not necessarily grow faster than the 2-0 and 3-0 stock (table 2). The mean annual height growths of spring-planted container, 2-0 and 3-0 stock did not differ statistically. Average annual height growth of fall-planted container and 3-0 stock was substantially less than either the 2-0 or 2-2 stock.

Height comparisons between the various stock types were affected by both the hare browsing and the subsequent use of the plastic mesh, which restricted height growth in some instances. In order to remove the effects of those influences, damaged trees were not included in the height summary and analysis.

Conclusions

Spring planting resulted in superior survival and growth rates for the 2-2, 3-0, and 2-0 stock in comparison to the fall-planted bareroot stock. Results similar to these have been documented in other studies of red pine regeneration (3, 4, 6). Seedlings grown in styro-plug containers had similar survival rates irrespective of planting season, but spring-planted containers

grew at a faster rate than those planted in the fall.

Survival and height growth of the container seedlings was comparable to those of the 3-0 seedling stock. Survival of container stock was similar to that of 2-0 seedlings, but fall-planted 2-0 stock grew at a substantially faster rate. As a result of acceptable field performance, similar to that found in this study and others, use of containerized seedlings as a supplement to bareroot stock has been increasing in the Lake States (1). Survival and height growth of the 2-2 transplant stock was as good as or better than that of the other stock types. The superior performance of red pine transplants over seedlings is well documented in the literature (4-6).

It must be noted that this study encompasses a single planting season and set of environmental conditions. Comparisons such as these must be repeated through time under various conditions. The results, however, do provide supportive data and aid in evaluation of stock type and planting season.

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