RESEARCH NOTE NC-159

NORTH CENTRAL FOREST EXPERIMENT STATION, FOREST SERVICE—U.S. DEPARTMENT OF AGRICULTURE

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PLANTING TECHNIQUE AND CARE OF STOCK AFFECT SURVIVAL OF PLANTED RED PINE

ABSTRACT.--Careless planting was found to be the most important of several possible causes of excessive mortality of newly planted red pine. Distribution procedures and high shoot/root ratios were also implicated.

OXFORD: 232.412:232.412.4:232.411.3:174.7 *Pinus resinosa*. KEY WORDS: shoot/root ratio, nursery practice, packing, shipping, competition.

Over the past 15 to 20 years, many changes have been made in the way coniferous planting stock is grown, packed, shipped, and planted; chiefly to reduce cost. As long as seedlings were vigorous when they left the nursery, kept cool and moist, and correctly planted, operational modifications that reduced costs were accepted. However, no systematic checks were made to evaluate the effects of these changes on seedling survival and growth. Recognizing that these new procedures might account for some of the exceptionally heavy mortality recently reported, we decided to study the effect of current procedures on survival and initial growth of red pine in northern Minnesota.

THE EXPERIMENT

The experiment included four variables: stock size, packing, distribution procedure, and planters. Survival and growth were measured after the first and second growing seasons.

Two stock sizes were compared. Top length of smaller stock used in the experiment averaged 19.4 centimeters (7.6 inches) and larger stock averaged 27.4 centimeters (10.8 inches).

Two packing methods were compared. Special packing consisted of taking seedlings to the cooler immediately after they were lifted and grading, sorting, and packing them there. Normal packing consisted of taking the seedlings to the packing shed a wagonload at a time, unloading on the dock, sorting, grading, and packing in a comparatively warm, dry area, and then depositing them in the cooler.

Two distribution procedures were compared. Special distribution consisted of keeping stock in the cooler until the day it was planted and then taking it directly to the planting site. Normal distribution involved keeping stock in a temporary storage area before it was taken to the planting site. For this experiment seedlings distributed in the normal manner were stored from 2 to 7 days after they left the nursery.

Contracts with planters made it impractical to have the same workers plant at all locations, so a different group of four was used at each of three locations and two men working together planted the fourth.

Four locations were selected for these comparisons: two with deep sandy soils, one with a very stony silt loam soil, and one on a steep hillside with a shallow silt loam over bedrock. The first two could be considered typical of the easier red pine planting chances in the area.

One had been occupied by a stand that was predominantly paper birch and red maple (fig. 1). It was rock raked after the stand had been windthrown. The terrain was rolling and the soil varied from a gravelly sand on the knolls and ridges to a medium-textured sand in the lower spots.

Figure 1.--An easy planting chance in northern Minnesota. The terrain is rolling, the soil varies from gravelly sand to a medium textured sand, and slash has been concentrated in windrows with a rock rake.

Figure 2.--A marginal planting chance in northern Minnesota. The soil is a shallow silt loam with numerous rock outcrops, the terrain is broken, and slash has been left in place after a commercial clearcut.

A stand of paper birch and jack pine had been clearcut from the second location and invading hazelbrush killed with herbicide. The terrain was flat and soil was fine textured with a well-developed profile.

The third location had also been rock raked before planting to remove a stand of pole-sized paper birch and red maple. Rocks made planting more difficult than on the first two, but the soil itself, a well-drained stony silt loam, is at least as productive as at the first two sites.

The fourth site represented a marginal planting chance (fig. 2). A stand of jack pine had been clearcut and the slash left in place. There were many rock outcrops and much of the soil was so shallow that seedlings could not be planted with their roots straight. Planters had to probe with their bars until they found soil deep enough to plant seedlings correctly.

From May through September of the first year after planting, precipitation in northeast Minnesota was 3.37 inches below normal and temperatures for every month except May were above normal. In June the rainfall was 1.32 inches below normal and the temperature averaged 2.8 degrees above normal.

RESULTS

After the first growing season, survival ranged from 52 percent on the shallow silt loam to 64 percent on the stony silt loam. Both the finer sand and the stony silt loam had significantly more survivors than the shallow silt loam. Some of the seedlings that were apparently still alive at the end of the first year had not grown. At the three better locations 46 to 55 percent not only survived, but made some height growth. On the shallow silt loam, less than 40 percent survived and grew.

Neither packing method nor seedling size had a measurable effect on first-year survival at any of the locations.

On the stony silt loam, 48 percent of the seedlings shipped directly to the planting site survived and grew the first year compared with 35 percent of those packed and shipped in the normal manner. On the coarser sand, 65 percent of the seedlings shipped direct survived and grew compared with 52 percent of the seedlings packed and shipped in the normal manner. At the other two sites, there were no differences related to packing and shipping.

Hot, dry weather undoubtedly accounts for at least part of the first-year mortality, but at the three locations where workers could be compared, there were significant differences in survival percent of trees planted by different workers (table 1). For the shallow silt loam and the stony silt loam, the differences between the best and poorest planters were 25 and 23 percent, respectively. On the finer sand the difference was 37 percent.

Table 1.--*Seedlings that survived and grew during the first growing season (In percent)*

Planter	Shallow silt loam	Finer sand	Stony silt loam
1	53	67	57
2	45	49	56
3	29	42	41
4	28	30	34

Note: Values enclosed by the same set of brackets are not significantly different.

Early in the third growing season, half of the seedlings on each plot were checked a second time and their competitive position classified. Fifty-three percent of the seedlings planted on the shallow silt loam and 55 percent on the coarser sand were found to be severely suppressed by herbaceous growth and brush. At these two locations survival after 2 years was not significantly lower than it was after one. In contrast, 78 and 77 percent were similarly suppressed on the other sites (fig. 3), and there was about 15 percent additional mortality on the finer sand and about 20 percent on the stony silt loam. On the finer sand there was additional mortality for all of the planters but it was greatest for the planter with the highest first-year survival. The net effect was to offset the differences that existed after the first year.

Figure 3.--Severe competition the third year after planting a stony silt loam where a stand of red maple and paper birch had been rock raked.

DISCUSSION

In this study, size alone had little effect on survival. Survival might have been better if the stock had been better balanced. Shoot/root ratios for five samples ranged from 6:1 to 7:1 and it has been shown that stock with a ratio of greater than 5:1 is susceptible to drought, heat, competition, and winter injury[1].

There is no evidence that seedlings were damaged in packing, but some stock was apparently damaged in the transfer from the nursery to the planting site. Wind or Sun may have dehydrated exposed tops, stock may have been injured by heat if it was left in the Sun under a dark-colored tarpaulin, heating or drying could have occurred if stock was improperly stored at an intermediate distribution point, or planters may have failed to care for stock properly after it was delivered to them in the field.

Planting technique had the most pronounced effect on first-year survival and growth. Of the four people planting on the finer sand, it seemed to the observer that one was careful and proficient, another was somewhat less proficient although equally careful, and the other two were careless. Failure to close the planting holes completely and firmly was the major fault of the careless workers, and this tendency was increased where they were hampered by slash piles. Of the four workers who planted in the stony silt loam, it was again obvious that some were more careful than others. The careful workers took more time to select their planting spots and made sure the holes were properly closed.

There is a strong possibility that differences within the area account for at least part of the differences in results among workers who planted the shallow silt loam. The part planted by workers who were apparently less effective had little slope, a great deal of slash cover, and shallow soil. Where soil was deep enough for planting, it was likely to be poorly drained because irregularities in the underlying rock tended to trap water. However, no such site differences could be found to account for the differences between the other two workers who planted where there was less slash, deeper soil, and enough slope to provide adequate soil drainage.

The location with shallow silt loam was more difficult to plant effectively than the other three sites. Nevertheless, results obtained with careful planting on the most favorable parts of the site were nearly as good as those obtained on the other sites. The finer sand

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[1] J. H. Stoeckler and G. W. Jones. Forest nursery practice in the Lake States. USDA For. Serv., Agric. Handb. 110, 124 p. 1957.

should have been the easiest to plant effectively, yet results obtained by the poorest planters on this site were no better than by poorest planters on other sites. Again, the implication is that the planter exercises decisive control over initial performance of planted seedlings.

The survival counts and classification of competition at the beginning of the second year are strong evidence that inadequate site preparation or delayed release can effectively offset the advantages gained by careful planting. That competition reduced second-year survival most where initial survival was best emphasizes that control of herbaceous vegetation and brush is essential if the best planting chances are to be fully exploited.

CONCLUSIONS

1. Adequate survival of red pine can be obtained on a wide variety of sites provided seedlings are planted correctly.

2. Planting technique is one of the most important factors influencing survival. Training and inspections should continually be emphasized.

3. Maximum feasible care must be exercised in shipping stock to distribution points and storing it at these distribution points and in the field.

4. Strive to produce nursery stock with a shoot/root ratio of 5:1 or less.

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