LARGE, WELL BALANCED STOCK AND CONTROL OF GRASS COMPETITION NEEDED FOR RED PINE PLANTINGS ON SANDY SOILS

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Red pine *(Pinus resinosa* Ait.) often has poor early survival when planted on coarse-textured, outwash, glacial sands of the Lake States. Our studies in central Minnesota show that good early survival is obtained when large, well balanced seedlings are planted. However, even with large, balanced seedlings, mortality occurred late in the first growing season after planting. Apparently grass competition on sandy soils uses soil moisture that is needed for tree growth and survival. Therefore, on sandy soils and herbaceous vegetation we recommend control of grass when planting large, well balanced seedlings.

The Study Area

This study was made on the Sand Dunes State Forest in Sherburne County, Minn.[1] The soil is Zimmerman loamy fine sand, a deep, excessively drained, noncalcareous glacial outwash sand. This soil is similar to the Plainfield series that is widely distributed in central Wisconsin and southern Michigan.

Methods

Red pine seedlings of three ages were planted (table 1, fig. 1). Both the 2-0 and 3-0 stock were well balanced; however, the 2-0 stock was smaller in size. The 4-0 stock was poorly balanced, having large tops but small root systems.

A total of 500 2-0, 250 3-0, and 1,000 4-0 seedlings were planted. These seedlings were arranged in randomly assigned rows of 50 to 100 trees. Trees were machine planted on May 1, 1967. No site preparation was done before planting, no furrowing attachment was used on the planting machine, and no vegetation control was done after the trees had been planted.

[1] Appreciation is extended to the Minnesota Division of Lands and Forestry, which provided trees, land, and assistance in establishing this study.

TABLE 1.—*Age and size of planted red pine*

Age class	Average stem diameter	Average length		Average weight of top-root ratios	
		Top	Root	Green	Ovendry
2–0	8/64	4.5	7.2	3.1:1	3.8:1
3–0	12/64	7.8	8.3	2.3:1	2.8:1
4–0	10/64	12.0	6.0	6.0:1	7.8:1

Survival counts were made at approximately 2week intervals throughout the first growing season. At the same time several gravimetric samples for soil-moisture determination were taken from the 0-1and 1-2-foot soil depths. Rainfall records were obtained from a U.S. Department of Commerce weather station located at Elk River, 10 miles southeast of the study area.

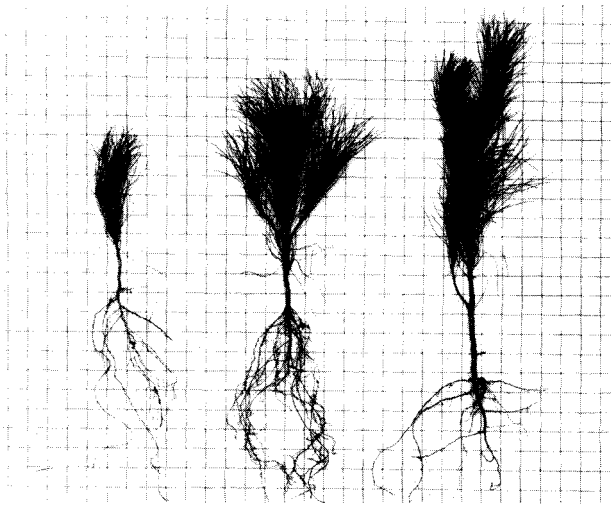

Figure 1.—Red pine seedlings used in the study: *Left*, small, well balanced 2–0 stock; *center*, large, well balanced 3–0 stock; *right*, large, unbalanced 4–0 stock. Background grid shows 1-inch squares.

Results

Survival during the first 2 months following planting was excellent for all seedlings (fig. 2). This was probably caused by above average rainfall during

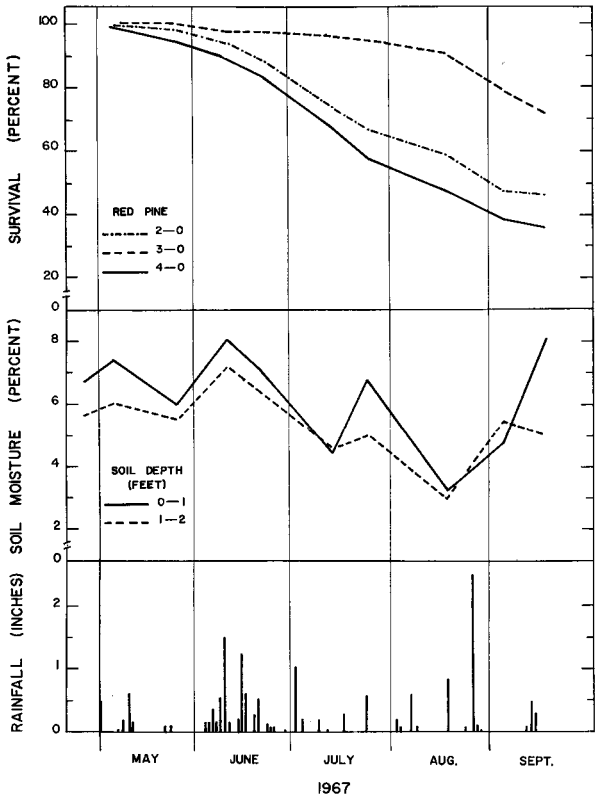

Figure 2.—Large, well balanced 3–0 red pine seedlings survived best after 2 years. Also shown is soil moisture and rainfall during the first growing season after planting.

June (5.84 inches) and, as a result, adequate soil moisture early in the growing season. But from July 2 to August 25, only 2.69 inches of rain fell. Thus soil moisture declined steadily during July and August until less than 3-percent moisture was left in the upper 2 feet of soil. Permanent wilting percentage (15-bar moisture) for the upper horizons of Zimmerman loamy fine sand ranges from about 1.3 to 3.3 percent. Thus by August 25 little soil moisture was available to sustain tree growth.

Tree survival declined steadily during July and August as a result of low rainfall and low soil moisture. Apparently the heavy rain of August 26 (2.45 inches) came too late to benefit the many seedlings that already had succumbed to the extended JulyAugust drought.

Ability to withstand drought varied with the age of seedlings (fig. 2). The large, poorly balanced 4-0 seedlings began to die sooner than the other stock, and severe mortality took place throughout the JulyAugust drought. By the end of the 1967 growing season, only 36 percent of the 4-0 stock was alive. The small, well balanced 2-0 seedlings also suffered severe mortality, and only 46 percent of this stock was alive by September 15.

The larger, well balanced 3-0 stock withstood the drought conditions better than the other stock. Survival was still 90 percent on August 18 while, in contrast, by this date the 2-0 and 4-0 stock showed only 68 and 47 percent survival, respectively. However, in late August, mortality of the 3-0 stock increased, and by September 15 survival had dropped to 74 percent.

Mortality continued in 1968, the second growing season after planting. By December 1968, survival of the 4-0 stock was only 18 percent, the 2- stock was 22 percent, and the 3-0 stock 44 percent. Moreover, many of the surviving seedlings were small, their foliage sparse, and they showed little or no height growth. Continued mortality can be expected, and this plantation must be considered a failure.

Conclusions

The large, well balanced 3-0 stock showed best survival during the first growing season after planting. In contrast, both the small 2-0 stock, and the large, unbalanced 4-0 stock showed early and severe mortality: the 2-0 stock apparently was too small to compete with the grass; the small root systems of the unbalanced 4-0 stock apparently were unable to absorb sufficient moisture to replace the moisture transpired from the large tops. Accordingly, when planting on dry, sandy soils, we can conclude that large, sturdy, well balanced seedlings (at least 7inches top length, and 10/64-inch stem diameter) will survive best.

Early survival of the large, well balanced 3-0 stock was fairly good-74 percent at the end of the first growing season. However, continued mortality reduced survival to 44 percent by the end of the second growing season despite above average summer rainfall. Lack of growth and the unthrifty nature of many of the remaining seedlings indicated that additional mortality will occur. Second-season mortality probably was caused by a rather heavy grass sod causing severe competition for light and soil moisture.

Poor survival and growth during the second growing season indicate that the planting of sturdy, well balanced seedlings must also be accompanied by

control of competing vegetation. Sandy soils, such as these, contain minimum amounts of soil moisture available for plant growth. Grass or other competing vegetation, no doubt, consumes much soil moisture that would otherwise be available for tree growth. Accordingly, control of this competing vegetation by mechanical or chemical means is recommended prior to planting and for at least 2 years following planting.[2] These recommendations also are supported by studies on sandy soils in Wisconsin (Hiawatha series) where cultivation for 2 years after planting greatly improved survival and growth of red pine.[3] In certain areas sandy soils may be subject to wind erosion, thus spot or strip vegetation control may be preferable to complete vegetation control.

2 Dunham, R. S. Herbicide manual for noncropland weeds. U.S. Dep. Agr. Handh. 269, 90 p. 1965.

3 Wittenkamp, R., and Wilde, S. A. Effect of cultivation on the growth of red pine plantations. J. Forest. 62: 35-37. 1964.