REFORESTATION VALUE OF SEEDLINGS AND TRANSPLANTS

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The use of red pine transplants in reforestation of nonpodzolic sandy soils with less than 5 tons of weeds per acre is not justified. The extra $30 per acre for transplants cannot be recovered with a reasonable interest by plantations growing at a rate of not more than 1 cord per acre per year on short rotations.

Materials and Methods

In the spring of 1959 reforestation of an abandoned field near the Gordon State Camp, Wisconsin, was accomplished by planting on 17 acres 3-0 seedlings and on the adjacent 10 acres 2-1 transplants of red pine *(Pinus* resinosa, Ait). The trees were set in deep furrows at a 6 by 6-foot spacing level topography of the river terrace and uniform sandy texture of the nonpodzolic soil provided a rather rare opportunity to evaluate the relative performance of the planting stock of different grade and cost The objective appraisal of the respective growth potential of 3-0 and 2-1 trees was also favored by the use of planting stock raised in the same nursery and the simultaneous planting by an experienced crew

Two 1/5-acre plots with each type of planting stock were located on the basis of a preliminary transect survey of the entire plantation (2). Analyses of two composite samples of soils, each of seven 6-inch cores for each plot, showed no significant deviations in the state of fertility factors (table 1). The competing vegetation on adjacent cutover areas consists now of *Agropyron repens,* other grasses, and a sprinkling of heath plants, particularly *Myrica asplenifolia* and *Vaccinium angustifolium.* The biomass of weeds (tops and roots)

Table 1.—*Composition of soils supporting red pine plantations established by the use of 3–0 seedlings and 2–1 transplants*

Soil sample No.	Reaction pH	Silt plus clay	Organic matter	Total N	Avail. P_2O_5	Avail. K_2O	Exch. Ca	Exch. Mg
		percent	percent	percent	pounds per acre		ME per 100 grams	
3–0 seedlings								
1	5.3	7.5	1.8	.083	44	86	2.12	0.48
2	5.4	9.0	1.7	.079	67	115	2.60	0.74
3	5.2	8.5	2.0	.089	44	72	1.76	0.34
4	5.1	10.0	2.1	.094	55	86	1.32	0.27
Ave.	5.1–5.4	8.7	1.9	.086	52	89	1.95	0.45
2–1 transplants								
5	5.4	11.0	2.2	.098	55	92	2.75	0.64
6	5.1	9.5	1.8	.081	55	63	1.50	0.30
7	5.2	9.0	2.2	.096	67	144	2.10	0.48
8	5.1	9.0	2.1	.088	50	101	1.20	0.25
Ave.	5.1–5.4	9.4	2.1	.090	56	100	1.88	0.41

Table 2.—*Growth of red pine plantations established simultaneously in the spring of 1959 by the use of 3-0 seedlings and 2-1 transplants*

Nature of planting stock	stems per acre	Survival	Ave./ DBH	Basal area	Average height
	Number	percent	Inch	square feet per acre	Feet
3–0 seedlings	1,052	86.9	4.0	91.4	21.9
do	1,094	90.4	4.2	97.6	21.4
Average	1,073	88.6	4.1	94.0	21.7
2–1 seedlings	981	81.0	3.9	84.8	18.4
do	1,107	91.1	4.1	96.8	18.9
Average	1,044	86.0	4.0	90.8	18.6

varies between 3.7 and 4.5 tons per acre, oven-dry basis (4).

The appraisal of the growing stock included the determination of average diameters at breast height, average heights of trees having average diameters, and the rate of height growth on the basis of annual internodes of average trees (1, 3). The results of mensuration analyses, given in table 2 and figure 1, show that in this particular case the performance of transplants is slightly inferior to that of seedlings. The slower growth of

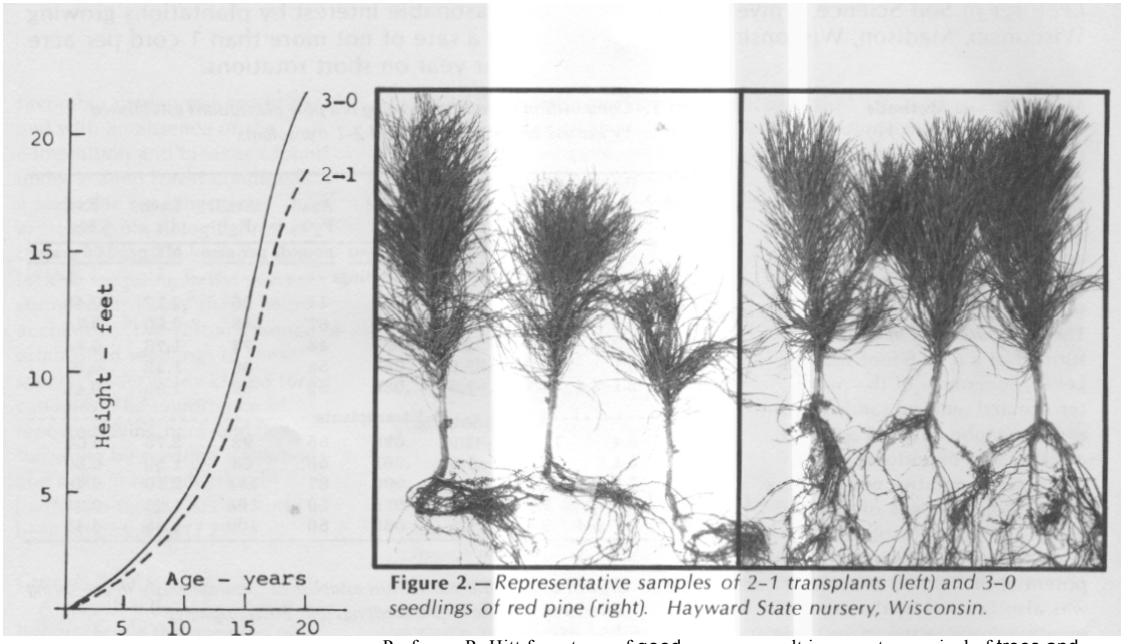

Figure 1.—*Rate of height growth of average trees of red pine plantations established by the use of 3-0 seedlings (solid line) and 2-1 transplants (broken line). Gordon State Camp plantations, Douglas County, Wisconsin.*

Figure 2.—*Representative samples of 2–1 transplants (left) and 3–0 seedlings of red pine (right). Hayward State nursery, Wisconsin.*

the 2-1 stock may have been caused by their deformed root systems, unavoidable in the use of a transplanting machine (figure 2).

The best performance of 2-1 stock was revealed on a small area (2 acres), reforested by transplants designated as "superior." These were produced from the seed collected by Professor R. Hitt from trees of good form and high rate of growth. This part of the plantation, occupying the southwest corner of the stand, exhibited a survival of 92 percent, average diameter b. h. of 4.2 inches, and average height of 20.5 feet, thus being fully comparable in its growth to the 3-0 seedlings.

Discussion

One outstanding forester of old times, Pfeil, preached to his colleagues that, "In silviculture there is only one general rule, namely that there are no general rules." There are conditions under which the use of transplants may result in a greater survival of trees and even a higher rate of tree growth. This may be particularly true in reforestation of fine textured soils and strongly podzolized soils with biomass of competing vegetation in the proximity of 10 tons per acre. On the other hand, as indicated by the results of our study, the use of transplants in reforestation of sandy soils with less than 5 tons of weeds per acre is not justified. An additional investment of some $30 per acre for transplants cannot be recovered with a reasonable interest (5 percent) by

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plantations on a 40-year rotation with an average annual increment of not more than 1 cord per acre.

Literature Cited
1. lyer, J. G. and R. C. Dosen
1974. Compensatory trends of forest growth. Ecology, 55(1) 211-212.
2. Leaf, A. L. and Th. Keller
1956. Tentative technique for determining the influence of soil on the growth of forest plantations Soil Sci Soc. Am. Proc. 20,110-112
3 Wilde, S A.
1964. Relation between the height growth, the 5-year intercept and site conditions of red pine plantations. J. For. 62 245248.
4. Wilde. S. A.
1969. Growth potential of Wisconsin native pines on weed-invaded soils. Wis. Acad Sci , Arts, and Lett 58:197-202

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amendments will be based on the results. Nutrient reference standards are available for many species, although such standards should be developed for each nursery site.

In developing fertilization schedules, soil factors, such as texture and temperature, must be taken into consideration. The type of nitrogen fertilizer is also important because release rates are variable. Any fertilizer, especially nitrogen, should not be applied merely as a matter of policy. Over-fertilization is a real possibility and can have serious direct and indirect effects on tree seedlings.

Literature Cited
1. LANDIS, T. D.
1974. Poor Growth and Mortality of Lodgepole Pine *(Pinus* contorta Dougl.) Seedlings. Biological Evaluation R2-7415. USDA Forest Service, State and Private Forestry, Denver, Colorado; 10 p.
2. PAUL, 1. L. and E. Polle.
1965. Nitrite Accumulation Related to Lettuce Growth in a Slightly Alkaline Soil. Soil Sci. 100:292-297.
3. WINSTON, D.A
1974. Urea Fertilizer Toxic to Young Jack Pine Seedlings Tree Planters' Notes 25:5-6.
4. PURITCH, G. S and A. V. Barker.
1967. Structure and Function of Tomato Leaf Chloroplasts During Ammonium Toxicity. PI. Physiol. 42:1229-1238.