OUTPLANTING PONDEROSA PINE IN POTS

James D. Curtis and Marvin W. Foiles, Silviculturists
Intermountain Forest and Range Experiment Station
Forest Service, U.S. D. A.
Boise, Idaho

Artificial forest regeneration in central Idaho is difficult because of adverse growing conditions. The soil is most commonly of granitic origin, coarse, and highly desiccative. The topography is rough, varying in steepness, aspect, and altitude over short distances. Average annual precipitation in the ponderosa pine type is about 23.0 inches; about 4.0 inches occurs from May 1 through September 30. Summer air temperatures of 95^0 F. are frequent, and relative humidities are often as low as 10 percent. Until recently, the survival of planted trees in this area seldom exceeded 30 percent. This low survival is unsatisfactory and indicates the need for new planting techniques.

The raising of seedlings from seed planted in inexpensive containers and then the outplanting of both the seedling and container was believed a good method of overcoming these adverse conditions. The idea of outplanting seedlings in containers is not new in the United States. It was tried with ponderosa pine on the Pike National Forest in Colorado and the Coconino National Forest in Arizona in the early twenties, but the results were never reported. In southern Europe and the Middle East, pot planting has been practiced' for some time, and experimental work using containers made from various materials has been started in many countries during the last few years.

Most of the containers used have been 6 inches or less in depth. Deeper containers may have the added advantage of minimizing root competition, and may provide the taproot with a better chance of remaining in soil where the wilting point is less likely to be reached. The chief disadvantage of pot planting, even if successful, is the added expense of handling the stock both in the nursery and in the field. Pot planting can be justified only if the increase in survival and growth offset the higher planting costs.

Methods

Exploratory studies to develop techniques for using pots for planting ponderosa pine in central Idaho were initiated in 1951 and expanded and intensified from 1956 to 1960. The choice of containers was limited to those available on the market. Therefore, they were somewhat of a compromise between-the

ideal and those which could be manufactured cheaply and still withstand the handling that nursery and fieldwork demanded. Sixteen kinds of pots, all at least 10 inches deep, were tested (table 1).

The various containers were filled to within 1 inch of their tops with a mixture of loam and a small amount of peat mos, Four seeds were sown in each container and covered with one-fourth inch of washed sand. The pots were then set in wooden boxes that had coarse hardware cloth bottoms fastened with one-halfinch wooden cleats. The wire permitted drainage, and the cleats prevented the seedling roots from entering the earth floor of the rectangular shelter where they were housed. This animal-proof structure was a frame covered by hardware cloth and building lath that permitted about two-thirds of full sunlight to filter through. The enclosure had a removable roof to prevent snow damage and a sprinkling system for overhead watering of the boxed containers. Soil in the containers was treated several times with a liquid fungicide to minimize the damping-off of seedlings.

Approximately one-half of the containers that had compositions other than tar paper were bored (perforated) at the time of sowing with two one-fourth inch holes at one-third and at two-thirds their depth to allow aeration, moisture movement, and root escape. These two pairs of holes were made at right angles to each other.

In a few containers no seed germinated, but most containers had one or more seedlings. Seedlings in most of the tar paper pots sent rootlets into the surrounding containers; these roots had to be cut before outplanting. Seedlings made satisfactory growth without fertilization. Thinning to one seedling per pot, before or after outplanting, apparently did not affect growth.

All pots were outplanted in holes bored by a 6-inch auger driven by a 2 1/2 hp. Little Beaver power unit. Soil was thoroughly tamped around the pots.

Experiments and Results

1. Kinds of pots.--One-year-old seedlings in 15 kinds (types A through 0, table 1) of containers were compared with regular 2-0 planting stock (type S) in a fenced, old field of rocky clay loam on an east aspect. The design of the experiment was a randomized block, with 128 seedlings in each of three blocks. Vegetation was removed, and the soil was harrowed just prior to planting. The site was invaded by annuals late in the spring of the first year and in each of the following 2 years. Survival was recorded annually for 3 years.

TABLE 1.--Kinds and sizes of pots tested

Type	Length	Cross section	Bottom	Perforations	Composition
	Inches	*Inches*			
A	12	1-1/2 diam.	Cardboard	yes	(1)
B	16	2 "	do.	yes	(1)
C	10	1 "	Metal with hole	yes	(2)
D	10	1 "	do.	yes	(3)
E	12	1 "	do.	yes	(2)
F	12	1 "	do.	yes	(3)
G	18	1 "	do.	yes	(2)
H	18	1 "	do.	yes	(3)
I	10	2 "	do.	yes	(2)
J	10	2 "	do.	yes	(3)
K	12	2 "	do.	yes	(2)
L	12	2 "	do.	yes	(3)
M	18	2 "	do.	yes	(2)
N	18	2 "	do.	yes	(3)
O	12	1-3/4 square	None	no	(4)
P	12	1-1/2 "	do.	no	(5)

[1] Cardboard soaked in melted paraffin.
[2] Wax impregnated heavy cardboard.
[3] Polyethylene and aluminum enclosed by paper.
[4] Light tar paper.
[5] Heavy tar paper.

The 3-year survival of 2-0 nursery stock (type S) was greater than for the 1-0 seedlings in any of the 15 types of pots (table 2). Of the potted seedlings, those in pots of cardboard with cardboard bottoms (type B) and light tar paper with no bottoms (type 0) had the best survival, and those in C and G type pots had the poorest survival. The 2-0 nursery seedlings in containers were as tall as the smallest 2-0 nursery seedling at the end of 3 years.

2. Season of outplanting.--Twenty-five 1year-old seedlings in tar paper pots (type P, table 1) and 25 in cardboard pots (type A, table 1) were set out in a plowed trench on an east aspect in deep sandy loam soil free of stones. This process was repeated 2 years later with 2-year-old trees in similar containers. Plantings were made in the fall of the year and again the following spring. The kinds of pots were alternated in each row at each planting.

Survival in all of these plantings was very poor. It averaged 9 percent for seedlings in pots of heavy tar paper (type P) and 5 percent in pots of cardboard soaked in paraffin (type A).

3. Effect of site preparation. --The survival of 1-year-old seedlings in two kinds of pots (types A and B, table 1) was compared with that of regular 2-0 seedling stock on east and west slopes where the ground was prepared by terracing (6-foot-wide, level, bulldozed strips on contours), trenching (10 inches deep and made by a Talladega plow on contours), and hand scalping (30 by 30 inch spots). The pots were planted-in holes made by a 6-inch auger; one-half the nursery stock was planted by powered auger and one-half by shovel and the dug-hole method. Planting was done on the inside, middle, and outside of each terrace. The design of this experiment was a randomized block, with two blocks on each aspect and 40 seedlings on each combination of all variables. The soil was granitic loam on a 30-percent slope.

TABLE 2.--Multiple range test of survival[1]

Pot type	Average survival	Surviving seedlings per block[2]	Significant at 1-percent level[3]
	Percent	*Average Number*	
S[4]	95.8	7.67	
B	87.5	7.00	
O	83.3	6.67	
L	66.7	5.33	
E	62.5	5.00	
I	62.5	5.00	
K	58.3	4.67	
A	54.2	4.33	
D	41.7	3.33	
H	41.7	3.33	
N	41.7	3.33	
J	29.2	2.33	
M	29.2	2.33	
F	20.8	1.67	
C	16.7	1.33	
G	16.7	1.33	

[1] LeClerg, E. L. 1957. Mean separation by the functional analysis of variance and multiple comparison. U.S. Dept. Agr., Agr. Res. Serv. 20-3, 33 pp.

[2] Eight seedlings were planted in each block.

[3] Lines indicate nonsignificant comparisons at the 1-percent level. Thus, the survival of type S is greater and highly significantly different from type G but not highly significantly different from types B or O etc.

[4] S denotes 2+0 nursery stock.

Site preparation, aspect, and type of container had no significant effect on seedling survival. The 2-1 nursery stock survived much better than the potted seedlings. Survival ranged from 12 to 50 percent for nursery stock and from 0 to 12 percent for potted seedlings.

4. Terrace planting.--One-year-old seedlings in two kinds of pots (types A and 0 table 1) and 2-1 nursery stock were planted in auger holes in terraced, erosible soil on steep west slopes. Terraces were constructed and planting holes positioned as explained in "site preparation." Additional plantings were made with 2-year-old seedlings in tar paper pots (type P, table 1) 2 years later on the same terraces on which the 1-year-old seedlings were planted.

In this planting and other plantings on terraces, survival was usually best on the inside of the terraces and poorest on the outside (table 2). Also, the nursery stock survived better than the potted seedlings.

5. Competition. --Elimination of survival of 2-year-old seedlings in tar paper pots (type P, table 1) and fertilized and unfertilized 2-1 nursery stock was compared on hand scalped plots on both east and west aspects. The heavy brush cover was killed piror to planting by five formulations of herbicides sprayed from a helicopter 2 years in succession. The soil was granitic loam. The design of the

experiment was a randomized block, with 500 seedlings in each combination of all variables.

The only significant difference in seedling survival in this test .was due to aspect. Survival on the east slope averaged 40 percent, but on the west slope it was only 16 percent.

6. Sandwich planting[1] --Survival of 2-0 nursery stock "sandwiches" and regular 2-0 nursery stock were compared on the granitic loam soil on east and on west aspects. The sandwich material was specially manufactured heavy felt paper. Each sandwich was made by puddling the roots of a seedling in thick mud slurry and placing them on an 8- by 10-inch piece of felt which had been soaked in water. The felt was then folded along its longer dimension, and the side and bottom were stapled. The design of the test was a randomized block, with 150 seedlings in each complete variable combination.

After three growing seasons there was no significant difference in the survival of the two kinds of planting stock. The survival of the 2-0 nursery stock averaged 27 percent, and that of the sandwich stock averaged 18 percent; these results are similar to those obtained elsewhere (1, 2).

1 The test was requested and the material was provided by Roland Rotty, Forest Service, U.S. Department of Agriculture, Washington, D .C.

Discussion and Conclusion

Growing and planting seedlings in pots did not improve survival in any of the above experiments. Usually the survival of potted seedlings was substantially poorer than that of regular planting stock. The poorer survival rates may result from the drying and contracting of the soil in the pots and the failure of enough of the roots to grow into the surrounding soil to assure an adequate water supply.

Results of these experiments suggest that the types and sizes of containers that have been discussed should not be used in artificial regeneration of ponderosa pine under the adverse conditions of central Idaho.

Literature Cited

(1) Schubert, Gilbert H., and Douglass, F. Roy. 1959. Tests of sandwich planting and the mechanical hole digger in California. U.S. Forest Service, Pacific Northwest Forest and Range Expt. Sta. Res. Note 151, 10 pp., illus.

(2) Sjoblom, Paul L. 1960. Tests of sandwich planting at Green Canyon Nursery. College of Forest, Range, and Wildlife Management, Utah State Univ., unpublished ms., 8 pp.