EARLY ATTEMPTS TO VEGETATE COALMINE SPOILS WITH CONTAINER-GROWN SEEDLINGS 1/

Walter H. Davidson and Edward A. Sowa 2/

Abstract.--Afforestation attempts in Pennsylvania with Ontario and other plastic tubelings, indicate that frost-heaving can be extremely detrimental on bituminous coal-mine spoils. Of the containers tested, peat pots and Jiffy-7's were found to be most resistant to frost-heaving. Compared with bare-root seedlings, seeded red pines in peat pots and Jiffy-7 containers performed well.

INTRODUCTION

Canadians have been using the container planting system for more than a decade; and the use of this method continues to expand. In the Province of Ontario alone, about 17 million tubed seedlings were planted annually from 1966 to 1969 (MacKinnon 1970). Confidence in this system is evidenced by the fact that seven forest districts in the Province continue to produce tubelings (Cayford 1972).

Not to be outdone by their neighbors up north, United States reforestation specialists have taken to container-grown planting stock, particularly in the Western States. Production in the Northwest has risen in only a few years to about 9.5 million seedlings in 1972, and it was expected to increase in 1973 (Owston 1972).

Container-grown seedlings have also aroused the interest of foresters engaged in revegetation of bituminous coal-mine spoils in Pennsylvania. The spoils challenge revegetation because they usually exhibit adverse physical characteristics, detrimental chemical levels, and lack of organic matter. Thus any planting method, technique, or material that would alleviate one or more of the problem factors, without intensifying others, would greatly enhance the success of afforestation efforts on these areas.

STUDY I -- ONTARIO TUBELINGS

A study to test Ontario tubelings as a means of revegetating coal-mine spoils was begun in the spring of 1968. We selected three graded bituminous strip-mine spoils (A, B, C) in Clearfield County, Pennsylvania, as experimental sites. Each site was chosen on the basis of pH to provide three different levels of acidity. The average pH's for the sites were as follows: A, 5.0; B, 4.0; and C, 3.7. The predominant parent material of the spoils was yellow to brown acid sandstone.

Plantings were made on four dates --April 15, May 13, June 10, and July 8--so we could compare survival of tubelings planted during the usual

1/Paper presented at North American Containerized Forest Tree Seedling Symposium, Denver, Colorado, August 26-29, 1974.

2/Respectively research silviculturist and forestry technician, Northeastern Forest Experiment Station, USDA Forest Service, Kingston, Pennsylvania.

planting time with plantings made later in the season.

Ten weeks before each planting date, tubes were seeded with red and scotch pines and placed in a greenhouse for germination. Red and scotch pines were used because both species are commonly planted on spoils. In addition, both germinate readily without stratification, thus simplifying conduct of the study. The planting medium used in the tubes was a mixture of fine sand and peat moss. Ten days before each planting date, the tubelings were taken out of the greenhouse and kept outdoors in a sheltered location for hardening-off.

Sixty tubelings of each species were planted on each site on each planting date, except that only 30 scotch pine were planted on each site on July 8. The tubelings were planted by hand. A bar designed for planting poplar cuttings was used to make the holes. Dry site conditions hampered the April planting and made it difficult to prepare the holes for the tubelings. Better site conditions on subsequent dates made the planting operation much easier.

Two-year-old nursery-grown red pine seedlings were planted on each site during the week of April 15 to provide a limited comparison of bare-root seedling versus tubeling survival.

Results

Survival counts were taken at the end of the first growing season (table 1). The data indicate that both pH of planting site and planting date influenced survival. Survival of both species was excellent on site A for the first three dates, with survivals of 90 percent or better for each planting. Survival for the late planting in July declined to 72 percent for the red pine and 83 percent for the scotch pine. On sites B and C, survival for the first three dates ranged from 73 to 88 percent and then dropped to 50 percent or less for the July plantings.

Table 1.--Survival of tubelings and bare-root seedlings after first growing season

Date planted	Planting site and pH							
	A--5.0		B--4.0		C--3.7		Total	
	Red pine	Scotch pine	Red pine	Scotch pine	Red pine	Scotch pine	Red pine	Scotch pine
Tubelings:								
4/15/68...No. planted..	60	60	60	60	60	60	180	180
% survival..	92	98	85	77	82	78	86	84
5/13/68...No. planted..	60	60	60	60	60	60	180	180
% survival..	90	93	87	88	85	80	87	87
6/10/68...No. planted..	60	60	60	60	60	60	180	180
% survival..	93	97	88	77	73	80	85	84
7/8/68....No. planted..	60	30	60	30	60	30	180	90
% survival..	72	83	42	50	48	47	54	60
Total.....No. planted..	240	210	240	210	240	210	720	630
Average... % survival..	87	94	75	76	72	75	78	82
Bare-root...No. planted..	68	--	111	--	70	--	249	--
seedlings... % survival..	98	--	98	--	64	--	89	--

Survival of bare-root seedlings was extremely good on sites A and B (98 percent) and satisfactory on site C (64 percent). Average tubeling survival was greater than bare-root seedling survival only on site C for the first three planting dates.

An examination of the plots, late in the first winter after planting, showed that 84 percent of all the tubelings had been frost-heaved. On one of the plots, 100 percent of the tubelings were affected. Even though frost-heaving occurred on all plots, the degree of damage varied. Some of the tubes were moved upward an inch or less; others were pushed completely out of the ground. No further evaluations were made of these plantings until the end of the fifth growing season. At that time average survival of both species for all planting dates was 50 percent. However, one-third of the surviving tubelings were growing so slowly that it is doubtful that they will ever attain meaningful size.

The potential of container-grown seedlings for afforesting mine spoils was clearly shown by the first-year survival of the Ontario tubelings. Survival data also suggest that container-grown seedlings show potential for extending the normal planting season. However, the difficulties encountered with frost-heaving indicate that Ontario tubes are poorly suited for mine spoils.

A second experiment was established in 1970 to test other types of containers of different sizes, shapes, and materials. We wanted to find a container that would resist frost-heaving.

STUDY II -- CONTAINERS 3/

There are many types of containers on the market today, but the containers we selected for this study were readily available and appeared to provide the needed anchorage. They were:

1. Peat pots--2 1/2 inches top diameter x 3 1/8 inches deep.
2. Jiffy-7's--compressed peat pellets, 1 3/4 inches high x 1 3/4 inches diameter when saturated.
3. Asphalt tubes--2 inches diameter x 4 inches long, fabricated from 15-pound felt building paper.
4. Conwed large perforated plastic tubes--1-inch diameter x 6 inches long.
5. Conwed small perforated plastic tubes--5/8-inch diameter x 6 inches long.
6. Ontario plastic tubes (included to corroborate performance in previous study).

Except for the Jiffy-.7's, which are made from compressed peat, the containers were filled with a 1:1 mixture of sterilized peat and vermiculite for the planting medium. Red pine was selected for the test species to evaluate the six types of containers.

In January 1970, three red pine seeds were planted in each of the containers, which were then placed in a greenhouse for germination. To test for any differences in survival between two ages of seedlings, the above procedure was repeated 1 month later.

On April 20, two weeks before planting, the 3-month-old seedlings and the 2-month-old seedlings were thinned to one plant per container and placed in a sheltered outdoor location for hardening-off.

For this study, too, we selected a bituminous strip-mine spoil in Clearfield County, Pennsylvania, as the planting site. The spoil, which had a pH of 3.5, was made up of yellow to brown acid sandstone and black pyritic material.

Four planting blocks were laid out on the site. Each block was to have 10 container-grown red pine seedlings from each seeding date, representing each of the six types of containers planted in randomly selected rows. Due to mortality in the greenhouse, some shortages of the container-grown red pines occurred. Consequently, only 32 Ontario (January) and 23 Jiffy-7's and 20 asphalt (February) container-grown seedlings were planted. The seedlings were planted with 2-foot spacing between seedlings and 3 feet between rows. In addition, 10 red pines, 2-0 nursery stock, were planted in each block to provide a comparison of container seedlings versus bare-root seedlings.

3/Mention of these products is for information only and does not imply endorsement by the U. S. Department of Agriculture.

To eliminate effects of different planting methods and because of the size of some of the containers, a mattock was used for planting all containers and bare-root seedlings.

We took survival counts at the end of the first, second, third, and fifth growing seasons and also after the first winter after planting. The number of living seedlings was counted, and the data were converted to percentage of survival. Height measurements were also taken at the end of the third and fifth growing seasons.

Results

After the first growing season, a Chi-square analysis was made of the survival data for the planted red pines. No significant difference was found in survival between the older and younger container-grown seedlings. Consequently, the data for the January and February seedlings were combined.

Overall survival after the first growing season ranged from 62 percent for the small Conwed tubes to 87 percent for the Jiffy-7's (table 2). The bare-root seedlings had 95 percent survival.

An examination of the containers soon after the first winter after planting revealed that almost one-half of the Ontario tubes, Conwed large tubes, and Conwed small tubes had been affected by frost-heaving. It was very evident that the small plastic containers were not suited for revegetation of bituminous coal-mine spoils because of their susceptibility to frost-heaving. The seedlings in peat pots, Jiffy-7's, and asphalt tubes also suffered some additional mortality, though not attributed to frost-heaving.

No additional mortality was noted during the second and third growing seasons. At this time, survival of the bare-root red pines was 90 percent; peat pots, 78 percent; Jiffy-7's, 73 percent; and other containers, 45 percent or lower.

Annual height growth of seedlings in peat pots, Jiffy-7's, and asphalt tubes for the 1972 season was comparable to that of the bare-root seedlings.

An examination of the planting at the end of the fifth growing season showed that overall survival of all red pines was about the same as that at the end of the third growing season (1972). Average survival and height growth are shown in table 2.

Average height growth of peat pot seedlings was 73 cm; for the Jiffy-7's,

Table 2.--Average survival and height growth[1/] of container-grown and bare-root red pines

Container	1st growing season survival	5th growing season		
		Survival	Total height	1974 height growth
	%	%	cm	cm
Peat pot	80	76	73	24
Jiffy-7	87	73	58	21
Asphalt tube	65	37	61	20
Large perforated plastic	69	45	56	18
Small perforated plastic	62	20	48	16
Ontario plastic	68	36	38	14
Bare-root seedlings	95	90	73	20

[1/] Weighted averages

it was 58 cm. The bare-root red pines, though 2 years older than the container-grown red pines, had an average height of 73 cm. Except for some of the Ontario tubelings, red pines in the other types of containers were also growing well.

The 1974 height growth of the peat pot and Jiffy-7 seedlings exceeded the growth of the bare-root seedlings. Height growth in this year was the same for seedlings in the asphalt tubes and for the bare-root stock. All the other containerized seedlings grew less than the bare-root seedlings in 1974.

CONCLUSIONS AND RECOMMENDATIONS

Although the data presented in this paper are limited and cover a time span of only five growing seasons, we feel that the following conclusions for container-grown seedlings are valid for Pennsylvania bituminous coal-mine spoils.

Frost-heaving of Ontario and other plastic containers was so severe that their use for afforestation on these spoils is not recommended.

Containers such as peat pots or Jiffy-7's can provide adequate seedling survival and satisfactory growth on marginal to good-quality spoils. Harsh or problem spoils may require amendment treatments or larger-sized containers or both.

At present, economic considerations may prohibit large-scale production of container-grown seedlings. However, the fact that plantable seedlings can be produced in 3 months could make this system attractive for small supplemental plantings or even large-scale plantings if bare-root nursery seedlings are in short supply.

We recommend that container research for spoil reclamation be continued. The following should be considered:

1. Determining costs of container production and outplanting.
2. Evaluating of other types of containers for frost-heaving resistance and optimum size for seedling survival and development.
3. Testing additional container-grown tree species and shrubs for compatability to coal-mine spoil reclamation.
4. Extending the normal planting season by using container-grown seedlings.

LITERATURE CITATIONS

Cayford, J. H.
1972. Container planting systems in Canada. For.Chron. 48(5): 235-239.

MacKinnon, George E.
1970. Container planting in Ontario. For. Chron. 46(6):470-472.

Owston, Peyton W.
1972. Field performance of containerized seedlings in the Western United States. West. For. & Conserv. Assoc. Perm. Assoc. Comm. Proc. 1972:109-112.