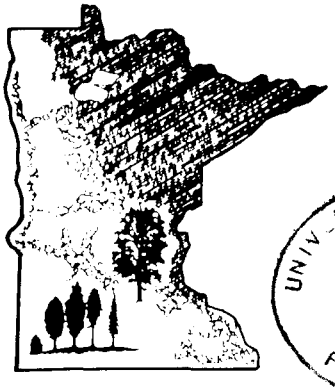

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COMPARISONS AFTER PLANTING OF JACK PINE GROWN FOR VARYING TIME PERIODS IN DIFFERENT CONTAINER SYSTEMS

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ABSTRACT

Containerized seedlings grown in five different container systems were evaluated one, two, and four years after planting. Seedlings were reared for periods of 6 and 18 months in Ontario tube, styroblock-2, styroblock-8, paperpot, and rootrainer containers. Seedlings reared for 18 months were larger at the time of planting. Initial seedling size also varied directly with rooting volume of container. Differences caused by container volume had disappeared by the end of the sampling period, but hare-browsing may have confounded these results.

INTRODUCTION

Containerized seedlings are of increasing importance in intensive forestry practices today. It has long been recognized that container characteristics influence the initial root system. Less is known about how container constraints on root development affect future growth and development of the planted seedling. The constraints on root development vary with size, shape, and design of the container. This study compared for 3 or 4 years after outplanting the development of seedlings grown in five different container systems for periods of 6 and 18 months.

DESCRIPTION OF STUDY

Jack pine (Pinus banksiana Lamb.) seedlings were grown in five different container systems: 1) Ontario tube: 11cc rooting volume, small open-ended plastic tube with slit on one side, tube planted with seedling, no longer used because of limited rooting volume; 2) British Columbia/ Canadian Forestry Service (BC/CFS) styroblock-2: 41cc cavity, bullet-shaped cavities with vertical ribs on interior wall, seedling plug removed and planted; 3) Spencer-Lemaire rootrainer: 57cc volume, folding book-type container with vertically ribbed walls, seedling plug removed and planted; 4) Japanese paperpot FH 315: 106cc volume, hexagonal-shaped paper cavities designed to decompose after planting; 5) BC/CFS styroblock-8: 131cc volume, otherwise similar to styroblock-2.

The containers were seeded on January 13, 1977 and were placed in a growth chamber where temperature was 25°C for 19 hours with fluorescent light and 18°C for five hours in darkness. Beginning five weeks after germination, the seedlings were given a 20-20-20 (NPK) water-soluble fertilizer once a week. Sixteen weeks after germination (May 13, 1977) the seedlings were placed outside, watered as needed, and fertilized once a week until planting.

On July 1, 1977, 60 seedlings from each container system were planted. Fifty seedlings from each system, except the Ontario tubes, were left in the containers and watered and fertilized until September, 1977. They were overwintered under snow cover and were considered to be 18 months old when planted on July 17, 1978.

All seedlings were planted in an old nursery at the University of Minnesota Cloquet Forestry Center in northeastern Minnesota (lat. 46°46', long. 92°31'). The soil was loamy medium sand without stones or other obstacles to alter root development. Seedlings grown in Ontario tubes were planted with a dibble while a Pottiputki planting tool was used for all other seedlings.

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Root systems of all the seedlings were well-developed and root plugs were easily extracted at time of planting. Shoot height, stem diameter, and shoot and root weight (oven-dried basis) were determined on ten seedlings from each container system at time of planting.

Ten sample trees from each container system were dug from the planting site at various time periods after planting. Six-month-old seedlings were sampled 1, 2, and 4 years after planting and 18-month-old seedlings 1 and 3 years after planting. Stem diameter, shoot height to the apical bud, shoot and root weight (o.d.), depth of taproot, number of laterals greater than 1mm in diameter measured at intersection with taproot, and average length of such laterals were determined for each seedling the first and second year after planting. Third and fourth year measurements were stem diameter, depth of taproot, and number of lateral roots greater than 1mm in size. Shoot height and weight measurements were not taken the third and fourth year because of hare browsing on the crowns.

RESULTS

Seedling characteristics at time of planting

The 6-month-old seedlings grown in Ontario tubes were significantly smaller than those grown in other types of containers (Table 1). This is consistent with their small rooting volume of 11cc and high density in the growing tray which results in increased competition for shoot growing space. In general, size of 6-month-old seedlings varied directly with rooting volume as paperpot seedlings were the tallest and styro-8 seedlings had the largest stem diameter. Styro-8 seedlings with 131cc of cavity space had the heaviest root and shoot weights of any of the 6-month-old seedlings.

The 18-month-old seedlings had more than twice the shoot height and substantially larger stem diameters than the 6-month-old seedlings. The relationship between rooting volume and seedling size was similar to that of the 6-month-old seedlings. Paperpot seedlings were largest in both shoot height and stem caliper with styro-8 seedlings second largest. Seedlings grown in the styro-2 and rootrainer containers did not differ significantly in size.

Shoot/root ratios of both the 6-month- and 18-month-old seedlings were all larger than the 1.0 or 2.0 suggested by Ferdinand (1972). However, there is evidence in the literature that shoot/root ratios similar to those in this study will perform satisfactorily and may outperform those with the lower shoot/root ratios (Walker and Johnson 1980).

Six-month-old seedlings 1, 2, and 4 years after planting (Table 1).

Size attained by 6-month-old seedlings one year after planting was generally consistent with size differences at the time of planting. The seedlings grown in Ontario tubes were smallest and those grown in styro-8 cavities were largest. Differences in size between the other three container systems were not well-defined. Two years after planting, tube seedlings were still smaller while seedlings grown in paperpots, rootrainers, and styro-2 cavities were the same size as those grown in styro-8 cavities. The fourth-year stem diameter measurement showed both the paperpot and the tube seedlings to be significantly smaller than the others. The slow degradation of the paperpots may have restricted root development and contributed to the small stem size. The problem of slow paper degradation has been previously noted both in the northern states (Ditmarsen and Alm 1979) and in the south (Barnett and McGilvray 1981).

The taproots of seedlings grown in the various containers did not differ significantly in depth even after three years in the field. There were differences in number of laterals greater than 1mm (Table 1). Average lateral root length was significantly larger for the styro-2 seedlings one year after planting. Two years after planting the tube seedlings had significantly shorter average lateral root length than seedlings grown in the other four systems. The root system evaluation tends to support the premise that slow degradation of the paperpots affected seedling development.

Eighteen-month-old seedlings 1 and 3 years after planting (Table 1).

One year after planting, the styro-8 seedlings were significantly larger than all others in shoot height, stem diameter, and shoot and root weight. There were no significant differences between any of the container systems when taproot depth, number of laterals greater than 1mm, and average lateral root length were considered. Three years after planting there were no significant differences between the four container systems in stem diameter, number of laterals greater than 1mm or length of taproot.

DISCUSSION AND CONCLUSIONS

Six-month vs. 18-month cultural periods

Since all seeds were sown at the same time and 18-month-old seedlings were planted one year later than 6-month-old seedlings, it is possible to compare 18-month-old seedlings 1 year and 3 years after planting with 6-month-old seedlings 2 and 4 years after planting. These comparisons indicate that even though the average 18-month seedlings were larger at the time of planting, the average

6-month seedling was substantially larger than average 18-month seedlings reared in the same container system at the end of comparative sampling periods.

With these results and the increased costs of growing stock for a longer period of time, the 6-month cultural period is more practical and productive of the two alternatives. However, the results also indicate that if circumstances (such as drought, labor shortages, etc.) make it necessary, container seedlings can be held and overwintered for planting the following year with satisfactory results. This flexibility is a real advantage in regeneration programs.

Comparison of container systems

As noted earlier, size of seedlings at time of outplanting in general varied directly with rooting volume. However, at the final sampling, 3 or 4 years after planting, there were no significant differences in stem diameter or rooting characteristics among seedlings grown in styro-2's, styro-8's, and rootrainers. The average stem diameter of 6-month paperpot seedlings was significantly smaller but this may have resulted from slow paper degradation as noted earlier. Based on these results it appears that growth of containerized seedlings after outplanting does not vary between the systems tested with the exception of the now obsolete Ontario tubeling. Therefore, selection of a container system for use should be based on logistic criteria which vary greatly between reforestation programs.

It is also evident from these results that larger trees can be grown in containers with larger rooting volumes. The results show that when planted on a site devoid of vegetative competition that the larger seedlings will not necessarily outperform smaller ones. However, it should be noted that these results might be different when plantings are established on sites where vegetative competition is a factor especially with species having a slower juvenile growth rate than jack pine. The possible effects on the results of hare browsing should also be noted.

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Table 1. Characteristics of seedlings grown in different container systems at time of planting and after various periods in the field.[2]

Container System	Size of 6-month-old seedlings on 7/77	7/78	7/79	7/81	Size of 18-month-old seedlings on 7/78	7/79	7/81
			Shoot Height (cm)				
Ontario tube	6.4c[3]	19.2c	41.0b	-	-	-	-
styro-2	11.5b	37.9ab	64.0a	-	26.9c	35.5c	-
rootrainer	12.0b	31.9b	57.0ab	-	29.7c	38.8bc	-
paperpot	17.4a	34.2b	54.4ab	-	44.2a	44.4b	-
styro-8	10.7b	43.8a	64.0a	-	35.2b	50.5a	-
			Stem Diameter (mm)				
Ontario tube	1.0c	3.8d	8.8b	39.3b	-	-	-
styro-2	1.9b	7.3b	15.0a	44.9a	3.0c	5.4c	29.1a
rootrainer	1.8b	5.6c	14.1a	46.5a	3.1c	6.4b	31.0a
paperpot	1.9b	6.1c	12.5a	41.7b	4.3a	6.4b	28.7a
styro-8	2.3a	8.8a	14.1a	46.3a	3.8b	7.9a	31.8a
			Shoot Weight (g)				
Ontario tube	0.1	2.8c	22.7b	-	-	-	-
styro-2	0.6	11.6b	90.4a	-	1.6	6.4c	-
rootrainer	0.5	8.1b	68.9a	-	1.6	9.4b	-
paperpot	0.6	8.5b	66.5a	-	2.9	6.7c	-
styro-8	0.9	18.6a	88.5a	-	2.7	12.6a	-
			Root Weight (g)				
Ontario tube	< 0.1	0.9d	3.9b	-	-	-	-
styro-2	0.2	3.3b	14.1a	-	0.6	2.0c	-
rootrainer	0.2	2.0c	11.8a	-	0.4	2.6b	-
paperpot	0.2	2.4c	9.3a	-	0.7	1.8c	-
styro-8	0.3	5.6a	12.7a	-	0.9	3.6a	-
			Shoot/Root Ratio (g/g)				
Ontario tube	4.0	-	-	-	-	-	-
styro-2	2.9	-	-	-	2.6	-	-
rootrainer	3.0	-	-	-	3.5	-	-
paperpot	4.2	-	-	-	3.9	-	-
styro-8	2.8	-	-	-	3.1	-	-
			Taproot Depth (cm)				
Ontario tube	-	30.7a	-	-	-	-	-
styro-2	-	31.7a	43.4a	103.7a	-	12.8a	51.4a
rootrainer	-	33.5a	39.1a	93.0a	-	11.2a	47.8a
paperpot	-	34.7a	31.5a	90.9a	-	16.3a	48.4a
styro-8	-	35.0a	35.6a	108.7a	-	11.5a	71.2a
			Number of Laterals ≥ 1 mm				
Ontario tube	-	3.2[4]	7.1[4]	26.3[4]	-	-	-
styro-2	-	8.6	15.0	41.9	-	3.1a	30.9a
rootrainer	-	8.2	15.4	43.6	-	2.8a	31.3a
paperpot	-	7.1	13.0	32.4	-	2.7a	33.6a
styro-8	-	9.4	14.3	39.6	-	2.9a	34.6a
			Average Lateral Root Length (cm)				
Ontario tube	-	35.7b	36.8b	-	-	-	-
styro-2	-	42.6a	57.7a	-	-	26.7a	-
rootrainer	-	35.1b	58.1a	-	-	38.1a	-
paperpot	-	36.8b	50.4a	-	-	23.1a	-
styro-8	-	34.7b	60.1a	-	-	27.0a	-

[2]Figures shown are means of ten trees.

[3]Means in a column within a characteristic followed by a common letter are non-significant at .05 level.

[4]Means differ significantly at the .01 level but because of nonparametric data differences, between individual means could not be determined.

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