GROWTH OF AUSTRIAN PINE AND NORWAY SPRUCE SEEDLINGS IN MINI-CONTATINERS

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ABSTRACT: Austrian pine (Pinus nigra Arnold) and Norway spruce (Picea abies (L.) Karst.) were seeded in selected mini-containers filled with Jiffy Mix and placed in a greenhouse eighteen weeks from germination. The stem length of both species was greatest in Book Tinus; intermediate in Book Hillson, Square Container and Tar Paper; smallest in Leach Tube, Styroblock 8 and Styroblock 7. The shoot and root dry weight of spruce were greater in smaller containers. Pine seedlings grew equally well in all containers. The ratio of the root dry weight/container volume (mg/cm^3) of both species was higher in the smaller containers.

INTRODUCTION

In recent years, there has been a gradual shift from field-grown, bare-root nursery stock to container production. The increased use of containerized seedlings in nursery and forestry production is due to the advantages of better plant survival and growth, extension of the planting season, and adaptability to mechanical planting. Growth of tree seedlings in mini-containers under controlled-environment conditions has been studied by various workers (Arnott 1974; Barnett 1982; Johnson 1975). Generally, there are three categories of containers used in forestry and ornametal plant production: tube, block, and plug (Barnett 1982). A containerized seedling has a root system which holds the growing medium when removed from the container, and when planted the roots make immediate contact with the soil (Mann 1977). Easy plug extraction depends upon the proper development of the root system, media, moisture content of the plug and the construction of the container walls and ridges (Tinus 1978). Usually, four to five months is needed to produce gro-plug seedlings with root systems suitable for transplanting into larger containers or the field, or for sale (Mann 1977; Thomas 1980).

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The design and shape of the nursery containers have been improved recently. Some mini-containers now have vertical ribs or grooves along the container wall with drainage holes at the bottom. The ribs are intended to direct the roots downward and therefore prevent circling of roots (Dickenson and Whitcomb 1978; Tinus and McDonald 1979).

Research has shown that container volume and diameter influence plant growth, and there is a minimum volume below which growth is limited (Wall and Whitcomb 1980). In one study (Venator and Rodriguez 1977), the shoot and root growth of Pinus caribaea var. hondurensis was influenced by the cavity sizes of Styroblock 4 and 8. Similar results were noted for lodgepole pine and white spruce (Carlson and Endcan 1976; Rndean and Carlson 1975).

Seedlings produced in uniform size mini-containers are adaptable to mechanized planting. The production cost of the containerized seedlings may be higher than field-grown ones, but compensations include faster and superior growth, higher production, longer planting periods and lower labor and land costs. The purpose of this research was to evaluate the effectiveness of selected minicontainers on the rate of seedling growth.

MATERIALS AND METHODS

Austrian pine (Pinus nigra Arnold) and Norway spruce (Picea abies (L.) Karst.) were grown in selected mini-containers to evaluate their effects on seedling growth (table 1). All containers were filled with Jiffy-Mix (commercially available peat-vermiculite 1:1 mix) and placed on wire benches in a glass greenhouse. Four seeds were placed in each cavity. At two weeks after germination seedlings were thinned to one per cavity and at three weeks seedlings were fertilized with liquid 20 N -8.6 P -16.6 K (100 ppm N) once a week and watered every two to three days as needed. The pH of the water was maintained between 5.0-5.5 using phosphoric acid (Tinus and McDonald 1979). The pH and Electrical Conductivity (EC) of the growing medium were monitored before and throughout the trial. Plants were grown for 18 weeks from March to August, 1981, with average day and night temperatures of 30^0 and 18°C, respectively.

Table 1. Container/cavity dimensions

Container Type[1]	Composition	Top Diam. (cm)	Length (cm)	Width (cm)	Depth (cm)	Volume (cm^3)
Styroblock 7[2]	Styrofoam	3.0	--	--	22.5	121.3
Styroblock 8	Styrofoam	3.8	--	--	15.0	131.1
Leach Tube[3]	Polyethylene	3.8	--	--	13.5	131.1
Book Hillson[4]	Polyethylene	--	3.8	3.8	12.5	172.1
Book Tinus	Polyethylene	--	5	3.8	18.1	352.4
Square Bottomless	Unknown plastic	--	4	4	18.9	302.4
Cylinder Tar Paper	Asphalt	6.2	--	--	18.9	570.8

[1]Containers referred to in text as small are, Styroblock 7, Styrobloc, 8, and Leach Tube. Containers referred to in text as large are, Book Hillson, Book Tinus, Square Bottomless and Cylinder Tar Paper.
[2]Styroblock 7 and 8-Silvaseed Company, P. O. Box 118, Roy, Washington 98580.
[3]Leach Tube--Ray Leach Cone-Tainer, 15--N. Maple Street, Canby, Oregon 97013.
[4]Book Hillson adn Book Tinus--Spencer--Lemaire Industries LTD., 11413-120 Street, Edmonton, Alberta, Canada T5G 2Y3.

At the eighteenth week, the plants were harvested. The development of the root system in each container was visually evaluated. The plant shoots and roots were dried at 65°C for 48 hours for dry weight determination. The experimental design was a split plot in a random block with seven containers and two species replicated four times. The growth rate measurements were determined randomly by selecting six plant samples from each container and species.

RESULTS AND DISCUSSION

Stem Length

Larger containers such as Book Tinus and Tar Paper produced greater stem length for Austrian pine and Norway spruce when compared with the small size cavities of Styroblock 7 (table 2). Possibly the larger diameter of these containers influenced the plant stem length. Similar results were reported for the lodgepole pine and white spruce (Carlson and Endean 1976; Endean and Carlson 1975). Wall and Whitcomb (1980) also reported an increase in seedling height of Lacebark Elm, Atlas Cedar and Japanese Black Pine.

Shoot and Root Dry Weight

With the exception of root dry weight in Tar Paper, the shoot and root dry weights of pine were similar in all containers tested (table 2). Whereas the greatest shoot dry weight of Norway spruce was obtained in the small and tapered containers. According to Endean and Carlson (1975), container configuration (height or diameter) had no effect on shoot dry weight or the shoot length of lodgepole pine seedlings, but it did on white spruce seedling growth. It appears that lodgepole pine and white spruce respond differently to containerized conditions (Carlson and Endean 1976). Spruce is a more shallowly rooted species than pine and therefore had a greater number of roots in the top quarter of the container. In contrast, pine had more roots in the bottom of the container. Austrian pine grew equally well in all containers tested regardless of container configuration and volume. However, Norway spruce seems to grow better in the smaller and tapered containers such as Styroblock 7, Styroblock 8, and Leach Tube, possibly because of its shallow root system.

Shoot/Root Ratio

The shoot/root dry weight ratio of pine seedlings was greatest in Tar Paper which gave the smallest root system (table 2). The Tar Paper was formed as a cylinder which had smooth walls and no ribs. Circulating and spiralling primary lateral roots about the tap root is common in cylindrical containers (Tinus 1978 and Agnew 1981). The main disadvantage observed with the Tar Paper container was the root penetration through the tar paper wall into the adjacent tar paper pots. This makes pot removal difficult, damages the root system and results in loss of roots. This is likely the reason for lower root dry weight of both species grown in Tar Paper containers. Such problems with Tar Paper containers also were noted by Strachan (1974). Norway spruce had a greater shoot/root dry weight ratio in the larger volume containers: Tar Paper, Book Tinus and Book Hillson (table 2).

Root Quality

The extensity,fibrousness, and uniformity of the root system were taken into consideration when visual evaluations on root quality were made. Austrian pine produced a very good root system in all containers tested except for Tar Paper. The root system of spruce was good in Leach Tube, Styroblock 8 and Styroblock 7 (table 2). The plugs of both species indicated a more fibrous and dense root system in Leach Tube and Styroblock containers (fig. 1). The Book planters produced plugs that were quickly and easily extracted (figs. 2 and 3).

Table 2. Effect of various containers on stem length (cm), dry weight (g), root quality and root dry weight/container volume ratio (mg/cm^3) of Austrian pine and Norway spruce seedlings.

Container	Stem Length (cm)	Dry Weight (g)			Root Quality[x]	Root Dry Weight/ Container Volume Ratio (mg/cm)
		Shoot	Root	Ratio		
				Austrian Pine		
Styroblock 7	4.3c[y]	0.92a	0.36ab	2.55c	4.2ab	3.0a
Styroblock 8	4.6bc	1.19a	0.44a	2.70c	4.5a	3.3a
Leach Tube	4.5bc	1.05a	0.39ab	2.69c	4.3a	3.0a
Book Hillson	5.0ab	1.11a	0.34ab	3.26b	4.0ab	2.0b
Book Tinus	5.2a	1.21a	0.41a	2.95bc	3.9ab	1.2c
Square Bottomless	4.7abc	1.24a	0.41a	3.02bc	4.4a	1.4c
Cylinder Tar Paper	4.8ab	1.23a	0.27b	4.55a	3.4b	0.5d
				Norway Spruce		
Styroblock 7	2.8c	0.30ab	0.18ab	1.66bc	3.4ab	1.5a
Styroblock 8	3.0bc	0.32a	0.20a	1.60bc	3.7a	1.5a
Leach Tube	3.0bc	0.27abc	0.19a	1.42c	3.7c	1.5a
Book Hillson	3.1b	0.22cd	0.09c	2.44a	2.1c	0.5b
Book Tinus	3.5a	0.19d	0.09c	2.11ab	2.0c	0.3b
Square Bottomless	3.0bc	0.23bcd	0.14abc	1.64bc	2.8abc	0.5b
Cylinder Tar Paper	3.4a	0.25abcd	0.12bc	2.08ab	2.5bc	0.2b

[z]Means of 24 seedlings from 4 replicates.
[y]Mean separation in columns by Ducan's multiple range test, 5% level.
[x]Visual rating of root system; 1 = poor, 2 = fair, 3 = good, 4 = very good, 5 = excellent.

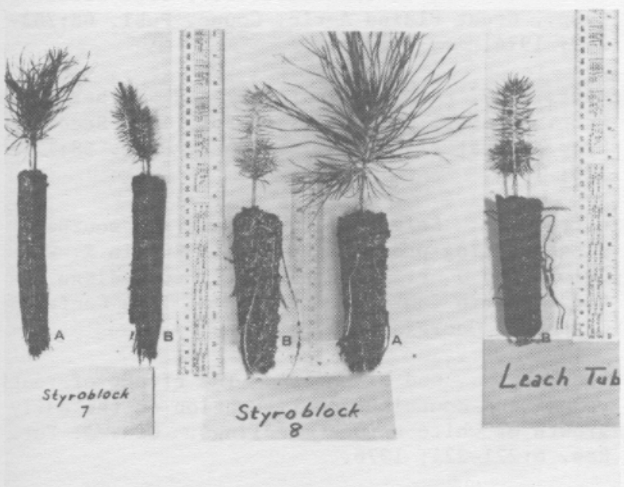

Figure 1. Austrian pine (A) and Norway spruce (B) plugs extracted from Styroblock 7, Styroblock 8, and Leach Tube.

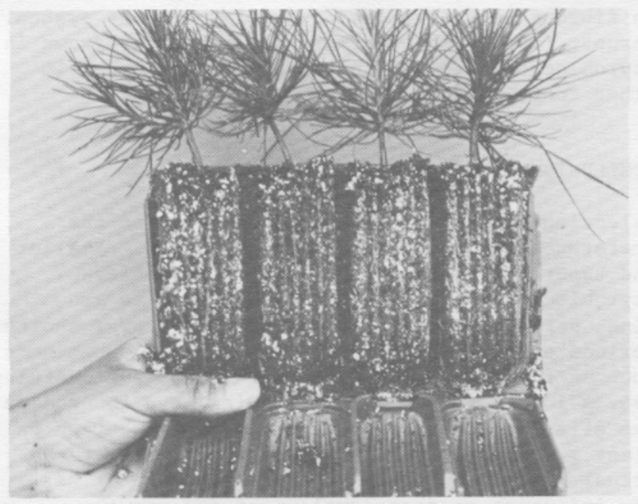

Figure 2. Austrian pine seedlings grown in Book Hillson which can be easily opened to observe the root system.

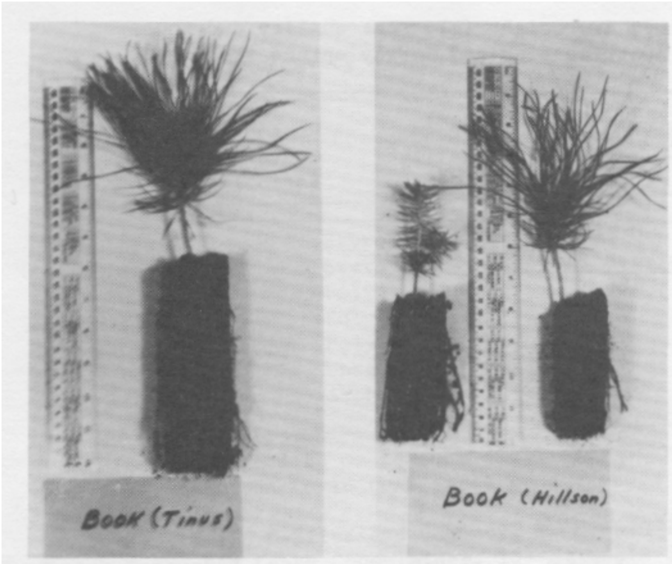

Figure 3. Austrian pine plugs extracted from Book Tinus and Book Hillson. Norway spruce plug of Book Hillson.

The square containers were effective for the production of a good root system in both species (fig. 4).

The smaller and tapered containers produced a more dense root system than the large container by the eighteenth week post-germination. It has been suggested (Allison 1974 and Sjoberg 1974) that the tapered cavity design with rigid and ribbed walls of RL single seedling container (Leach Tube), or the Styroblocks, influences the root growth resulting in fibrous well-developed and balanced root system. Barnett (1982) showed that pine seedlings grown in Styroblocks performed better than those grown in other containers.

CONCLUSION

Selection of containers should be based on the preference of a particular plant species. Smaller and tapered containers such as the Styroblock 7, Styroblock 8 and Leach Tube can be used to grow pine, spruce or similar plant seedlings over shorter periods of up to six months. The larger containers such as the Book and Square may be used successfully over a longer period. Many studies have focused on the effect of container shape and configuration on plant growth, but yet it is not known whether the actual material which containers are made of has any influence on root development and growth. Effects of various types of mini-containers on the seedling performance after transplanting need further research.

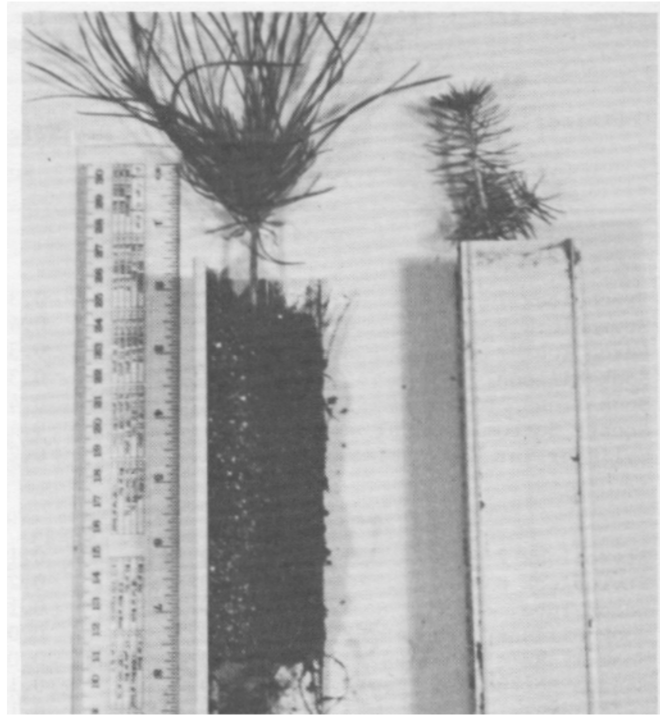

Figure 4. Austrian pine and Norway spruce grown in square bottomless container.

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