Container Size Affects Dimensions Of White Spruce, Jack Pine Planting Stock

J. B. Scarratt
Canadian Forestry Service

Partly as a result of economic pressures, an increasing interest has surfaced over the past decade in the development of container-planting systems as a possible means of achieving large-scale forestation rapidly and economically.

Recent developments in North America differ from traditional concepts of container planting in two respects. First, practical considerations favor containers considerably smaller than those used in the past, and, second, seedlings are usually planted when only a few weeks old and much smaller than conventional nursery stock. The reasons for this are economic rather than biological, influenced by such factors as nursery production costs, weight in relation to transportability, and ease of planting.

Containers used for operationalscale planting in Canada up to now have ranged in size from the 3-inch x 9/16-inch diameter split-plastic tube (MacKinnon, 1970) to the 4 1/2-inch x 3/4-inch diameter Waiters' bullet (Kinghorn, 1969). Vigorous planting stock can be raised in containers of these dimensions, and, practically speaking, such sizes are ideal for handling at all stages from nursery production to field planting. Moreover, they are the types of basic units we may visualize being used in a fully mechanized planting system. However, they have drawn some criticism as a result of their small size and restricted rooting volume and because of the unknown effects of initial root constriction by the impenetrable container wall upon future tree development and stability.

Although the biological performance of containerized seedlings may dictate important modifications in technique, for economic reasons the overall size of container used will probably remain relatively small for all large-scale forestry applications. This will be true regardless of whether the container is a physical package planted with the seedling or discarded before planting, or a molded block of compressed growing medium. Diameter is probably the most critical dimension influencing choice of size, since it is a major determinant both of the seedling production capacity of a nursery and transportation and handling costs. A container exceeding 1 %2 inches in diameter would probably not be practical for large-scale coniferous planting programs, but it would give an appreciably greater rooting volume than provided by the split-plastic tube currently used in Ontario, raising the question of whether a change to a larger diameter tube might be advantageous in terms of improved outplanting success and overall regeneration efficiency. Although rooting volume may also be increased by increasing container depth, this is less effective in improving rooting density (Boudoux, 1970). In Ontario, because of the essentially shallow nature of many of the soils and the desirability for early root egress, container depth is likely to remain at about 3 inches.

This article discusses the results of studies comparing the effects of relatively, small changes in container diameter, in the range 9/16 to 1 1/4 inches, upon the dimensions of white spruce *(Picea glauca* (Moench) (Voss) and jack pine *(Pinus banksiana* Lamb.) seedlings raised for an outplanting experiment on 8- and 12week production schedules.

Procedure

Seedling growth in the "Ontario" split-plastic tube was compared with that in two other plastic tubes of essentially the same length but of larger diameter. The three tube sizes were: -

1. 3 inch x 9/16 inch diam. (standard in Ontario)
2. 3 1/4 inch x 3/4 inch diam.
3. 3 inch x 1 1/4 inch diam. (locally produced by cutting the bottom from a pill vial and splitting the tube longitudinally)

When filled to within 1/4 inch of the tube lip, the three sizes contained 0.7, 1.3, and 3.4 cubic inches (11, 22, 55 cubic centimeters) of soil, respectively.

The methods used for growing seedlings paralleled as closely as possible those used in operational practice in Ontario, including the type of growing medium used. Tubes were filled by hand with a locally collected, well-decomposed peaty muck, supplemented with potassium sulphate and finely ground monosuperphosphate at the rate of 2 and 35 grams per cubic foot of soil, respectively. These were packed into the standard 12- x 6-inch plastic trays used for the "Ontario" tube, each tray having been painted internally with copper paint to inhibit root growth from the bottom of the tubes.

The white spruce seed was soaked in tap water at 36°F. for 48 hours before sowing; the jack pine was not pretreated. Seed for the 12-week-old seedlings was sown in the second week of April and that for the 8week-old ones 4 weeks later. The seed was covered with about 1/8 inch of sand after sowing. Normally only one seed is sown per tube, but in this instance two seeds were sown in each tube to insure against blanks in trays of tubes and the possibilities of non uniform growth because of differences in aerial growing space. This factor was particularly important with the largest tubes since each tray contained only 32 tubes. Seedlings were thinned to one per tube as soon as secondary needles began to develop.

Seedlings were germinated and grown under greenhouse conditions. Trays of tubes were initially covered with plastic sheeting and burlap to promote germination; these were removed as soon as the germinating seedlings began to touch the plastic. Wetting the burlap frequently on sunny days prevented excessively high temperatures from developing under the plastic. Daytime temperatures in the greenhouse ranged from 70°F. to 85°F., depending on external weather conditions; night temperatures were maintained at 70°F. Day length was extended to 14 hours by the use of low-intensity incandescent lamps. Starting the twenty-first day from sowing, all seedlings were fertilized at 2-week intervals by substituting a proprietary nutrient solution (RX-15) for a routine watering.

The experiment used five randomized blocks, each treatment combination being represented by a single tray of tubes within each block. At the termination of the experiment, a group of 20 seedlings was taken from the center of each tray for measurement. Data presented here are therefore based upon the means of 100 observations for each species X tubesize treatment.

Results and Discussion

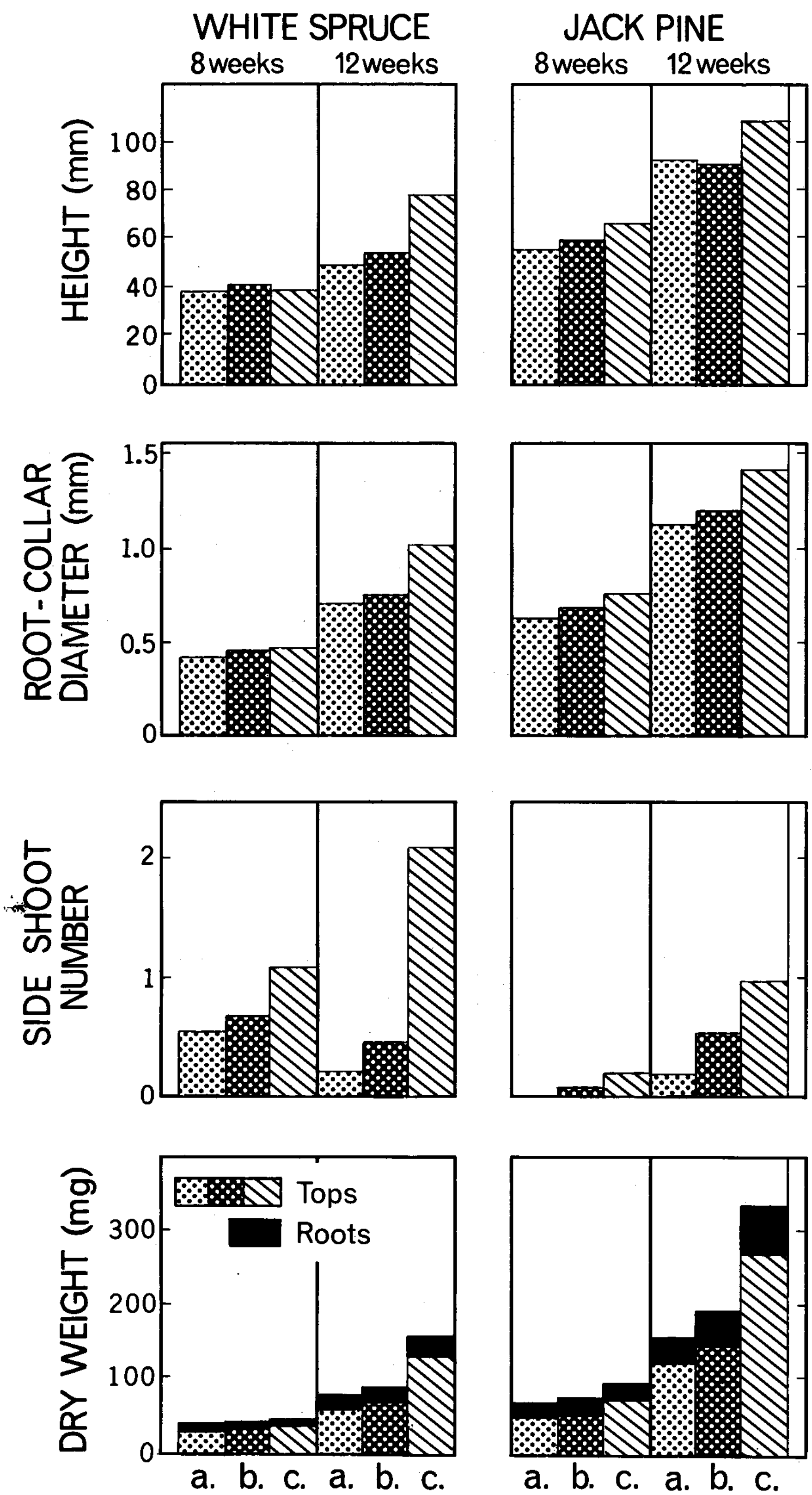
The effect of tube diameter upon seedling size for the two age classes of each species is presented graphically in figure 1. Sample seedlings from the three tube diameters are illustrated in figure 2.

Generally speaking, differences in size attributable to tube diameter were convincing only in the 12-week old seedlings. No significant differences in seedling size related to tube diameter were found in the 8-weekold seedlings, although jack pine from the 1 1/4-inch-diameter tubes did show a 38 percent increase in dry matter production over the average for the two smaller tubes. This increase was almost equally divided between roots (34 percent) and shoots (39 percent). In fact, both species showed a small, but consistent, trend of increasing size with increasing diameter at this age for all factors measured. Thus, although the differences were not significant, results do indicate that the two smallest tubes began to have an adverse effect on seedling development from a very early age.

By the time seedlings were 12 weeks old, the growth restriction imposed by the 9/16-inch tube had become very evident. Some improvement in growth was obtained with the 3/4-inch diameter tube, but was relatively small and generally nonsignificant, indicating that this tube also was severely restricting seedling development.

For all characters measured, seedlings grown in the 1 1/4-inch-diameter tubes were conspicuously and significantly superior to those grown in the smaller tubes for both species. Dry weight increases were the most prominent, but there were major increases in seedling height, stem diameter, and root development also (fig. 2). Although relative increases in dry weight were very similar for the two species, the improvement in height and stem diameter was most marked in the spruce. Table 1 summarizes these relationships by expressing the increased growth in the 3/4- and 1 1/4inch-diameter tubes as a percentage of seedling size in the 9/16-inch-diameter Ontario tube. Clearly, the only improvement in overall growth of any practical significance at the

Figure 1.—Effect of tube diameter on size of white spruce and jack pine tubed seedlings at 8 and 12 weeks from sowing: (a) 9/16 inch, (b) ¾ inch, (c) 1¼ inch diameter.



end of the 12-week production period resulted from the use of the I V4inch-diameter tube.

Twelve-week-old seedlings of both species grown in the 1 1/4-inch-diameter tube were sturdy, well-furnished with foliage, and (in white spruce particularly) were beginning to develop side shoots. The effect of the smaller tube diameters on white spruce was apparently to reduce only the overall size of seedlings and the amount of branching; there was no .noticeably adverse influence upon seedling quality. In jack pine, however, seedling quality did suffer, those grown in the small tubes being tall and spindly with sparse, thin foliage, and small diameter stems. This was especially true of seedlings grown in the 9/16-inch-diameter tubes, where the combination of weak, slender tops and low root mass made for a relatively poor choice of planting material (fig. 2). The poorer quality of these seedlings can undoubtedly be attributed to the effects of mutual shading at the close spacings imposed by the narrow tube diameters. However, even for jack pine, it is not possible to say from this study whether or not the close aerial spacing of the small tubes caused any reduction in growth in addition to that resulting directly from tube diameter. The remarkable similarity between the relative increases in dry matter production of the two species for tube diameters greater than 9/16 inch (table 1) suggests that close spacing did not further reduce growth and that the only detrimental effect it had, at least up to 12 weeks, was in terms of seedling quality. This aspect of container diameter is under continuing investigation.

Conclusions

The results showed clearly that the 9/16-inch-diameter plastic tube currently used in Ontario and elsewhere severely restricts seedling growth from an early age. Growth is only slightly better in the 3/4-inch-diameter tube and here also growth restriction starts early. Over an average 12-week production period, much growth potential is lost in containers of these sizes. For a given cultural regime, better quality planting stock of the desired size can be raised in a shorter period by using a l 1/4-inch-diameter container.

Figure 2.—Examples of 12-week-old seedlings grown in three diameters of split-plastic tubes: White spruce from (A) 9/16-inch-, (B) ¾-inch- and (C) 1¼-inch-diameter tubes; Jack pine from (D) 9/16-inch-, (E) ¾-inch- and (F) 1¼-inch-diameter tubes.

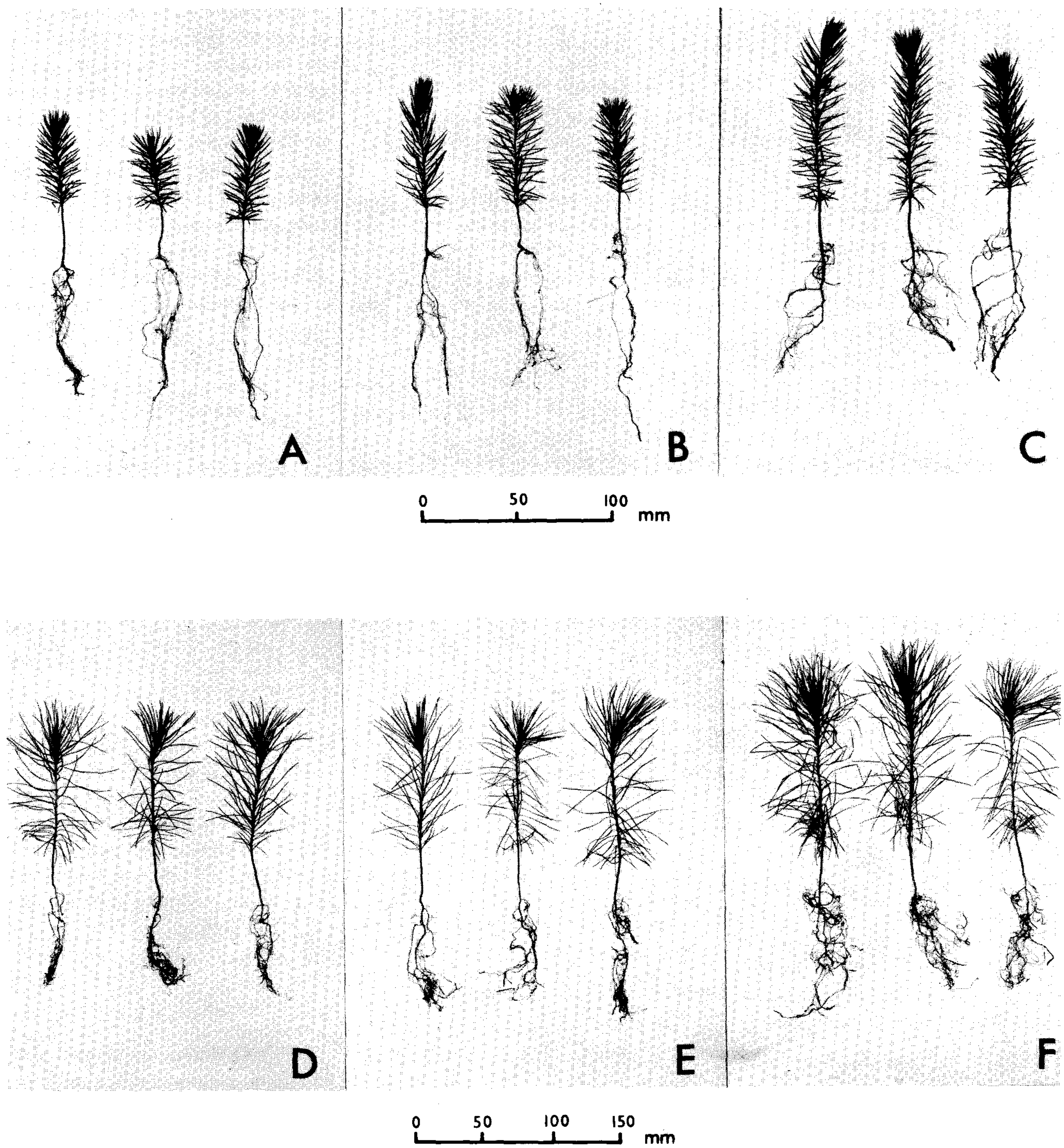


TABLE 1.—*Improvement in size of 8- and 12-week-old seedlings grown in ¾-inch- and 1¼-inch-diameter tubes compared with those grown in the 9/16-inch "Ontario" tube (percent increase)*

	Height	Root-collar diameter	Top wt.	Root wt.	Total wt.
White spruce					
8 weeks					
¾"	3.5	3.5	6.5	6.1	6.5
1¼"	2.2	6.1	15.1	7.5	14.2
12 weeks					
¾"	11.5[1]	4.2	18.4	17.4	18.2
1¼"	58.9[1]	45.1[1]	113.0[1]	90.4[1]	109.4[1]
Jack pine					
8 weeks					
¾"	8.2	10.7	8.1	18.0	9.7
1¼"	12.3	21.0	45.0	46.1	45.2
12 weeks					
¾"	0.0	5.1	19.6	24.7[1]	20.8
1¼"	20.3[1]	28.3[1]	119.2[1]	90.3[1]	113.0[1]

[1]Dimensions significantly different from those of seedlings grown in 9/16-inch-diameter tubes at the p.05 level.

Since there is evidence from field studies that the adverse effects of small containers continue for a period after outplanting, we suggest that using a *1 1/4-* or *1 ½*-inch-diameter container would be both biologically advantageous and practically feasible. However, there are obviously a number of practical considerations influencing choice of container size. Mainly these relate to the amount of nursery space required to grow seedlings and the transportation and handling costs. Small diameter containers such as the 9/16-inch Ontario tube have a great advantage in this respect, coupled with ease of planting. Increasing container diameter to *3/4* inch doubles the space requirement and unit weight, while there is a fivefold increase in these factors as diameter is increased to 1 1/4 inches. Additionally, problems of keeping planters supplied with seedlings also increase with increasing container size, thereby inflating planting costs also. Thus, while there is an obvious biological advantage in choosing the largest of these three containers, increased costs should be borne in mind, and hopefully could be offset by improvements in nursery production and field performance.

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News & Reviews

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New Publications

Forest Service, U. S. Department of Agriculture.
1972. Seed and Planting Stock Dealers-A directory of dealers that sell the more common forest and shelterbelt seeds and plants. 26 p.
This Directory was compiled from data furnished by dealers who responded to a letter sent to all commercial dealers of which the Forest Service and State Foresters had a record. Its purpose is to provide a list of possible vendors that sell common forest tree and shelterbelt seed and plants. Published for the convenience of planting stock buyers, it contains information on geographic origin of seed; names, addresses, phone numbers of dealers; information from dealers regarding minimum orders and seed certification; commercial sources of seed and planting stock by species; and a sample form for obtaining data on seed origin and quality.

Shipman, R. D.
1971. Soil-applied herbicides in control of temperate zone grasses, broadleaf weeds, and woody plants. Rept. covering May 1969-Aug. 1971. 140 p. illus. Defense Documentation Center, Dept. of the Army, Fort Detrick, Frederick, Md.
Describes, the total vegetation control of dominant poverty grass, Kentucky bluegrass, and timothy on abandoned fields employing granular, pelleted and wettable powder herbicides. Susceptibility ratings are developed according to chemical and rate of application and their effects upon 180 taxonomically classified species occurring in central Pennsylvania.