CONTAINER PRODUCTION IN ONTARIO 1/

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Abstract.--In Ontario, containers will, for the present, be grown in relatively small numbers and be used as a supplement to bare root nursery stock for planting in northern Ontario. Containers could be more widely adopted by using greenhousing to replace the nursery seedbed stage in transplant production. Development of equipment and facilities for container production is proceeding slowly. Quality of containers is being emphasized, with standards of quality being established, and techniques for monitoring and assessing quality being developed. Field performance data are still lacking.

INTRODUCTION

The forest production program in Ontario has used small seedlings in containers on an operational scale since 1966. Production in the past few seasons has stabilized at approximately 7-8 million seedlings, largely of three species and in seven locations. Production and planting occur only in the northern part of the province. For comparison, conventional bare root nursery stock production is approximately 80 million.

Two years ago a study of the development of planting stock production facilities was initiated (OMNR Project 258, 1973) in an attempt to integrate the bare root production with greenhousing and container production. In the long term, a highly capitalized greenhouse system will probably emerge from our present labour intensive system with its brief high peaks of activity. In short term there are no immediate cost advantages to changing from conventional bare root stock to container stock and there are a number of disadvantages when the probability of success is considered. Large scale greenhousing is an unknown item to us and the growth performance of outplanted containers is not yet clear, particularly for spruce.

Production of container stock will continue at a relatively small volume and development of the container system will continue at a modest scale for the near future.

ROLE OF CONTAINERS IN THE PLANTING SYSTEM

We envision a planting system that will extend throughout the entire growing season. This will require a number of techniques and planting products. Ideally, survival and growth would, after a few growing seasons, be of equal impact for whatever planting product is used.

In the production phase, containers offer considerable flexibility because

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

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of their short rotation, so that they are able to respond very quickly to the demands of the planter. Containers provide an alternative technique for producing species that are difficult to grow in the conventional bare root system. For example, for large size black spruce, we will attempt to use the greenhouse-container system for the seedbed stage to overcome losses due to frost heaving and then transplant into the open nursery field to complete development.

In the planting phase, the use of containers is restricted by site. Containers cannot yet replace large bare root stock on areas with heavy grass and vigorous shrub growth. On sites with heavy stones and boulders, a container dibble has a distinct planting advantage over a shovel. Containers can be a component of the planting system that extends over the entire growing season. In northern Ontario most planting is now done in the spring, starting May 1, but this could be extended through the summer and fall until August 30.

Cost and performance are the realities of large scale use of container stock. In the Project 258 study costs of production were relatively easy to develop, although assumptions were made in constructing a container model of an equivalent scale to a large nursery. The cost of producing containers was compared to medium sized bare root stock - either a seedling or a transplant. As illustrated in Figure 1, containers were 25 to 40% more expensive to produce. Early comparative planting trials were not done, so it was not possible to get reliable costs for planting container and bare root products on equivalent sites. It was estimated that containers are 1/3 less costly to plant than bare root. It was also impossible to get even an estimate on the outplanted performance of container and bare root stock on equivalent sites. There are projects underway now that will provide some of this missing data.

For the near future, the greatest volume of container stock will be used for outplanting directly into the field to extend the planting to August 30. Containers will be used when we know that bare root will not perform well enough. For jack pine, containers will be used for summer planting. For spruce, it appears that bare root can be planted continuously and containers will have to compete to be adopted. The most promising period to plant spruce containers would be late June and early July. The total volume of containers will remain secondary to bare root.

A MODEL CONTAINER SYSTEM

In developing a model for large scale container production, we considered a number of components. These will be built into our present container system as it evolves in the next few years.

Due to economics of overhead and for quality of staff we plan to develop large production centres of 5-15 million annual capacity. Considering geography and probable production, two centres would be required with a maximum trucking distance of 300 miles. These large centres will require high capacity filling and seeding equipment capable of producing one million containers per shift, with sufficient precision to place one seed only in each container.

For jack pine 4 inches (10cm) in height, a 3/4 inch (19mm) diameter container is acceptable. If over 4 inches (10cm) in height, a 1 inch (25mm) diameter container is preferred to reduce the density of seedlings per tray so that good diameters and bottom foliage are maintained. For spruce, a 1 inch (25mm) container is preferred. Container material of plastic or paper will be used for jack pine. We are particularly interested in paper containers for spruce since it provides a plantable container for water conservation yet permits the roots of black spruce to egress into their normal rooting zone in the surface humus layers.

The tray of containers must be constructed so that culls or empties can be sorted during the growing cycle. This then means the containers must separate from one another. Sorting is required as a standard treatment for certain species and for the inevitable bad batch. Probably 10% cull or empties would be the acceptable limit considering transportation and servicing of the hand planting.

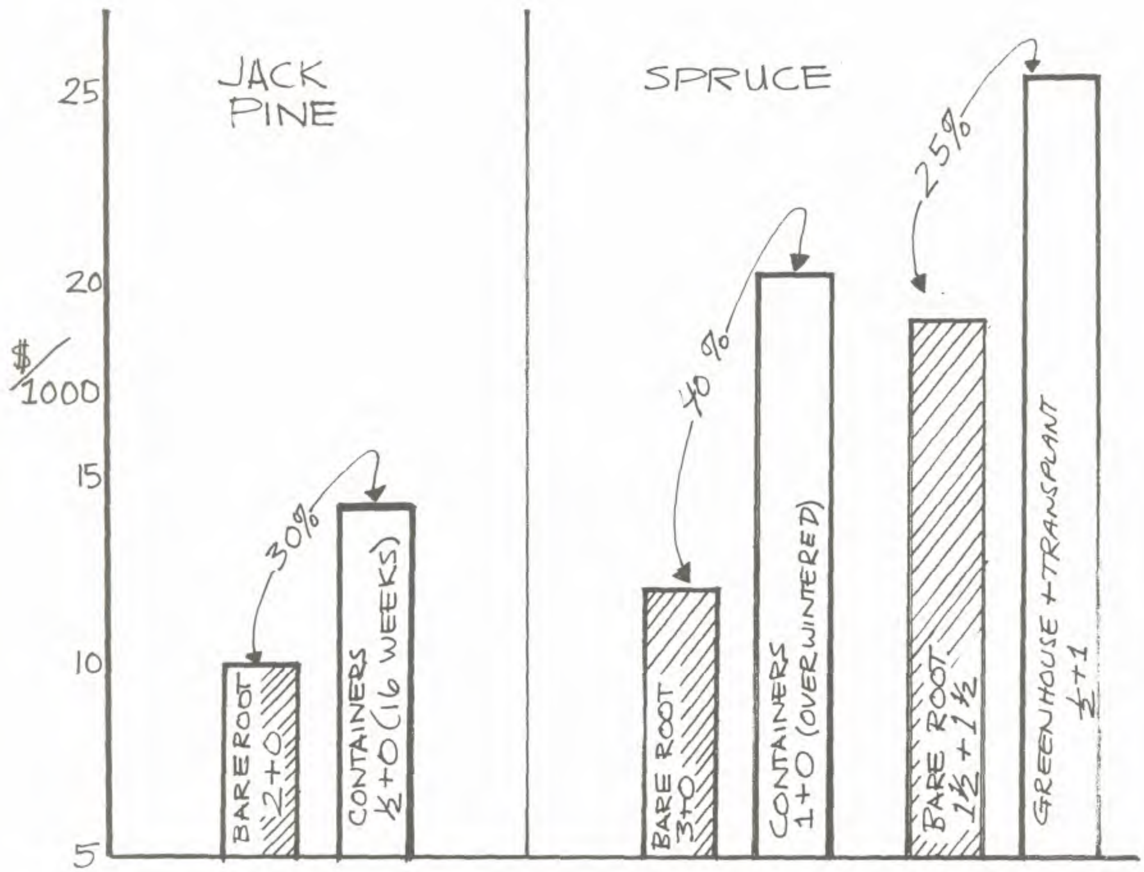

Figure 1.--Production Costs($/1000)of Equivalent Planting Products, as developed in the Project 258 Study (OMNR,1973)

Heated greenhouses should produce two or three crops of jack pine each season or one or two crops of spruce. Only the first crop will be planted in the current season. The remaining crops will be partly grown in the first season, held overwinter, and the growth completed for planting in the second season.

Greenhouses will be closed for the 3 months of December, January , February, due to excessive cold. Heat will be required for the 6 months of March, April, May,and September, October, November, and an effective cooling system using air exchange and irrigation for the 5 summer months, May to September. An area for outside storage at least equal to the area of the greenhouse will be required for hardening off and over-winter holding. An alternative to moving the stock outside is to move the greenhouse to an adjoining area to permit the next crop to be started.

The seedling should be planted intact with its container. Evidence to date suggests that in droughty soils, the container will conserve moisture during the critical initial establishment phase (Cary, 1973). As well, seedlings can be transported to the planting site and held with greater ease if intact in a container and flat.

THE CURRENT SYSTEM

Greenhouses

Seven production sites are operated across the province. Four continue to operate with the original portable greenhouses described in the 1968 Provisional Instructions for Tubed Seedlings. One production centre contracts the growing to a local greenhouse operator. Two other centres have rebuilt their houses to quite different standards and both still have start-up problems and operate below capacity.

White River has two aluminum arch Gro-Mor houses (160 feet x 32 feet) covered with fiberglass. The heat is supplied from hot water through perimeter finned heaters. Ventilation is by a double plastic tube Fan-Jet system and four exhaust fans. It should be possible to produce two crops of pine or one of spruce.

Swastika has a more sophisticated, partially controlled environment facility. Two Gro-Mor greenhouses are covered with a double plastic skin and are 135 feet x 32 feet each. At one end of the house is a large plenum in which the air is heated, cooled or humidified and then blown under the benches at high velocity. An extended day and a carbon dioxide atmosphere is possible. This type of house should yield one additional crop of pine or spruce over the White River facility.

Seeding Equipment

Development of this aspect of our work has progressed very little. The Canadian Forestry Service, Sault Ste. Marie, Ontario is testing the paper pot and its associated equipment acquired from Finland. These operational scale trials will evaluate the present equipment and highlight the characteristics of this paper container system before it is adopted on a large scale. It appears that the Finnish components could satisfy our daily seeding target. To date, all centres continue to use the basic hand equipment developed by Vic Williamson (Ont.Dept.L & F, 1968) with perhaps slight modification.

Containers and Species

Two types of containers are being used. The plastic tube, either 9/16 inch (13mm) or 3/4 inch (19mm) is used for 75% of the volume. The Spencer-Lemaire container, either 3/4 inch (19mm) or 1 inch (25mm), is used for the remaining 25%.

During the last two seasons, the following species have been produced. Over 90% of the volume is of northern forest species.

Jack Pine 1/	50 - 70%
White Spruce Black Spruce	20 - 40%
Red Pine White Pine Yellow Birch	10%

Staffing

In considering our past experiences, one of the most critical aspects in the production of containers has been the staffing of production centres. In recent years very little additional growing experience has accumulated in these centres and our working level is probably inadequate to apply our present knowledge of managing houses and growth. This is reflected in reliability - how closely we achieve production targets - and in quality - an adequate size of seedling for outplanting.

The container program is supervised with regular professional or technical personnel who usually have no greenhouse experience and who are unlikely to remain in one location for more than 3-5 seasons. The greenhouse staff is casual labour employed for the summer and they may or may not return for the next season. If the greenhouses are located at a nursery, the staff will have experience growing seedlings but only under an open field system. It is expected that with large production units we can develop more stable and permanent staff with greenhousing expertise.

QUALITY OF PRODUCTION

During the past 2-3 years, a system has been developing for assessing the container soils and plants. The objective is to even out the variation in quality of seedlings between centres, to set standards for stock and to develop a method for monitoring production.

1/ Botanical Names (in respective order)

Pinus banksiana Lamb.
Picea glauca (Moench) Voss
Picea mariana (Mill). BSP
Pinus resinosa Ait.
Pinus strobus L.
Betula alleghaniensis Britt.

Swastika has been sampling its production since 1968 and it is evident in Table 1 that much variation exists in the size of stock being planted from year to year. This is partly due to the growing schedule and partly due to prolonged holding periods caused by germinating too many seedlings at one time or by not starting the planting as scheduled. As a result of this variation, some seedlings are too small for the container and some are oversized, so that the outplanting results are not optimized.

Considerable variation in the size in planting material also exists within the same season and from centre to centre as is shown in Table 2. Again the potential of the container may not be optimized.

Seedling Specifications

To provide an objective for the grower we are developing height specifications for early plantation performance. Table 3 is our first estimate and at this stage should be considered as an example. It is not based on field performance measurements. Modifications will be made as the effects of site, site preparation, tending and weather become evident.

From the plantation growth indicated at Year 3, it is possible to work back to determine the specifications for the plantable container seedling.

A preliminary estimate for a jack pine container seedling ready for shipment to the planting area would be as in Table 4.

Table 1.--Size of container seedlings produced at Swastika over several seasons

Batch	Date Sampled	Age	O.D.Wt. mg	Height cm	Diameter mm
69-1	Aug. 1/69	Current	190	-	-
69-3	July 15/70	Overwintered	330	12.9	1.4
70-1	July 15/70	Current	90	7.9	0.8
70-2	July 7/71	Overwintered	340	10.2	1.3
72-1	July 31/73	Overwintered	600	13.1	2.0
73-1	Aug. 2/73	Current	440	12.7	1.7

Table 2.--O.D. Weights of container seedlings produced at several locations in 1973

Jack Pine(13 weeks approx)		Black Spruce(22 weeks)	
Thessalon	176 mg	Cochrane	49 mg
Cochrane	215 mg	Thessalon	150 mg
Fort Frances	320 mg	Fort Frances	228 mg
Thunder Bay	462 mg		

Table 3.--Performance specifications(Height) for planted container seedlings

	Year 1		End of	End of
	Summer Planted	End of Season	Year 2	Year 3
Jack Pine	4 in (10 cm)	6 in (15 cm)	14 in(36 cm)	30 in(76 cm)
White Spruce	6 in (15 cm)	7 in (18 cm)	12 in(30 cm)	20 in(51 cm)
Black Spruce	7 in (18 cm)	8 in (20 cm)	14 in(36 cm)	25 in(64 cm)

Table 4.--Specifications for a container seedling ready for planting

Jack Pine	O.D.Weight	Height	Diameter
Sown in April (planted as ½+0 in mid-July)	350 mg	10 cm	1.0 mm
Sown in July (Overwintered for early June planting as 1+0)	350 mg	10 cm	1.0 mm

These specifications will be reviewed as additional data becomes available but this illustrates the principle we are attempting to achieve.

Growth Progression

How does a grower know if his seedlings will meet the required specifications at the date set for planting? How do we reduce the extreme variation in the size of seedlings being produced? Our approach has been to prepare a growth progression curve which shows physical parameters (weight, height etc.) plotted against time. This is illustrated for jack pine dry weight in Figure 2 and is similar to that proposed by Sadreika (1973).

In planning production, a grower can use this type of graph. The month of germination is the most important controllable growth variable since most growers are not equipped to modify day length. When the planting date has been determined, the grower can calculate seeding date from the graphs. This ensures in a general way that the seedlings will be neither too large nor too small for the size of container being used.

Once the seedlings are growing, the greenhouse operator can sample his seedlings, plot the actual parameters on the theoretical curve and determine whether his growth is progressing satisfactorily. If a seedling is small at an early stage of growth then it will be small at ship time, and an early small difference will be greatly magnified at the final stage. Early recognition of these differences when relative growth rates are highest is essential if the grower is to compensate by modifying his greenhouse and tending schedule. In this way, the variation in the size of different crops can be reduced.

These growth progression curves give the grower a tool that he can use on-site to assess growth. The system has been available for two seasons and to date two growers have adopted it and

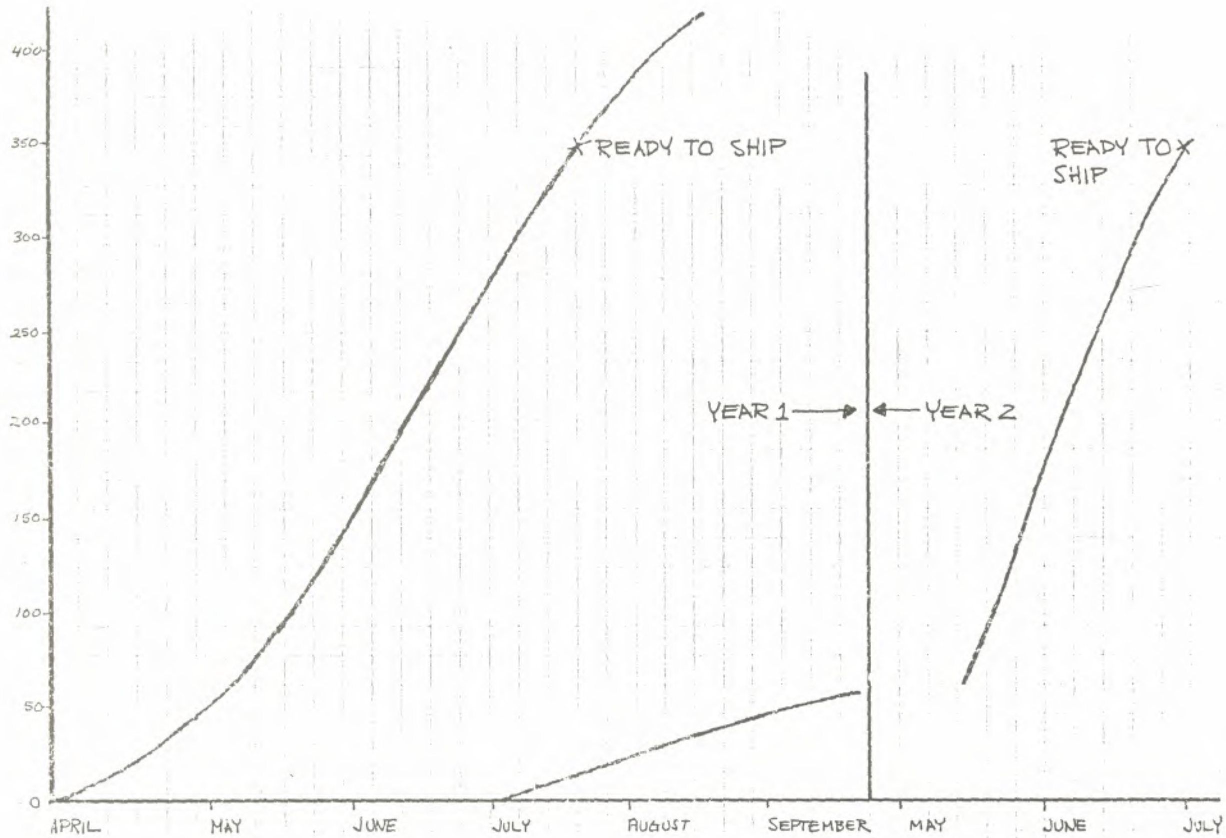

Figure 2.--Growth Progression Curve for Jack Pine showing O.D.Weight (mg) for two different germination dates

these are the larger growers. Considerable testing is required yet before a grower will know how much to compensate for a given response.

Annual Sampling and Fertilization

The first season for a complete sampling of plants and soils was in 1973. Samples of seedlings are taken at the time of shipping and if being overwintered, also at the end of the first growing season. This plant analysis has established the basis for the plant weights that constitute our preliminary seedling specifications. Soils were sampled prior to seeding and again when the seedlings are sampled. This before and after soil analysis monitors the level of the more stable elements, trying to maintain reasonable levels. On the basis of the first year's complete sampling, we have established working levels for the total concentration of five elemental nutrients in our peat medium as follow:

N	P	K	Ca	Mg
1.00%	0.05%	0.06%	1.50%	0.35%

These are the levels that have produced the better seedlings. In all cases it represents at least the same concentration or an increase over the levels of the raw peat. At this stage of monitoring nutrients we have assumed that the working levels will be those levels achieved by the better growers.

Using the soil analysis, we calculate the fertilizer requirements as follows. For phosphorous, potassium and magnesium, we deduct the concentration in the new peat from our target level and add the difference in fertilizers during the growing. For nitrogen we ignore any existing level and add the total amount. Calcium is a problem as yet, probably because it is difficult to apply, and what is reported to have been added, has not really gone on. For now we treat it as nitrogen. The total elemental requirements are calculated (representative amounts are shown in Table 5) and developed into a recommendation using commercially available formulations such as 28-14-14 or 20-20-20, supplemented if necessary with ammonium nitrate, agricultural lime and magnesium sulphate.

This total fertilizer requirement added at regular intervals over the length of the growing period. One program, made for a 16 week rotation is illustrated in Table 6 (Sadreika, 1974). the resulting fertilizer rates approximate other formulas we have checked.

With samples of soils and plants being analysed at the end of the season and prior to planting we can determine the resulting levels of elements in the soils and tissues and the resulting plant quality. The grower can then assess the effectiveness of his growing schedule.

Table 6.--A fertilizer recommendation for container seedlings showing fertilizers per application (gm/100 sq.ft.) assuming 16 weekly applications

Fertilizer	Jack Pine	Black Spruce
20-20-20	100	170
Ammonium Nitrate	30	40
Agricultural Lime	25	40
Magnesium Sulphate	15	20

LITERATURE CITED

Cary, J. R.
1973, Summer water behaviour and seedbed survival. Tubes or Plugs? Lakehead University, Thunder Bay, Report pp 9, mimeo.

Ontario Ministry of Natural Resources, Project 258 - Analysis of Nursery Production and Distribution Systems, Phase II, 1973.

Table 5.--Examples of 1974 fertilizer recommendations for container seedlings showing the total elemental nutrients required for crop rotation (gm/100 sq.ft.)

Nutrients	Jack Pine				Black Spruce			
	Fort Frances	Hearst	Swastika	White River	Fort Frances	Hearst	Swastika	White River
N	340	320	320	320	440	440	440	440
P	80	100	95	60	85	110	125	77
K	120	75	190	160	275	220	370	325
Ca	-	-	170	170	-	-	240	240
Mg	-	10	16	25	-	30	40	60

Ontario Dept. Lands & Forests, Revised 1968, Provisional Instructions for Growing and Planting Seedlings in Tubes, pp 73, mimeo.

Sadreika, V.
1973, Container plant and peat analysis, Internal memo, Ontario Ministry of Natural Resources.

Sadreika V.
1974, Container stock fertilization, Internal memo, Ontario Ministry of Natural Resources, pp 14.

Question: Why should the plant be in the container for summer planting? Why not remove it from the container before planting?

Reese: Day and Cary 1/ report that a container around the seedling will create a water sink. Water will gravitate down to where initial root development occurs. This form of water conservation may be advantageous in the summer because of the probability of drought.

1/Day, R. J., and J. R. Cary.
1974. Differences in post-planting soil moisture relations of container grown tube and plug stock affect the field survival and growth of black spruce. p. 388-392, In North Am. Containerized For. Tree Seedling Symp. Proc. Great Plains Agric. Counc. Publ. 68.

Question: Why are different techniques used for jack pine and black spruce?

Reese: Jack pine grows rapidly, but the spruce is much slower. A good grower can produce 350 mg (dry weight) jack pine in 16 weeks, so you can seed and outplant in the same season. However, spruce is generally overwintered.

Question: Does a 350 mg (dry weight) jack pine planted in July maintain height growth to the end of the season? If so, what height does it reach?

Reese: No, there is generally little height growth after planting, perhaps 1/2 to 1 inch. Most of the development is in root and diameter growth.