COMPARATIVE FIELD PERFORMANCE OF PAPERPOT AND BARE-ROOT PLANTING STOCK IN NORTHEASTERN ONTARIO

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Abstract.--Between 1974 and 1980 numerous experimental plantings were established in northeastern Ontario to compare the biological performance of black spruce *(Picea mariana* [Mill.] B.S.P.), white spruce *(Picea glauca* [Moench] Voss), and jack pine *(Pinus banksiana* Lamb.) paperpot and bare-root planting stock. Morphological specifications of the various stock types at planting, and seedling survival and height growth after one to five growing seasons, are presented and compared.

Résumé.--Entre 1974 et 1980, on a établi un grand nombre de plantations expérimentales dans le nord-est de l'Ontario afin de comparer les caractéristiques biologiques de plants d'épinette noire *(Picea mariana* [Mill.] B.S.P.), d'épinette blanche *(Picea glauca* [Moench] Voss) et de pin gris *(Pinus banksiana* Lamb.) en pots de carton et à racines nues. On présente et on compare les caractéristiques morphologiques des divers matériels au moment de leur plantation ainsi que le taux de survie et la croissance en hauteur des jeunes pousses après une à cinq saisons de croissance.

INTRODUCTION

Ever since 1966 when Ontario initiated an operational containerized tree planting program, which featured the use of small temporary greenhouses and styrene tubelings, there has been debate over the role of containerized trees in the provincial planting program. Resolution of this debate requires reliable information on the comparative biological performance of containerized and bare-root planting stock. Relevant studies were initiated in 1973, and this report summarizes the results obtained to date.

OBJECTIVES

The objective of the series of experiments reported here was to compare the biological performance of containerized and bare-root trees on a variety of important site types in northeastern Ontario.

Containerized trees were reared in Japanese paperpots, because it was believed that deterioration of the paperpots would enable tree roots to penetrate the container wall, minimizing distortions in root form and facilitating root egress into the soil. The fact that the paperpot remained around the root mass and its growing medium during shipping and outplanting was also regarded as a significant advantage. A third major reason for the selection of the paperpot was the existence of commercial equipment to assemble, load, and sow the paperpots.

Initially, only black spruce *(Picea mariana* [Mill.] B.S.P.) and white spruce *(Picea glauca* [Moench] Voss) were included in the study, but by 1976 interest in the performance of jack pine *(Pinus banksiana* Lamb.) led to the inclusion of this species also. While only medium grade bare-root

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stock was compared with containerized stock in the early experiments, the provincial trend toward increased use of heavy grade bare-root stock led to the incorporation of this additional stock grade into the study from 1978 onwards.

METHODS

Experimental Design and Layout

Changes in emphasis of the overall study and the desire to include variations in site type and condition necessitated some changes in experimental design over the period reported. However, all experiments involved a factorial design with species, stock type and grade, and planting date as the factors. The number of levels of each factor varied (species 1 to 3, stock type and grade 2 to 4, and planting date 1 to 2) from site to site.

Variation in site type, even within small sample areas (e.g., 0.25 ha), led to a number of modifications in design to minimize potential site bias. On the largest scale, variations in site were accommodated by establishing separate experimental plots. On a smaller scale site variation was accommodated by establishing partially randomized blocks of treatments. At the smallest scale, plots were stratified by replicate to distribute treatments within the sample area. Sampling intensity also varied between experiments (e.g., number of trees per replicate and number of replicates per treatment).

All plots were established by first locating a baseline along a slope within the prospective sample area. Treatment rows, at 2 m spacing, were oriented at right angles to this baseline. Use of a baseline consisting of a series of straight-line segments allowed an experiment to be fitted into an irregularly shaped site. The location of each tree in a treatment row was marked with a looped wire pin to which flagging tape was attached. Every fifth seedling was numbered with a metal tag.

Data Collection

For each sample tree, survival, morphological condition and form were observed, and total height and current height increment were measured. Only survival and total height data are reported here. Trees were classified as alive so long as the slightest evidence of life was detected. Total height was the above-ground length of the main stem extending to the base of the terminal bud.

To characterize the planting stock used in each experiment, samples of 25 or 50 sorted seedlings were taken at the end of planting for each species, stock type and grade, planting date, and planting location. Each sample was measured for shoot height, root-collar diameter, total dry weight, shoot:root ratio and root area index. Sorting was undertaken to remove any diseased, badly deformed or damaged seedlings. Samples taken during the 1978-1980 period, when both medium and heavy grade seedlings were included in experiments, are summarized in Tables 1-3.

Data Analysis

Since the intention of this report is to provide a general summary of results obtained to date, it combines experiments varying in both design and sampling intensity; consequently, no statistical analysis of results is presented. The data in this report summarize the treatment means only for all the experiments undertaken during the period 1974 to 1980.

The size of the data base varies because the number of assessments received by an experiment varies, depending on its date of planting, and because in 1976 only spring planting was undertaken, so that the data available on summer planting were reduced. The standard error of means quoted in the tables provides a measure of variation in results between experiments at a particular assessment date.

RESULTS

Planting Stock Characteristics

Tables 1 to 3 summarize planting stock characteristics for black spruce, white spruce, and jack pine, respectively.

In black spruce, heavy grade bare-root trees (1-2) were consistently shorter with a lower shoot:root ratio and a larger root area index than their medium grade (3-0) counterparts. Bare-root trees for spring and summer planting, though nominally of equivalent grade, differed substantially in dry weight, root collar diameter and root area. Paperpot seedlings differed substantially in all parameters from the two grades of bare-root trees, the differences being more pronounced for the spring plant.

Table 1. Black spruce planting stock characteristics (1978-1980).

		Spring planting (5 May - 15 June)			Summer planting (15 June - 30 July)		
		Paperpot[a]	Bare-root[b]		Paperpot	Bare-root[c]	
		Medium	Medium (3-0)	Heavy (1-2)	Medium	Medium (3-0)	Heavy (1-2)
Dry weight (g)	Mean	0.84	4.72	6.84	0.60	2.48	3.54
	SEM[d]	0.15	0.58	1.32	0.07	0.09	1.28
Shoot:root ratio	Mean	2.2	6.1	3.0	4.4	5.1	4.3
	SEM	0.2	2.5	0.6	1.5	0.7	1.1
Root area index (cm^2)	Mean	8.0	25.7	59.0	7.0	9.0	20.7
	SEM	1.0	5.5	12.4	2.1	--	5.2
Shoot length (cm)	Mean	9.7	30.0	25.2	14.7	28.8	25.5
	SEM	0.5	2.1	3.4	1.0	4.7	4.5
Root-collar diameter (mm)	Mean	1.8	4.1	4.8	1.5	3.2	3.5
	SEM	0.1	0.2	0.2	0.2	0.3	0.4

[a]Containerized stock reared in both the FH 308 and FH 408 paperpots is combined.
[b]Spring planted bare-root trees are primarily spring-lifted with a short period of cool storage.
[c]Summer planted bare-root trees are primarily "rising" stock planted directly after lifting.
[d]Standard error of mean.

Table 2. White spruce planting stock characteristics (1978-1980).

		Spring planting (5 May - 15 June)				Summer planting (15 June - 30 July)			
		Paperpot[a]	Bare-root[b]			Paperpot	Bare-root[c]		
		Medium	Light (3-0)	Medium (2-1)	Heavy (2-2)	Medium	Light (3-0)	Medium (2-1)	Heavy (2-2)
Dry weight (g)	Mean	0.65	6.08	7.93	10.72	0.54	1.98	2.08	4.61
	SEM[d]	0.09	0.16	0.56	0.50	0.06	0.03	0.29	0.08
Shoot:root ratio	Mean	2.5	4.6	3.2	3.0	2.3	5.8	4.8	4.7
	SEM	0.2	0.1	0.4	0.2	0.5	0.1	0.7	0.2
Root area index (cm^2)	Mean	5.0	23.5	47.3	57.0	4.3	10.5	19.0	25.5
	SEM	1.5	4.3	1.8	2.9	1.2	0.3	3.5	1.4
Shoot length (cm)	Mean	6.8	34.0	25.8	29.3	9.2	21.7	20.3	24.7
	SEM	1.2	4.8	1.0	0.8	1.2	0.2	1.1	0.3
Root-collar diameter (mm)	Mean	1.4	4.4	5.2	6.1	1.5	3.2	3.6	4.3
	SEM	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1

[a]Containerized stock reared in both the FH 308 and FH 408 paperpots is combined.
[b]Spring planted bare-root trees are primarily spring-lifted with a short period of cool storage.
[c]Summer planted bare-root trees are primarily "rising" stock planted directly after lifting.
[d]Standard error of mean.

Table 3. Jack pine planting stock characteristics (1978-1980).

		Spring planting (5 May - 15 June)		Summer planting (15 June - 30 July)	
		Paperpot[a]	Bare-root[b]	Paperpot	Bare-root[c]
		Medium	Heavy (2-0)	Medium	Heavy (2-0)
Dry weight (g)	Mean	1.06	4.14	0.96	1.74
	SEM[d]	0.08	0.09	0.33	0.29
Shoot:root ratio	Mean	2.4	4.8	2.6	3.8
	SEM	1.0	0.8	0.4	1.5
Root area index (cm^2)	Mean	13.0	32.3	10.3	15.9
	SEM	1.5	2.3	3.3	2.1
Shoot length (cm)	Mean	1.6	2.0	1.5	2.1
	SEM	0.4	0.2	0.3	0.1
Root-collar diameter (mm)	Mean	2.1	4.7	2.0	2.9
	SEM	0.2	0.1	0.4	0.2

[a]Containerized stock reared in FH 408 paperpots only.
[b]Spring planted bare-root trees are primarily spring-lifted with a short period of cool storage.
[c]Summer planted bare-root trees are primarily "rising" stock planted directly after lifting.
[d]Standard error of mean.

Similar differences between stock types existed with white spruce. An exception was the heavy grade (2-2) bare-root stock, which was taller than either of the two lighter grades (3-0 and 2-1) while maintaining its lower shoot:root ratio and larger root area index. There was also a much larger differential in dry weight between the paperpot and bare-root trees in white spruce.

Smaller differences existed between jack pine paperpot and bare-root stock than in either of the spruces. The paperpot seedlings were much better balanced than the bare-root trees in terms of shoot:root ratio.

Planting Stock Performance

Tables 4 to 9 present an overview of planting stock performance to date. Data are drawn from samples established in every year except 1977, when poor quality planting stock yielded anomalous results.

Note that the "n" value given in the tables indicates the number of experiments which were of sufficient age to be included in a particular assessment. By multiplying this "n" value by 150 (the number of trees per treatment in each experiment), it is possible to determine the approximate number of trees on which the figures for a particular row in the tables are based. For a given time of planting (e.g., spring) and assessment (e.g., first), all the stock comparisons are drawn from the same experiments. The same number of trees were assessed.

With spring planting, black spruce paperpot stock attained higher survival rates than medium grade (3-0) bare-root, but lower survival rates than heavy grade (1-2) bare-root stock (Table 4). The difference is considerably greater in the former instance. However, with summer planting, black spruce paperpot seedlings attained lower survival rates than the medium grade bare-root but higher rates than the heavy grade stock type. This incongruity will be discussed later.

Only in one experiment involving summer-planted paperpot seedlings and heavy grade (1-2) bare-root trees has black spruce paperpot stock attained a greater total height by the time of the third assessment (Table 5). The difference in total height between stock types decreased generally for the first three years but subsequently increased.

With spring planted white spruce, all three grades of bare-root trees had a survival rate superior to that of the paperpot stock (Table 6). However, the difference was generally less than 5% in the test plantings conducted to date. With summer planting, the light (3-0) and heavy grades (2-2) of bare-root trees attained higher survival rates than paperpot seedlings, whereas the opposite was true for comparisons involving medium

Table 4. Percent survival of black spruce stock types (1974-1980).

Year assessed	n[a]		Spring planting (10 May - 15 June) Paperpot Medium	Spring planting (10 May - 15 June) Bare-root Medium (3-0)	n	Summer planting (15 June - 30 July) Paperpot Medium	Summer planting (15 June - 30 July) Bare-root Medium (3-0)
First	6	Mean	85.4	75.9	6	78.7	82.7
		SEM[b]	4.3	5.0		7.2	5.0
Second	6	Mean	71.5	65.0	6	71.1	72.2
		SEM	5.5	5.5		8.8	4.4
Third	5	Mean	78.0	63.4	5	65.4	69.6
		SEM	4.8	6.4		8.9	4.7
Final[c]	4	Mean	68.0	57.5	4	48.2	62.3
		SEM	5.1	6.4		4.6	2.6
	n		Paperpot Medium	Bare-root Heavy (1-2)	n	Paperpot Medium	Bare-root Heavy (1-2)
First	12	Mean	87.9	93.4	4	99.2	88.4
		SEM	2.1	1.5		0.4	4.9
Second	9	Mean	83.6	88.8	3	97.1	83.5
		SEM	2.8	2.8		0.7	6.5
Third	7	Mean	80.2	88.0	1	98.5	69.5
		SEM	2.7	2.8		-	-
Final	6	Mean	77.5	84.6			
		SEM	2.8	2.5			

[a]Number of experiments
[b]Standard error of mean
[c]Final assessment was normally made at the end of the fifth year after outplanting.

grade (2-1) bare-root stock. Only in comparisons involving paperpots and light grade bare-root stock was the disparity large enough to be important: it ranged from 11 to 16% in the different years of assessment.

In no instance had any of the white spruce paperpot plantings outgrown, in height, any of the bare-root grades by the final assessment (Table 7). Although the height difference between paperpot and bare-root stock did diminish during the first three years after planting, for both spring and summer plantings, the gap remained wider than in black spruce, and actually increased by the final assessment (as in black spruce).

Jack pine has been planted over a much shorter period (1976-1980) than the spruces. The most dramatic result for jack pine was the dismal performance of summer-planted bare-root stock. The survival rate at the end of the first growing season, only 3 months after outplanting, was only 24.8% (Table 8). This contrasts with the very acceptable survival rates attained by summer-planted paperpot seedlings, which exceeded 97% after three growing seasons. Spring-planted paperpot seedlings attained a survival rate only slightly higher than that attained by bare-root trees.

Height growth of jack pine differed in two respects from that of white spruce and black spruce. With spring plantings, the larger bare-root trees increased their height advantage continuously from time of planting (Table 9). With summer plantings the paperpot trees, which exhibited a dramatically higher survival, also outgrew the rising 2-0 bare-root trees by a wide margin. Jack pine did not exhibit the same trends of decreasing height differential between stock grades, followed by an increase, that were found in the spruces.

Table 5. Total height of black spruce stock types (1974-1980).

Year assessed	n[a]		Spring planting (10 May - 15 June) Paperpot Medium (cm)	Spring planting (10 May - 15 June) Bare-root Medium (3-0) (cm)	n	Summer planting (15 June - 30 July) Paperpot Medium (cm)	Summer planting (15 June - 30 July) Bare-root Medium (3-0) (cm)
First	6	Mean	11.9	26.7	6	11.1	20.8
		SEM[b]	1.1	0.9		1.5	1.9
Second	6	Mean	21.4	32.3	6	20.6	24.0
		SEM	1.3	2.0		1.8	1.7
Third	5	Mean	31.6	41.1	5	29.3	31.2
		SEM	2.1	4.3		2.8	2.4
Final	4	Mean	70.1	86.4	4	56.9	71.7
		SEM	7.5	17.9		7.0	1.2
	n		Paperpot Medium (cm)	Bare-root Heavy (1-2) (cm)	n	Paperpot Medium (cm)	Bare-root Heavy (1-2) (cm)
First	12	Mean	9.0	26.9	4	12.8	21.9
		SEM	0.4	1.2		1.4	3.6
Second	9	Mean	20.0	36.7	3	20.2	21.9
		SEM	1.2	2.2		3.4	1.0
Third	7	Mean	32.2	51.4	1	34.1	32.1
		SEM	1.8	1.3		-	-
Final	6	Mean	54.4	82.8	-		
		SEM	4.7	3.7			

[a]Number of experiments
[b]Standard error of mean

DISCUSSION

In Ontario containerized regeneration is viewed primarily as a supplement to bare-root planting. The hope was that containerization would enable the planting season to be extended into the summer months, thereby permitting an increase in the provincial planting program without necessitating an increase in spring planting.

By examining the comparative performance of spring and early summer plantings, it is possible to speculate whether bare-root or containerized planting stock are viable alternatives for either season. However, difficulties arise when two such inherently different regeneration systems are compared, particularly with regard to differences in rearing techniques, age and size of tree, and storage practices.

In this study, the paperpot seedlings used for spring planting were held through the winter under a natural snow cover. Summer-planted containers were not overwintered, and were outplanted directly after removal from the greenhouse, with a short period of conditioning in a shadehouse. Most spring-planted bare-root stock was fresh-lifted, with cool storage employed only where this was necessary to accommodate work schedules. Summer-planted bare-root trees were planted directly after lifting from the nursery as "rising" stock.

Differences in tree age also pose a problem when one is comparing performance. Is it more appropriate to compare performance in relation to tree age or to time since planting? By the former method containerized trees would need to grow for 1 to 3 years (depending on age of the bare-root trees) under forest conditions before they are comparable with bare-root trees at time of

Table 6. Percent survival of white spruce stock types (1974-1980).

Year assessed		Spring planting (10 May - 15 June) n[a]	Paperpot Medium	Bare-root Medium (3-0)	Summer planting (15 June - 30 July) n	Paperpot Medium	Bare-root Medium (3-0)
First	Mean	9	80.0	84.0	5	74.9	91.4
	SEM[b]		4.6	2.5		10.6	3.2
Second	Mean	9	73.5	74.3	5	64.8	76.2
	SEM		5.1	3.5		11.9	4.6
Third	Mean	8	69.0	73.5	4	54.6	77.2
	SEM		4.8	3.7		11.7	3.6
Final	Mean	8	64.7	69.6	4	45.1	69.0
	SEM		4.3	4.0		6.7	4.4
		n	Paperpot Medium	Bare-root Medium (2-1)	n	Paperpot Medium	Bare-root Medium (2-1)
First	Mean	5	94.9	98.7	3	98.8	96.9
	SEM		1.5	0.7		0.4	1.3
Second	Mean	2	89.7	92.4	2	96.2	91.3
	SEM		0.4	5.6		1.8	2.0
		n	Paperpot Medium	Bare-root Heavy (2-2)	n	Paperpot Medium	Bare-root Heavy (2-2)
First	Mean	1	96.0	96.7	1	98.0	99.0
	SEM	-	-	-		-	-
Second	Mean	1	89.3	93.3	1	94.5	96.0
	SEM	-	-	4.0		-	-

[a]Number of experiments
[b]Standard error of mean

planting. Such a basis for comparison would be to the advantage of containerized trees in terms of height hut to their disadvantage in terms of survival. In this series of experiments it was decided that early height performance in relation to height of competing vegetation was most crucial and that comparability ought to be sought in terms of total height by the end of a regeneration period of 5 years.

Large differences in initial tree size create another problem. In such a situation which is the better measure of performance: height increment in relation to initial height or absolute height increment? In fact, it is necessary to know both absolute height and rate of height increment in order to compare growth.

Scheduling of the summer plant created different problems for each stock type. The need to avoid or minimize any time gap between the spring and summer plantings, which, in operational practice, involves laying off and trying to rehire large planting crews after the work interruption, demanded that the later planting be initiated as soon as possible after the traditional spring plant was finished. For paperpot trees this reduced the time available for conditioning in the shadehouse and increased the vulnerability of succulent trees to harsh summer conditions. For bare-root trees, especially transplants, the greater concern was that root development would not have progressed sufficiently and that actively growing, top-heavy trees would have difficulty coping with more severe summer conditions.

Perhaps the most important result obtained to date is the generally satisfactory performance of summer planting regardless of stock type. Prior to these plantings, conventional wisdom asserted that failures would occur during most years and that only cool, wet summers would produce success. Except for summer planting of jack pine bare-root

Table 7. Total height of white spruce stock types (1974-1980).

Year assessed		Spring planting (10 May - 15 June) n[a]	Paperpot Medium (cm)	Bare-root Light (3-0) (cm)	Summer planting (15 June - 30 July) n	Paperpot Medium (cm)	Bare-root Light (3-0) (cm)
First	Mean	9	6.8	24.6	5	5.3	17.6
	SEM[b]		0.5	0.8		0.7	0.8
Second	Mean	9	13.2	29.7	5	11.4	20.3
	SEM		0.5	1.0		1.4	0.6
Third	Mean	8	20.2	34.9	4	18.6	26.8
	SEM		1.0	1.2		2.4	0.9
Final	Mean	8	33.7	49.5	4	34.9	47.2
	SEM		3.4	4.1		3.0	3.9
		n	Paperpot Medium	Bare-root Medium (2-1)	n	Paperpot Medium	Bare-root Medium (2-1)
First	Mean	5	5.8	26.9	3	6.8	14.2
	SEM		0.5	0.8		0.5	0.5
Second	Mean	2	8.7	27.5	2	9.4	16.3
	SEM		1.7	2.0		0.4	0.5
		n	Paperpot Medium	Bare-root Heavy (2-2)	n	Paperpot Medium	Bare-root Heavy (2-2)
First	Mean	1	7.0	31.8	1	6.2	21.9
	SEM		-	-		-	-
Second	Mean	1	10.4	32.8	1	9.8	23.5
	SEM		-	-		-	-

[a]Number of experiments
[b]Standard error of mean

stock, this does not appear to have been the case. The somewhat poorer performance with summer planted than with spring planted stock can be partially explained by the use of smaller grade seedlings and the short growth period following planting.

Tables 4, 6 and 8 reveal the relentless progression of mortality over the regeneration period regardless of stock type, with most mortality occurring during the first three years. The data also suggest that poor survival (<90%) at the end of the first season may provide a reliable indication of eventual plantation failure, given the present level of plantation tending.

The results in Tables 5, 7 and 9 indicate that, in nearly all cases, total tree height at the end of the first growing season is less than initial height as reflected by shoot lengths in Tables 1 to 3. Although differences are partially due to sample variability, the primary cause is probably deep planting. This tendency is more pronounced with bare-root trees since piece-rate planters, penalized for loose planting, tend to plant bare-root trees deeply to increase firmness.

These same tables reveal some interesting comparisons between the various species and stock types in terms of relative and absolute height growth. In all cases, relative height growth peaks during the assessment period, generally between the second and third growing seasons. Paperpot trees peak at a higher level than bare-root trees and maintain that superiority to the end of the assessment period. If the smaller paperpot trees are to overtake their bare-root counterparts they must do it during this period of peak relative height growth. Such is the case where paperpot trees have

Table 8. Percent survival of jack pine stock types (1976-1980).

Year assessed		n[a]	Spring planting (10 May - 15 June) Paperpot Medium	Spring planting (10 May - 15 June) Bare-root Heavy (2-0)	n	Summer planting (15 June - 30 July) Paperpot Medium	Summer planting (15 June - 30 July) Bare-root Heavy (2-0)
First	Mean	8	95.8	94.1	2	98.0	24.8
	SEM[b]		1.8	2.5		1.2	11.0
Second	Mean	6	91.5	89.6	2	96.5	20.3
	SEM		2.8	3.2		0.5	10.5
Third	Mean	5	91.4	89.3	1	97.8	10.8
	SEM		3.0	3.0		-	-
Final	Mean	4	88.4	86.0			
	SEM		3.2	3.0			

[a]No. of experiments
[b]Standard error of mean

Table 9. Total height of jack pine stock types (1976-1980).

Year assessed		n[a]	Spring planting (10 May - 15 June) Paperpot Medium (cm)	Spring planting (10 May - 15 June) Bare-root Heavy (2-0) (cm)	n	Summer planting (15 June - 30 July) Paperpot Medium (cm)	Summer planting (15 June - 30 July) Bare-root Heavy (2-0) (cm)
First	Mean	8	13.3	25.2	2	14.8	11.1
	SEM[b]		1.0	0.8		2.6	0.1
Second	Mean	6	31.8	52.8	2	29.2	18.4
	SEM		2.1	2.2		1.2	4.4
Third	Mean	5	54.9	83.7	1	50.3	23.8
	SEM		3.7	4.8		-	-
Final	Mean	4	123.4	164.5			
	SEM		6.2	10.4			

[a]Number of experiments
[b]Standard error of mean

achieved superiority in comparisons involving heavy-grade (1-2), summer-planted black spruce (Table 5) and summer-planted jack pine (Table 9). In jack pine, which is not as strongly affected by planting stress as the spruces, smaller paperpot trees should overtake bare-root stock within the first year if they are to gain superiority. After the peak in relative height growth is passed, the larger trees are able to take advantage of their superior size and, regardless of stock type, increase their height advantage.

CONCLUSIONS

A number of tentative conclusions may be drawn from the comparative plantings undertaken to date. If we recollect that in the early 1970s containerized regeneration was not generally considered suitable for northern Ontario, the most noteworthy conclusion must be that containerized seedlings can yield acceptable results for both spring and summer planting of the three most important boreal conifer species.