

TESTS OF FROZEN SPRING STORAGE FOR WHITE SPRUCE AND RED PINE PLANTING STOCK

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Much of the investigation on frozen storage of conifer nursery shipping stock has been done for over-winter storage (3,6) but few studies have examined the possibilities of frozen storage for spring-lifted nursery stock. One test at the Swastika Nursery in Northern Ontario gave satisfactory results for 2+0 jack pine (*Pinus banksiana* Lamb.), 3+0 white spruce (*Picea glauca* (Moench) Voss), and 3+0 black spruce (*Picea mariana* (Mill) BSP) (4). This report is based on the fifth-year results of spring frozen storage with 3+0 white spruce and red pine (*P. resinosa* Ait.) at the Midhurst Nursery in Southern Ontario.

Materials and Methods

In the spring of 1972, a series of liftings and plantings, with and without frozen storage, were carried out at Midhurst Nursery and Midhurst Research Centre, on the schedules outlined in table 1. At each lifting for storage (L1 to L4) trees were placed in storage at -3° C in kraft-polyethylene bags and held until the scheduled planting date. Thus trees lifted on April 25 were held for all five plantings but later-lifted trees for proportionally shorter periods. At each time of planting, fresh unstored trees that had been lifted on the previous day were planted in the randomized blocks with the stored trees.

Both species stored successfully when lifted early; the safe lifting period is shorter for white spruce than for red pine.

At each lifting, weather and soil conditions were monitored and samples (100 trees) were taken for the laboratory measurements (table 2). The results of the experiment were examined in terms of the fifth-year survival, total height and terminal growth (1976 leaders). The plantings with five replications were in blocks by species and dates, hence analyses for the comparisons of stored and fresh trees were obtained only within these blocks. The analyses of variance of survival (angular transformation of percentages), height and terminal growth (approximate method for unequal plot sizes) have been summarized (table 3).

Results and Discussion

The data in table 2 show the changes in the stock from the almost-dormant 3+0 at the beginning, to a state where a large part of the height growth of the fourth year is included. It is obvious that growth took place in height, but with little increase in diameter or weight even into mid-July. The stock of both species was in the "very large" class of Armson and Carman (1) although toward the upper limit or just beyond the top-root ratio recommended by the same authors. However, the results of the testing should apply to regular planting stock.

Table 1.—Dates of lifting and planting, white spruce and red pine, 1972¹

Liftings	Plantings				
	1 May 16	2 May 30	3 June 13	4 June 27	5 July 11
L1—April 25	X	X	X	X	X
L2—May 9	X	X	X	X	X
C1—May 15	X				
L3—May 23		X	X	X	X
C2—May 29		X			
L4—June 6			X	X	X
C3—June 12			X		
C4—June 26				X	
C5—July 10					X

¹ Plots consisted of 50 trees in all plantings, in 5 replications, to compare stored stock and fresh stock.

L1 = lifting 1, etc. C1 = controls for plant 1, etc.

Time of Lifting

The stored white spruce stock was consistently successful only for the first lifting. However, for the red pine, the first three liftings provided stock which survived and grew adequately following storage (table 3).

A survey was made of soil temperatures for spring lifting similar to attempts to characterize the time of fall lifting by soil temperature (D-H-D, degree-hardening-days: cumulative daily

minimum below 10° C or 50° F) (5). Using a base of 0° C and accumulating daily maximum soil temperatures at 15 cm depth (to nearest 0.5° C) it was estimated that the cutoff for storage of white spruce was about 50 degree-days, and that of red pine was about 300.

Extended Planting Season

The effects of the use of stored stock or fresh stock for extended planting can be interpreted from

table 3 that shows survival and growth for planting during and beyond the normal planting season (about April 15-May 30 in this area). This relationship is also shown in figure 1, in curves which represent averages of aggregate height (survival percentages by average tree height) for stored and unstored (controls) trees.

In the white spruce the stored stock was equal to fresh stock at the beginning but much better for later plantings. It is assumed that fresh stock was affected to a greater degree by weather and other conditions, both at time of lifting and at time of planting.

However, the results suggest that stored spruce can be safely used to extend the planting season within reason. This confirms the results from an earlier study (5).

On the other hand, both stored and unstored red pine trees gave rapidly decreasing aggregate heights with passage of time (fig. 1). This indicates that the optimum planting period for this species, even with storage, is comparatively brief. As indicated (fig. 1), storage might improve the results for only a matter of a week or two. Thus, very little extension of the normal planting season can be expected for red pine. Similar results have been found in white pine (2).

Table 2.—Stock measurements by dates of lifting; 3+0 white spruce and red pine, Midhurst 1972¹

Date	Top length 1971	Terminal length 1972	Stem diameter	Oven-dry weight	Top-root ratio
	————— (cm) —————			(g)	(in ODW)
WHITE SPRUCE					
L1—Apr. 25	20.6	0.5	0.43	4.72	3.30
L2—May 9	22.6	0.8	0.48	6.13	4.12
C1 for P1—May 15	21.6	0.8	0.50	6.03	3.41
L3—May 23	23.6	1.7	0.49	6.37	3.60
C2 for P2—May 29	20.0	2.5	0.43	4.30	3.63
L4—June 6	21.4	4.5	0.44	5.21	5.83
C3 for P3—June 12	22.6	6.5	0.43	5.27	4.95
C4 for P4—June 26	21.0	9.6	0.45	5.68	5.66
C5 for P5—July 10	20.7	10.3	0.48	6.42	4.63
RED PINE					
L1—Apr. 25	18.1	1.8	0.55	9.63	4.73
L2—May 9	20.3	1.9	0.57	10.87	5.46
C1 for P1—May 15	24.7	2.0	0.61	12.26	6.09
L3—May 23	22.6	4.0	0.62	12.20	5.13
C2 for P2—May 29	23.0	4.9	0.62	12.56	5.80
L4—June 6	23.5	8.2	0.66	13.87	5.77
C3 for P3—June 12	22.7	9.4	0.62	11.56	6.09
C4 for P4—June 26	20.4	14.8	0.61	10.79	6.66
C5 for P5—July 10	20.8	16.8	0.64	13.21	6.37

¹ Plots consisted of 50 trees in all plantings, in 5 replications, to compare stored stock and fresh stock.

L1 = lifting 1, etc. C1 = controls for plant 1, etc.

Table 3.—Survival (percentages) average height and average terminal (1976 leaders) for 3+0 white spruce and red pine at five years after planting

	White Spruce			Red Pine		
	Surv.	Ht.	Term.	Surv.	Ht.	Term.
	(percent)	(cm)	(cm)	(percent)	(cm)	(cm)
Plant 1, May 16						
L1—April 25	93.2 b	77.3	22.3	94.0	133.6	50.2 c
L2—May 9	38.4 a	70.4	21.1	88.0	125.9	47.7 b
C—May 15	90.8 b	77.2	22.0	88.8	124.3	46.1 a
	***1	NS	NS	NS	NS	***1
Plant 2, May 30						
L1—April 25	92.8 b	78.2	23.0	85.2	136.6	49.2
L2—May 9	74.4 a	73.5	22.2	83.6	131.6	47.8
L3—May 23	86.4 ab	69.2	20.8	82.8	127.5	46.0
C—May 29	80.4 a	70.3	20.8	80.0	126.2	45.0
	*2	NS	NS	NS	NS	NS
Plant 3, June 13						
L1—April 25	93.6 c	75.8 c	19.6 b	87.6	114.9	42.5
L2—May 9	27.6 a	64.0 ab	18.8 b	77.6	119.0	43.4
L3—May 23	78.4 b	67.9 bc	20.1 b	87.2	128.8	45.1
L4—June 6	67.6 b	57.4 a	16.0 a	76.0	114.4	42.4
C—June 12	81.6 bc	69.3 bc	18.8 b	86.0	120.4	42.6
	***1	*3	*2	NS	NS	NS
Plant 4, June 27						
L1—April 25	92.8 c	73.4 c	21.2 d	66.8 b	102.4	38.1 c
L2—May 9	68.0 b	65.0 b	19.1 cd	71.2 b	101.2	38.6 c
L3—May 23	27.2 a	52.5 a	16.3 a	69.6 b	97.1	36.2 bc
L4—June 6	54.4 b	56.9 a	16.8 ab	3.6 a	63.8	25.0 a
C—June 26	66.8 b	64.2 b	18.5 bc	66.8 b	94.7	33.8 b
	***1	***1	***1	***1	NS	*3
Plant 5, July 11						
L1—April 25	48.4	56.6	13.6	66.8	82.7	20.9
L2—May 9	37.6	48.8	13.4	43.6	83.5	21.8
L3—May 23	42.0	56.2	12.6	59.2	81.2	18.7
L4—June 6	35.2	54.0	12.8	78.4	78.9	20.4
C—July 10	32.4	56.8	13.2	70.0	86.9	22.3
	NS	NS	NS	NS	NS	NS

1 *** = Significant at 0.1% level.

2 * = Significant at 5.0% level.

3 ** = Significant at 1.0% level.

Items in vertical columns not followed by same letter are statistically different at 5.0 percent level or better.

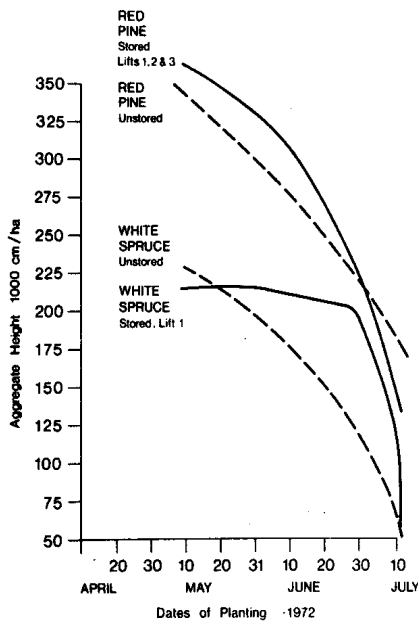


Figure 1: Aggregate height (percentage survival by average height in cm) at 5 years after planting for white spruce and red pine by dates of spring planting.

Literature Cited

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