WATER DIPPING AND FROZEN OVER WINTER STORAGE OF RED AND WHITE PINE

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In 1973 an experiment was started at Midhurst Nursery and Research Unit (100 km north of Toronto) to examine the effects of dipping the roots of bare-root stock in water prior to packaging for frozen overwinter storage. The species tested were red pine (*Pinus resinosa* Ait.) and white pine (*P. strobus* L.); difficulties in later seasonal lifting limited the information from the latter species. The readiness of the stock for storage was expressed in terms of Degree-Hardening-Days (D-H-D: cumulative daily differences of minimum soil temperatures below 10° C at a depth of 15 cm) and two temperatures of frozen storage were compared. (D-H-D may be converted to Fahrenheit on base 50°F by multiplying D-H-D base 10° C by 1.8.)

Previous studies of water dipping have shown some benefit for certain species and conditions (*2, 4, 15*) but no benefit for others (*5, 6, 11*). Water dipping before frozen overwinter storage was found damaging to jack pine *(Pinus banksiana Lamb*.) and of no benefit to white spruce (*Picea glauca* (Moench) Voss) or black spruce (*P. mariana* (Mill.) B.S.P.) (*10, 11*).

Previous work on readiness for storage as indicated by D-H-D has been done for white spruce (D-H-D =110° C), jack pine (D-H-D =210° C), white pine (D-H-D =125° C) and red pine (D-H-D =165° C) (*9*). Subsequent field testing has suggested increasing the D-H-D for white pine from 125 to 165° C (*13*).

Frozen storage for overwinter holding has become common practice of the northern nurseries since the late 1960's, with the temperature usually held just below freezing (-1 or -2° C) to control molds (*14*). One study of storage of white spruce and jack pine at a lower temperature, -18° C, did not succeed in controlling mold (*9*).

Methods and Procedures

In the fall of 1973 a series of randomized plots was laid out in the regular red and white pine seedbeds to provide stock for seven weekly test liftings for overwinter frozen storage. Plots were also reserved to provide stock for fresh-lifted control trees in the following spring. Both species were 3-0 shipping stock-of the local seed region. A thermograph with a probe set at 15 cm depth recorded daily soil temperature, from which calculations were made of Degree-Hardening-Days.

At each date of lifting the trees were loosened by garden forks, pulled by hand, and tied in bundles of 25 trees. Half of the bundles were dipped in water (roots only) and then packed in kraft-polyethylene bags with wet moss. The other half were packed with moss, but without dipping. At each date of lifting, six bags of each treatment of each species were packed; three were placed in storage for the winter at -3° C and the other three at -12° C. Samples of 200 trees were taken at each lifting and from these, 50 trees were selected at the laboratory for measurements to characterize the stock.

For each of the three plantings (red pine-May 7 and 8; June 3, 4, and 5; and July 2 and 3; white pine—May 13, June 10, and July 4) samples were also obtained from the seedbeds for the planting of control plots and characterization of the stock. The schedule of liftings by dates, the appropriate D-H-D, and the characterization of the stock are summarized in table 1. Data for white pine were omitted because of incompleteness. In the first three liftings, the dipping and packaging were done in the field. Some active roots still showed white tips. From the fourth lift on, cold conditions and snow made this difficult; therefore dipping and packing were done in a shed. No fresh root tips were visible during these lifts.

Only the first three liftings (of the seven planned) of white pine were completed because the seedbed area became inaccessible thereafter. Planting was carried out for these three lifts and controls.

The planting was done in separate blocks for each species, using a randomized plot design

Table 1.—*Characteristics of the stock, 3+0 Midhurst red pine, by dates of lifting and Degree-Hardening-Days (D-H-D), from samples of 50 trees*

Lift	Date	Stock readiness	Top length, 1973	Stem diameter	Ovendry weight	Top:root ratio[1]
		D-H-D	*cm*	*cm*	*g*	
1	Oct. 17	2	23.0	0.49	6.68	6.33
2	Oct. 24	20	25.4	0.56	8.57	7.38
3	Oct 31	30	21.0	0.45	5.85	5.75
4	Nov. 8	77	21.9	0.40	4.76	6.24
5	Nov. 13	116	23.1	0.46	5.88	6.48
6	Nov. 21	185	23.3	0.47	5.94	6.67
7	Nov; 29	243	24.0	0.49	7.18	6.37
Control for Plant 1						
	May 6		24.9	0.57	10.50	5.39
Control for Plant 2						
	June 3		23.4	0.57	10.08	5.86
Control for Plant 3						
	July 2		24.4	0.63	12.26	6.59

[1]Of ovendry weights.

with main plots based on liftings, and sub-plots based on storage temperatures and dipping. The first two plantings were established in plowed furrow bottoms in an area of sandy loam covered with short white clover. Weed control after planting was by mowing. The third planting was also by the wedge method but without furrowing, in a sandy soil cultivated before and after planting to control weeds.

The results of the experiment were examined in the fall of 1978, the end of the fifth year after outplanting. Analyses of variance were performed using an angular transformation for survival percentages, and plot averages for tree heights. These data are summarized in table 2; those for the white pine were omitted because of incompleteness. The information from the experiment pertains to 1) effect of the water dipping procedure, 2) time of fall lifting related to D-H-D, and 3) temperature for storage.

Results and Discussion

An unusual aspect of the data in table 2 is the good performance shown by trees in Plant 3 for both the best of the stored treatments (Lift 7) and the controls. Previous studies have usually shown reduced growth from late planting (*12*). In this case, however, the difference is undoubtedly due to both a better site and to cultivation of all plots in Plant 3 as opposed to mowing in Plants 1 and 2. The advantages of cultivation have been shown for other species (*7*). The procedure is thus similar to summer transplanting on the nursery that results in the absence of the usual planting check for field outplantings.

Water Dipping

As shown in table 2, water dipping of red pine before frozen storage resulted in lower survival. This treatment also resulted in lower total growth as shown in terms of aggregate height (planting rate per hectare *x* survival percentage *x* average height) for the three plantings combined; water dipping produced only 1,330 m/ha (assumed planting rate 3,000/ha) whereas the undipped trees produced 1,535 m/ha, about 15 percent more. Water dipping of the fresh or control stock for the three plantings in the spring had no significant effect.

The results for white pine,

Table 2.—*Survival (percentages) and average height for 3-0 red pine at 5 years after planting*

	Plant 1 May 7, 8		Plant 2 June 3-5		Plant 3 July 2, 3	
	Survival	Height	Survival	Height	Survival	Height
	pct.	*cm*	*pct.*	*cm*	*pct.*	*cm*
By lifting dates						
Lift 1, Oct. 17	0.4a	97 b	—	—	—	—
Lift 2, Oct. 24	15.6 b	104 cd	2.0a	101 b	8.0a	126ab
Lift 3, Oct. 31	28.4 b	99 bc	16.0 b	92ab	20.4 b	114a
Lift 4, Nov. 8	24.4 b	78a	27.6 b	80a	28.4 b	121a
Lift 5, Nov. 13	47.6 c	92 b	20.0 b	92ab	37.2 b	119a
Lift 6, Nov. 21	52.0 c	100 bc	52.8 c	100 b	59.2 cd	135 b
Lift 7, Nov. 29	71.2 d	108 cd	50.4 c	94 b	66.0 cd	136 b
Controls	80.6 d	113 d	84.2 d	114 c	78.2 d	154 c
	***	***	***	***	***	***
By water dipping						
No water dipping	46.9	105	42.3	102	44.4	137
Water dipping	42.1	104	32.6	104	39.0	142
	*	NS	**	NS	**	**

[1]Figures in vertical columns not followed by same letter are statistically different at the 5.0 percent level or better.

NS = not significant.
* = significant at 5.0 percent level.
** = significant at 1.0 percent level.
*** = significant at 0.1 percent level.

although based on fewer trees, confirm the reduction of performance from dipping trees before storage. Also, water dipping of fresh stock in the spring gave significantly lower survival in one planting, and significantly lower height in another.

Time of Fall Lifting for Storage, D-H-D

The readiness of red pine for storage is indicated by performance of the stand produced. The aggregate heights and the D-H-D (°C) are summarized in table 3. There was a slight levelling-off of aggregate height after Lift 6 when the D-H-D was 185° C. Therefore a D-H-D of 185° to 200° is suggested for red pine at Midhurst.

It is obvious that the stored red pine, even at its best—Lift 7 (table 2)—was inferior to the freshly lifted control stock. This is probably due to storage difficulties with poor quality stock as indicated by the high top-root ratios in table 1 (*8*). The maximum top-root ratio for red pine in Ontario has been given as 5.0:1 (*1*). There are also other problems in red pine production presently under investigation (3).

Temperature for Storage

In the white pine test, storage at -12° C was totally fatal for the

Table 3.—*Fifth-year aggregate height (planting density 3000/ha X survival percentage X average height) and Degree-Hardening-Days (D-H-D, cumulative daily differences below 10° C for soil temperature at 15 cm depth) for red pine by dates of lifting*

Lift	Date	Aggregate height	Stock readiness
		m/ha	*D-H-D*
Lift 1	Oct. 17	12	2
Lift 2	Oct. 24	280	20
Lift 3	Oct. 31	660	30
Lift 4	Nov. 8	750	77
Lift 5	Nov. 13	1,060	116
Lift 6	Nov. 21	1,840	185
Lift 7	Nov. 29	2,120	243
Controls		3,090	—

three early liftings. In the red pine the same pattern was true for early liftings but by the last two fall lifts a few trees did survive and grow. Obviously storage at -3° C was superior and safer than storage at -12° C. Earlier tests of low temperature freezing (-18° C) of stock have also shown unsatisfactory results (*8*).

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