A Test of the Polybin for Frozen Overwinter Storage of Red Pine

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The polybin was as successful as the regular Kraft-polyethylene bag for frozen overwinter storage of red pine. Dipping of tree roots before packaging was not advisable.

Frozen overwinter storage of packaged nursery stock has been an accepted practice at Ontario nurseries since about 1970, and expansion of storage facilities is still proceeding. This report is based on the fifth-year measurements of a 1974-75 storage test with red pine *(Pinus resinosa* Ait.) to examine the effects of (1) two containers (the regular poly-lined Kraft bag and the polybin[2]), (2) water-dipping of roots before packaging for storage, and (3) effects of time of fall lifting on readiness for storage.

Studies of red pine in frozen overwinter storage have shown variable results. However, it has been determined that successful red pine storage requires large, well-balanced stock (with a top-root ratio below 5.0:1).

Previous studies of the polybin in comparison with the regular Kraft-polyethylene bag have found the polybin particularly beneficial in the packing and storing of white spruce *(Picea glauca* (Moench) Voss) and about equal to the bag in the storage of black spruce (*P. mariana* (Mill) B.S. P.) and jack pine *(Pinus banksiana* Lamb). In white pine (*P. strobus* L.), the polybin was found slightly inferior to the Kraft-polyethylene bag.

The limited number of studies that have compared water-dipping roots with dry packaging for overwinter storage have suggested that this may be an unnecessary or even harmful procedure.

Previous studies of the dates of fall lifting for red pine have indicated that a D-H-D (Degree-Hardening-Days) accumulation, based on daily differences of minimum soil temperatures below 10° C at a depth of 15 centimeters, of about 167° C is appropriate (5, 6, 7). This was later revised to D-H-D 185° to 200° C (360° F) (3).

Methods and Procedures

Randomized plots were laid out in the fall of 1974 in the regular 3+0 seedbeds of red pine at Midhurst Nursery (about 100 km north of Toronto) to provide stock for four weekly test liftings for overwinter frozen storage. The stock was of the local seed origin. A recording thermometer with a probe set at 15 centimeters was used to record the daily soil temperatures, from which calculations were made for Degree-Hardening-Days. Plots were also reserved for the fresh-lifted controls in the following spring.

The trees were loosened in the bed with the Egedal lifter, pulled by hand, and tied in bundles of 25 seedlings. Trees less than 15 centimeters in top length or 0.40 centimeter in diameter were discarded. All packaging was done in the field according to the following schedule of treatments:

Kraft bags, wet: Bundles of trees were dipped, roots only, in water for about 10 seconds and packed with wet moss, top and bottom, in regular Kraft-polyethylene shipping bags.

Kraft bags, dry: Same as above, without water-dipping.

Polybin, wet: Bundles of trees were dipped, roots only, in water for about 10 seconds, and packed with wet moss, top and bottom, in polybins.

Polybin, dry: Same as above, without water-dipping.

At each of the four liftings, October 7, 24, and 31 and November 7, two containers of each treatment were packed and immediately placed in frozen storage at about -3° C for overwinter holding. The Kraft bags contained about 300 trees and the polybins about 500 trees each, a total of about 12,800 trees in storage. At each date of lifting, 200 trees were taken for laboratory measurements to characterize the stock (table 1).

Two plantings were carried out in the spring of 1975 at the Midhurst Research Unit, in accord with randomized designs. For the first plant

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[2]Scepter shipping container #71216, approximately 30 by 45 by 55 centimeters, peg-down cover; Scepter Manufacturing Company Limited, 11 Bermondsey Rd., Toronto, ON.

Table 1.—*Stock characteristics of 3+0 red pine at Midhurst Nursery, fall 1974 and spring 1975*

	Top length	Stem diameter	Ovendry weight	Top-root ratio by ovendry weight
	Cm	*Cm*	*G*	
Fall 1974				
Lift 1, October 17	30.7	0.50	8.78	5.09:1
Lift 2, October 24	28.5	.48	8.57	5.69:1
Lift 3, October 31	33.1	.53	10.28	6.55:1
Lift 4, November 7	32.3	.50	9.12	6.50:1
Spring 1975				
Plant 1 controls				
May 12	34.0	.61	14.70	5.39:1
Plant 2 controls				
June 2	33.9	.58	12.73	5.83:1

ing, from May 12 to 15, half of the frozen containers were removed from storage on May 11. Also, fresh-lifted controls (1,000) were obtained early on May 12 from the same seedbeds as the stored material. At the time of lifting, this stock appeared dormant above ground, although slight root growth to about 1.5 centimeters was visible. The planting was done by hand, using the modified wedge method in furrows turned in sod. Spacing was about 1.2 by 1.2 meters. The weather was generally clear; air temperatures were 15° to 25° C; soil temperature was about 13° C at a 15-centimeter depth; and relative humidity was extremely low for part of the planting, a range of about 12 to 55 percent. The planting consisted of 5,000 trees randomly chosen by bundles from the containers; five replications by five main blocks of 200 trees (four lifts plus control) by four sub-blocks of 50 trees (containers by dipping).

The second planting, from June 2 to 6, comparatively late for planting in this area, was done in a similar manner on a site about 1 kilometer away. The weather was also generally warm and partly clear, air temperature was 18° to 28° C; soil temperature was about 15° C; and relative humidity was again low for part of the planting (20 to 80 percent). The controls for the planting were lifted early on June 2 and showed considerable growth, an average of about 12 centimeters for new top growth and much root growth about 1.0 centimeter long. The planting plan used the same design and number of trees as in the earlier planting. The average measurements of the control trees for both plantings are also given in table 1, excluding the new top growth in the current year, 1975.

Competition control following planting has been limited, largely hand-scything of larger weeds in the first 2 years and machine-mowing two or three times in subsequent seasons.

The results of the experiment were examined in terms of fifth-year survival, total height, and terminal growth (1979 leaders). Analyses of variance were performed using an angular transformation for survival percentages and plot averages for tree heights and terminal lengths. These data have been summarized in table 2. The information from the experiment pertains chiefly to (1) comparison of the two containers (polybin and Kraft bag), (2) water-dipping or dry packaging, and (3) readiness of stock for fall storage.

Results and Discussion

The planting material used in the experiment, 3+0 red pine from Midhurst Nursery (table 1), was exceptionally large ("very large" class, over 6.0 g (1)), although not well balanced (top heavy, the average was above the working range of 3.0 to 5.0:1 of top-root ratio by ovendry weight (1)). The survival and growth of the material from the better storage methods (Kraft, dry, and polybin, dry) were, however, reasonably good in comparison with the freshly lifted controls (table 2) or with general performance standards for the species in Ontario (2). The good performance may also be

Table 2.—*Fifth-year results of two plantings (plant 1, May 12–15; plant 2, June 2–6) of frozen overwinter-stored and freshly lifted red pine by containers (Kraft-polyethylene versus polybin), by dry or water-dipping, and by date of fall lifting*

	Plant 1 May 12–15, 1975			Plant 2 June 2–6, 1975		
	Survival	Height	Terminal length	Survival	Height	Terminal length
	%	Cm	Cm	%	Cm	Cm
By containers and dipping						
Kraft bag, dry	63.9ab[1]	115.6	33.0	77.1c	114.6b	33.4
Kraft bag, wet	56.7a	116.0	33.5	67.2a	112.6ab	33.0
Polybin, dry	66.5b	116.1	33.0	75.9bc	112.5ab	32.7
Polybin, wet	61.2ab	116.4	33.4	69.2ab	109.7a	32.3
Significance	***	NS[2]	NS	*	*	NS
By dates of lifting						
Lift 1, October 17	38.6a	107.9a	30.8a	63.0a	110.1	31.9a
Lift 2, October 24	71.0bc	113.1b	32.7b	77.5b	112.8	32.8ab
Lift 3, October 31	64.8b	118.7c	33.7bc	70.6b	113.4	33.5b
Lift 4, November 7	73.9c	120.7c	34.5c	78.6b	113.0	33.1ab
Plant 1 controls May 12	82.2d	119.6c	33.0b	NA[3]	NA	NA
Plant 2 controls June 2	NA	NA	NA	80.6b	113.0	32.2a
Significance	***	*	*	*	NS	*

[1]Entries in vertical columns not followed by same letter differ significantly at 5.0-percent probability level.
[2]NS = not significant.
[3]NA = not applicable.
* = significant at 5.0-percent probability level.
*** = significant at 0.1-percent probability level.

partly caused by the special handling and care received in a research program (8) and to the exceptionally wet weather of July, August, and September 1977. It is believed that the good performance of the late planting from June 2 to 6 is also in part caused by these two favorable factors.

Polybin versus Kraft bag. This comparison can best be made from the results of the dry treatment of both containers as summarized in table 2. There were no statistically significant differences among the six comparisons (two plantings: survival, height, terminal lengths). In terms of aggregate height (planting rate 3,000 trees/ ha x survival percent/100 X average height), the Kraft bag produced 2,434 meters per hectare and the polybin 2,442 meters per hectare at 5 years. The polybin can therefore be considered as an optional container for storage and handling of red pine. It has previously been shown successful for storage of white spruce, black spruce, and jack pine (4).

Water-dipping. The comparison of dry and wet (water-dipping) treatments for frozen overwinter storage in both containers is also given in table 2. In only one direct comparison (of 12 possible) was the difference statistically significant (plant 2, Kraft bag, survival), and this was in favor of dry packaging. However, combining the results of the two containers, the aggregate height for dry storage was 2,438 meters per hectare and that for wet storage was 2,168 meters per hectare. Therefore, it is obvious that water-dipping is unnecessary for red pine storage and possibly dangerous.

Time of fall lifting. A summary of aggregate height in relation to Degree-Hardening-Days (D-H-D) is presented in table 3, in which all treatments and both plantings have been averaged. These results indicate an improvement in performance with later lifting, with some variation, but with no indication that an optimum has been reached. There is, therefore, no cause or evidence to change a previous recommendation of 185° to 200° C (D-H-D) for the fall lifting of red pine at Midhurst (3).

Table 3.—*Fifth-year aggregate height (planting density 3,000/ha × survival percentage/100 × 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 at Midhurst, by dates of lifting*

Lift	Date	Aggregate height	Stock readiness
		M/ha	*D–H–D*
Lift 1	October 17	1,661	10
Lift 2	October 24	2,516	73
Lift 3	October 31	2,357	133
Lift 4	November 7	2,673	163
Control	(May 12, June 2)	2,835	—[1]

[1]— = not applicable.

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