Overwinter Cold Storage Of Nursery Stock

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It would appear that we in Ontario are rather late in getting into the field of overwinter cold storage of nursery stock. This has not been because of a lack of interest, but rather because of a lack of necessity. In the past our nurseries have produced mainly transplanted trees for shipping; as a result our planting stock has been available for shipment, in the spring, almost as soon as the planting sites were ready, negating the need for overwinter stored trees.

Our first work in overwinter cold storage (as far as I can ascertain) was done over the winter of 1944-45, when ten coniferous species were stored by our Department at the Agricultural College at Guelph, Ontario. This test indicated that overwinter storage of coniferous stock was feasible.

In 1953, my predecessor at Orono, Mr. G. M. Linton, built a common storage shed for overwinter storage. This shed was designed to have storage temperatures maintained by electronically controlled vents and fans which pulled in cool outside night air as needed to maintain storage temperature. These tests were unsuccessful because of molding, and were finally dropped after the winter of 1955-56.

In 1966 Dr. R. E. Mullin, of our Research Branch, published a report - "Overwinter Storage of Baled Nursery Stock in Northern Ontario". This report indicated a large element of risk and uncertainty in overwinter storage.

In 1966 a decision was made by the Ontario Department of Lands & Forests to shift the production of nursery stock from a mix of transplant and seedling stock to almost complete' seedling production. This decision led to an immediate renewal of the interest in cold storage, since at Orono it takes about 1 1/2 to 2 weeks longer for the frost to come out of the shipping seedling compartments than out of the transplant blocks.

Under this new production regime, stock would no longer be available for shipment as soon as planting sites thawed out in the spring. Overwinter storage of stock was rather an obvious solution to this problem.

Since Orono already had a common storage shed, it was decided to install a refrigeration unit in this building and begin overwinter storage tests as soon as possible, to build up some background knowledge on storing methods, survival and growth, before cold storage of stock became a general practice across the province a few years hence.

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A visit was made to the Lowville N.Y. Nursery, where the Superintendent, Mr. Bob Evans, demonstrated and explained the methods used there to store seedling stock overwinter.

Our Research Branch was asked for assistance in designing and completing the project, and Dr. R. E. Mullin accepted the task of working with the Orono staff. Actually, Dr. Mullin is the senior member on the project, and he, not I, would have been here today except that circumstances made it impossible for him to attend.

In the fall of 1968, after much discussion, it was decided to store trees Ain the following manner:

1. Cold Tray (C T) 500 trees packed on wood slatted trays and covered with sphagnum moss . (Lowville treatment)

2. Cold Bale (C B) 750 trees in standard burlap and wax paper lined bales.

3. Cold Polybaq (C P) 500 trees in polyethylene 4 mil bags, handful of wet moss, closed with wire ties.

4. Cold Bale in Polybaq (C-BP) Bales as in "2", tied in poly bag.

5. Frozen Bales (FR B) As in "2", but stored below freezing.

6. Frozen Polybaq (Fr P) As in "3", but stored below freezing.

7. Frozen Bale in Polybaq (FR BP) As in "4" but stored below freezing.

8. Control (C) Freshly lifted stock, randomly selected from nursery beds.

The test was carried out on -

3-0 White Spruce (Picea Glauca (Moench) Voss)
Red Pine (Pinus Resinosa Ait.) and
White Pine (Pinus Strobus L.)

In the fall of 1968, areas were staked out in the seedbeds of the three species, to allow for the random selection of stock for fall and spring lifting.

On November 25th, the trees were lifted in the usual manner - (loosened by lifting blade, pulled by hand, and tied in bundles of 25 in the field) taken to the packing shed, centre piled, and watered for overnight holding.

Packing as described was carried out on November 26th. The packed trees were placed on wooden racks, (a la Lowville) to prevent compression from piling, and to permit air circulation.

November 25th is quite late in the fall. at Orono, as we usually figure on getting "frozen out" of the nursery between November 25th and December 5th. On the day the trees were lifted the temperature was about 35 F, and there had been night frosts for the previous 3 to 4 weeks.

The cold room of the storage was maintained between 0.8°C and 3.0°C overwinter, with an of about 1.5°C. Temperature inside the bales averaged about 0.5°C. Relative humidity (uncontrolled) ranged from 86% to 90%.

In the below freezing room, temperatures ranged between - 0.5°C and -5.0°C - with an average of -3.0°C. Inside bale temperature averaged about -4.0°C.

On April 25th, 1969, the refrigeration units were turned off to thaw the frozen stock prior to handling. On April 28th fresh stock from the reserved seedbed areas was lifted and brought to the storage building. From this, and from the packages in the stored treatments, random samples were selected for planting at three locations. This stock was packed in poly-lined Kraft paper bags for transportation to the planting sites.

One planting of all species was made at the Orono nursery on a cultivated area at close spacing - about 12" x 24". A second planting was at the Ganaraska Forest, 20 miles North-East of Orono, on a dry old field site, in furrows, at normal spacing -5' x 5' . The third planting was at the Kemptville research area, about 200 miles east of Orono, on a wet, old field site, at normal spacing.

Planting, using the wedge method, was completed on April 30th at Orono, May 3rd at Ganaraska, and May 6th at Kemptville. Number of trees planted - 2,000 of each species at each location. Total - 18,000 trees.

Because of separation by distance and species, the data were individually examined by the analysis of variance for each of the nine location-species units. The parameters examined were survival (by angular transformation), totals of terminal growth per plot (called "terminal production" herein), average terminal length per plot, totals of heights per plot ("height production") , and average height per plot. The many analyses were generally confirmatory in results, and hence discussion is confined to survivals (by precentages) and to terminal production. The latter term seems advantageous to express survival and new growth (after storage treatments). (The results have been summarized by species in Tables 1, 2, 3, 4, 5, and 6.) The differences by species in relation to the effects of storage on survival and growth, makes separate discussion by species necessary.

a. White Spruce

The effects of storage treatment on survival were not significant at any location. However, when summarized for the three locations it was found that the frozen bale (FrB) was consistently damaging to survival and the frozen polybag (FrP) consistently beneficial.

Statistically significant differences in the terminal production data showed that the frozen bale treatment (FrB) had inhibited growth, as had also the cold tray (CT) and cold bale (CB) treatments. The other four storage treatments appeared satisfactory for this species Of these, the frozen polybag (FrP) was the most promising, giving better survival and growth than the control (C) .

b. White Pine

The effects of the storage treatments on survival of white pine were statistically significant in the separate analyses, Table 3, and indicated the poor results of cold bale-in-polybag treatment (C B-P). When averaged for all locations there were nearly equal effects for the other storage treatments. The most promising treatment, the frozen polybag (Fr P) showed a survival rate considerably above that of the control (C).

The production of terminals indicated similar conclusions to the survival data, Table 4, although in this species the individual analyses by locations were not significant. The cold bale-in-polybag treatment (CB-P) was much poorer than all the other treatments, and the frozen polybag (FrP) the best, considerably above Control (C) in this aspect, as well as survival.

c. Red Pine

The effects of storage on survival of red pine, Table 5, showed highly significant differences. The cold bale-in-polybag (CB-P) was extremely poor, as in white pine, and the cold tray (CT) also very unsatisfactory. Again, the best storage treatment was the frozen polybag (FrP). The average survival of the fresh or control stock (C), was greater than that of any storage procedure, in contrast to the other species.

The terminal production of the red pine was also highly significant at all locations, and confirms the foregoing, Table 6.

Important species differences in relation to storage treatments were found in the initial experiment. The effects of the storage treatments on survival were not significant in white spruce, even for the poorest treatments, but they were in other species. On the other hand, the effects on new growth were not signigicant in white pine but they were for the other two species .

The cold tray (CT) method of storage as used in the experiment was obviously detrimental to white spruce and red pine, but reasonably successful with white pine. No attempt had been made to keep relative humidity at a high level, and hence exposed tops of trees were able to dry out. White pine had obviously a better resistance to this type of desiccation.

The cold bale-in-polybag (CB-P) gave very poor results in red and white pine, but was quite satisfactory in white spruce. It was found on opening the bales 'of the two pines that mold had formed and there was a strong offensive odor. This may have been related to softer needles and greater surface contacts between the trees.

The differences between the remaining treatments, cold bale (CB), cold polybag (CP), the frozen bale (FrB) and frozen polybag (FrP), were not so great and indicated that further experimentation was necessary. The frozen polybag (FrP) was the most promising method for all species tested, and highly satisfactory in terms of survival and growth. However, it is possible that the best methods and storage conditions may differ by species or by site region. Further tests are being conducted.

The poor success of the control treatment at Kemptville, compared with Ganaraska and Orono, is of interest. Kemptville plots had consistently lower survival and poorer growth . Statistical comparison would be invalid between the three species . The Kemptville planting, which was at the farthest location from the cold storage at Orono, was delayed for several days, whereas the other two areas were planted within a few days of lifting. This might indicate that the cold-stored stock was able to withstand handling and holding better than the freshly-lifted stock at this date of lifting because the latter may have been more active, or more advanced in the dehardening process.

TABLE I

WHITE SPRUCE

Survival

	Orono Survival %	Ganaraska Survival %	Kemptville Survival %	Total Survival	As a % of "C"
1. CT	85.2	76.4	84.0	81.9	102.7
2. CB	81.2	85.6	92.0	86.3	108.2
3. CP	88.2	83.6	85.6	86.0	107.8
4. CB-P	88.4	87.6	86.8	87.6	109.9
5. FrB	80.4	74.4	76.0	76.9	96.5
6. FrP	92.4	93.6	90.8	92.2	115.7
7. FrB-P	85.6	86.0	83.2	84.9	106.5
8. C	83.2	88.0	68.0	79.7	100.0
Significance	NS	NS	NS		

Significant Values - NS = Not Significant

TABLE II

WHITE SPRUCE

Production of Terminals

	Orono Total Terminals cm	Ganaraska Total Terminals cm	Kemptville Total Terminals cm	Total	As a % of "C"
1. CT	622 a	476 a	721 a	1819	58.1
2. CB	754 a	728 a	981 b	2463	78.7
3. CP	1280 b	1098 b	1027 b	3405	108.9
4. CB-P	1268 b	1055 b	1040 b	3363	107.5
5. FrB	636 a	460 a	740 a	1836	58.7
6. FrP	1364 b	1293 b	1282 c	3939	125.9
7. FrB-P	1195 b	1079 b	995 b	3269	104.5
8. C	1084 b	1158 b	887 b	3129	100.0
Significance	***	***	***		

Significant Values - *** = Significant at 0.1% level.

Values followed by same letter are not significantly different.

TABLE III

WHITE PINE

Survival

	Orono Survival %	Ganaraska Survival %	Kemptville Survival %	Total Survival	As a % of "C"
1. CT	80.0 b	80.8 b	72.0 ab	77.6	94.5
2. CB	84.0 b	79.6 b	86.8 bc	83.5	101.6
3. CP	88.0 b	81.6 b	94.4 c	88.0	107.1
4. CB-P	48.8 a	40.0 a	55.2 a	48.0	58.4
5. FrB	86.0 b	86.4 b	81.6 bc	84.7	103.1
6. FrP	92.0 b	93.6 b	91.6 c	92.4	112.5
7. FrB-P	81.2 b	78.4 b	86.4 bc	82.0	99.8
8. C	84.4 b	89.2 b	72.8 ab	82.1	100.0
Significance	**	*			

Significant Values - * = Significant at 5.0% level.

** = Significant at 1.0% level.

Values followed by same letter are not significantly different.

TABLE IV

WHITE PINE

Production of Terminals

	Orono Total Terminals cm	Ganaraska Total Terminals cm	Kemptville Total Terminals cm	Total	As a % of "C"
1. CT	1144	1224	1180	3548	110.4
2. CB	1476	1379	1581	4436	138.1
3. CP	1462	1132	1773	4367	135.9
4. CB-P	780	635	1044	2459	76.5
5. FrB	1269	1413	1386	4068	126.6
6. FrP	1654	1900	1747	5301	165.0
7. FrB-P	1410	1270	1360	4040	125.7
8. C	1020	1307	886	3213	100.0
Significance	NS	NS	NS		

Significant Values - NS = Not Significant

TABLE V

RED PINE

Survival

	Orono Survival %	Ganaraska Survival %	Kemptville Survival %	Total Survival	As a % of "C"
1. CT	58.4 b	35.2 b	37.2 b	43.6	49.5
2. CB	66.4 bc	82.4 cd	80.0 cd	76.3	86.7
3. CP	70.8 bc	76.4 cd	71.6 cd	72.9	82.9
4. CB-P	1.6 a	9.6 a	5.2 a	5.5	6.2
5. FrB	76.0 bc	68.8 c	69.2 c	71.3	81.1
6. FrP	82.4 bc	80.8 cd	88.0 d	83.7	95.2
7. FrB-P	70.0 bc	81.6 cd	84.0 cd	78.5	89.2
8. C	85.6 c	94.0 d	84.4 cd	88.0	100.0
Significance	***	***	***		

Significant Values - *** = Significant at 0.1% level

Values followed by same letter are not significantly different.

TABLE VI

RED PINE

Production of Terminals

	Orono Total Terminals cm	Ganaraska Total Terminals cm	Kemptville Total Terminals cm	Total	As a % of "C"
1. CT	290 a	205 a	205 a	700	18.6
2. CB	928 b	929 b	989 bdc	2846	75.6
3. CP	943 b	1099 b	965 bc	3007	79.9
4. CB-P	2 a	56 a	19 a	77	2.0
5. FrB	1027 bc	911 b	740 b	2678	71.1
6. FrP	1230 c	1226 b	1352 d	3808	101.1
7. FrB-P	956 b	1072 b	1202 cd	3230	85.8
8. C	1478 c	1212 b	1075 bcd	3765	100.0
Significance	***	***	***		

Significant Values - *** = Significant at 0.1% level.

Values followed by same letter are not significantly different.