Late lifting and freezing in plastic bags improve white spruce survival after storage

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Overwinter storage of conifer seedlings is useful f or various reasons, but two compelling ones at the Alberta Provincial Tree Nursery (Edmonton, Alberta) are to reduce the spring workload and improve inventory accuracy for planning o f planting schedules. This article reports studies o f several packaging methods and storage at sub-freezing temperature for white spruce.

A 1966 trial showed that survival of conifer seedlings after storage at 340 to 360F. was improved by delaying lifting until Oct. 24 when compared with lifting (1) up to a month earlier. A recent publication describes successful long term storage of red pine frozen in plastic bags (6).

We planned to lift 3-0 white spruce *(Picea glauca* (Moench) Voss var. *albertiana (S.* Brown) Sarg.) weekly from October 13 to November 3, 1969. Inclement weather prevented lifting during the last 2 weeks, so stock for this trial was lifted on only October 13 and October 20.

Methods

Before packaging, seedlings were graded and culled to a mean height of about 8 inches, counted into bundles of 50, and root-dipped in water to remove excess soil.

Six packaging methods were tested with five replicates of 50 seedlings for each method:

1. Heeled-in in peat. (Roots were loosely packed in moist peat in wooden flats, tops exposed.)
2. Jelly-roll bales. (Seedlings were rolled up root-to-root, with peat moss, in a plastic and burlap wrapper, tops exposed.)
3. Plastic (polyethylene) bags, with moist peat. (Seedlings were placed root-to-root, lying horizontally in the bags, roots covered loosely with moist peat. The bags were then sealed by folding and stapling the tops.)
4. Plastic bags, with steamed peat. (The same as method 3, but the peat was steamed for 3 hours at 185°F. in an attempt to reduce mold inoculum.)
5. Plastic bags, no peat. (The same as method 3, but without peat.)
6. Current Alberta Tree Nursery method. (Essentially similar to method 3, but larger bags are used and are covered with burlap to improve mechanical strength for shipping.)

Plants were packaged and placed in storage on racks with good air circulation on the day of lifting. Storage was at a nominal 25°F. Daily monitoring of the maximum-minimum thermometer indicated fluctuations of up to ± 5°F., but generally within ± 2°F. On eight individual, widely-separated days maximum readings were above 32°F. On April 20, controls were raised to 32°F. to start the thawing process, and monitoring after that date indicated fluctuations of up to ± 4°F. Humidity was *not* controlled or monitored because instruments were not available, but the presence of moist peat on the floor and racks ensured relatively high levels.

Samples of 10 seedlings were taken from each packaging method at roughly monthly intervals during storage, and moisture contents and presence of starch in tops and

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roots were determined. Moisture content was determined by difference in weight after drying at 1000C. for 24 hours. Presence of starch was visually quantified after freshly cut sections of stems and roots were dipped into 1 percent iodine in 2 percent aqueous potassium iodide.

All the stored seedlings were hand-planted in the nursery during the period May 11-15, 1970. On May 19, 250 check seedlings from the same nursery plot were lifted and planted. All seedlings were irrigated and weeded.

Survival was tallied on June 29. (Trees were counted living if they had initiated new top and root growth.)

Results

Survival rate of seedlings stored in plastic bags without peat was significantly higher than in any other methods but significantly lower than among freshly-dug checks. Survival rate in each method was higher for seedlings lifted October 20 than for those lifted October 13 (table 1).

Moisture content (fig. 1) of seedlings with tops exposed (methods I and 2) declined progressively throughout the storage period, more rapidly at first from tops, but later more from roots. This uneven moisture change was also observed by Tarrant (8) from seedlings in bundles. However, seedlings totally enclosed in polyethylene bags lost no moisture or else gained moisture, and there were no important differences between tops and roots or among methods 3, 4, 5, and 6.

Starch content, determined by the iodine test, consistently decreased with increasing duration of storage. This trend was more marked in seedlings lifted on the earlier date and in seedlings stored with tops exposed, but no seedlings were totally without starch on May 11. Some seedlings lifted October 13 and stored in heeled in peat had no detectable starch in tops by March 20, but roots still stained deep blue.

TABLE 1.—*Survival of white spruce seedlings stored frozen overwinter using different packaging methods*

(Figures in the same column followed by the same letters do not differ significantly at the 1 percent level. Basis: five replicates of 50 seedlings per treatment; Duncan's multiple range test.)

Packaging Method	Survival when lifted on Oct. 13	Oct. 20	Mean (both dates)
		Percent	
Heeled in peat	1.2 a	11.6 a	6.4 a
Jelly-roll bales	16.0 b	46.8 b	31.4 b
Plastic bags with moist peat	37.6 c	64.0 c	50.8 c
Plastic bags with steamed peat	47.2 c	58.1 b c	52.6 c
Plastic bags without peat	77.0 d	87.3 d	82.2 d
Current nursery practice	49.2 c	79.7 c d	64.5 c
Check (lifted May 19)	97.0 e	97.0 e	97.0 e
Mean, all methods	34.8	58.0	
Mean, method 1 and 2	8.6	29.2	
Mean, method 3, 4, 5, & 6	52.4	72.3	
Mean, method 3, 4, & 6	44.7	67.3	

Discussion

In the Alberta nursery, as in other northern nurseries, it is often difficult to postpone fall lifting beyond the end of October, leading to a need for overwinter storage of 6 months or more. In this trial, storage was for 7 months. The present results confirm and extend knowledge of the beneficial effects of late lifting, in improved survival after storage. The benefits probably result from reducing the duration of artificial storage and from ensuring more complete dormancy of the planting stock, as indicated by less rapid depletion of starch reserves in stock lifted at the later (late, and borne out by improved survival rates. Similar correlation was observed by Hellmers (3).

Grouping the survival data into methods totally enclosing the seedlings and those with tops exposed confirms the need for stringent precautions against desiccation. Seedlings stored with tops exposed retained considerable starch reserves, but had lost moisture to near or below levels found to be critical in other studies (2). In this study, too, desiccation during storage was apparently the primary cause of mortality.

Slayton (7) reports successful storage of white spruce in opentopped bales, at 28°F. and 97 to 100 percent relative humidity. Desiccation of bales in the present study may result from failure to control humidity and the rather broad temperature variation. However, the ease of packaging in totally enclosed systems, such as multi-walled kraft paper bags with polyethylene liners, and the better results obtained with such systems, lessen the need for humidity controls on the whole building.

Molding of foliage, a principal cause of losses in stock stored at

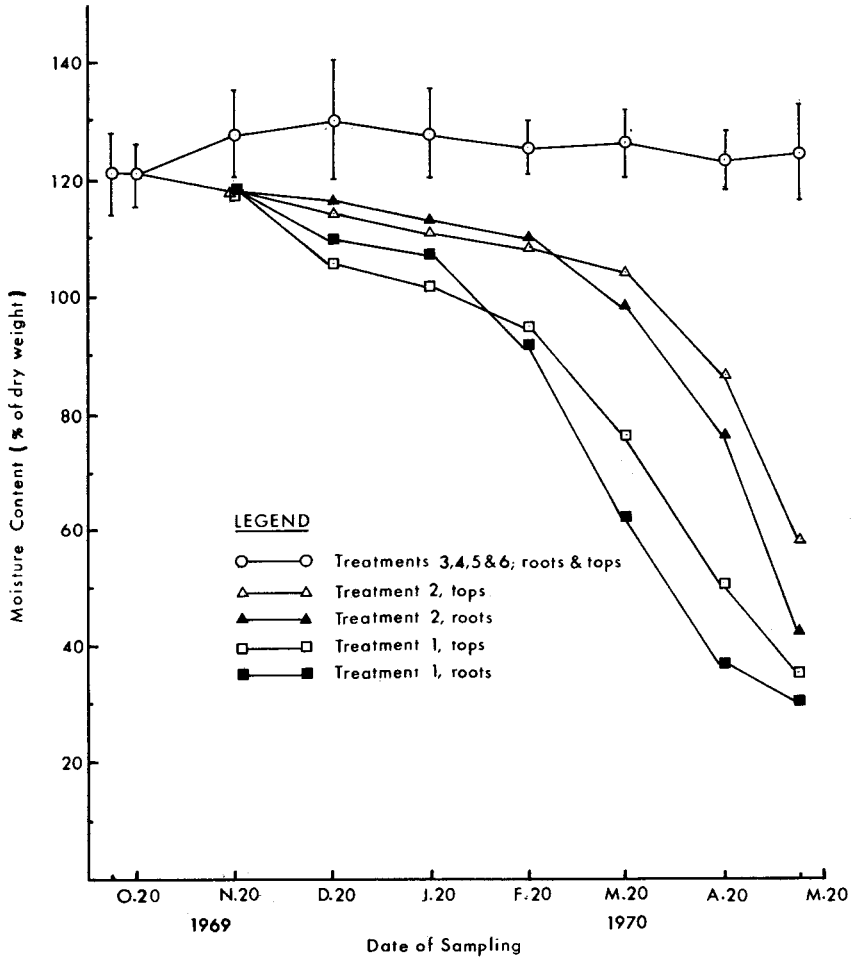

Figure 1.-Moisture depletion from white spruce seedlings with duration of storage in various packaging methods,

temperatures above freezing (4), was almost wholly absent in this study; a result no doubt attributable to lower storage-temperature.

Since both molding and desiccation were controlled when seedlings were stored frozen in plastic bags, the question arises: Why did so many seedlings die? Check seedlings left in the ground all winter showed 97 percent survival rate whereas the mean of the plasticbag methods lifted on October 20 was 72 percent. Temperatures prevailing under snow cover during the winter are usually in the same range of 200 to 320F., so the causes of mortality cannot be simply dependent on temperature. The answer must lie in other physiological changes taking place in stored seedlings, not detectable by the rather crude starch-staining iodine test.

Another curious observation is the effect of peat in methods 3, 4, and 6. Mean survivals in these methods were 33 and 20 percent less for the two lifting dates than in method 5, which was without peat. Similar observations were made recently by Lindquist (5). Possible reasons for this difference might be microbiological activity or toxins in the peat leading to root damage, but no evidence to support this is available.

Conclusions

From the present results, white spruce may be stored for 7 months if the following conditions are met:

1. The seedlings are dormant, achieved by late lifting.
2. Desiccation is prevented by packaging in plastic bags. No added peat or other moisture-retaining materials are necessary.
3. Molding and metabolic activity are minimized by storage at sub-freezing temperature.

Literature Cited

1. Chedzoy, J.
   1967. Storage requirements for nursery stock. *In:* Proc. Intermountain Nurseryman's Assoc. Annu. Meeting, Indian Head, Sask., Aug. 1967: 66-68.
2. Faulkner, R. and J.R. Aldhous.
   1958. Handling of plants. Rep. Forest Res., Forest Comm. Lond., 34-36.
3. Hellmers, H.
   1962. Physiological changes in stored pine seedlings. Tree Planter's Notes 53: 9-10.
4. Hocking, D.
   1972. Effect- and characteristics of pathogens on foliage and buds of cold-stored white spruce and lodgepole pine seedlings. Can. J. Forest Res. 1 (4):208-215.
5. Lindquist, C. H.
   1970. Plant storage studies. 1969 Summary Rept., Tree Nursery, P.F.R.A., Indian Head, Sask., Can. : 17-18.
6. Mullin, R. E. and W. R. Bunting.
   1970. Frozen overwinter storage for red pine. Tree Planters' Notes 21 (4): 15-17.
7. Slayton, S.H.
   1970. Storing baled red pine, black spruce, and white spruce over winter feasible in upper Michigan. Tree Planters' Notes 21 (4): 15-17.
8. Tarrant, R. F.
   1964. Top and root moisture content of stored Douglas-fir planting stock. U.S. Dept. Agric. Forest Service, Res. Pap. P.N.W.-13: 1-8.