Overwintering Black Spruce Container Stock Under a Styrofoam® SM Insulating Blanket

Robert E. Whaley and Lisa J. Buse

Stand establishment project forester, Northwest Region Science and Technology, Ministry of Natural Resources, Thunder Bay, Ontario, and education and communication coordinator, Ontario Forest Research Institute, Ministry of Natural Resources, Sault Ste. Marie, Ontario, Canada

In northwestern Ontario, large numbers of container seedlings are overwintered either outdoors or in frozen storage. Seedlings stored outdoors are subject to severe conditions overwinter and are prone to considerable damage, whereas freezer storage is expensive and has its own associated risks. To examine an alternative method for overwintering black spruce (Picea mariana *(Mill.) B.S.P.) container stock, we tested different configurations of a rigid Styrofoam® SM insulating blanket. Third-year outplanting results showed no differences in growth or survival performance between controlled frozen and Styrofoam® SM stored stock.* Tree Planters' Notes 45(2):47-52; 1994

Currently, about 159.2 million seedlings are produced for forest renewal in Ontario. Of these, about 55 million container and 44 million bareroot seedlings are overwintered outdoors. These seedlings can suffer considerable damage during outdoor overwinter storage, principally from root damage due to rapid freezing and shoot desiccation. Other problems include mechanical damage, such as the flattening of seedlings from the weight of snow and ice, and snow mold. All these problems are due to, or accentuated by, insufficient or fluctuating snow cover on outdoor stored stock and/or improper conditioning of the seedlings. Therefore, the emphasis in overwintering nursery stock is on protecting seedlings from desiccation and protecting seedling roots from critically low and/or rapid changes in temperature (McNiel and Duncan 1983).

Outdoor overwintered container stock suffered heavy losses in the Thunder Bay area in the years leading up to and including 1987 (OMNR 1987). These losses prompted the examination of alternative overwintering techniques, such as indoor frozen storage facilities, snow making, and insulating blankets. This report examines the feasibility of outdoor overwintering black spruce *(Picea mariana* (Mill.) B.S.P.) seedlings grown in Styroblocks under Styrofoam® SM insulating blankets.

Insulating blankets have been in use throughout North America since the mid-1970's for protecting overwintered horticultural plants (Green and Fuchigami 1985). Their use in forestry for protecting container seedlings is a recent practice. Several different configurations of insulating blankets have been tried, such as placing polyethylene film over plants packed in straw or covering seedlings with a sandwich of straw between layers of either clear or translucent polyethylene film (Green and Fuchigami 1985). Other insulating materials used have included rigid Styrofoam® and manufactured "Microfoam " sheets that can be up to 19 mm thick (Gouin 1977).

The procedure for protecting container seedlings consists of either erecting a frame over seedling trays to support the blanket or aligning rigid trays on their sides and surrounding them with an insulating blanket, thereby sealing in the stored stock. The weight of winter snow and/or other material such as wooden strips holds the blanket down and keeps it from whipping in the wind.

To evaluate the use of a Styrofoam® SM insulating blanket for protecting overwintered container stock, we began tests at Hodwitz Enterprises Ltd. in Thunder Bay, Ontario, in 1990. The objectives of our tests were to:

1. Examine the feasibility of overwintering Styroblock seedlings under Styrofoam® SM insulating blankets.
2. Determine the cost of and procedures for overwintering stock using insulating blankets.

Materials and Methods

A demonstration project was established at Hodwitz Enterprises Ltd., Thunder Bay, Ontario, to investigate the ability of rigid Styrofoam® SM insulating blankets to protect seedlings from rapid and extreme changes in temperature, drying winds, and desiccating sun. The containers examined were Styroblock 130's and 165's, which measure about 47 by 35.1 by 13 cm (18 by 14 by 5 in) and hold 130 and 165 seedlings, respectively.

Test Configuration – Year 1. For the first overwintering period of this test (1990-91), 50 trays of Hodwitz Enterprises' black spruce Styroblock 165 seedlings were placed under an insulating blanket. This equated to approximately 8,200 seedlings.

The treatment trays were placed on their sides in pairs, with seedling tops together— the tray tops were about 25 cm (10 in) apart— and tray bottoms touching, in both single- and double-layer configurations (figure 1B). The "blanket" consisted of covering the trays with 5.1-cm-thick (2-in-thick) R10 Styrofoam® SM on the top and sides. The treatment seedlings remained covered from mid-November to mid-April. The control trays were stored as normal outdoor overwinter stock-uncovered and unprotected by cardboard boxes (figure 1A).

Temperature probes were inserted into selected root plugs while the trays of seedlings were being placed under the insulating blanket. A total of 12 temperature probes were used to monitor both air (4) and in-plug temperatures of the single-layer (2), double-layer top (2) and double-layer bottom trays (2). Two probes were also placed in control trays, inside the container medium. An automatic recording device logged temperatures from the probes hourly during the entire storage period. Probes in the control, single-layer, and

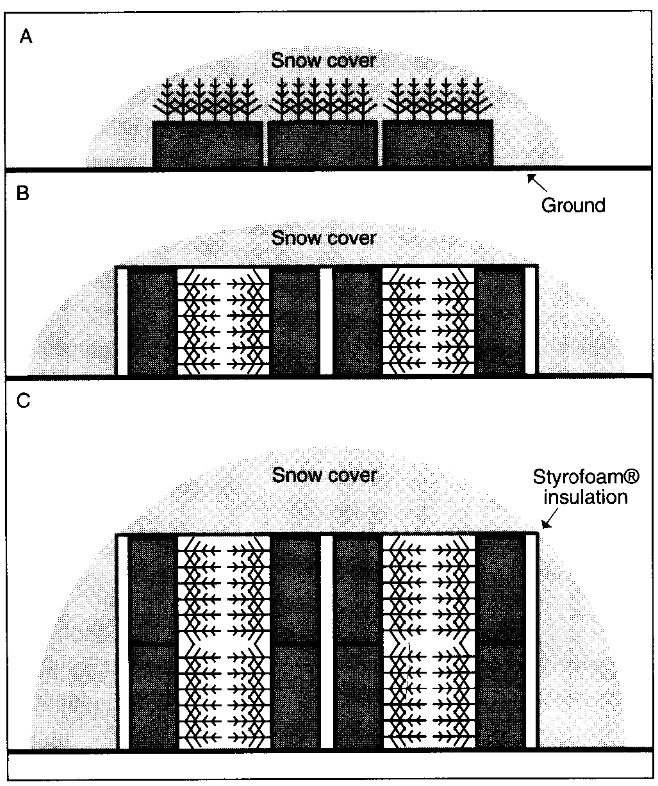

Figure 1—*Diagrammatic representation of overwinter storage treatments for black spruce in Styroblock 165's stored normally* **(A)**, *one layer* **(B)**, *and two layers deep* **(C)** *under the Styrofoam® SM blanket.*

double-layer bottom trays were approximately 10 cm (4 in) above ground level, whereas probes in the double-layer top trays were approximately 45 cm (18 in) above ground level.

Six trays of the same Hodwitz stock were also placed into controlled frozen storage at the former Thunder Bay Forest Nursery (TBFN), Thunder Bay, Ontario. These trays were first placed in plastic bags inside cardboard storage boxes and then overwintered in cold storage at -2 °C (28.4 °F). This stock remained in cold storage from mid-November to mid-April.

Test Configuration — Year 2. In 1991-92, the stacking configuration was changed. Although the controls remained the same, the Styroblock 165 trays under the blanket were stacked with seedling tops closer together-the tray tops were about 10 to 15 cm (4 to 6 in) apart-but with their bottoms touching and three rows high. The "single-layer" treatment was discontinued. Instead, trays of seedlings were sealed in plastic bags inside standard nursery cardboard boxes and placed in a standard shade area for overwintering. These boxes had no overwinter protection other than that provided by normal snowfall throughout the winter.

Between 3,000 and 4,000 Styroblock trays of black spruce seedlings were placed under the blanket in the second year. The trays consisted of both Styroblock 130's and 165's, with a total of about 500,000 seedlings being stored.

The Styrofoam structure was also improved (figure 2). Sand and gravel were laid down as a base to facilitate proper drainage, along with a layer of Weedmat® to prevent the growth of weeds during the summer months and to provide a better stacking and walking surface.

Temperature probes (a total of 12) were once again placed in selected root plugs of control seedlings (1), those sealed in cardboard boxes (1) and in the top (2), middle (2), and bottom (2) layer trays under the Styrofoam blanket. In addition, 4 probes were used to monitor outdoor and underblanket ambient air temperatures. An automatic recording device logged temperatures from the probes from late-November until seedlings were removed from storage on May 1, 1992. Temperature probes for the control, cardboard box, and bottom layer underblanket were approximately 10 cm (4 in) above ground level, while probes in the middle and top underblanket trays were approximately 45 and 80 cm (18 and 31.5 in) above ground level, respectively.

No seedlings were placed into controlled frozen storage during this second year of the test.

Figure 2—*Operational setup of Hodwitz Enterprises Styrofoam® SM cold frame for the overwinter storage of container stock.*

Seedling testing and outplanting. Bud flushing tests were conducted by the Ontario Ministry of Natural Resources' North Central Region container production monitoring staff between February and April of each year of the study. Sample seedlings were removed from under the Styrofoam blanket and from the outdoor storage area, thawed, potted into a peatvermiculite mixture, placed in a greenhouse, and monitored for bud swell and flushing.

An outplanting trial was implemented in the spring of 1991 using stock from each of the two 1990-91 insulating blanket treatments. Eighty seedlings from each of the insulating blanket and frozen storage treatments were outplanted in the spring of 1991 in the Thunder Bay Nursery outplant trial site near Raith, Ontario. Seedlings from each treatment were planted in four replicates of 20 seedlings each at 2-m (6.5-ft) spacing. The seedlings were measured in the fall of both 1991 and 1993 for total height, height increment (CAI), and root collar diameter (RCD). None of the control seedlings were outplanted. The balance of the (1991) experimentally stored seedlings were operationally planted by Canadian Pacific Forest Products (now Avenor), Thunder Bay, Ontario.

No seedlings from the 1991-92 overwintering study were experimentally outplanted in the spring of 1992. This is unfortunate, as apparently these seedlings overwintered better than those from the first year of the test. All of the overwintered seedlings were planted by Canadian Pacific Forest Products as part of their normal reforestation program.

Results

Overwintering-1990-91. Temperature monitoring showed that stock under the insulating blanket maintained fairly constant and warmer temperatures than control stock (figure 3). Minimum temperatures fluctuated less than 1 /C (33.8 /F) under the blanket in late fall, while the control fluctuated (sometimes daily) by 3 /C (37.4 /F) before sufficient snow had fallen to help in the insulation process. The seedlings were place into storage in mid- to late November and weather records show that 14 cm (5.5 in) of snow fell on December 12th and another 10 cm (4 in) on December 20th. Temperatures inside the structure then hovered at 0 /C (32 /F) throughout the balance of the winter months, while the control continued to vary by up to 5 /C. Ambient temperatures for the overwintering period ranged from 0 to -35.5 /C (32 to -31 /F) (figure 3). Snowfall for the storage period can be seen in table 1.

Flushing tests conducted throughout the winter months showed that seedlings from all treatments were normal and healthy. After thawing for 6 to 13 days, the potted seedlings took from 4 to 9 days to reach full bud swell. All seedlings were fully flushed in another 4 to 5 days.

The stock monitoring staff noted that all seedlings were healthy except for those underblanket seedlings in tray plugs closest to the ground. These were prone to considerable damage, believed to be the result of warmer temperatures and higher humidity at ground level. This problem was also experienced at Jellien Nursery in Armstrong, Ontario, where a similar test was conducted with jack pine *(Pinus banksiana* Lamb.) (Neill 1991, personal communication). There are no temperature records for the Armstrong trial.

Overwintering-1991-92. Minimum temperatures recorded in the second season of this trial were considerably different from the first year. In the first year, the temperature in the control fluctuated throughout the winter, while in the second year the control remained more stable (as ambient temperatures were more moderate and snow cover more consistent) until early March, when lack of snow cover and plunging ambient temperatures allowed temperatures in the root plugs to drop considerably and rapidly. Underblanket root

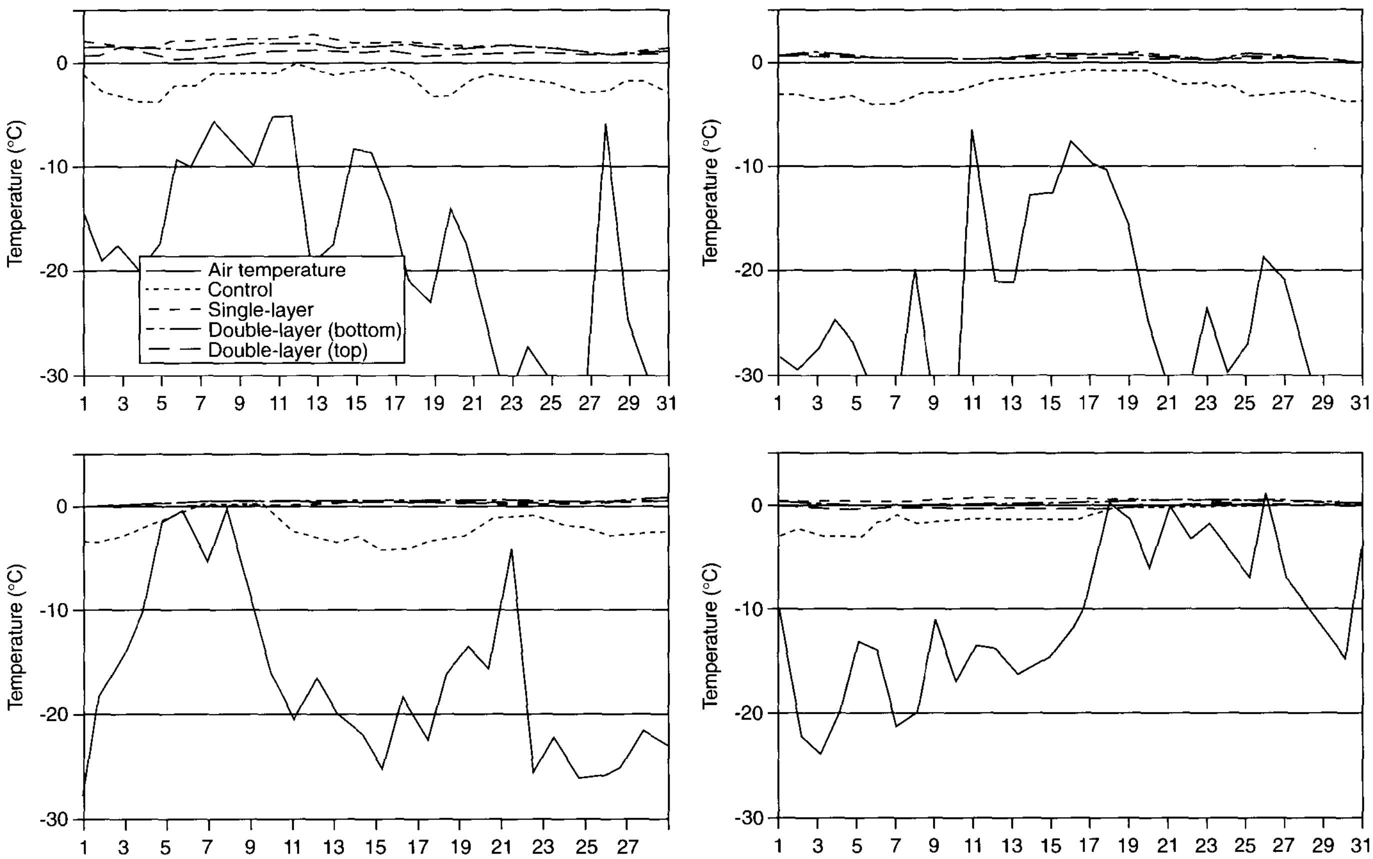

Figure 3—*Temperature fluctuations for outdoor stored Styroblock seedlings, compared to those under a Styrofoam® SM insulating blanket through the winter of 1990–91.*

Table 1-*Monthly snowfall (cm) amounts for Thunder Bay, Ontario, during the winters of 1990-91 and 1991-92 and the 30-year average for comparison*

	1990-91		1991-92		30-year average	
Month	cm	in	cm	in	cm	in
December	50.4	19.7	53.6	20.9	46.2	18.0
January	44.0	17.2	24.8	9.7	48.4	18.9
February	15.6	6.1	28.4	11.1	30.7	12.0
March	23.6	9.2	2.4	0.9	34.2	13.3
Totals	133.6	52.1	109.2	42.6	159.5	62.2

plug temperatures fluctuated between -1 and -5 °C (30.2 and 23 °F) during this second winter (figure 4) while ambient temperatures ranged from 0 to -29 °C (32 to -20.2 °F).

One flushing test involving the stored stock was conducted during the winter of 1991-92. Seedlings were removed from both the Styrofoam and outdoor storage areas, thawed, potted, and placed in a green house. The underblanket stock all had good color with no damage, while some of the outdoor stock had dead terminal buds and desiccated tops.

Outplanting results. Third-year outplanting results from the black spruce seedlings overwintered under the Styrofoam® SM blanket and the same stock overwintered in conventional cold storage at the TBFN were nearly identical (figure 5). Even though the under blanket seedlings outplanted in this test came from the first overwintering period (which had less than ideal storage temperatures, see Discussion), outplant performance of all measured parameters (height, CAI, RCD, and survival) showed no differences from that of the frozen stored stock.

Discussion

During the first year of the trial, temperatures under the blanket were observed to hover around -0 /C (32 /F). This is too warm for seedling storage (Hocking and Nyland 1971, Zalasky 1986, Odlum 1992) and can

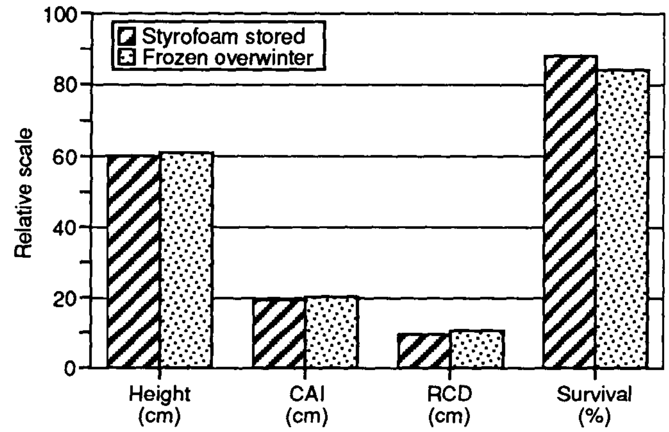

Figure 5—*Third-year outplanting results for black spruce seedlings grown in Styroblock 165's at Hodwitz Enterprises and overwintered under a Styrofoam® SM insulation blanket and in a conventional cold storage unit at the former Thunder Bay Forest Nursery. CAI = height increment, RCD = root collar diameter.*

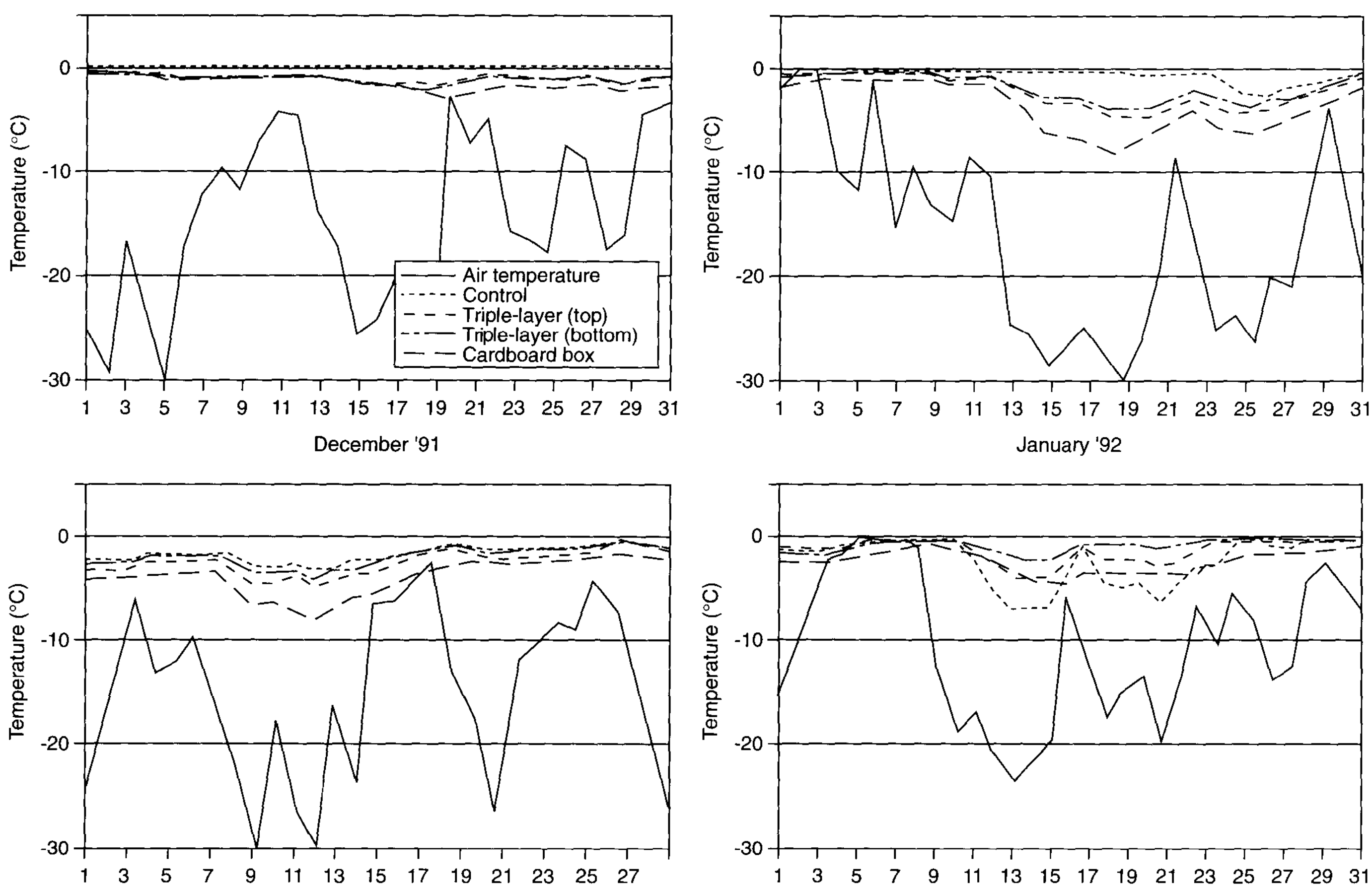

Figure 4—*Temperature fluctuations for outdoor stored Styroblock seedlings, compared to those under a Styrofoam® SM insulating blanket through the winter of 1991–92.*

promote mold growth. It resulted in excessive damage to seedlings touching the ground, where both temperature and humidity were higher.

Changing the structure of the storage area under the blanket in the second year, by stacking the trays three high (figure 2), changed the overwintering storage temperatures and provided a better balance between cold outside air temperatures and ground heat. The storage temperatures, although somewhat variable, ranged from -1 to -5 /C (30.2 to 23 /F). This range is closer to ideal for overwintering stock, and the stock came out of storage in the spring of 1992 looking extremely healthy (Duckett 1992, personal communication).

The reduced desiccation, reduced temperature fluctuation, and reduced seedling mortality observed in this test with the use of the Styrofoam structure mirror results of a similar trial in Alberta (Matwiend).

Constructing the final overwintering storage unit cost about Can$8,000.00, with minimal maintenance costs (Hodwitz 1992, personal communication). If storage unit construction costs are depreciated over 5 years, then overwinter storage costs are about Can$6.30 per thousand. This compares to 1991 capital and operating expenses of Can$26.50 per thousand for freezer storage (Aidelbaum 1993).

Over the winter of 1992-93, Hodwitz Enterprises stored about 1.2 to 1.3 million seedlings in the unit. Loading the unit took 10 nursery workers 3 days. Unloading took a similar amount of time.

The unit should remain sealed throughout the winter, but timing of the unloading of the unit in the spring is critical. Temperature probes should be placed inside the Styrofoam blanket unit (during the loading process in the fall) to monitor underblanket temperatures in the spring. As soon as underblanket temperatures rise and remain above freezing, the unit must be opened and unloaded to prevent the seedlings from overheating.

Conclusions

Outplanting performance did not differ between the underblanket and the frozen storage treatments. However, with potential cost savings of about Can$20.00 per thousand over freezer storage, the storing of Styroblock seedlings under a Styrofoam® SM blanket seems to be a practical and economical alternative to freezer storage. Outdoor storage of seedlings, which costs practically nothing, will continue to be used by nurseries. But this savings in overwinter storage must be weighed against the potential losses that can occur (i.e., annual losses of outdoor overwintered container stock can range between 1 and 3 million in northern Ontario, depending upon weather and seedling preconditioning (Duckett 1992, personal communication)). However, when selecting a system for overwinter storage of seedlings, numerous factors must be taken into account. These include elements of stock handling such as extraction, packaging, grading, transportation, field storage, and timing of flushing/ planting.

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