

# OVER WINTER COLD STORAGE OF RED AND WHITE PINE TRANSPLANTS SUCCESSFUL IN NORTHERN INDIANA

ROBERT D. WILLIAMS and RICHARD RAMBO <sup>1</sup>

Overwinter cold storage at the Jasper-Pulaski Nursery in northern Indiana kept red and white pine (*Pinus resinosa* Alt, and *P. strobus* L.) transplants in good condition for spring planting. However, survival of 2-0 red and white pine seedlings stored in the same manner was poor. Overwinter storage of such seedlings seems inadvisable.

Cold storage was tried at the northern Indiana nursery because the only other conifer-producing State nursery (in southern Indiana) was closed, and because soil in the northern nursery commonly is still frozen when seedlings are needed for early spring planting in the south. Deffenbacher and Wright (1) have reported getting excellent first-year survival of four western conifers that were kept 8 months in cold storage. So in Indiana, where the storage period will seldom exceed 4 months, survival of stored trees should be satisfactory once

<sup>1</sup> Associate Silviculturist, North Central Forest Experiment Station, Forest Service, USDA, Bedford, Ind., and Staff Forester in charge of State Nurseries, Indiana Division of Forestry, respectively.

adequate lifting schedules and storage techniques are developed.

## The Study

The purpose of the study was to find out what effects (1) lifting date, (2) age class of the stock, (3) storage method, and (4) watering schedule have on the survival of planting stock dug in late fall and held through the winter in cold storage.

Storage was in an earth-covered concrete building formerly used to store trees for short periods during the lifting and packing season. Storage temperature was held between 34 and 38 degrees F. by two thermostatically controlled condensers suspended from the ceiling. Air circulation was provided by two fans on each condenser. Humidity remained between 90 and 95 percent and was governed by the amount of moisture on the floor and in the tree-packing material.

On Nov. 13 and Dec. 3 the trees (2-0, 1-1, and 2-1 red pine and 2-0, 1-2, and 2-2 white pine) were lifted and prepared for storage. Half of the

trees were packed in burlap bales and half were placed in wooden bins. Trees of the three age classes of both species were packed together in bales of 5,000. Similar 500-tree mixtures of age classes and species were placed in each wooden bin. A 50-50 mixture of sphagnum moss and wood excelsior was used to retain moisture around the roots. The tops of the trees were exposed to the air by overlapping the roots at the center of the bale or bin. Half the stored trees were watered every 2 weeks and half every 4 weeks.

Stored trees, and check trees lifted March 28, were packed for shipping March 29, 1963. During the following week all trees were planted on three different sites in southern Indiana: (1) an abandoned red clover hay field, (2) an old field, and (3) coal strip-mined banks. The trees were planted in randomized blocks.

First-year survival at all locations was estimated in mid-June to eliminate confounding effects of dense weed competition and late summer drought. Only trees that had started new growth were considered alive.

### Results

Transplant stock of both species survived better than 20 seedlings (table 1). Survival of stored red pine was 70 percent for the 2-0 seedlings and 85 percent for the 2-1 transplants. Although survival differences were great, there was so much variation within age classes that only differences between the two extremes, 2-0 stored seedlings and spring-lifted 2-1 transplants, were statistically significant. These results indicate that 2-0 red pine should not be stored overwinter. Also, although differences were not statistically significant, results indicate that 2-1 red pine transplants are a better risk for cold storage than 1-1 -transplants.

TABLE 1.—June survival of cold-stored and spring-lifted red and white pine by stock age  
(IN PERCENT)

Age class	Red pine		White pine		
	Stored <sup>1</sup>	Spring lifted	Age class	Stored <sup>1</sup>	Spring lifted
2-0-----	70	93	2-0-----	63	93
1-1-----	72	87	1-2-----	86	98
2-1-----	85	97	2-2-----	87	95

<sup>1</sup> All stored trees were lifted Nov. 13 and packed in burlap bales. Spring-lifted trees were dug March 28.

Survival of stored white pine ranged from 63 percent for 2-0 seedlings to 87 percent for 2-2 transplants, and differences were significant at 1 percent. The poor survival of 2-0 white pine is unfortunate because seedlings of this age are normally planted in southern Indiana where stored stock is needed. These results show that 2-0 white pine seedlings should not be stored overwinter. A later lifting date, as mentioned later, might increase survival of stored seedlings.

Until more studies have been made and more information is available, only transplants of red and white pine should be lifted in the fall and held overwinter in cold storage.

### Lifting Dates

Lifting dates did not significantly affect survival of red pine (table 2). However, white pine lifted Dec. 3 and March 28 survived better than trees lifted Nov. 13, and differences were significant at 1 percent. Survival differences between white pine lifted Dec. 3 and March 28 were not statistical, significant.

In California, Stone and Schubert (2) found that survival of stored 1-1 ponderosa pine lifted at 2week intervals, beginning Sept. 15, increased after each 2-week delay in lifting until Nov. 1. Thereafter, until Dec. 1, there was no significant improvement. They conclude that poor survival of some cold-stored stock may be caused by a failure of the trees to achieve "physiological hardening" or "readiness" before being placed in storage.

TABLE 2.—June survival of red and white pine<sup>1</sup> by lifting date  
(IN PERCENT)

	November 13	December 3	March 28
2-1 Red pine----	85	81	88
1-2 White pine--	76	88	93

<sup>1</sup> All fall-lifted trees were stored in burlap bales.

In northern Indiana, red pine evidently is ready for fall lifting before white pine. Weather, especially fall frost, affects the physiological hardening of trees, so the best date for fall lifting probably varies from year to year. There is no known way to tell when conifers are ready to lift for cold storage, so nurserymen will have to learn through experience when the trees are ready. Since red pine had "hardened off" before white pine, it is likely that other species differ in the date that physiological hardening occurs. Until the best date for fall lifting is found for each species, nurserymen must rely on a "safe" date. Both fall-lifting dates tried were rather late, so it may be safe to lift red pine in northern Indiana earlier than Nov. 13. However, until more information becomes available, fall lifting should be delayed as long as practical.

#### Storage Methods and Watering Schedule

Survival was satisfactory for trees stored in bins or burlap bales but results varied by species (table 3). Red pine survival was best for trees stored in bins. In fact, red pine stored in bins survived as well as spring-lifted trees. Differences in survival between baled and bin-stored red pine were statistically significant at 5 percent. Ninety-four percent of red pine stored in bins survived while only 85 percent of the baled red pine survived.

There was no statistical difference in survival between white pine stored in bins or bales, but survival differences between stored and spring-lifted

**TABLE 3.—June survival of red and white pine by storage method (IN PERCENT)**

Species and age	Storage Method <sup>1</sup>		
	Bale	Bin	Spring lifted
2-1 Red pine.....	85	94	88
1-2 White pine.....	85	85	95

<sup>1</sup> All baled and bin-stored trees were lifted Nov. 13. Spring-lifted trees were dug March 28.

trees were significant at 5 percent. Survival of stored white pine probably would have been better if the trees had been lifted later. However, for the sites planted, survival of 85 percent of the stored trees was satisfactory.

Although it made little difference whether white pine was stored overwinter in bales or bins, the study showed that bin storage was somewhat better for red pine. If all trees are stored in bins, the stock can be graded as it is packed for shipment.

Stock watered every 4 weeks survived as well as stock watered every 2 weeks. Average survival for red pine watered every other week was 84 percent, and for stock watered every fourth week, 87 percent. White pine survival was 86 and 82 percent, respectively, for stock watered every 2 and 4 weeks.

No mold occurred in this study, even when trees were watered every 2 weeks, so watering stored stock every fourth week should be safe.

As a safeguard against mold, the storage room and shelves should be treated with a fumigant before trees are stored in the fall. As a further precaution, Eliason (3) recommends that storage shelves be made of metal and trees in bulk storage not be stacked over 20 inches high.

#### Literature Cited

1. Deffenbacher, Forrest W. and Wright, Ernest. 1954. Refrigerated storage of conifer seedlings in the Pacific Northwest. Jour. Forest. 52: 936-938.
2. Stone, E. C. and Schubert, G. H. 1959. The physiological condition of ponderosa pine (*Pinus ponderosa* Laws.) planting stock as it affects survival after cold storage. Jour. Forestry 57: 837-841.
3. Eliason, E. J. 1962. Damage in overwinter storage checked by reduced moisture. Tree Planters' Notes, No. 55: 5-7.