

# Storage of Southern pine seedlings: A Review

by

Hamlin L. Williston

Forest Management Specialist,  
Southeastern Area State and Private  
Forestry, USDA Forest Service

Whereas it used to be customary for the planting season to last from December 1 to March 1, planting now frequently lasts until the middle of May. The lengthened season has been due to the press of other work, labor shortages, occasional bad weather, and the discovery that one can plant in the spring months with good success. Thus, because southern pine seedlings are stored for longer periods than ever before, the tree planter should be aware of some of the critical storage factors that affect survival in the field. Following is a summary of what is now general practice with southern pine.

## Packaging

Most pine seedlings today are packaged either in (1) standard Forest Service bales consisting of two 1x2x24-inch wooden slats, a 2x6-foot wrapper, and two metal straps, or (2) kraft-polyethylene (K-P) bags. Packing mediums for both bales and bags are sphagnum moss, granulated peat moss, or a clay slurry dip; but sometimes no medium is used with KP bags.

Packaging in bales is cheaper, but when stored for longer than 1 week,

seedlings must be heeled in or, if held in a warehouse, the bales must be watered every 2 or 3 days (9). K-P bags do not need watering, but are costlier and need more careful handling because the bag tears more easily than the bale wrapper. Both should be stored on racks, with bundles no more than 3 feet high. Handling is easier if no more than 1,000 seedlings are packaged in each bale or bag.

Loblolly pine seedlings have been held in cold storage for as long as 12 weeks without adverse effect on first-year survival when packaged in K-P bags, with or without moss (16). Moss helped the survival of seedlings stored more than 8 weeks in the warehouse, but 1 pound was about as effective as 10 pounds. No moss appears to be needed in the bags for the first 8 weeks if the roots are moist when packed and the seedlings are kept cool (air temperature 60° F. or less).

A clay slurry dip was found to be as efficient as moss in maintaining seedling viability in one study (4). In fact, clay appears to have certain advantages over moss:

1. Clay-packed bales require no watering for at least 8 weeks after packing.
2. Clay lends itself to a mechanized planting operation better than does moss.
3. Clay protects seedling roots before and after planting.

## Temperature

Most refrigerated storage rooms are kept at 33°-40° F. with excellent results. In warehouse storage, temperatures fluctuate widely, ranging from subfreezing to 80° F. and higher. In April and May, when maximum daytime temperatures are consistently in the 80's, seedlings begin to spoil (16). First they become moldy, then the tops begin to rot. Although we know that temperatures of 118° F. for 2 hours are lethal to loblolly pine seedling roots (10), we have no reliable information on the effects of various temperature-time combinations lower than this.

Storage must protect seedlings from freezing as well as heating. In Tennessee, loblolly and shortleaf pine seedlings were stored at 34, 18, and 0 degrees for 12 hours, 36 hours, and 1 week (1). Exposure at the freezing temperatures for 12 hours reduced the survival of shortleaf 50 percent and that of loblolly 70 percent. Freezing for 36 hours and longer resulted in total mortality for both loblolly and shortleaf pine seedlings. In North Carolina, freezing at 20° F. for periods of up to 24 hours lowered the survival rate of slash and loblolly pines only slightly, but survival after 48 hours at this temperature was practically nil (6). Freezing at 20° F.

for periods of 6 to 12 hours substantially lowered the survival of longleaf, and freezing for 24 and 48 hours resulted in almost no survival.

Information from Louisiana (2) somewhat contradicts that from North Carolina and Tennessee. Slash and loblolly pine seedlings which had been subjected to temperatures of 20° F. for 48 hours had outplanting survival rates of 98 and 96 percent, respectively. Both species showed a very poor survival rate when subjected to 0° and 20° F. temperatures for longer than 48 hours. The differences in survival among States may be due to differences in the physiologic condition of the seedlings and in the outplanting situation.

#### Humidity

Relative humidity in cold storage units generally runs high, as it should. Many refrigeration units

recycle moisture back into the air in the storage room. In a cold storage room we know of, the humidity ranged from 40 to 100 percent and averaged about 77 percent. But Hocking (5) suggests that, because of the trend toward totally enclosing stock in waterproof wrappings,

precise humidity control may be less important than before.

#### Duration

Seedlings in K-P bags can be held in cold storage for at least 3 months without being packed in moss (12). But if stored in a warehouse for more than 4 weeks or after March 15, they should be packed with 1 pound of damp moss, well distributed among the roots. Even so, they should not be stored more than 8 weeks, and the bags should not be watered.

Forest Service bales packed with moss can also be held in cold storage for 3 months without special attention. Warehouse storage should be limited to 8 weeks, during which time the seedlings should be watered twice a week.

Where summer planting has been tried with slash pine, it has been determined (14) that outplanting should take place within a day after lifting from the nursery if possible; otherwise, refrigeration is needed. Storage of slash pine seedlings in Florida for 1 or 2 days during the summer did not affect survival, but seedlings stored for 4 to 6 days without refrigeration showed 15 to 30 percent reduction in survival rates (8).

Care must be taken in interpreting results of many studies involving storage of long duration. Early lifting (prior to complete dormancy) and late

planting (late May and June) may have caused the poor planting survival attributed to long term storage.

#### Other Considerations

Cold storage is the ideal but warehouse storage, properly attended to, is also satisfactory. Refrigerated railroad cars offer an excellent alternative to permanent cold storage units (15) (figs. 1 and 2). In underground storage units, temperature extremes are less than those in warehouses and, in one test with them better outplanting success resulted in one year out of two with seedlings stored longer than 4 weeks (3).

Burying seedlings in well-drained pits also has proven satisfactory for at least 6 weeks (11).

In some situations, it may be necessary to resort to heeling-in. Wakeley (13) had this to say about longleaf and slash pine: "Stock in good condition to start with can be heeled-in safely, during the ordinary winter planting season, for periods of at least 21 to 28 days .... Heeling in for periods as long as 70 days, especially toward the end of the planting season, may seriously reduce initial survival."



Figure 1.—Seedlings arriving for storage in refrigerated railroad car. Note lack of protective tarpaulin and no stickers between K-P bags.

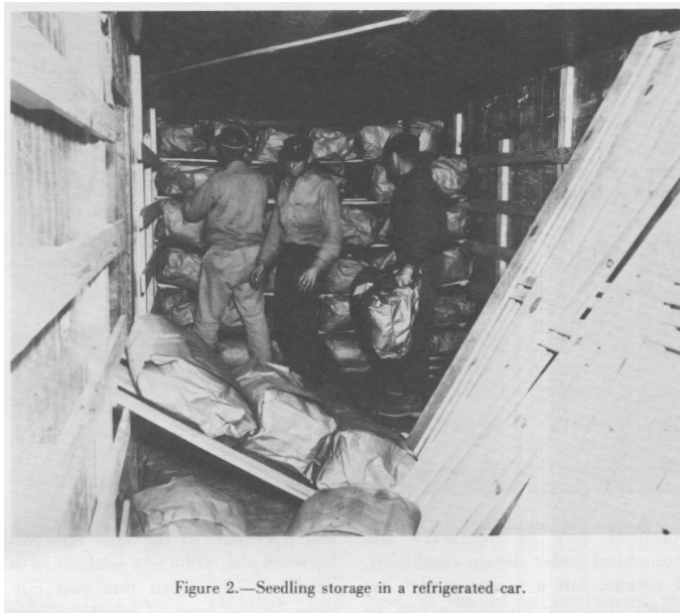


Figure 2.—Seedling storage in a refrigerated car.

It does seem likely that seedlings stored for long periods of time in heel-in beds would need heavier culling than seedlings stored in bales or bags (9). This writer had a disastrous experience outplanting loblolly pine seedlings that had been frozen in a sandy heeling-in bed for 10 days. Despite heavy culling before planting, less than 10 percent of the seedlings were alive at the end of the first growing season.

Seedlings that break dormancy while at the nursery or while in storage are still good planting risks. In northern Mississippi, mortality among nondormant loblolly seedlings, even when frost-nipped, averaged only 1 percent more than for seedlings planted while dormant (7). However, breaking of the tender terminals of nondormant seedlings will result in some loss in first-year height growth.

Package temperature should be monitored, even in a cold storage facility, because seedlings will heat. This is particularly true if packages are stacked too closely or too high. In one cold storage study, the temperature in the middle of the bags averaged 2° F. higher than just inside the bags and 6° F. higher than the air temperature outside the bag (15). Moisture helps prevent the seedlings from heating.

As in any efficient operation, frequent inspections are necessary. Constant attention to all factors involved in the storage operation will pay off in better outplanting survival and probably in greater first-year growth.

#### Literature Cited

1. Bean, S. D.  
1963. Can bundled seedlings survive freezing? *Tree Planters' Notes* 58:20, 21.

2. Byrd, R. B. and Peevy, C. E.  
1963. Freezing temperatures affect survival of planted loblolly and slash pine seedlings. *Tree Planters' Notes* 58:18, 19.
3. Dierauf, T. A. and Marler, R. L.  
1971. Effectiveness of an underground storage unit for loblolly pine seedlings. *Va. Div. For., Dep. Conserv. Econ. Dev., Occas. Rep.* 31: 10 p.
4. Hammer, J. G. and Broerman, F. S.  
1967. A comparison of three packaging methods for slash pine seedlings. *Tree Planters' Notes* 18(4): 3-4.
5. Hocking, D.  
1972. Nursery practices in cold storage of conifer seedlings in Canada and the United States: A survey. *Tree Planters' Notes* 23(2): 26-29.
6. Hodges, C. S.  
1961. Freezing lowers survival of three species of southern pines. *Tree Planters' Notes* 17: 23-24.
7. McClurkin, D. C.  
1962. Good survival of nondormant loblolly pine seedlings. *Tree Planters' Notes* 51:10.
8. Schultz, R. P. and Wilhite, L. P.  
1967. Operational summer planting of slash pine. I SDA, Forest Serv. Res. Note SE-80, 3 p.
9. Ursic, S. J.  
1956. Bale storage effective for loblolly pine seedlings. *J. For.* 54(12): 815-816.
10. Ursic, S. J.  
1961. Lethal root temperatures of 1-0 loblolly pine seedlings. *Tree Planters' Notes* 47: 25, 28.
11. Ursic, S. J.  
1961. Pit storage of baled loblolly seedlings. *Tree Planters' Notes* 45: 13, 14.
12. Ursic, S. J., Williston, H. L. and Burns, R. M.  
1966. Late planting improves loblolly survival. USDA Forest Serv. Res. Pap. S-121. 12p.
13. Wakeley, P. C.  
1954. Planting the southern pines. USDA Agric. Monogr. 18. 233 p.
14. Wilhite, L. P.  
1966. Summer planting of slash pine shows promise in Florida. USDA Forest Serv. Res. Pap. SE-23. 8 p.
15. Williston, H. L.  
1964. Refrigerated - car storage of loblolly pine seedlings highly successful. USDA Forest Serv. Res. Note SO-13. 3 p.
16. Williston, H. L.  
1965. Moss not needed in Kraft-polyethylene bags during loblolly pine seedling transport and cold storage. *Tree Planters' Notes* 72: 10-11.