Survival of Shortleaf Pine (*Pinus echinata* Mill.) Seedlings as Influenced by Nursery Handling and Storage

Charles R. Venator

Research p/ant physiologist, USDA Forest Service, Southern Forest Experiment Station, Pineville, LA

*Shortleaf pine (*Pinus echinata *Mill) seedlings were successfully established in the Ouachita Mountains when planted promptly after lifting. Five different handling and storage treatments were tested on December 10, 1980, January 10, 1981, and February 10, 1981. Survival rates of seedlings that were hand lined carefully were not significantly higher than those of seedlings that were liked operationally if the seedlings were planted with 48 hours of lifting. Second-year survival rates of seedlings planted within 48 hours of liking averaged 87 percent; the rates of seedlings stored for 30 days averaged 51 percent. The results show that seedlings liked in January and February should be planted as soon as possible after liking. Seedlings lifted in December survived adequately after 30 days of storage.* (Tree Planters' Notes 36 (4):17-19; 1985)

Shortleaf pine seedlings generally survive poorly when planted on the rocky, drier slopes of the Ouachita Mountains, and loss of 2-year-old seedlings to drought is not uncommon. Because of the rocky terrain, slope, and soil, machine planting shortleaf pine seedlings is difficult. Most of the trees are planted by hand with the use of a dibble bar. Because of the high costs of site preparation and planting in the Ouachita Mountains, it is critical to establish successful plantings on the first effort.

Field survival alone does not necessarily reflect the full capability of seedlings to become established and initiate vigorous growth (1). In addition to survival, rapid initiation of shoot and root growth increases the ability of seedlings to quickly overcome weed competition. Lifting, packing, transportation, storage, and planting techniques all influence seedling quality and the seedlings' subsequent capability to develop a strong root system.

Year-to-year variation in plantation survival is common. The most critical environmental factor affecting survival after outplanting is soil moisture. Seedling quality is the single most important biological factor for survival.

The objective of this study was to test whether extra care in nursery lifting and handling, time of lifting, length of seedling storage, and planting techniques affected survival of shortleaf pine seedlings planted in the Ouachita Mountains.

Materials and Methods

On December 10, 1980, shortleaf pine seedlings of morphological grades 1 and 2 (based upon Wakeley's 1954 classification) were carefully handlifted from the Weyerhaeuser Company Nursery in Magnolia, AK.

The seedlings were assigned to one of the following study treatments:
A. Controls-hand lifting and handling, with planting within 48 hours.
B. Normal operational handling, with planting within 48 hours.
C. Four hours' storage in tubs at ambient (45 + 10 °F) packing shed temperatures followed by normal handling, planting within 48 hours.
D. Normal handling plus 30 days' cold storage (36 °F).
E. Four hours' storage in tubs at the nursery followed by normal handling and 30 days' cold storage (36 °F).

For treatment A, root-zone soil was gently washed away to minimize root loss and every precaution was taken to handle the seedlings as gently as possible, with minimal exposure of roots to drying conditions. Immediately after lifting, seedlings were carefully packed for transport in sphagnum moss within bags. These seedlings were hand planted with dibbles on the Ouachita National Forest within 48 hours after lifting. This treatment served as the control for the treatments B, C, D, and E. These treatments were located on two sites near Mt. Ida and two sites near Mena, AK.

Seedlings were lifted on December 10, 1980, January 10, 1981, and February 10, 1981. Those kept in cold storage for 30 days were planted at the same time as those newly lifted the following month. Storage temperature was 36 °F throughout the study.

The four planting sites had been logged within the past 3 years. Burning the previous fall reduced weed and brush competition. Six 50-seedling rows were planted for

each of six replications in a completely randomized design. Spacing within and between rows was 2 feet.

Table 1—*Survival of shortleaf pine seedlings 2 years after planting at four sites in the Ouachita National Forest*

Lifting date & treatment[1]	Percent survival March 1983				Average[2]
	Mena A	Mena B	Mt. Ida A	Mt. Ida B	
December 10, 1980					
A	91	86	90	94	90 ± 3.3a
B	92	82	94	94	91 ± 5.6a
C	89	84	91	88	88 ± 3.2a
D	86	76	72	85	80 ± 6.9ab
E	81	74	50	54	65 ± 14.7bc
January 10, 1981					
A	89	87	90	91	89 ± 1.4a
B	87	79	90	93	87 ± 6.0a
C	85	85	85	90	86 ± 2.6ab
D	62	54	61	58	59 ± 3.6c
E	65	50	37	53	51 ± 11.2c
February 10, 1981					
A	84	82	94	93	88 ± 6.0a
B	85	75	96	92	87 ± 9.1a
C	78	67	91	89	81 ± 11.2ab
D	32	18	20	24	24 ± 6.4d
E	41	22	20	30	28 ± 9.5d

[1]A = control (handlifting, planting within 48 hours); B = normal operational handling, planting within 48 hours; C = 4 hours' storage in tub (45 ± 10 °F), normal handling, planting within 48 hours; D = normal handling, 30 days' cold storage (36 °F); E = 4 hours' storage in tubs, normal handling, 30 days' cold storage (36 °F).
[2]Values followed by different letters are significantly different $P < 0.05$) according to Duncan's multiple range test.

Results

Second-year survival of all seedlings lifted in December and planted within 48 hours was uniformly high, averaging 90 percent (table 1). Storage for 30 days resulted in lower survival rates. Seedlings of treatment D (Normal handling plus storage) averaged 80 percent, while those of treatment E (4 hours in tubs plus storage) averaged 65, indicating that the additional exposure is detrimental.)

All seedlings lifted in January and planted without storage had a uniformly high survival rate, averaging 87 percent (table 1). There were no significant differences in survival among treatments A, B, and C. Seedlings stored for 30 days prior to planting (D and E) had an average survival rate of 55 percent. Storage was clearly detrimental to successful establishment of seedlings lifted in January.

Greater differences in survival appeared among treatments in the February planting than in the earlier two outplantings. Treatments A, B, and C had survival rates equal to those of comparable treatments in December and January. The survival rates for seedlings stored for 30 days (D and E) averaged 26 percent, a great reduction.

Discussion

The results summarized here illustrate that shortleaf pine seedlings can be successfully established on the stressful sites found in the Ouachita Mountains if they are planted shortly after lifting. Statistical analysis did not reveal any significant differences in survival rates of seedlings given special handling and those that were lifted and graded normally if the seedlings were planted within 48 hours of lifting.

Shortleaf pine seedlings apparently do not store as well as expected from data on loblolly pine. The data show that the survival of shortleaf pine seedlings in cold storage is highly sensitive to the date of lifting. The mean survival rate for seedlings in treatment D lifted in December 1980 was 80 percent and 59 and 24 percent for those lifted in January and February 1981. This difference may reflect the shorter period for establishment before the spring drought for seedlings planted at the later dates. Mean survival of treatment E seedlings was low for all dates.

The poor survival of stored seedlings indicates that the seedlings lifted in January and February were

not physiologically capable of adjusting to storage following lifting or that the stored seedlings were not capable of initiating adequate root growth after storage. Drought following outplanting is always a serious problem in the Ouachita Mountains. Seedlings held in cold storage for 30 days after lifting have a greater ability to survive if outplanted early in the winter than if planted later in the planting season. Until additional studies establish optimum times for lifting and storing shortleaf pine seedlings, lengthy storage should be avoided. Lifting should be done immediately before planting.

Literature Cited

1. Venator, Charles R. Is it possible to defect-cull trees within 1 year after planting? Tree Planters' Notes: 34(2):26-27; 1983.
2. Wakeley, Phillip C. Planting the southern pines. Agric. Monogr. 18. Washington, DC: U.S. Department of Agriculture; 1954.