SURVIVAL AND HEIGHT GROWTH OF LOBLOLLY PINE SEEDLINGS AS INFLUENCED BY PACKING, STORAGE, AND DROUGHT

by

Charles R. Venator
and
John C. Brissette 1/

Abstract.--The effects of nursery packing and storage methods on survival and height growth of loblolly pine seedlings were analyzed over a 3-year period. No clear-cut statistically significant difference in survival was detected among either packing methods or storage methods. Seedling height growth was also not significantly affected by packing method or storage. Lack of adequate rainfall was far more detrimental to seedling survival and height growth during the first two growing seasons.

Additional keywords: nursery practice, Pinus taeda.

INTRODUCTION

Year to year variation in seedling survival in plantations is common, yet often unexplainable. Nursery site and culture, lifting date, planting date, length of exposure between lifting and packing, and numerous more subtle impacts--any of which may not be serious alone--are believed to cummulatively affect survival (Edgren 1980). However, **it is** generally believed that if recommended guidelines--such as those found in USDA Forest Service 1984--for lifting, handling, and storing hardened-off seedlings are followed, survival will be satisfactory.

Although many cultural techniques have been somewhat standardized, differences still exist that may result in significant survival differences among stock from different nurseries. Seedling packing and storage are practices where considerable differences exist. Three packing methods are commonly used in southern pine nurseries. These are: 1) Forest Service bales with moist sphagnum moss or peat moss packed around the roots, 2) Kraft-polyethylene (K-P) bags with clay slurry on the roots, and 3) K-P bags with 1 to 2 kilograms of water-saturated moss dispersed among the roots. Since the mid-1960's, the combination of K-P bags and clay slurry has become increasingly popular. Cold storage is recommended with each of these packing methods to maintain seedling dormancy and to avoid root rot and overheating (Williston 1974).

1/ Research Plant Physiologist and Research Forester, respectively, Southern Forest Experiment Station, Pineville, La.

Considerable research has been done over the past 50 years on how handling and packing affect pine seedlings. However, few clearcut conclusions can be made from reviewing the literature. One of the most serious obstacles in interpreting the impact of seedling handling techniques on survival is the lack of long-term studies. The impact of uncontrollable factors that change each year, such as climate and soil moisture, make it difficult to assess the importance of such controllable factors as packing method and length of storage. One planting survival study of note was reported by Ursic and others (1966). The study was repeated yearly between 1955 and 1963, but the variables examined--time of lifting, storage duration, time of planting, storage methods, packing methods and planting site--differed each year. Consequently, the 8-year study is actually a series of 1-year studies, each testing different variables that impact survival.

The objective of the present study was to test the effect of different handling, packing, and storage techniques on loblolly pine (Pinus taeda) seedling survival and growth over a 3-year period.

MATERIALS AND METHODS

Seedlings from the 1978-79 crop were grown at the Beauregard and Columbia nurseries in Louisiana and the W. W. Ashe Nursery in Mississippi. The seedlings were all from woods-run seed sources. Seeds were sown in separate replicated plots, and the seedlings were grown using the normal cultural practices of each nursery. Five treatments, combining various lifting, packing, and storing methods, were compared:

1. Careful hand lifting and immediate packing beside the nursery beds, then hand planted within 36 hours.

2. Normal lifting by field crews, packed after 4 hours in the packing shed, then hand planted within 36 hours.

3. Normal lifting and packing, storage at 3°C for 14 days.

4. Normal lifting and packing, storage at 3°C for 30 days.

5. Normal lifting and packing, storage at air (ambient) temperature for 30 days.

The actual packing method varied with nursery. At Ashe Nursery, the seedlings were packed in K-P bags and the roots were sprayed with a kaolin clay slurry. At the Beauregard Nursery, the seedlings were baled in wet sphagnum moss. The seedlings lifted from the Columbia Nursery were packed in K-P bags and kept moist by adding a large scoop of wet peat moss to the bag before sealing.

For the 1979-80 and 1980-81 planting seasons, seedlings were only lifted from the Ashe Nursery. However, the five treatments were all retained in the study and applied to the Ashe Nursery seedlings.

The seedlings were hand planted with dibbles on the J. K. Johnson Tract of the Palustris Experimental Forest in central Louisiana. The site had been chopped in 1977 and then burned prior to planting each year of the study. Four rows of 50-seedlings each were planted in replicated and randomized blocks for each treatment. Spacing was 0.6 meters within and between rows. Survival and height measurements were made two full growing seasons after the seedlings were planted. Analysis of variance was used to compare treatment means, and significance is reported at the 0.05 level.

RESULTS AND DISCUSSION

Second-year survival for all loblolly pine seedlings is summarized in table 1. For those planted in 1979, survival ranged from 72 to 94 percent fo the 15 different treatments, with the best survival seen in seedlings packed at Beauregard Nursery using the Forest Service bale with careful packing and handling (treatment 6). The next best survival, 92 percent, was for the seedlings lifted at the Ashe Nursery, packed in K-P bags with clay slurry on the roots, and cold stored for 14 days (treatment 3). The K-P bag/moist peat treatments (Columbia Nursery) were slightly inferior to the bale and K-P bag/clay slurry treatments--survival averaged 78 percent versus 87 and 85 per cent respectively. Since this packaging method was superior in both the 1980 and 1981 plantings, these first year results probably indicate a difference in planting stock quality rather than an effect of the packaging on survival.

The best performance among the 1980 planted stock, 77 percent survival, was obtained from the carefully handled seedlings packed in K-P bags with moist peat moss and planted within 36 hours after lifting (treatment 11). Th poorest survival, 20 percent, was treatment 4 (30 day cold-stored in bags wit clay slurry). Surprisingly, seedlings packed in K-P bags with peat and air stored for 30 days prior to planting had 61 percent survival, which, although low, was higher than several treatments that were planted within 36 hours after lifting.

Second year survival of seedlings lifted in 1981 ranged from 82 to 94 percent. Seedlings lifted and packed in K-P bags with moist peat moss had th most uniform survival, although there were no statistical differences among the means. Seedlings stored for 30 days at air-temperature before outplanting had survival rates comparable to those of carefully lifted and cold-stored seedlings.

Monthly rainfall data for the years 1979 to 1983 is summarized in table 2. A comparison of the rainfall data with survival clearly indicates that lack of rainfall had a major impact on survival and height growth of seedlings. In 1980 there were 5 consecutive, extremely dry months between April and October. Comparison of the monthly rainfall data for 1979 and 1981 shows there were no more than 2 consecutive months of rainfall substantially below normal. Thus, it appears that 2 months of below normal rainfall did no significantly affect survival. However, rainfall timing is also important, since an early drought before seedlings become established may be more damaging than a late season drought.

Table 1.--Second year survival of loblolly pine seedlings outplanted in central Louisiana for 3 consecutive years after various nursery handling and storage treatments

Treatment number	Lifting	Package/medium	Storage	Storage condition	Year planted [a] 1979	1980	1981	Mean
			--days--		--------% survival----------			
1	Careful	K-P Bag/clay slurry	None		83	45 bcde	91	73
2	Operational	K-P Bag/clay slurry	None		87	45 bcde	88	73
3	Operational	K-P Bag/clay slurry	14	Cold(3°C)	92	28 ab	90	70
4	Operational	K-P Bag/clay slurry	30	Cold(3°C)	82	20 a	82	61
5	Operational	K-P Bag/clay slurry	30	Air	80	36 bc	86	67
		Mean			85	35	87	69
6	Careful	Bale/peat moss	None		94	56 def	90	80
7	Operational	Bale/peat moss	None		87	48 cde	90	75
8	Operational	Bale/peat moss	14	Cold(3°C)	88	40 bcd	93	74
9	Operational	Bale/peat moss	30	Cold(3°C)	83	52 cde	84	73
10	Operational	Bale/peat moss	30	Air	85	46 cde	84	72
		Mean			87	48	88	75
11	Careful	K-P Bag/peat moss	None		81	77 g	94	84
12	Operational	K-P Bag/peat moss	None		80	71 fg	91	80
13	Operational	K-P Bag/peat moss	14	Cold(3°C)	78	70 fg	91	80
14	Operational	K-P Bag/peat moss	30	Cold(3°C)	80	44 bcde	90	71
15	Operational	K-P Bag/peat moss	30	Air	72	61 efg	91	75
		Mean			78	65	91	78

[a] Means followed by the same letter are not significantly different at the P=0.05 level. No differences were detected among the 1979 or 1981 planted stock.

Table 2.--Monthly rainfall for 1979-83, plus the 31-year means recorded at the J.K. Johnson Tract in central Louisiana[a/]

Month	1979	1980	1981	1982	1983	31-year mean
	cm					
January	23.8	15.6	4.8	5.8	19.3	12.4
February	22.6	9.8	7.4	6.4	11.2	10.7
March	6.1	17.1	10.5	7.9	14.0	10.5
April	14.7	14.1	2.9	10.3	19.9	11.9
May	12.7	0.3	10.2	3.2	24.8	14.3
June	0.5	1.3	18.9	10.7	19.4	9.1
July	10.9	3.8	11.6	7.4	1.1	10.6
August	4.9	2.3	3.0	8.9	11.3	9.9
September	7.4	5.1	2.3	15.0	21.2	9.4
October	4.7	11.4	10.8	7.1	0.0	7.7
November	30.9	9.7	7.6	27.7	16.8	12.4
December	3.3	4.6	8.8	29.2	16.4	15.1
Total	142.5	95.1	98.8	139.6	175.4	134.0

[a/] Data collected within 1.6 km of the outplantings that are summarized in tables 1 and 3.

Analysis of height growth data clearly show the negative effect of the prolonged drought of the summer of 1980 on first and second year seedling growth. The seedlings planted in 1980 had a mean height of only 49 cm after 2 years (table 3). Seedlings planted in 1979 averaged 62 cm at 2 years. These seedlings experienced the drought after having been in the field for 1 full year. Seedlings planted in 1981 and not drought stressed their first 2 years averaged 72 cm tall (table 3). Height growth differences for these years did not appear to follow any trend with handling, packing, or storage treatment.

Most reviews indicate that cold storage is best for seedlings (Hocking and Nyland 1971, Williston 1974). However, there are reports that seedlings can be successfully stored at ambient temperatures (Dierauf 1982, Broerman and Hamner 1966). It is commonly stated that baled seedlings store better than seedlings in K-P bags at ambient temperature. This is because of a greater potential buildup of undesirable respiratory products inside the sealed K-P bags than in the bales, which allow circulation among seedling tops. Although the 3-year data summarized in tables 1 and 3 do not support this assumption, it must be remembered that the mid-January lifted seedlings were well hardened off. No attempt was made to study the effect of storage at air temperature on early- or late-lifted seedlings.

Table 3.--Second year total height of loblolly pine seedlings outplanted in central Louisiana for 3 consecutive years after various nursery handling and storage treatments

Treatment number	Lifting	Package/medium	Storage	Storage condition	Year planted [a/] 1979	1980	1981	Mean
			---days---		----------height----------			
1	Careful	K-P Bag/clay slurry	None		54	55	71	60
2	Operational	K-P Bag/clay slurry	None		62	52	84	66
3	Operational	K-P Bag/clay slurry	14	Cold(3°C)	58	46	71	58
4	Operational	K-P Bag/clay slurry	30	Cold(3°C)	57	49	68	58
5	Operational	K-P Bag/clay slurry	30	Air	54	50	65	56
		Mean			57	50	72	60
6	Careful	Bale/peat moss	None		65	47	72	61
7	Operational	Bale/peat moss	None		66	52	88	69
8	Operational	Bale/peat moss	14	Cold(3°C)	64	47	77	63
9	Operational	Bale/peat moss	30	Cold(3°C)	63	48	68	60
10	Operational	Bale/peat moss	30	Air	66	44	67	59
		Mean			65	48	74	62
11	Careful	K-P Bag/peat moss	None		68	54	70	64
12	Operational	K-P Bag/peat moss	None		60	46	72	59
13	Operational	K-P Bag/peat moss	14	Cold(3°C)	62	51	70	61
14	Operational	K-P Bag/peat moss	30	Cold(3°C)	59	43	68	57
15	Operational	K-P Bag/peat moss	30	Air	65	48	71	61
		Mean			63	48	70	60

[a/] There were no statistical differences among treatment means within years.

CONCLUSIONS

Overall, there were no significant differences in survival or growth among the various packing and storage combinations studied. The survival results averaged over three consecutive planting seasons indicate that there is no individual packing and storage treatment that will consistently result in superior seedling survival. If any trend is apparent, it is that clay slurry did not improve survival when compared with either of the other two systems. The only suggestion of a superior quality seedling packing method was during the drought of 1980, when the seedlings planted that year that had been packed in K-P bags with moist peat had the best survival during the devastating 5-month drought. This should be interpreted with caution, however, since it is a single year response to drought.

Although the results do not indicate any clearcut superiority among the treatments studied, the data indicate some general trends. Careful handling is more important to survival than it is to height growth. Also, storage length is important, but cold storage is not crucial if the seedlings are dormant when lifted. The suppressed growth of first and second year seedlings during the 1980 drought supports the observations made in an unrelated study (Venator 1983) that drought stressed trees in a plantation will not perform as well as trees that have not been stressed and that this loss of vigor may continue for several years.

LITERATURE CITED

Broerman, F.S. and J. G. Hamner. 1966. More on packaging of planting stock. Woodland Research Notes No. 16, Union Bag-Camp Paper Corportion, Savannah, GA. 4 pp.

Dierauf, Thomas A. 1982. Planting loblolly pine. Symposium on the loblolly pine ecosystem (East Region). December 8-10, p. 124-125. N.C. State Univ. School Forest Res. and So. For. Exp. Sta., USDA.

Edgren, J. W. 1980. The reforestation system--a team effort. North American Forest Tree Nursery Soils Workshop. July 28-August 1.p. 12-20. State Univ. of New York, College of Env. Sci. and For., Syracuse, NY.

Hocking, Drake and Ralph D. Nyland. 1971. Cold storage of coniferous seedlings. Applied Forestry Research Institute Report No. 6, State Univ. College of For., Syracuse, NY 13210. 70 pp.

Ursic, S.J., H. L. Williston and R. M. Burns. 1966. Late planting improves loblolly survival. U.S. Forest Service Research Paper S0-24. 12 pp.

USDA-Forest Service. 1984. Guidelines for seedling care. USDA-Forest Service. National Forests in Miss. Booklet. 24 pp.

Venator, Charles R. 1983. Is it possible to detect cull trees within 1 year after planting? Tree Planters' Notes 34(2): 26-27.

Williston, Hamlin L. 1974. Storage of southern pine seedlings: a review. Tree Planters' Notes 25(4): 1-3.