NURSERY MORPHOLOGY OF LOBLOLLY PINES AS AN INDICATOR OF FIELD PERFORMANCE

Hoy C. Grigsby

Are easily identifiable morphological traits of nursery seedlings indicative of subsequent field performance? The study described here was designed to answer that question for loblolly pine (Pinus taeda L.). The value of a strongly affirmative answer is obvious. By sorting nursery stock, foresters would be able to establish plantations of trees with more uniform and perhaps more desirable features than heretofore. Results of the study do not suggest such striking possibilities, but some differences observed in the nursery were maintained in the field.

METHODS

Six distinctive and easily identifiable classes were set up for 1-0 loblolly pine seedlings in beds at an Arkansas Forestry Commission nursery in December (fig. 1):

Type 1. Normal winter bud not formed, no side branches, all needles primary.

Type 2. Terminal bud, no side branches, secondary needles of normal length. Typical 1-0 nursery seedling.

Type 3. Terminal bud, no side branches, secondary needles very long.

Type 4. Winter terminal and lateral buds formed and elongating, but no signs of buds breaking.

Type 5. Winter buds formed and open, shoots actively growing, tufts of short secondary needles formed at the tops of the buds. This phenomenon is known as lammas growth (Rudolph 1964).

Type 6. Terminal bud normal, at least one whorl of side branches present, secondary needles normal length. To eliminate possible confounding effects of additional growing space, no type 6 selections were made from isolated areas or from the border rows of beds.

1/ The author is on the staff of the Institute of Forest Genetics, Gulfport, Mississippi, and is located at Crossett, Arkansas, as an Associate Plant Geneticist. The author expresses appreciation to Roland E. Schoenike, Associate Professor, Department of Forestry, Clemson University, for planning the study.

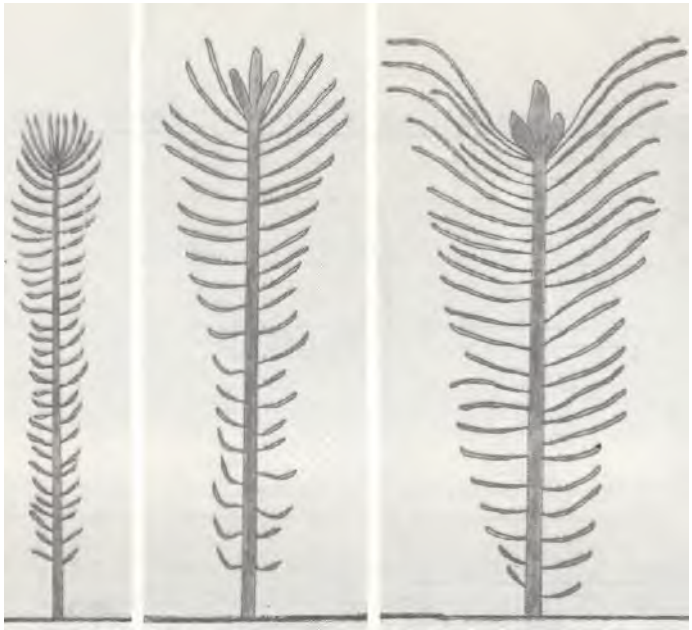

Figure 1.--Six types of 1-0 loblolly pine seedlings in December.

This numbering system arranges the seedlings in the order of apparent maturity at the time of selection. Type 1 is the least developed and type 6 the most fully developed.

About 5 million seedlings from local seed were observed in the nursery to obtain 504 trees--84 of each of the six types. Only seedlings conforming exactly to type description were selected. Observations in other nurseries have shown that all types occur frequently in loblolly pine beds. Twenty-one trees of each type were planted in randomized row-plots in four replications. The plantation was established in January 1958.

Trees were observed at the end of the third, seventh, and tenth growing seasons. At these times survival, height, number of branch whorls, number of branches per whorl, crown width, number of needles per fascicle, and length of needles were recorded. D.b.h. was measured only at the end of 10 years. Total cubic-foot volume inside bark was computed at age 10 by an equation from Schmitt and. Bower (1970). All data were subjected to analysis of variance for randomized block design, and significant differences among means were determined at the 0.05 level of probability by Duncan's multiple range test (Duncan 1955).

RESULTS

Survival.--At age 10, survival by seedling type ranged from 75 to 82 percent (table 1). Types 1 and 2, the least developed at the time of planting, along with type 4, had the greatest survival. Type 5, which had the largest spurt of late growth, had the poorest survival.

Table 1.--Survival, by seedling type, at ages 3 and 10

Age	Seedling type					
	1	2	3	4	5	6
	Percent					
3	92	86	87	87	83	82
10	82	82	8o	82	75	8o

Branch number and length.--Type 6 seedlings, which were the only ones with at least one whorl of branches at the time of selection, had the greatest number of whorls throughout the study (table 2). Types 6 and 4 had significantly more whorls than type 1 after 10 years.

Table 2.--Branch whorls and branch number at age 10

Seedling type	Whorls per tree	Branches per whorl	Branches per tree
		Av. number	
1	14.35	4.78	68.59
2	15.94	4.66	74.28
3	16.05	4.6o	73.83
4	15.94	4.84	77.15
5	16.80	4.56	76.61
6	16.87	4.7o	79.29

Type 4, the fastest grower (table 3), had the highest number of branches per whorl and type 5 had the lowest. Type 6, which maintained the greatest number of whorls, was intermediate in number of branches per whorl (table 2). Type 1, the lowest in d.b.h. and next to the lowest in height, had next to the highest number of branches per whorl.

Table 3.--Relationship of crown width to tree height, diameter, and volume at age 10

Seedling type	Height	D.b.h.	Volume[1/]	Crown width		
				Overall width	Per foot of height	Per inch of diameter
	Feet	Inches	Cu. ft.	Feet	Feet	Feet
1	28.67	4.88	1.465	12.19	0.4252	2.498
2	28.50	4.96	1.504	11.92	.4126	2.403
5	29.22	5.21	1.696	13.52	.4627	2.595
6	29.74	5.43	1.871	13.02	.4378	2.398
3	30.18	5.74	2.117	13.73	.4549	2.392
4	31.40	5.88	2.308	14.31	.4557	2.434

1/ Schmitt and Bower (1970), $V = 0.03789 + 0.0020911\ d^2h$.

Type 6, which developed branches while in the nursery bed, had the greatest number of branches. Even though type 1 seedlings grew slowly and had the least number of branches, there appeared to be little relationship between total number of branches and vigor.

Crown width was considered a measure of relative branch length at age 10. Average width varied from 14.3 feet for trees from seedling type 4 to 11.9 feet for type 2 (table 3). Types 4 and 3 had significantly greater width than types 1 and 2.

Crown width was significantly correlated with height growth ($r = 0.91$), with d.b.h. growth ($r = 0.91$), and thus with volume. On the basis of crown width per foot of height and per inch of d.b.h., trees from seedling type 5 had the greatest spread. It should be noted, however, that this type had the poorest survival and therefore the greatest growing space.

Needle length.--To test the variation in needles, several fascicles were examined on each tree. Differences in needle length existed at the time of selection, but at age 10 these differences were not significant and bore no relationship to growth or form.

Height, diameter, and volume.--The pattern of height growth during the 10-year period was fairly stable. Trees from seedling types 4 and 3 kept the number one number two spots, respectively, throughout the study. Types 5 and 6 have switched back and forth for third and fourth positions, and types 1 and 2 have done the same for fifth and sixth positions (table 3). At age 10, type 4 was significantly taller than 5, 1, and 2. Since the survival of type 4 seedlings was among the highest, height differences cannot be accounted for by growing-space differences.

D.b.h. differences, as expected, were similar to height differences at age 10, but were more pronounced. Between the largest and smallest seedling types there was a diameter difference of 17.0 percent and a height difference of 8.7 percent. Types 4 and 3 had significantly greater diameters than types 2 and 1. The difference between the averages for types with the smallest and largest diameter was exactly 1 inch (table 3).

Volumes ranged from 1.47 cubic feet per tree for seedling type 1 to 2.31 cubic feet for type 4 at age 10 (table 3). The volume of type 4 was significantly greater than those of types 5, 2, and 1, and volume of type 3 was significantly greater than those of 2 and 1.

DISCUSSION AND CONCLUSIONS

Trees from seedling type 5, which exhibited lammas growth in the nursery, had the poorest initial survival and were among the three poorest selections in terms of volume production. Romberger (1963) states that long buds or late shoots are triggered by a secondary increase in auxin yield. Whatever the cause, Rudolph (1964) working with jack pine (Pinus banksiana Lamb.) in the Lake States, concluded that trees with late shoots should be avoided in collecting seeds. The results of the present study indicate that loblolly pine seedlings with late shoots are undesirable if the condition is pronounced enough to produce lammas growth.

Some late growth appeared to be beneficial, however. Trees from seedling type 4, whose buds were elongated, were the fastest growing selections in terms of volume. Type 3, in which buds remained dormant after they were set, also grew well. Types 1 and 2, the least developed seedlings at the time of selection, grew slowest.

Survival at age 3 was correlated with seedling development at the time of selection. Types 1 and 2 apparently suffered less shock in transplanting, for they survived better than types 5 and 6, the most fully developed seedlings.

Limby seedlings (type 6) produced limby trees, and the extra branches did not appear to result in either broader crowns or more rapid growth than in other trees.

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