An Evaluation of Growth and Form in 5-Year-Old Open Pollinated Progeny From Selected Loblolly Pine

by

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Resume

Five year old open pollinated progeny of six loblolly pines selected for outstanding quality were compared with progeny from rough, mostly open grown check trees. Comparisons were made of height, d. b. h. , limb length, limb diameter, limb angle and bole straightness. Progeny of two of the selections were no better than their respective checks in any of these characteristics. The remaining selected trees had progeny significantly better than checks in one or more characteristics but none were better in all characteristics.

The need for careful statistical design, adequate measurements, sufficient time for plants to express certain characteristics, the need for uniform controls, and the limitations of open pollinated progeny tests are discussed.

Introduction

The selection of outstanding trees to serve as parental stock has been proposed as one of the major methods of accomplishing forest tree improvement and probably every public and private tree improvement program has made some selections of this nature. The only test of the value of these selections as sources of seed for reforestation is the performance of their progeny. In this paper such a test of loblolly pines selected as outstanding is discussed.

Present Study

During the summer of 1951 a few "superior" pines were selected from a number of trees reported as outstanding by Texas Forest Service personnel throughout East Texas. The second selection was entirely subjective and was made on the basis of apparent superiority to other trees in the vicinity, using as criteria stem form, natural pruning, relative height, and such crown characteristics as limb length, limb angle and limb diameter.

1/ Texas Forest Service, College Station,Texas

2/ A. J. Hodges Industries, Many, La.

Among the trees selected were six loblolly pines from widely scattered locations as indicated on the map (Figure 1). Three "commercial collection" type trees in the general vicinity of each selected tree were chosen as checks 1/. Check trees were mostly open grown with large crowns, short clear boles and abundant cone production - the type tree a commercial cone collector paid by the bushel would favor. The trees were not the same age nor growing under the same stand conditions as the select trees.

Seedlings from open pollinated cones of select and check trees were out-planted in December, 1952, at the Arthur Temple Sr. Research Area near Alto, Texas, and at A. J. Hodges experimental area near Many, La. Unfortunately, due to extreme drought during 1953 and 1954 the planting at the Temple Research Area was almost completely lost. Survival in the Hodges area was more satisfactory, ranging from 60 to 83 per cent after five years in the field.

The site near Many, La. is fairly good. It is located on an old bottomland field. The top soil is a sandy loam 16 to 20 inches deep grading into a whitish mottled clay with rather poor drainage. Measurements of loblolly pine timber adjacent to the field indicate a site index of approximately 95 feet.

Two replications of each source were planted at the Many site. In each replication trees from each source were planted in 100 tree plots, ten rows of ten trees, at a spacing of 7 x 7 feet. Plot locations were randomly assigned selected trees with the respective check trees assigned to adjacent plots.

Periodic height measurements of the interior eight rows of eight trees have been recorded, the exterior plants serving as buffers. At the end of the fifth growing season after out-planting, both height and d. b. h. of all measurement trees were recorded. In addition, as an indication of form, the length, diameter and angle of the largest limb of the second and third major whorls as well as the stem diameters immediately above the whorls in question were measured (Figure 2, 3).

Results

Height Growth - Results of periodic measurements are summarized in Table 1. While it is evident that there has been considerable shifting of relative position in ranking of mean heights from year to year, various progeny means tend to remain either in the upper or lower portion of the range. The most notable exception is the progressively higher ranking of S62, progeny heights from seventh to first.

1/ The same check trees were used for the two select trees in the same county.


OKLAHOMA
RED RIVER
BOWIE
FRANKLIN
TITUS
MORRIS
CASS
CAMP
WOOD
UPSHUR
MARION
VAN ZANDT
HARRISON
GREGG
SMITH
HENDERSON
PANOLA
RUSK
CHEROKEE
SHELBY
ANDERSON
FREESTONE
Many
NACOGDOCHES
LOUISIANA
SAN AUGUSTINE
SABINE
HOUSTON
LEON
ANGELINA
TRINITY
MADISON
POLK
TYLER
WALKER
JASPER
NEWTON
SAN JACINTO
GRIMES
MONTGOMERY
HARDIN
LIBERTY
ORANGE
WALLER
HARRIS
JEFFERSON
CHAMBERS

Table 1. Average Heights of Progenies of Select and Check Loblolly Pines During First Five Years in the Field.

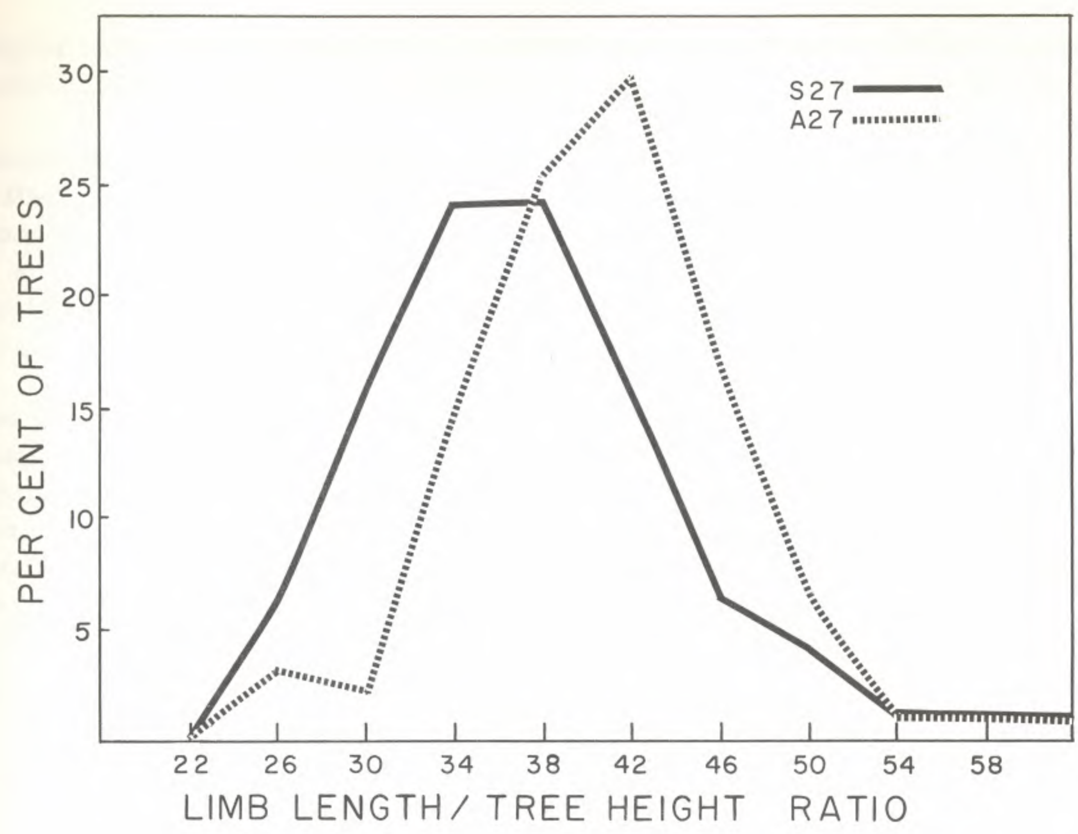
	First Year		Second Year		Third Year		Fifth Year	
Parent Tree 1/	Ht. (cm)	Rank	Ht. (cm)	Rank	Ht. (cm)	Rank	Ht. (cm)	Rank
S62	24	7	66	5	152	3	435**	1
S47	27	4	68	4	156	1	419	2
A110	28	3	68	2	148	4	412	3
S27	29	2	71	1	156	2	406**	4
S61	29	1	64	6	141	5	403	5
A47	23	9	58	10	135	8	403	6
A35	23	8	64	7	139	7	394	7
A61	19	11	55	11	127	11	392	8
S35	20	10	57	8	131	9	384	9
A27	26	5	68	3	141	6	380	10
S110	24	6	61	9	130	10	375	11

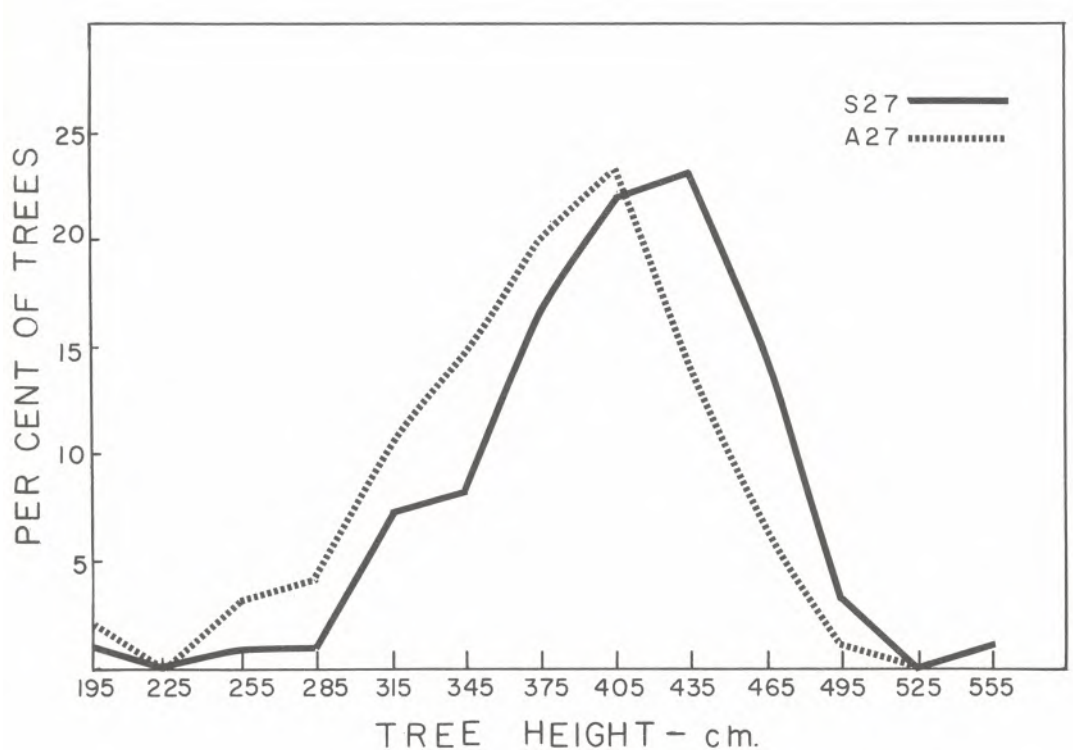
1/ S in parent tree designation signifies select tree, A signifies check.
**Significantly better than respective check at 1% level.

It is of interest to note that four of the six groups with the greatest mean height are progenies of select trees. However, it should also be pointed out that the greatest difference in mean heights at the end of the fifth year is 60 cm., about two feet. It is pertinent to ask if these are real differences. Because the parent trees are located from the Oklahoma border to near the coastal prairies of Texas on a variety of sites, and because it did not seem advisable to compare progeny of one select tree with the progeny of check trees from a widely different location, the progeny of each select tree was analysed with only the progeny of other trees from the same area. On this basis, in only two cases were the mean heights of superior tree progenies better than the respective check tree progenies. The next figure illustrates the shift of the population curves in one of these comparisons (Figure 4).

Diameter Growth - While there is a considerable range in diameter at breast height of individual trees in this study and as much as one half inch difference between means, the variation within progenies of one mother tree was so large that in only one case was there a significant difference between select and check trees.

Limb Diameter - By measuring only two limbs per tree, and these the largest on each of the two largest whorls for trees of this age, the average


PER CENT OF TREES
30
25
20
15
10
5
S27
A27
22 26 30 34 38 42 46 50 54 58
LIMB LENGTH/ TREE HEIGHT RATIO


PER CENT OF TREES
25
20
15
10
5
S27
A27
195 225 255 285 315 345 375 405 435 465 495 525 555
TREE HEIGHT - cm.

limb size is by no means indicated. However, measurement of the largest limbs should indicate a potential for development of large or small limbs.

While there were no significant differences between means of absolute limb size of any of the superior and check tree comparisons, it was felt that a better indication of relative limb size would be the ratio of limb diameter to bole diameter at the level of the limb. The mean limb diameter bole diameter ratio of progenies from three of the select trees were significantly lower than their checks.

Limb Length - As was the case with limb diameter, there were no significant differences in absolute limb length between select tree progenies and their checks. As an indication of relative limb length, the ratio limb length/total tree height was calculated for each tree. The mean limb length/ tree height ratio of three of the select trees were significantly lower than their respective checks. Figure 5 indicates the trend for progeny of one select tree to have shorter limbs for a given height than progeny of its check trees.

Limb Angle m There was high variability and no significant differences between mean limb angles of select and check trees.

Bole Form m All trees of the progeny test were classified as straight, slightly crooked and very crooked, and any forking was recorded. Very few trees were found that fell in the very crooked or forked category and in most of these cases some environmental causes such. as insect attack or broken leader was evident. There were no indications of inherent tendencies toward poor bole form in either select or check tree progenies.

Discussion

In Table 2 a summary of the results discussed above is presented. None of the select tree progenies are better than those of their check trees in all characteristics and two of them are in no way superior to the checks. There are several possible reasons for this situation, all of which may have some bearing.

First, the select trees may be no better than the checks genotypically. Selection techniques have been greatly revised since these selections were made and several methods are now in use which take more factors into consideration and attempt to reduce subjectivity in selections. In addition, the check trees were of different age and grown under different stand conditions than the select trees. It is entirely possible that the check trees might have developed a much more satisfactory bole and crown form had they been subjected to normal competition and no valid comparison of growth rates of select and check trees is possible. But no matter what selection criteria are used nor how high the degree of selectivity, it is only the phenotype that is being

Table 2. Comparisons of Means of Select and Check Tree Progenies for Four Characteristics

Parent Tree	Progeny Means			
	DBH (cm)	Ht. (cm)	LD/BD[1/]	LL/Ht.[2/]
S27	6.1	406**	31.1*	37.4**
A27	5.6	380	33.3	40.3
S35	5.1	384	29.9	38.1**
A35	5.3	394	31.2	42.6
S47	5.6	419	31.0	37.1
A47	5.3	403	29.4	37.6
S61	5.6	403	28.6**	35.8**
S62	6.4	435**	29.7**	38.4
A61	5.6	392	31.3	39.8
S110	5.6	375	32.2	37.2
A110	6.1	412	30.8	37.7

*Significantly different from check at 5% level.

**Significantly different from check at l% level (highly significant).

1/ Limb diameter/bole diameter ratio.

2/ Limb length/tree height ratio.

judged. Possibly all desirable characteristics of forest trees are more or less drastically influenced by environment and if 60 percent or more of our selections pass on desirable traits to their offspring we might consider our selection technique successful.

Second, it may be too soon to detect some real differences between select and check tree progenies. After five years in the field these trees are just reaching their stage of most rapid height growth,and substantial diameter growth is some years in the future. Present differences in height and diameter may be widened or entirely changed in the future. However impatient we may be to assess the potential value of a selected tree as a future source of seed, it may not be advisable to make a final decision at this stage.

The design of the test or the measurements recorded may not be sensitive enough to detect real differences among the various sources. More replications and more measurements may be desirable. However, it must be considered that each replication in this small test required approximately 1 1/4 acres. With numerous selections to be tested, not only initial planting area and expense, but also subsequent measurements must be considered. Some limitations must be placed on the amount of data collected per tree with hundreds of individuals to be measured. This points out that very careful experimental design is required if the maximum amount of information is to be obtained from the space and labor available for the job.

Another and probably a major reason for the relatively small differences between the progenies of the select and check trees is the fact that both resulted from open pollination. After all, the mother trees furnished only 1/2 of the germplasm of their progenies. The expression of any particular economic characteristic of forest trees is most probably influenced by many genes. With such multiple factors the mean expression of a character should be expected to fall near the mean. of the two parents. With numerous pollen parents, some of which may be very poor, the mean of the progenies cannot be far above the population average even though weighted to the side of the good mother tree. If we also consider that these characteristics are influenced by environment, in some cases to a large degree, it is obvious that some genotypic difference between the progenies of select and check trees will not be detected. This is a major limitation of open pollinated progeny tests and a strong point in favor of controlled pollinations.

In Table 3, parent trees have been ranked from best to poorest according to the means of their progenies for various characteristics. The survival percentage for each source has been included to indicate the lack of relationship between survival and any of the characteristics considered. In some cases the progeny of select trees were significantly better than the progeny of their check trees but ranked lower for that character than other check trees. These tests indicate possible inherent differences in the characters studied. They do not necessarily indicate the degree of improvement that would be attained by using the selected trees in seed orchards.

This points out the need for a common control to which all selections for a given area could be compared. As we are trying to improve the genetic quality of seedlings produced by state or company nurseries, it might be suggested that nursery run seedlings be used as controls. While this has some obvious advantages, there may be considerable variation in the quality of nursery run seedlings from year to year - even wide variation in seed source. The authors propose to use progeny of several trees in a seed production area as controls for future tests of selected trees. As the supply of seeds from these trees can be replenished as required, such seedlings could

Table 3. Ranking of Means of Select and Check Tree Progenies for Five Characteristics

Parent Tree	DBH (cm)	Parent Tree	LD/BD	Parent Tree	Ht. (m)
S62	6.4	S61	28.6	S62	4.35
S27	6.1	A47	29.4	S47	4.19
A110	6.1	S62	29.7	A110	4.12
S110	5.6	S35	29.9	S27	4.06
S47	5.6	A110	30.8	S61	4.03
S61	5.6	S47	31.0	A47	4.03
A27	5.6	S27	31.0	A35	3.94
A61	5.6	A35	31.2	A61	3.92
A35	5.3	A61	31.3	S35	3.84
A47	5.3	S110	32.2	A27	3.80
S35	5.1	A27	33.3	S110	3.75

Parent Tree	LL/Ht.	Parent Tree	Survival
S61	35.8	S110	83.5
S47	37.1	A35	78.1
S110	37.2	S27	75.7
S27	37.4	A27	74.2
A47	37.6	S62	74.1
A110	37.7	S35	72.6
S35	38.1	A61	69.5
S62	38.4	S61	64.8
A61	39.8	S47	62.4
A27	40.3	A110	61.7
A35	42.6	A47	60.1

serve as a basis of comparison of test plantings in various locations and years. Seedlings from seed production area trees may be of superior genetic quality to a hypothetical "average nursery run" seedling, but if careful selection shows improvement over them, improvement over nursery run trees is certainly indicated.