Five-Year Results of the Southwide Pine Seed Source Study

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It is still too early to delimit the southern pine seed-collecting zones that the Southwide Pine Seed Source Study is designed to map. Only 53 percent of the trees in the study have been 5 years in plantation. In many of even the older plantations, survival and growth are still undergoing rapid modification by brown spot, tip moth, or fusiform rust. Any conclusion regarding general patterns of racial variation and the influences from which they have originated would be premature. It would be the height of impropriety to immortalize such conclusions in the proceedings of this Conference. They might distrub or even mislead planting agencies, and would surely be quoted here and abroad and remain in the literature to haunt us forevermore. This report is therefore limited to incontrovertible facts that cannot becloud later issues.

First and foremost of these facts is the status of the study itself.

The study was proposed and undertaken at the First Southern Conference on Forest Tree Improvement, at Atlanta, in January 1951, partly in view of the need for the information it would yield, partly in view of the opportunity offered by the general seed crop due to mature the following fall.

Active preparations started in July 1951. Seed was collected in 1951 and again in 1952. In 1952-53 and 1953-54, hundreds of individuals in dozens of agencies in 16 States cooperated in establishing 9 test plantations of slash pine and 19 plantations apiece of longleaf, loblolly, and shortleaf (table 1). These were installed in accordance with the study working plan of September 12, 1952.

A principal feature of the study is that at or near each source of seed, stock representing that source is tested in comparison with stock representing several other sources of the same species. The study does not, however, test every source at every other source. To keep seed requirements and and plantation layouts within bounds, sources were grouped in "series" to test hypotheses regarding the effects of temperature, evapotranspiration rate, gross soil differences, and plant migration upon the evolution of geographic races. Series within species are linked together by inclusion of certain sources that they share in common, and plantations representing both series

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Table 1. Status of Southwide Pine Seed Source Study as of June 1, 1959 1/

Date of plantation establishment, and species	Plantations				Plots				Measurement trees 2/				All trees, including border rows 2/			
	Active	Doubtful	Abandoned	Total	Active	Doubtful	Abandoned	Total	Active	Doubtful	Abandoned	Total	Active	Doubtful	Abandoned	Total
1952-53; 1953-54																
Longleaf pine	10	-	9	19	228	-	216	444	11,172	-	10,584	21,756	27,588	-	26,136	53,724
Slash pine	8	1	-	9	174	28	-	202	8,526	1,372	-	9,898	21,054	3,388	-	24,442
Loblolly pine	18	-	3/ 1	19	588	-	3/ 36	624	28,812	-	3/ 1,764	30,576	71,148	-	3/ 4,356	75,504
Shortleaf pine	12	2	5	19	312	52	120	484	15,288	2,543	5,880	23,716	37,752	6,292	14,520	58,564
Subtotal, all species	48	3	15	66	1,302	80	372	1,754	63,798	3,920	18,228	85,946	157,542	9,680	45,012	212,234
1956-57																
Longleaf pine	28	1	-	29	666	24	-	690	32,634	1,176	-	33,810	80,586	2,904	-	83,490
Shortleaf pine	32	1	-	33	812	24	-	836	39,788	1,176	-	40,964	98,252	2,904	-	101,156
Subtotals, both species	60	2	-	62	1,478	48	-	1,526	72,422	2,352	-	74,774	178,838	5,808	-	184,646
Grand total, all years and species	108	5	15	128	2,780	128	372	3,280	136,220	6,272	18,228	160,720	336,380	15,488	45,012	396,880

1/ Exclusive of plantations lost and replaced the next year by means of seed from the same crop, and of certain side studies and supplementary plots.

2/ Approximate numbers planted, including trees that have subsequently died.

3/ Destroyed by incendiary fire shortly after 5-year reexamination.

have been established in the vicinity of such common or "link" sources.

Adverse influences, particularly the 1953 and 1954 droughts, depleted or destroyed so many of the original longleaf and shortleaf plantations that, with the concurrence and help of the original and many new cooperators, more seed of these 2 species was collected in 1955 and 29 new longleaf and 33 new shortleaf plantations were established in 1956-57. The series represented in these new plantations paralleled as closely as possible, although they did not exactly duplicate, the original series of the same species.

To date, 128 plantations, including 3, 280 plots, about 161, 000 "measurement" trees, and nearly 400, 000 trees in all, have been established in the course of the study. These totals exclude several side studies and several plantations reestablished a year late with, stock from seed carried over as insurance.

As of today, 15 plantations have been abandoned, but 14 have been replaced with later plantations. The status of 5 plantations is in doubt. On the list for further reexamination are 108 plantations, all of which have already been remeasured at least twice (during spring and fall of the first year) and 48 of which have been remeasured 4 or more times. These active plantations are not all equally suitable for the purposes of the study; some have been marred by accidents, or are on sites less uniform than might be desired, or have suffered enough mortality to reduce their effectiveness for evaluating infection, infestation, and growth. The majority are quite satisfactory, however, and some are outstandingly successful. As a group, the 108 active plantations, which contain 2, 780 separate plots and 136, 000 measurement trees, are of tremendous research value. They constitute an accomplishment of which the cooperators and the forestry profession may well be proud.

One of the clearest, most interesting, and economically most important results of the study to date is evidence of racial variation of loblolly pine, significant at the 5-percent level and in some instances at the 1-percent level, in susceptibility to southern fusiform rust. The findings confirm and extend the results of racial-variation studies of loblolly based on seed from the 1925 2/ and 1935 3/ crops. As they form the main theme of the next paper on this program, I will leave the details to be presented by Dr. Henry.

Differences in fifth-year survival, attributable to geographic source of seed and significant at the 1-percent level, have shown up in all 4 species in this study. They have not appeared in all series of each species, or in

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2/ Wakeley, Philip C. 1954. Planting the southern pine. U. S. Dept. Agr. Agr. Monog. 18, pp. 14-16.

3/Wakeley, Philip C. 19510 Importance of geographic strains. In Report 1st So. Conf. Forest Tree Improvement, 9 pp. (Processed.)

every plantation of any one series. Attempts to elucidate a pattern must await further analysis, including covariance analyses of the effects of latitude, longitude, elevation, temperature, seasonal and annual rainfall, extent of rust infection, and distance of plantation from seed source. It may be, also, that fifth-year survival of trees alive at the end of the first year will be more revealing than absolute survival, which in many cases has obviously been affected by nursery treatment, site variation, and first-year drought. The following examples, however, illustrate the type of variation in survival which has appeared so far.

Loblolly Series 1 represents Somerset County, Maryland; Onslow, North Carolina; Pamlico, North Carolina; Wilcox (and adjacent Crisp), Georgia; Cullman, Alabama; Jefferson, Alabama; Livingston Parish, Louisiana; Angelina County, Texas; and Clark County, Arkansas. The series was planted in Worcester County, Maryland. Survivals after 5 years (transformed to arc sin percent for analysis) varied at better than the 1-percent level of significance. They ranged downward from 96 to 76 percent. While the local (Somerset County, Maryland) source was fifth from highest in survival, its survival was 90 percent--exceeded by survivals of 94 to 96 percent for sources representing Pamlico, North Carolina; Jefferson, Alabama, Cullman, Alabama; and Clark, Arkansas, sources. In contrast, the southernmost, low-elevation Coastal Plain sources--Angelina, Texas, and Livingston, Louisiana--were eighth and ninth on the list, with survivals of 84 and 76 percent, respectively.

Except for the Cullman County, Alabama, source, for which stock was unavailable, the same loblolly series was planted in Pearl River County, Mississippi, near the Gulf Coast. Five-year survivals again varied at better than the l-percent level of significance, ranging downward from 98 to 73 percent. Here, however, the Angelina, Texas, and Livingston, Louisiana, stock, instead of doing least well, survived best -- 98 and 95 percent, respectively. Stock representing Somerset, Maryland, had next to the lowest survival -- 83 percent.

In a Cherokee County, Texas, plantation of Loblolly Series 1, also in the southern part of the loblolly range, 5-year survivals barely missed significance at the 5-percent level. (This plantation includes only 2 replications of each source, instead of the usual 4.) Here, as in Pearl River County, Mississippi, stock from the Angelina, Texas, source showed best survival--53 percent. Livingston, Louisiana, dropped to sixth place of eight, with 17 percent survival. Somerset, Maryland, dropped to last: place, with a survival of 6 percent.

Right next to the Pearl River County, Mississippi., plantation of Loblolly Series 1, just discussed, is a plantation of Loblolly Series 2 that illustrates another element in the survival pattern, Series 2 includes 3 sources that appear in Series 1: Onslow County, North Carolina; Livingston Parish, Louisiana; and Clark County, Arkansas. It includes 6 additional sources:

Newberry, South Carolina, Clarke, Georgia; Spalding, Georgia, Clay, Alabama; Prentiss, Mississippi; and Hardeman, Tennessee.

Loblolly Series I in Pearl River County represents 3 average annual temperature zones--57° F. (1 lot), 62° F. (4 lots), and 67° F. (3 lots). In contrast, all of the 9 sources in Series 2 except that from Livingston Parish, Louisiana, are from the 62° or 63° average annual temperature zone. In other words, Series 1 represents, roughly, two or three up-and-down transects of the range of loblolly pine, radiating south and southwest from Maryland. Series 2 represents, essentially, a single east and west transect of the range, almost wholly in one temperature zone.

The contrast in 5-year survivals in the two series in Pearl River County is striking. In Series 1, survival, as already noted, varies with seed source at the 1-percent level of significance; survival percents range downward from 98 to 73 percent. In Series 2, survivals range downward from 95 to 85 percent, and do not approach significance even at the 5-percent level.

The southernmost source of slash pine included in the study may be mentioned as having consistently low survival, even though it is not significantly low in more than one plantation. It is, furthermore, suspected of containing an admixture of South Florida slash pine (Pious elliottii densa), perhaps from pollen contamination. This Polk County, Florida, source has had the lowest 5-year survival of 5 or 6 sources in all 6 plantations in which it has been tested, from Bladen County, North Carolina, to Polk County, Florida, and west to Pearl River County, Mississippi.

The southernmost source of longleaf seed in the study, Hillsborough County, Florida, has shown almost equally consistent low survival, Stock planted in 1953-54 survived least well, at 5 years, of 4 or 5 sources tested in Virginia, North Carolina, Mississippi, and Louisiana. It survived next to best of 4 Sources tested in Dooly County, Georgia--the nearest of the 5 plantations to the geographic source.

Retested in the new 1956-57 longleaf plantations, the Hillsborough County, Florida, source had the lowest 1-year survival. of 6 sources in 6 out of 8 plantations, and next to the lowest in the other 2 plantations. One of the 2 exceptions was again in Dooly County, Georgia.

So much for survival, the pattern of which may be expected to change somewhat as fusiform rust takes lethal effect, as years of climatic extremes occur, and particularly as crowns close and competition begins within individual plots.

Average heights at 5 years vary with seed source, at the 1-percent level of significance, in some plantations of longleaf, slash, and loblolly. In shortleaf, height differences closely approach the 5-percent level. (The

shortleaf plantations in which the treatest differences in height growth were logically to be expected were lost in the 1953 and 1954 droughts.) Heights of the plantations on which only 1 year's growth has been measured can hardly be expected to show much variation, and have not yet been analyzed.

A noteworthy example of variation of height with source of seed is the Longleaf Series 1 plantation in Dooly County, Georgia. Average heights at 5 years range from 6. 2 to 9. 0 feet, with the 2 nearest sources (which are from, as well, the most similar climates) well ahead of the other 4. The variation is significant at far better than the 1-percent level. This is one of the first instances on record of such unequivocal racial variation in growth rate of longleaf pine.

The Worcester County, Maryland, and Pearl River County, Mississippi, plantations of Loblolly Series 1, however, and the Pearl River County plantation of Loblolly Series 2, already discussed in connection with 5-year survival, perhaps give a better idea of the results beginning to appear in terms of height.

The 5-year average heights, like the 5-year survivals, varied with seed source, at the 1-percent level of significance, in both the Maryland and the Mississippi Loblolly Series 1 plantations. As with survival, the variation in 5-year heights in the Mississippi plantation of Loblolly Series 2 (the east-west transect of the loblolly range, representing mainly one temperature zone) fell far short of even the 5-percent level of significance.

In the Maryland plantation of Loblolly Series 1, Somerset County, Maryland, stock did best, with an average 5-year height of 10. 1 feet. Angelina County, Texas, and Livingston Parish, Louisiana, stock did least well, with average 5-year heights of 7. 6 and 6.6 feet, respectively.

In the Mississippi plantation of the same series, by contrast, the Louisiana and Texas stocks stood first and second, with average 5-year heights of 8.4 and 6. 6 feet, respectively. Stock from the Somerset County, Maryland, source, although in fifth place of 8 on the list, had an average 5-year height of only 5. 6 feet, 2. 8 feet less than that of the Louisiana loblolly source.

Graphic analysis shows that, in the Maryland plantation of Loblolly Series 1, there is a strong positive regression of average 5-year height over latitude of seed source. In the Mississippi plantation, there is a weak but still distinct negative regression of average 5-year height over latitude of seed source. In the light of Perry's studies at Gainesville, Florida, 4/ and

4/ Perry, Thomas 0., and Wang, Chi Wu. 1957. Second progress report, Cooperative Forest Genetics Research Program. Univ. Fla. School Forestry Res. Rpt. 4, pp. 21-22.

of observations of onset of dormancy in the fall (both in the Southwide Pine Seed Source Study and in an earlier study), it is surmised that day length as well as temperature may affect the height relationships shown in Loblolly Series 1. If this surmise is correct, variation in height in Series 1 may be expected to intensify as time goes on. Whether significant variations in height will also develop in Series 2, which includes sources having a much narrower range of latitude and hence of day length, remains to be seen.

To sum up briefly, the Southwide Pine Seed Source Study comprises at present 48 plantations established in 1952-53 or 1953-54, and 60 more (all longleaf or shortleaf) established in 1956-57, plus a few ragged remnants of other plantations and a few special studies. The 108 successful plantations have been reexamined 2 to 5 times each, depending on age and on special features of interest. Survival percents and average heights have been worked up for all reexaminations, and pest incidence for many.

Detailed analyses now under way have already shown variations of 5-year survival, of all species, attributable to source of seed and significant at the 1-percent level. They have shown similar variations in average height, also significant at the 1-percent level, in longleaf, loblolly, and slash pines, and approaching the 5-percent level in shortleaf. They have shown widespread variations in the rust-susceptibility of loblolly pine, attributable to seed source and significant at the 5-percent level, the pattern of which will be described in the next paper. Examples of the variations found in survival and height have been given here, but a full report must await further analysis.