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**Early Results of a
Loblolly Pine
Seed Source Study
in Alabama**

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EARLY RESULTS OF A LOBLOLLY PINE SEED SOURCE STUDY IN ALABAMA

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IMPORTANCE OF SEED source in determining the growth of planted loblolly pines (*Pinus taeda* L.) has been shown in numerous studies. Most of these involved testing of seed collected in widely separated areas of the species' range. While these studies are important and provide much needed information, they do not aid forest land managers in making decisions concerning source of seed for local reforestation programs. This study was begun in an attempt to better define optimum seed collection areas for Alabama.

Several investigators (1,8,9) have reported significant differences in seedling growth rate among seed sources. Kraus (7) found height growth was greatest for seedlings of either local seed sources or those south of the planting location in a Georgia study involving several seed sources and planting locations. Collins (2), in reporting on the Southwide Pine Seed Source Study planting in Dooly County, Georgia, stated that a regression of height on latitude and longitude revealed that height growth increased as seed source became more southerly. Both Zarger (9) and Kraus (7) reported that diameter growth rates of seedlings varied significantly among seed sources. Zarger found diameter growth to be greater in trees from inland seed sources than in trees from Atlantic Coastal Plain sources. Kraus reported equal or better diameter growth of trees from seed sources located south of the planting site than was true for trees from local sources.

In many studies survival of seedlings after planting has been

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found to be strongly associated with source of seed. Kraus (7) found that seedlings from northern sources survived better than those from southern sources in most plantings in Georgia. Wakely (8) reported variation in survival of loblolly pine among seed sources to be greater from north to south than from east to west in the Southwide Pine Seed Source Study. He stated that seedlings from the western part of the species range generally survived better but grew slower than local seedlings, and that seedlings from southern, southeastern, or eastern sources generally grew faster but had poorer survival than local seedlings. On the other hand, Crow (3) found no significant differences in survival among several Louisiana seed sources.

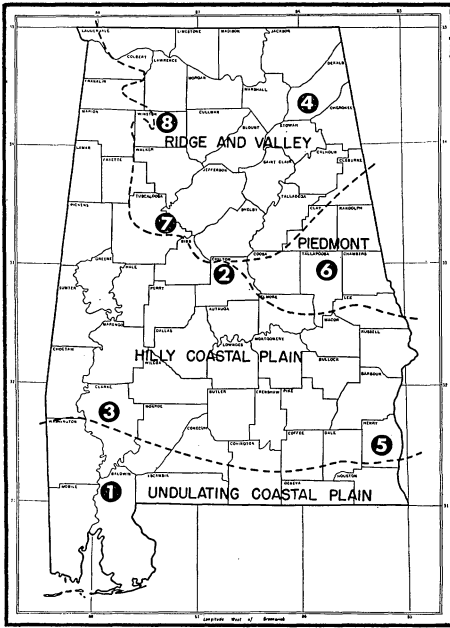
Incidence of fusiform rust (*Cronartium fusiforme* Hedgc. and Hunt) in loblolly pine plantations is a serious problem. The existence of variation in susceptibility to rust among different seed sources is well established. Seedlings from Georgia seed sources varied significantly in amount of rust infection, but no definite north-south trend could be identified (7). Observations by Goggans (4,5) indicate that trees with the fastest growth rate are generally most susceptible to fusiform rust infection. Bethune and Roth (1), Coilins (2), and Henry (6) all report significant differences in amount of rust infection among loblolly pine seed sources. In general these studies all indicate that trees from northern and western sources of loblolly pine are more resistant to fusiform rust infection than trees from the more southern and eastern sources.

METHODS AND MATERIALS

Eight seed sources within Alabama were chosen for the study, map and Table 1, because they represent differences in rainfall, soils, and latitude within the species range in Alabama. Within each seed source 10 parent trees were chosen from natural, well-stocked stands. The parent trees were all healthy, mature dominants and were located at least $\frac{1}{4}$ mile apart. Cones were col-

TABLE 1. KEY TO SEED SOURCE AND PLANTATION LOCATIONS
SHOWING COUNTY AND PHYSIOGRAPHIC REGION

Source number	County	Physiographic region
1.....	Baldwin	Undulating Coastal Plain
2.....	Chilton	Hilly Coastal Plain
3.....	Clarke	Hilly Coastal Plain
4.....	DeKalb	Ridge and Valley
5.....	Henry	Hilly Coastal Plain
6.....	Tallapoosa	Piedmont
7.....	Tuscaloosa	Ridge and Valley
8.....	Winston	Ridge and Valley



Seed source and plantation locations.

lected from each parent tree in the fall of 1959. The seeds were extracted and all seeds from the 10 parents within each source were combined. The seeds were planted at the Auburn Forest Tree Nursery in the spring of 1960 in a randomized complete-block design with eight replications.

Seedlings were lifted from the nursery beds in the winter of 1961 and outplanted in eight locations. One plantation was established near each source of seed. In this way, trees from each seed source were allowed to compete against trees

from each of the other seven seed sources both in their area of origin and in the seven other seed source areas. A randomized complete-block design with seven replications was used for each outplanting. Within a replication, trees of each seed source were planted in a square plot of 121 trees at an 8 × 8-foot spacing.

When lifted in the nursery, all seedlings for a given source from each of the eight nursery replications were mixed and then drawn at random for planting at the different locations. This was done to eliminate any differences in quality or size of seedlings resulting from location in the seed bed. The seedlings were also inspected for signs of southern fusiform rust and those having visible signs of infection were not planted.

Plant height was measured in the nursery beds before lifting (winter of 1960-61), at the end of the first year in the field (winter 1961-62), and at the end of the seventh year in the field (winter 1967-68). Per cent survival was recorded in 1961-62 and 1967-68. Diameters at breast height and number of trees having limb or stem infections of fusiform rust were recorded in the winter of 1967-68.

Measurements were made in the nursery beds on all seedlings from each source in each replication, whereas measurements in the winter of 1961-62 were made on a square plot containing 81 trees in the interior of the 121-tree square plot found in each replication. Measurements taken in the winter of 1967-68 were made on a square plot containing 49 trees located in the interior of the source plot.

An analysis of variance was computed for each variable at each planting location for measurements made in 1961-62 and 1967-68. A Duncan's new multiple range test was computed when the analysis of variance for the trait indicated statistically significant differences among seed sources. Five replications of the Henry County planting were destroyed by fire in 1964 leaving only two undamaged replications to provide data for this county analysis.

For each variable, 1967-68 measurements from all planting locations except Henry County were combined and subjected to an analysis of variance and Duncan's new multiple range test.

PERFORMANCE OVER ALL PLANTING LOCATIONS

Height

Average heights by year of measurement, planting location, and seed source are presented in Tables 2, 3, and 4. Mean height growth at the end of the first year in the nursery beds was 0.82 feet and the range in source means was 0.68 to 0.90 feet. The Winston County seed source produced the smallest seedlings, whereas both Baldwin and Henry County sources produced seedlings averaging 0.90 feet, the largest first year height. The analysis of variance indicated that both replications and geographic seed sources were significant sources of variation ($P = .01$). The Win-

TABLE 2. AVERAGE HEIGHTS OF SEEDLINGS WHEN LIFTED FROM THE NURSERY SEED BEDS

Seed source	Height <i>Ft.</i>
Baldwin.....	0.90a ¹
Henry.....	0.90a
Tuscaloosa.....	0.85a
Clarke.....	0.83a
DeKalb.....	0.80ab
Tallapoosa.....	0.80ab
Chilton.....	0.79ab
Winston.....	0.68 b
AVERAGE.....	0.82

¹ Heights with the same letter are not different at the .05 probability level.

TABLE 3. AVERAGE HEIGHTS OF SEEDLINGS ONE YEAR AFTER PLANTING

Seed source	Height, by planting location								
	Baldwin	Henry	Tuscaloosa	Clarke	DeKalb	Talla- poosa	Chil- ton	Win- ston	Average
	<i>Ft.</i>	<i>Ft.</i>	<i>Ft.</i>	<i>Ft.</i>	<i>Ft.</i>	<i>Ft.</i>	<i>Ft.</i>	<i>Ft.</i>	<i>Ft.</i>
Henry.....	0.94	0.96	1.21	0.85	1.35	1.63	1.32	2.14	1.30
Clarke.....	0.99	0.97	1.11	0.95	1.47	1.52	1.20	2.00	1.28
Baldwin.....	0.85	0.93	1.13	0.85	1.47	1.19	1.22	1.79	1.18
DeKalb.....	0.94	0.89	1.01	0.86	1.39	1.26	1.27	1.73	1.17
Chilton.....	0.88	0.89	0.95	0.86	1.23	1.18	1.15	1.82	1.12
Tuscaloosa.....	0.81	0.90	1.06	0.82	1.23	1.18	1.21	1.65	1.11
Tallapoosa.....	0.86	0.84	0.99	0.81	1.19	1.15	1.16	1.71	1.09
Winston.....	0.83	0.85	0.92	0.74	1.18	1.04	0.91	1.61	1.01
AVERAGE.....	0.89	0.90	1.05	0.84	1.31	1.27	1.18	1.81	1.16

ston County seed source was lower ($P = .05$) in nursery height growth than the top four seed sources, Table 2.

Average total height at the end of the first year in the field was 1.16 feet. The range in seed source means for the first year was 1.01 to 1.30 feet, Table 3. Winston County seed source again had the shortest seedlings while the Henry County source had the tallest. Clarke County seed source was second with an average seedling height of 1.28 feet. An analysis of the combined data from all locations was not made; however, an analysis of variance and a Duncan's new multiple range test were computed for data from each planting location. Results indicated that there were differences among seed sources in all planting locations. These data generally indicate that, for the eight locations where the seed sources were tested, seedlings from Henry County had the greatest total height at the end of the first year. Clarke and Baldwin County seedlings were next in growth. The Duncan's new multiple range tests for each location indicated no significant dif-

TABLE 4. AVERAGE HEIGHTS OF TREES AFTER SEVEN YEARS IN THE FIELD

Seed source	Height, by planting location							
	Baldwin	Tuscaloosa	Clarke	DeKalb	Talla- poosa	Chilton	Winston	Average
	<i>Ft.</i>	<i>Ft.</i>	<i>Ft.</i>	<i>Ft.</i>	<i>Ft.</i>	<i>Ft.</i>	<i>Ft.</i>	<i>Ft.</i>
Henry.....	11.51	14.16	13.71	19.61	26.16	17.78	21.00	17.70a ¹
Baldwin.....	11.05	13.53	14.00	20.02	24.52	18.04	20.70	17.41a
Clarke.....	9.95	12.70	14.81	19.93	25.85	17.29	20.58	17.30a
Tuscaloosa.....	11.50	13.03	12.75	18.13	23.81	16.74	20.25	16.60 b
Chilton.....	11.54	11.84	12.88	17.40	23.67	16.92	20.18	16.35 bc
Tallapoosa.....	9.80	12.03	13.08	18.05	23.50	16.84	19.32	16.09 bc
DeKalb.....	10.82	11.52	12.39	17.60	22.55	16.19	19.77	15.83 c
Winston.....	10.54	11.73	12.11	17.11	21.20	15.60	19.63	15.42 c d
AVERAGE.....	10.84	12.57	13.22	18.48	23.91	16.92	20.18	16.59

¹ Means with the same letter are not different at the .05 level of probability.

ferences among Henry, Clarke, and Baldwin County seed sources, except in the Winston and Tallapoosa plantings where Henry and Clarke County sources were taller than all others ($P = .05$).

At the end of seven growing seasons in the field, mean tree height for all sources in all locations was 16.59 feet. Henry County seed source had the highest mean height, 17.70 feet, and Winston County source the lowest, 15.42. The combined analysis of variance and the Duncan's new multiple range test, Tables 4 and 5, showed that trees from Baldwin, Henry, and Clarke County seed sources were taller than those from all other sources ($P = .05$). Seedlings from the Winston County seed source were shorter than those of the other sources ($P = .05$).

TABLE 5. ANALYSIS OF VARIANCE AND MEAN SQUARES FROM THE COMBINED DATA OF ALL PLANTING LOCATIONS FOR SEVENTH YEAR SURVIVAL, HEIGHT, DIAMETER, AND FUSIFORM RUST INFECTION

Source of variation	d.f.	Mean squares			
		Survival	Height	Diameter	Rust infection
Location.....	6	1.56*	29645.00*	1431.40*	2450.80*
Replications in location....	42	0.05	436.35	21.09	84.55
Seed source.....	7	0.03	773.41*	15.38*	98.87*
LxS.....	42	0.03	58.67	1.46	32.11
Error.....	294	0.02	48.03	2.27	23.12

* Significant at the .01 level.

Survival

There were no differences among seed sources in per cent survival at either the end of the first year or the seventh year in the field. At the end of the seventh year in the field, per cent survival by source ranged from 72.73 to 77.56 and averaged 76.07.

Diameter

The combined analysis of variance for diameters at breast height revealed both planting locations and seed sources to be significant sources of variation ($P = .01$), Table 5. Trees from the three southern sources (Henry, Clarke, and Baldwin counties) were larger in diameter than trees from any of the other seed sources ($P = .05$). Trees from the Henry County seed source had the largest diameters at breast height, an average of 3.13 inches, followed by Baldwin and Clarke counties with average diameters of 3.04 and 3.02 inches, respectively, Table 6. Winston

TABLE 6. AVERAGE BREAST HEIGHT DIAMETERS OF TREES
AFTER SEVEN YEARS IN THE FIELD

Seed source	Diameter, by planting location							
	Baldwin	Tuscaloosa	Clarke	DeKalb	Tallapoosa	Chilton	Winston	Average
	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>
Henry.....	1.71	2.16	2.40	3.90	4.46	3.16	4.10	3.13a ¹
Baldwin.....	1.59	2.05	2.39	3.85	4.21	3.16	4.00	3.04a
Clarke.....	1.42	1.91	2.57	3.82	4.40	3.07	3.98	3.02a
Tuscaloosa.....	1.82	1.98	2.24	3.58	4.14	3.04	3.85	2.95 b
Chilton.....	1.79	1.74	2.22	3.50	4.21	3.11	3.91	2.93 b
DeKalb.....	1.71	1.72	2.18	3.52	4.18	3.09	3.79	2.88 bc
Tallapoosa.....	1.39	1.74	2.29	3.63	4.12	3.00	3.73	2.84 bc
Winston.....	1.56	1.76	2.07	3.35	3.95	2.91	3.88	2.78 c
AVERAGE.....	1.62	1.88	2.30	3.64	4.21	3.07	3.91	2.95

¹ Means with the same letter are not different at the .05 level of probability.

County seed source produced trees with the lowest overall diameter; however, they were not significantly smaller than those from DeKalb and Tallapoosa counties.

In general, trees from southern seed sources had faster diameter growth at all planting locations than did the trees from more northern seed sources. Overall mean diameter at breast height for trees from all seed sources at all planting locations was 2.95 inches.

Fusiform Rust

The combined analysis of variance for per cent fusiform rust infection showed both test location and seed source to be significant sources of variation, Table 5. The range in fusiform rust infection by seed source was 4.73 per cent for Winston County to 9.09 per cent for Clarke County, Table 7. Winston County seed

TABLE 7. AVERAGE FUSIFORM RUST INFECTION AFTER SEVEN YEARS IN THE FIELD

Seed source	Rust infection, by planting location							
	Baldwin	Tuscaloosa	Clarke	DeKalb	Tallapoosa	Chilton	Winston	Average
	<i>Pct.</i>	<i>Pct.</i>	<i>Pct.</i>	<i>Pct.</i>	<i>Pct.</i>	<i>Pct.</i>	<i>Pct.</i>	<i>Pct.</i>
Clarke.....	3.00	3.34	17.73	4.77	24.16	8.24	2.36	9.09a ¹
Baldwin.....	4.65	1.17	14.77	5.50	21.60	5.94	3.18	8.12a
Henry.....	7.68	3.60	9.89	2.80	21.90	7.68	2.57	8.02a
DeKalb.....	3.87	2.24	13.80	3.13	23.66	6.93	1.97	7.94a
Chilton.....	3.43	2.09	11.04	2.84	21.81	7.52	3.89	7.52ab
Tallapoosa.....	3.64	2.16	9.51	3.54	22.20	5.04	2.36	6.92ab
Tuscaloosa.....	4.87	1.56	11.94	2.71	12.74	5.37	0.99	5.74 bc
Winston.....	2.03	1.20	10.83	0.91	10.89	5.23	2.02	4.73 c
AVERAGE.....	4.15	2.17	12.44	3.28	19.87	6.49	2.42	7.26

¹ Means with the same letter are not different at the .05 level of probability.

source showed lower rust infection ($P = .05$) than all other sources with the exception of Tuscaloosa County. The three southern seed sources, Baldwin, Clarke, and Henry counties, had highest infection rates, but amount of fusiform rust was not significantly higher than in any of the other sources except Winston and Tuscaloosa counties. These were the three sources that had the largest heights and diameters. The tendency for faster growing trees to have higher infection rates from fusiform rust has been reported previously by Goggans (4,5) and Kraus (7).

Average fusiform rust infection by planting location varied from 19.87 to 2.17 per cent. The Tallapoosa County planting had the highest infection and Tuscaloosa County the lowest among plantings in the overall analysis.

PERFORMANCE AT INDIVIDUAL PLANTING LOCATIONS

To provide more detailed information for management foresters in their particular areas of the State, results from each planting location are discussed. Where the analysis of individual seed source plantings indicated statistically significant differences among the seed sources for height, diameter, or total southern fusiform rust infection, results of a Duncan's new multiple range test are presented. Where no significant differences ($P = .05$) were present among seed sources for a given variable-location combination, the actual differences that were present are given in Tables 4, 6, and 7.

Baldwin County

Baldwin County had the lowest mean height growth and lowest mean diameter growth of all planting locations. This is attributable, at least in part, to the planting site, which was not well suited to growing loblolly pine. Longleaf pine is much better adapted to the planting site and some problems with natural longleaf invasion have been encountered. The growth in this planting is not indicative of growth that may be expected of loblolly pine in this area.

Average height and diameter growth for the Baldwin County planting was 10.84 feet and 1.62 inches, respectively. Fusiform rust infection averaged 4.15 per cent. No statistically significant differences among seed sources were found for any of the variables studied at this location.

Chilton County

The Chilton County planting had the fourth highest overall average seedling height and diameter growth among the eight locations. Average height growth was 16.92 feet and average diameter growth was 3.07 inches. Overall per cent fusiform rust infection at this planting was 6.49, the fourth highest rate of infection among the eight planting sites.

The analysis of variance indicated differences ($P = .05$) in height growth among seed sources at this location. Seedlings from the three southernmost seed sources, Baldwin, Henry, and Clarke counties, grew taller than those from the two most northern sources, DeKalb and Winston counties ($P = .05$), Table 8.

TABLE 8. SEED SOURCE AVERAGES OF TREE HEIGHTS IN THE CHILTON COUNTY PLANTING

Seed source	Average height ¹
	<i>Ft.</i>
Baldwin.....	18.04a
Henry.....	17.78a
Clarke.....	17.29a
Chilton.....	16.92ab
Tallapoosa.....	16.84ab
Tuscaloosa.....	16.74ab
DeKalb.....	16.19 b
Winston.....	15.60 b

¹ Heights with the same letter are not different at the .05 probability level.

No significant differences among seed sources were found for either diameter growth or fusiform rust infection.

Clarke County

The Clarke County planting location ranked fifth in overall average rate of growth for both height and diameter. Height averaged 13.22 feet and diameter 2.30 inches. Southern fusiform rust infection was moderately severe, with 12.44 per cent of the trees having one or more infections.

Results of the multiple range test for height growth at this planting are presented in Table 9. Clarke County seed source, which produced the greatest height growth, was significantly different from the five slower growing sources ($P = .05$). Height growths produced by seedlings from Clarke, Baldwin, and Henry counties were significantly greater than those produced by seedlings from DeKalb and Winston counties.

TABLE 9. SEED SOURCE AVERAGES OF TREE HEIGHTS IN THE CLARKE COUNTY PLANTING

Seed source	Average height ¹
	<i>Ft.</i>
Clarke.....	14.81a
Baldwin.....	14.00ab
Henry.....	13.71ab
Tallapoosa.....	13.08 bc
Chilton.....	12.88 bc
Tuscaloosa.....	12.75 bc
DeKalb.....	12.39 c
Winston.....	12.11 c

¹ Heights with the same letter are not different at the .05 probability level.

No significant differences were found for either diameter growth or infection by fusiform rust.

DeKalb County

Though the DeKalb County seed source was one of the slowest growing, overall growth at the DeKalb County planting location was among the most rapid. Height there for seedlings of all seed sources averaged 18.48 feet and diameter averaged 3.64 inches. The amount of southern fusiform rust in this planting was low, 3.28 per cent.

With the exception of Henry County seedlings, the Baldwin County and Clarke County sources produced seedlings with greater height growth ($P = .05$) than any of the other seed sources, Table 10.

TABLE 10. SEED SOURCE AVERAGES OF TREE HEIGHTS IN THE DEKALB COUNTY PLANTING

Seed source	Average height ¹
	<i>Ft.</i>
Baldwin.....	20.02a
Clarke.....	19.93a
Henry.....	19.61ab
Tuscaloosa.....	18.13 bc
Tallapoosa.....	18.05 bc
DeKalb.....	17.60 c
Chilton.....	17.40 c
Winston.....	17.11 c

¹ Heights with the same letter are not different at the .05 probability level.

Differences in rate of diameter growth were not as pronounced as those of height growth. Though the southern sources – Henry, Baldwin, and Clarke counties – did produce seedlings with the fastest diameter growth, the only significant difference ($P = .05$)

TABLE 11. SEED SOURCE AVERAGES OF TREE DIAMETERS (b.h.)
IN THE DEKALB COUNTY PLANTING

Seed source	Average diameter ¹ <i>In.</i>
Henry.....	3.90a
Baldwin.....	3.85a
Clarke.....	3.82a
Tallapoosa.....	3.63ab
Tuscaloosa.....	3.58ab
DeKalb.....	3.52ab
Chilton.....	3.50ab
Winston.....	3.35 b

¹ Diameters with the same letter are not different at the .05 probability level.

in diameter growth was between seedlings of these three sources and Winston County seedlings, Table 11.

No differences in southern fusiform rust infection were found at this location.

Henry County

Since all but two replications of the Henry County planting location were destroyed by fire in 1964, this site was not included in the overall analysis for the seventh year; however, data were collected from the remaining two replications and analyzed.

The analysis of variance for height, diameter, and per cent fusiform rust infection showed no significant differences among seed sources; however, this was probably attributable to there being only two replications. This allowed only 7 degrees of freedom for the replication treatment interaction, rather than 42 as in the other locations, and resulted in an unusually large mean square for testing treatments.

The mean value of height and diameter in this planting was lower than in any of the other seven plantings, Table 12. Per cent

TABLE 12. SEVENTH YEAR HEIGHT, DIAMETER, AND TOTAL FUSIFORM RUST INFECTION FOR THE HENRY COUNTY PLANTING LOCATION

Seed source	Height	Diameter	Rust infection
	<i>Ft.</i>	<i>In.</i>	<i>Pct.</i>
Baldwin.....	12.57	2.16	45.50
Henry.....	10.13	1.45	54.15
Tuscaloosa.....	9.77	1.42	24.10
Clarke.....	11.30	1.77	37.90
DeKalb.....	10.66	1.70	61.30
Tallapoosa.....	9.39	1.31	34.85
Chilton.....	9.97	1.43	27.25
Winston.....	8.42	1.16	29.60
AVERAGE.....	10.28	1.55	39.33

total rust infection was almost twice as high here as at any other planting location. Although there were slight shifts in ranking of seed sources for resistance to southern fusiform rust in this high rust incidence area, there were no major changes in relative position.

Tallapoosa County

Rates of both height and diameter growth were greater in the Tallapoosa County planting than at any other location. Trees there averaged 23.91 feet tall and 4.21 inches in diameter. With an infection rate of 19.87 per cent, this planting had the second highest fusiform rust infection.

Table 13 presents results of the Duncan's multiple range test for height growth at this location. Trees from Henry and Clarke County sources were taller ($P = .05$) than trees from all other sources with the exception of those from Baldwin County. Trees from the Winston County source grew less in height than trees from all other sources except DeKalb County.

There were no significant differences among average diameters of trees in the various seed sources at this location.

TABLE 13. SEED SOURCE AVERAGES OF TREE HEIGHTS IN THE TALLAPOOSA COUNTY PLANTING

Seed source	Average height ¹ Ft.
Henry.....	26.16a
Clarke.....	25.85a
Baldwin.....	24.52ab
Tuscaloosa.....	23.81 b
Chilton.....	23.67 b
Tallapoosa.....	23.50 b
DeKalb.....	22.55 bc
Winston.....	21.20 c

¹ Heights with the same letter are not different at the .05 probability level.

TABLE 14. SEED SOURCE AVERAGES OF FUSIFORM RUST INFECTION IN THE TALLAPOOSA COUNTY PLANTING

Seed source	Total rust infection ¹ Per cent
Clarke.....	24.16a
DeKalb.....	23.66a
Tallapoosa.....	22.20a
Henry.....	21.90a
Chilton.....	21.81a
Baldwin.....	21.60a
Tuscaloosa.....	12.74 b
Winston.....	10.89 b

¹ Means with the same letter are not different at the .05 probability level.

The multiple range test for fusiform rust infection showed that trees from Tuscaloosa and Winston counties had fewer infections than trees from any of the other sources ($P = .05$), Table 14.

Tuscaloosa County

The Tuscaloosa County location was among the poorest of the eight from an overall growth standpoint. Trees there averaged only 12.57 feet tall and 1.88 inches in diameter. Though growth was slow at this location, the incidence of fusiform rust was also low, averaging only 2.17 per cent.

Trees from the Henry County seed source produced greater height growth than those from Clarke, Tallapoosa, Chilton, Winston, and DeKalb counties, Table 15. Clarke County trees did not grow particularly well in that they ranked fourth in height growth and were not significantly taller than those from DeKalb County, which ranked eighth.

Henry and Baldwin County trees produced greater diameter growths than trees from Winston, Tallapoosa, Chilton, and DeKalb counties, Table 16. Clarke County trees ranked fourth in diameter growth also.

TABLE 15. SEED SOURCE AVERAGES OF TREE HEIGHTS IN THE TUSCALOOSA COUNTY PLANTING

Seed source	Average height ¹
	<i>Ft.</i>
Henry.....	14.16a
Baldwin.....	13.53ab
Tuscaloosa.....	13.03abc
Clarke.....	12.70 bcd
Tallapoosa.....	12.03 cd
Chilton.....	11.84 cd
Winston.....	11.73 cd
DeKalb.....	11.52 d

¹ Heights with the same letter are not different at the .05 probability level.

TABLE 16. SEED SOURCE AVERAGES OF TREE DIAMETERS (b.h.) IN THE TUSCALOOSA COUNTY PLANTING

Seed source	Average diameter ¹
	<i>In.</i>
Henry.....	2.16a
Baldwin.....	2.05a
Tuscaloosa.....	1.98ab
Clarke.....	1.91ab
Winston.....	1.76 b
Tallapoosa.....	1.74 b
Chilton.....	1.74 b
DeKalb.....	1.72 b

¹ Diameters with the same letter are not different at the .05 probability level.

No significant differences among seed sources for rate of infection by fusiform rust were found in this planting.

Winston County

Growth in the Winston County planting was good. Average height and diameter of trees from all sources were 20.18 feet and 3.91 inches. This was the second fastest growth rate in the study. Amount of fusiform rust was also low, averaging only 2.42 per cent.

No significant differences in rate of height growth or fusiform rust infection were found among seed sources at this location. However, there were differences in rate of diameter growth. Trees from Henry County produced significantly greater diameter growths than those from Tallapoosa County. The six sources between these extremes were ranked as shown in Table 17.

TABLE 17. SEED SOURCE AVERAGES OF TREE DIAMETERS (b.h.)
IN THE WINSTON COUNTY PLANTING

Seed source	Average diameter ¹ In.
Henry.....	4.10a
Baldwin.....	4.00ab
Clarke.....	3.98ab
Chilton.....	3.91abc
Winston.....	3.88abc
Tuscaloosa.....	3.85 bc
DeKalb.....	3.79 bc
Tallapoosa.....	3.73 c

¹ Diameters with the same letter are not different at the .05 probability level.

DISCUSSION

Significant differences in seedling performance attributable to seed source were found for all factors included in this study except per cent survival. The three southern seed sources, Henry, Baldwin, and Clarke counties, produced trees that generally exhibited fastest rates of growth in both height and diameter. They were also the three sources having trees with the highest rates of infection by southern fusiform rust. Trees from the Winston County seed source were consistently the slowest growing in both height and diameter, and had the lowest amount of fusiform rust. Average rust infection over all planting locations, excluding Henry County, was 7.26 per cent. This was generally lower than expected. In the Tallapoosa and Henry County plantings, level of rust infection agreed with that previously reported by Goggans

(4,5). Since it has been found that faster growing trees are more susceptible to fusiform rust, it is possible that the low rate of infection in the Baldwin County planting can be explained by a poor site that caused the trees to grow slower than other loblolly pines in the area.

In general, the southern seed sources were better than those from farther north from a growth standpoint but poorer in resistance to rust infection. Little evidence was found to support the belief that local stock is superior to non-local stock in growth rate.

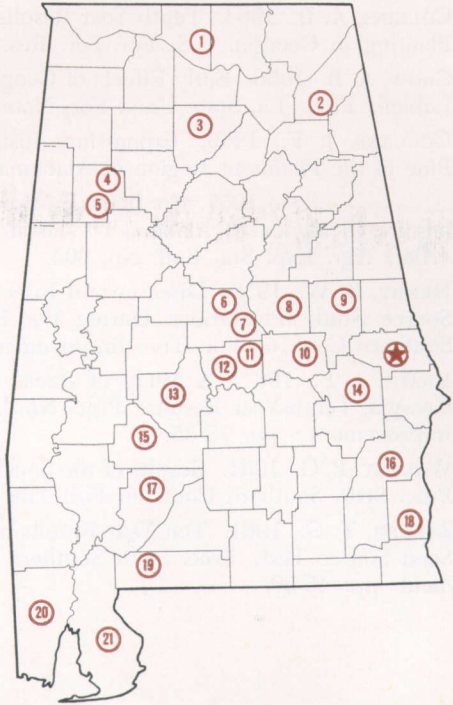
Seed from any one of the three southern seed sources tested in this study would appear to be suitable for planting over wide areas of Alabama. Trees from the Henry County seed source appear to have a slightly better growth rate than trees from the other two southern sources, Baldwin and Clarke counties. There were no significant differences between these three seed sources in either height growth or diameter growth, as indicated by the various Duncan's new multiple range tests.

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AGRICULTURAL EXPERIMENT STATION SYSTEM OF ALABAMA'S LAND-GRANT UNIVERSITY

With an agricultural research unit in every major soil area, Auburn University serves the needs of field crop, live-stock, forestry, and horticultural producers in each region in Alabama. Every citizen of the State has a stake in this research program, since any advantage from new and more economical ways of producing and handling farm products directly benefits the consuming public.



Research Unit Identification

★ Main Agricultural Experiment Station, Auburn.

1. Tennessee Valley Substation, Belle Mina.
2. Sand Mountain Substation, Crossville.
3. North Alabama Horticulture Substation, Cullman.
4. Upper Coastal Plain Substation, Winfield.
5. Forestry Unit, Fayette County.
6. Thorsby Foundation Seed Stocks Farm, Thorsby.
7. Chilton Area Horticulture Substation, Clanton.
8. Forestry Unit, Coosa County.
9. Piedmont Substation, Camp Hill.
10. Plant Breeding Unit, Tallassee.
11. Forestry Unit, Autauga County.
12. Prattville Experiment Field, Prattville.
13. Black Belt Substation, Marion Junction.
14. Tuskegee Experiment Field, Tuskegee.
15. Lower Coastal Plain Substation, Camden.
16. Forestry Unit, Barbour County.
17. Monroeville Experiment Field, Monroeville.
18. Wiregrass Substation, Headland.
19. Brewton Experiment Field, Brewton.
20. Ornamental Horticulture Field Station, Spring Hill.
21. Gulf Coast Substation, Fairhope.