RESULTS OF THE SOUTHWIDE PINE SEED SOURCE STUDY

THROUGH 1960 - 61

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The Southwide Pine Seed Source Study was launched by the Committee on Southern Forest Tree Improvement in 1951 to delimit practicable seed-collecting zones for longleaf (Pinus palustris, Mill.), slash (P. elliottii elliottii, Engelm.), loblolly (P. taeda, L.), and shortleaf (P. echinata Mill.) pines. It was established and is being maintained entirely by the generous and painstaking cooperation of numerous Federal, State, educational, and industrial agencies. It includes seed from and plantations in 16 States, from Pennsylvania and New Jersey south to Florida and west to Missouri, Oklahoma, and Texas.

Nine plantations of slash pine and 19 apiece of longleaf, loblolly, and shortleaf were established in 1952-53 and 1953-54 with stock from 1951 and 1952 seed. Each seed source in the study was represented in either 1 or 2 plantations close to that source. For slash pine, 3 supplementary plantations were established outside the species' range.

Rainfall was deficient in most of the southern pine region during both 1953 and 1954, and some of the plantations suffered severely from drought. Losses were greatest in longleaf and shortleaf. Fresh collections of seed of these 2 species were accordingly made in 1955, duplicating as nearly as possible the 1951 and 1952 collections, and 29 new longleaf plantations and 33 new shortleaf plantations were established in 1956 - 57 and 1957 - 58. Some of these new plantations replace earlier ones that failed; the rest constitute immensely informative replications, in time and place, of the earlier ones that survive.

Of the total of 128 plantations established in the study, 108 have survived well enough to justify reexamination on schedule[2].

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[2] A tabular summary of plantations, by species, dates of establishment, and suitability for continued remeasurement, appears on page 6 of the Proceedings of the Fifth Southern Conference on Forest Tree Improvement. See also the explanatory note in the second full paragraph on page 7 of those Proceedings.

Before results can be presented, one special feature of the plantations must be mentioned. This is that, except with slash pine, the geographic seed-sources represented in each year's planting of each species are grouped in 2 or 3 series.

Each series consists of from 6 to 9 sources representing either 2 north-and-south transects of the species' range or 1 east-and-west transect. Each such series has at least 1 seed source in common with each other series of the same species planted in the same year. These sources-in-common serve to link the various series together.

The series were instituted mainly to conserve seed supplies and to relieve cooperating planters of the burden of planting unduly large acreages. They were designed to test definite hypotheses concerning the origin and distribution of racial variation -- the north-and-south transects, for example, to test the hypothesis that racial variation is associated mainly with differences in temperature. As things have worked out, the series constitute an unexpectedly powerful analytical tool as well.

The immediately pertinent data on the 108 successful plantations consist -- in addition to voluminous establishment records and special notes -- of either 3 or 4 observations apiece of some 136,000 measurement trees, or upwards of 500,000 observations in all.

When the preliminary report on 5-year results was presented at the Fifth Southern Conference (Wakeley 1959), fewer than 5 percent of these data had been analyzed. Now routine analysis is 92 percent complete. Since the Fifth Conference, analyses of variance have been made of 397 out of 432 available reexaminations of survival and height--mostly by IBM-704, but in a few instances by hand. Thirty-five analyses remaining to be made by hand involve either missing-plot technique for which a suitable IBM program is lacking, or complications arising from replacements of dead trees.

This report presents the 5-year results of the original plantings and the 3-year results of the supplementary plantings from 1955 seed. Information at later ages is not yet available, as the next regular periodic reexamination is not due in any of the plantations until 1961-62.

Caution Necessary in Drawing Conclusions

Five years' growth in plantations is not enough to justify final conclusions regarding the suitability or unsuitability of seed from various sources for use in specific localities.

Weidman (1939), in his article on evidences of racial influence in ponderosa pine, offers a classic example of the pitfalls involved in too early evaluation of seed-source plantations. He describes a study of 19 geographic sources of ponderosa pine seed, planted on the Kaniksu National Forest, in northern Idaho. At 10 years--twice the age of the oldest trees in the present report--the stock of Coconino origin excelled all but 1 of the other stocks in height, and equalled that one. The square outlined in the lower left-hand corner of figure 1 shows the course of growth of the Coconino and 3 of the other stocks over

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Figure 1.-- Height growth of geographic sources of ponderosa pine planted on Kaniksu National Forest (after Weidman, 1939).

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the first 10 years. The easy assumption at this stage would have been that the Coconino source was best adapted to the site.

By the end of the twentieth year, however, the height of the Coconino stock, as shown in the main part of figure 1, had dropped below the heights of the 3 stocks that the Coconino had equalled or excelled at 10 years. It had dropped below 9 of the other 15 stocks in the study, as well. Obviously, a favorable rating of the Coconino stock, based on the first 10 years' growth, would have been premature.

There is no evidence whatever that some of the southern pine sources that top the lists in the analyses presented here today may not, by the next reexamination, fall behind like Weidman's Coconino stock.

Occurrence of Significant Variation in Southern Pines at 5 and 3 Years

Nevertheless, certain significant differences in survival and height that have already developed in the Southwide Study cannot be disregarded. Moreover, there are indications of a consistent pattern among successive plantings of the same species, and among different species.

The least evidence of this pattern is afforded by the slash pine plantations. Survival varies significantly (5-percent level) with seed source in 71 percent of the plantations; very

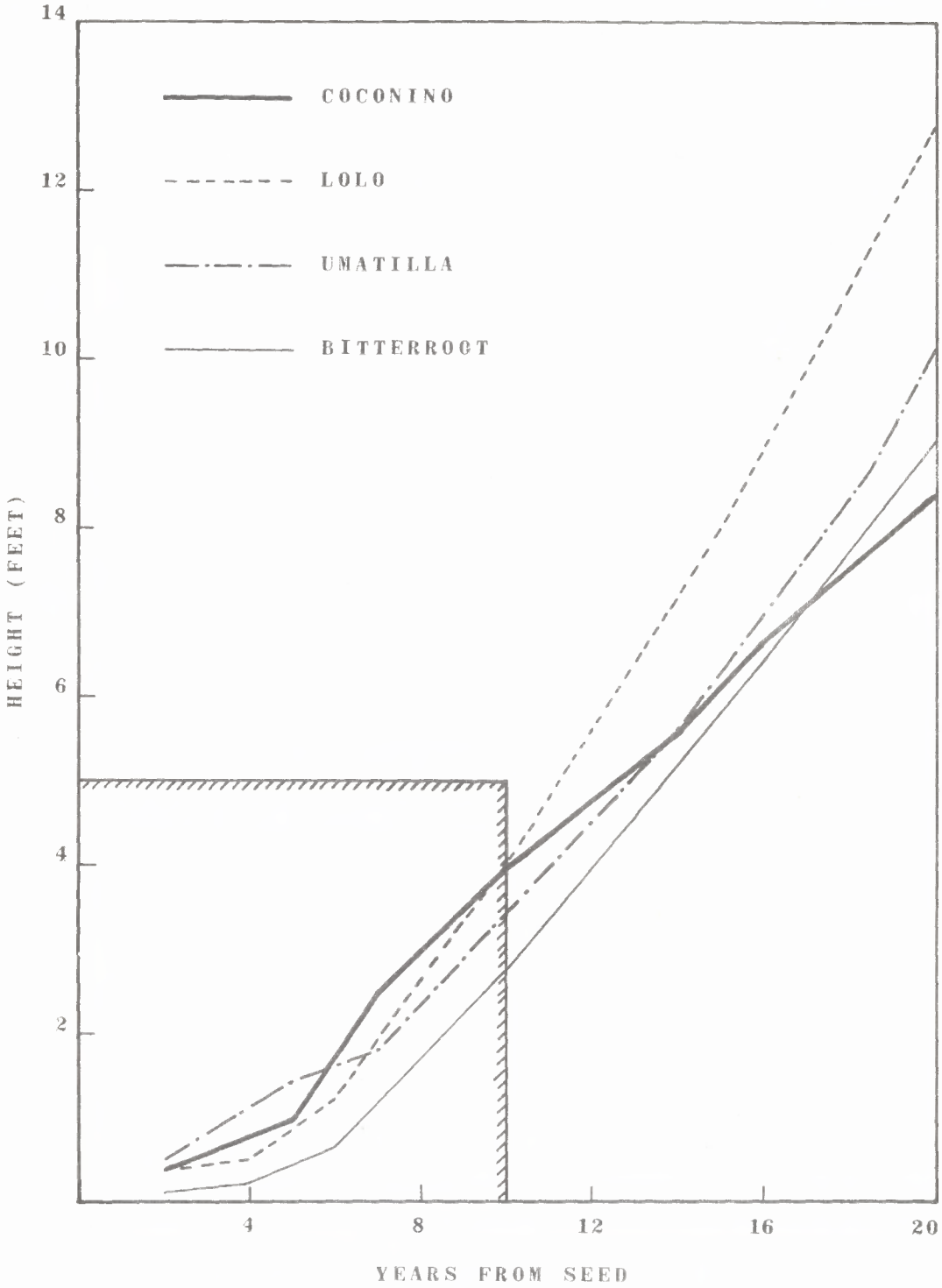

Figure 1.--Height growth of geographic sources of ponderosa pine planted on Kaniksu National Forest (after Weidman, 1939).

significantly (1-percent level) in 57 percent. The corresponding percentages for significant variation in height are 14 and 29. As a group, though, both the slash seed sources and the slash plantations are the least satisfactory in the entire study. Even more important, all but 1 or possibly 2 of the significant differences are attributable to a single seed source, from the lower part of the Florida peninsula. Apparently the pollen parents of some of the seedlings representing this source were South Florida slash pines (P. elliottii densa Little and Dorman), and poor survival and growth of the resulting inter-varietal hybrids may have accentuated the differences between the southern Florida and the other slash pine stocks.

If the atypical stock from this southern Florida source is discounted, the slash pine included in the study has exhibited less racial variation during the first 5 years, in either survival or height, than any of the other 3 species.

Many of the longleaf plantations exhibit significant or highly significant variation from source to source, in survival, height, or both, but the variations must be interpreted cautiously.

Of the 19 longleaf plantations established in 1952-53 and 1953-54, only 9 have been successful enough to justify reexamination as scheduled; and in some of these the survival pattern was seriously modified by the unavoidable use of stock of some sources from one nursery and of other sources from another. In other words, physiological quality of stock, attributable to nursery soil or nursery treatment, may have outweighed geographic source of seed in its effect on survival; in a few plantations there is clear evidence that this is true. The 5-year heights may also have been modified by nursery sources of the stock; and in the plantations characterized by slower average growth, average heights have excessive experimental errors because of individual-tree variations in the onset of height growth.

More of the longleaf plantations established in 1956-57 were successful, and in the great majority of them all the stocks in 1 plantation are from 1 nursery. The 3-year heights of these plantations--the latest heights available--have, however, even larger experimental errors than the 5-year heights of the older plantations, because of the characteristically irregular onset of height growth of longleaf pine.

Figure 2A shows the extent of significant variation in survival and height of the earlier

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Figure 2.-- Extent of significant variation in survival and height of longleaf pine. A, in 1952-53 and 1953-54 plantations at 5 years; B, in 1956-57 plantations at 3 years.

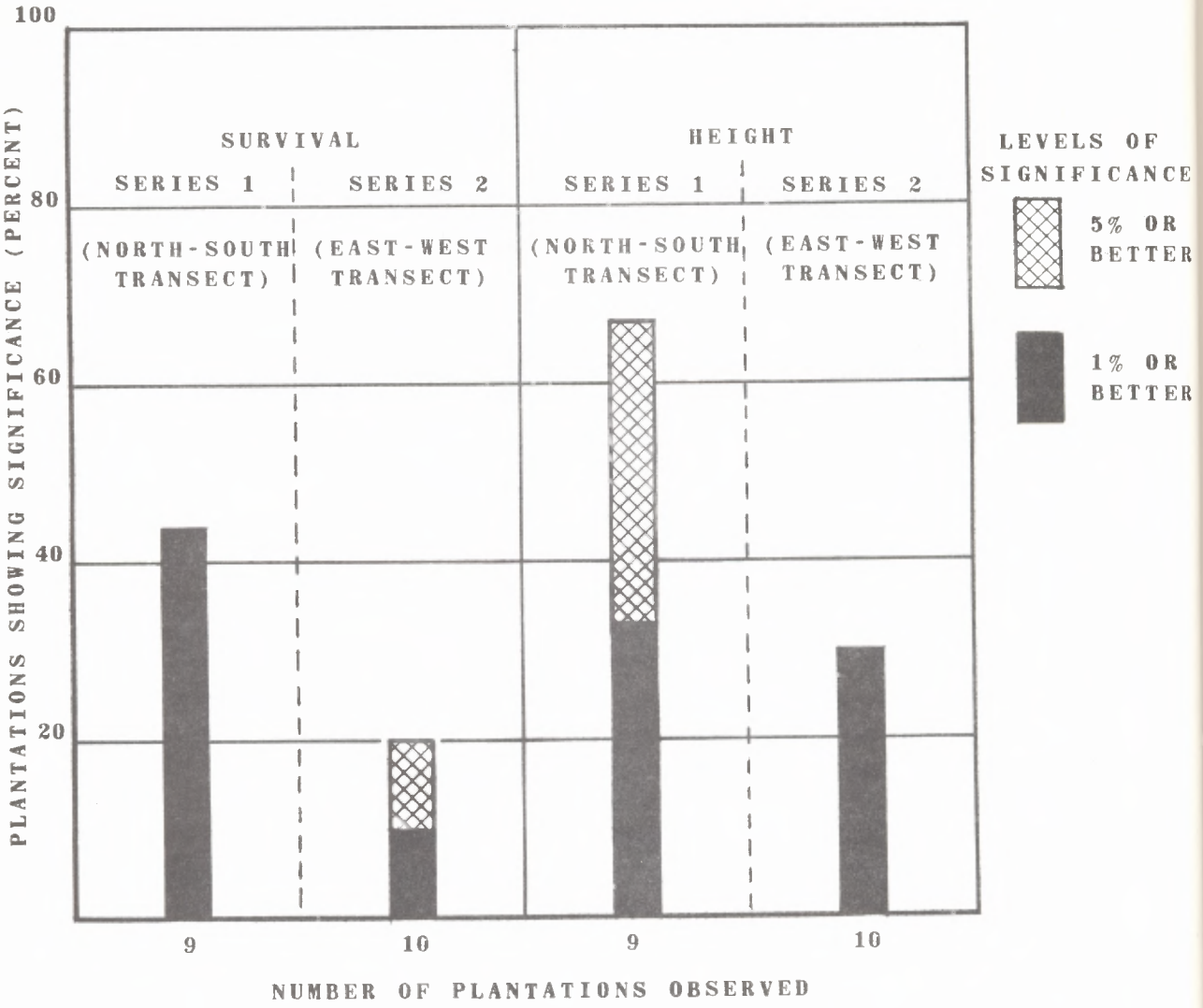
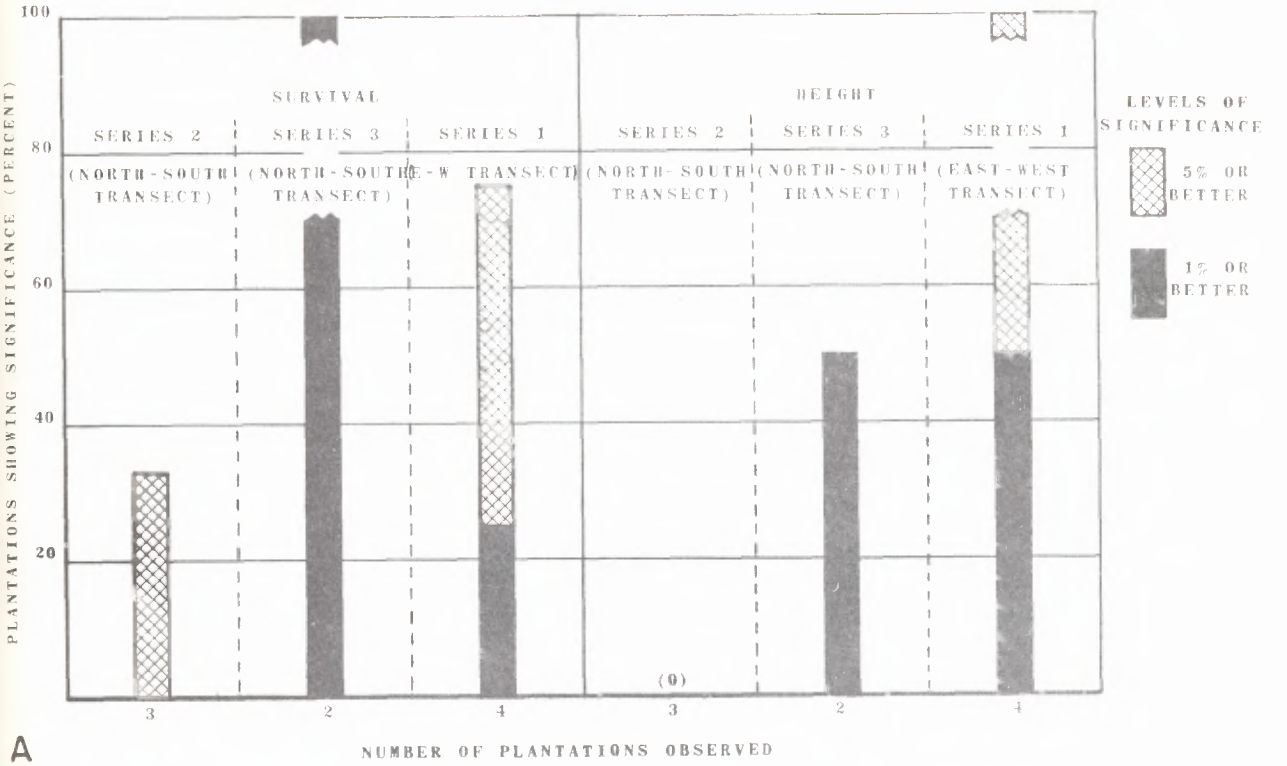


Figure 3.--Extent of significant variation in survival and height of loblolly pine at 5 years.



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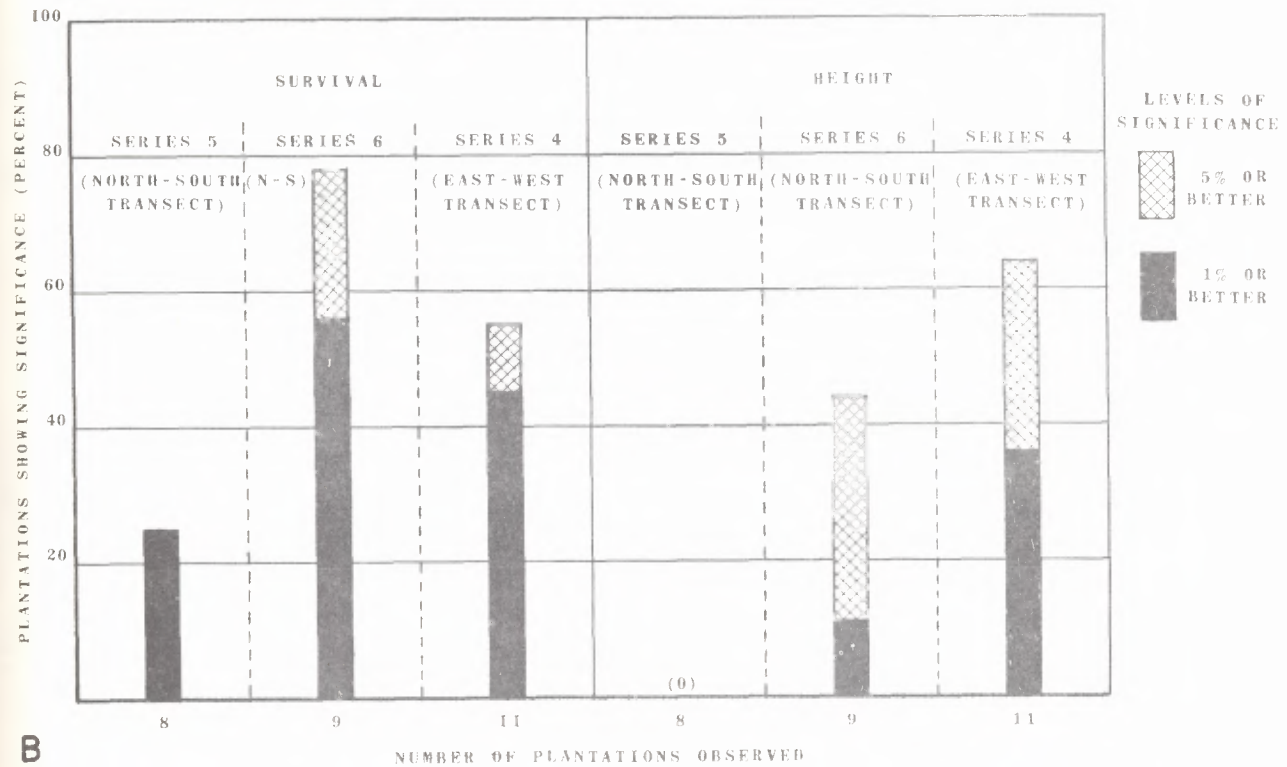

B

Figure 2.--Extent of significant variation in survival and height of longleaf pine. A, in 1952-53 and 1953-54 plantations at 5 years; B, in 1956-57 plantations at 3 years.

longleaf plantations. Much significant variation occurs in the series representing sources along an east-west transect of the species range, but part of it is definitely attributable to nursery influence. Relatively little significant variation--none in height--occurs in connection with one of the north-south transects, but much highly significant variation occurs in the other.

Figure 2B, based on many more later longleaf plantations, essentially confirms the pattern indicated in the earlier plantings. The 3 transects duplicate almost exactly those shown in figure 2 A. As in figure 2 A, sources representing the east-west transect vary greatly in survival and in height. Those representing one north-south transect vary greatly; those representing the other do not.

In loblolly pine, the pattern is simpler. Loblolly Series 1 consists of sources representing north-south transects of the species range; Series 2, of sources representing a roughly east-west transect, along the isotherm of 62°-63° F. mean annual temperature. As figure 3 shows, significant variation in both survival and height is much more common among sources

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Figure 3.-- Extent of significant variation in survival and height of loblolly pine at 5 years.

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ranging from north to south than among those ranging from east to west.

Figure 4 A shows the same pattern in shortleaf pine at 5 years as in loblolly at 5 years. Significant variation in both survival and height is consistently more frequent among the

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Figure 4.-- Extent of significant variation in survival and height of shortleaf pine. A, in 1952-53 and 1953-54 plantations at 5 years; B, in 1956-57 plantations at 3 years.

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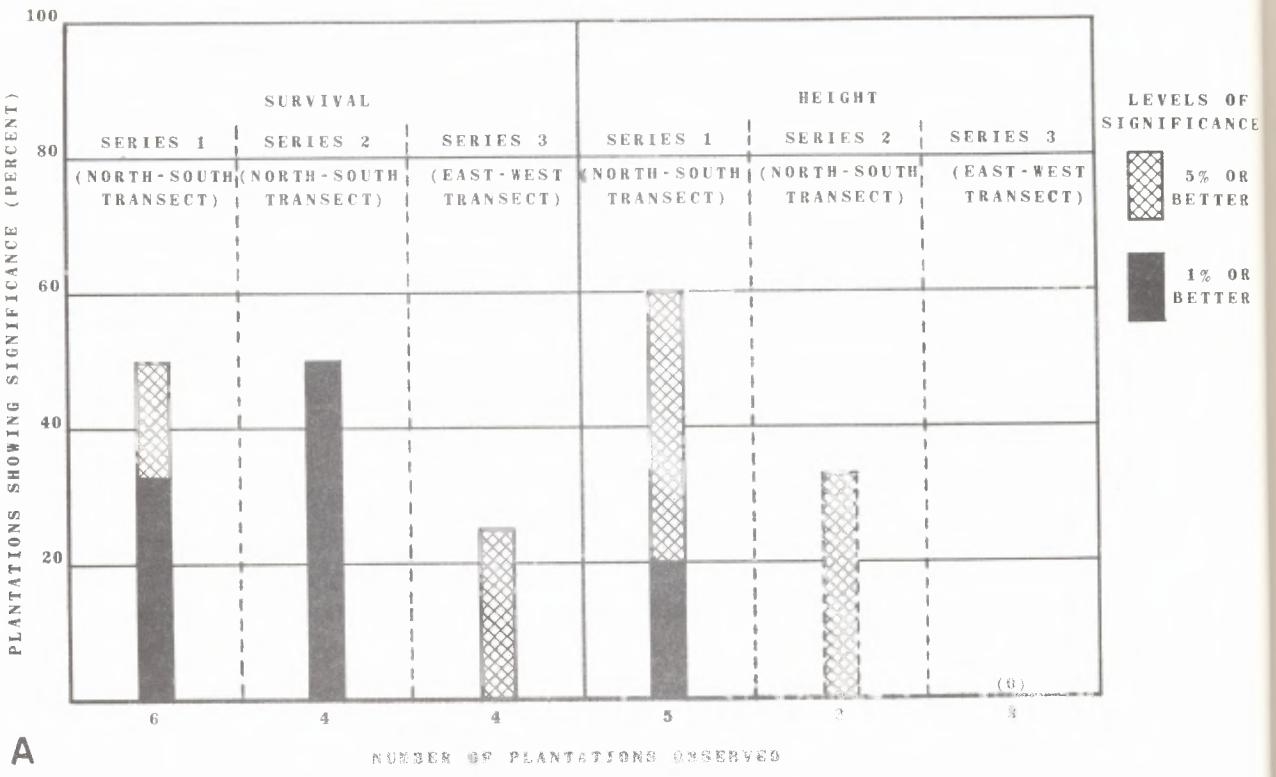
plantations containing sources along the north-south transects than among the plantations containing sources along the east-west transect.

Figure 4 B shows the occurrence of significant variation at 3 years in the 3 shortleaf series planted in 1956-57. Series by series, the sources duplicate in part the sources in



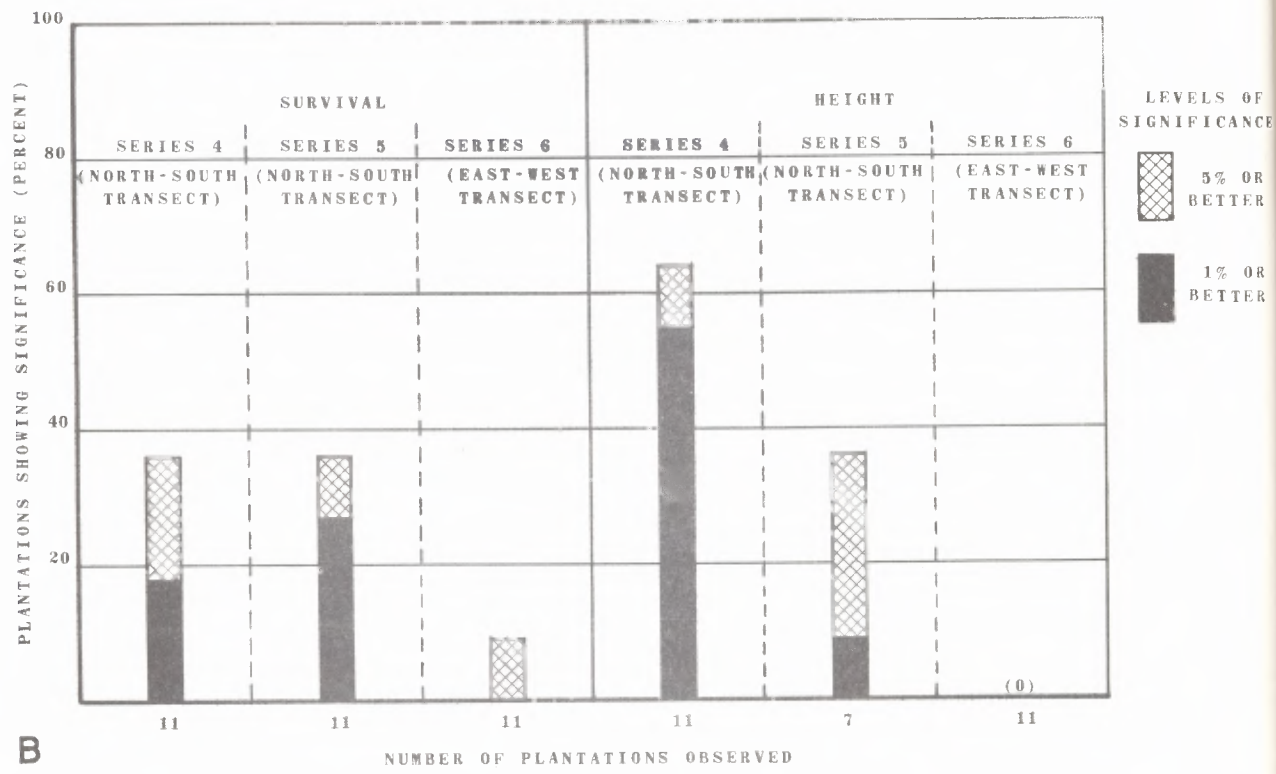


Figure 4.--Extent of significant variation in survival and height of shortleaf pine. A, in 1952-53 and 1953-54 plantations at 5 years; B, in 1956-57 plantations at 3 years.

the earlier plantations, but, because of fluctuations in seed supply, a few of the original sources had to be replaced by new ones. Despite these substitutions, the pattern of variation is essentially the same as that shown in figure 4 A: frequent significant variation, in both survival and height, among sources ranging from north to south, and little or none among sources ranging from east to west.

The foregoing results suggest that, when local seed is unavailable, it may be better to get seed from sources east or west of the planting locality than from sources farther north or south. The 5-year-old loblolly plantations and the 5 and 3-year-old shortleaf plantations indicate that both survival and height of stocks from farther north or south are more likely to differ significantly from those of local stocks than are the survivals and heights of stocks originating farther east or west. The longleaf plantations confirm the suggestion only in part, as east-west variation is greater and north-south variation is less than in loblolly and shortleaf, but, as has been pointed out, the results with longleaf merit less weight, for several reasons. The results with slash pine lend little weight to the suggestion, but do not conflict with it in any way.

A special note about loblolly pine is in order. Although survival and height vary less significantly among sources ranging from east to west than among those ranging from north to south, susceptibility to fusiform rust varies more from east to west, especially in the central and southern parts of the species' range (Henry 1959). Stock from eastern sources is more susceptible than that from western sources. With loblolly pine, therefore, substitutes for local seed probably should be obtained from west of the planting locality, rather than north, south, or east. This will be discussed in more detail later.

Local versus Other Individual Sources

Discussion so far has been in terms of the "series" described in connection with the longleaf, loblolly, and shortleaf components of the Southwide Study, and of the generally more frequent occurrence of significant variations in the series representing north-south transects of the species' ranges.

As each series representing an east-west transect of a species' range in linked to 1 or 2 north-south series by 1 or more common seed-sources, stocks from the seed-sources used as links have been planted more or less widely throughout the species' ranges. Their survivals and heights throughout the species' ranges can therefore be compared with those of stocks from sources local to the various plantations. In the paragraphs that follow, comparisons are made in terms of the frequency with which survivals or heights excel over-all averages of individual plantations, or are best in individual plantations. Frequencies are expressed as percentages of all plantations in which the specified stocks have been observed.

It may be stated at the outset that stock from local seed, especially of longleaf, has by no means always proved best at the end of 3 to 5 years. It has not always been above average for the individual plantation. In a number of plantations the local stock has survived or grown less well than any other. In evaluating these facts, it must be remembered that: (1) Many of the differences between local and other stocks fall far below the 5-percent level of significance, especially in the series representing east-west transects; and (2) with longleaf, some of the differences in survival are directly attributable to nursery rather than to genetic influences, and many of the differences in height are associated with excessively high mean squares for error. With these 2 reservations in mind, some of the differences between local and selected individual sources merit discussion.

Figure 5 A compares the performance of local longleaf stocks, at 5 years, with those

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Figure 5.-- Comparison of survival and height of local longleaf stocks with those of widely planted stocks representing individual sources. A, in 1952-53 and 1953-54 plantations at 5 years; B, in 1956-57 plantations at 3 years.

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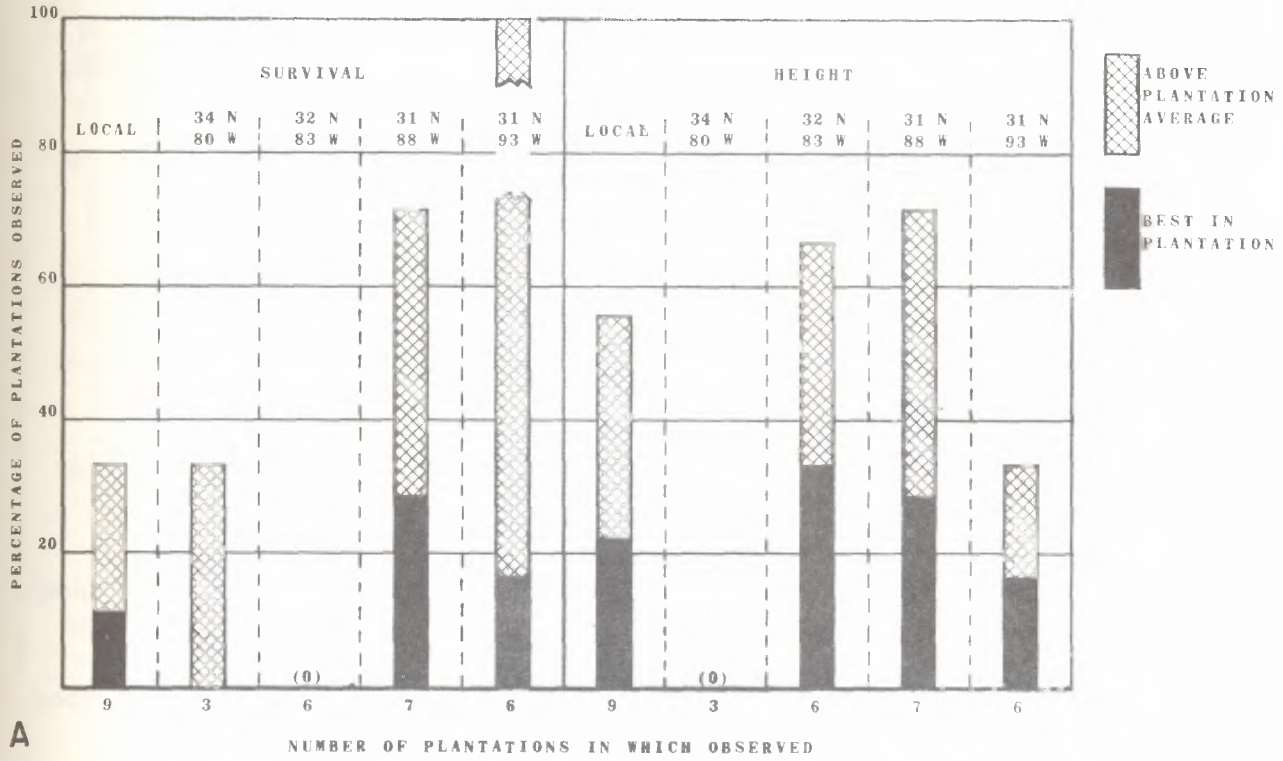
of individual stocks representing (within a narrow range of latitudes) longitudes of 80°, 83°, 88°, and 93° W.

Local stocks had average or better survival in a far smaller percentage of plantations than did the stocks from longitudes 88° and 93° W.

In height, local stocks made a somewhat better showing but were still surpassed by the stocks from longitudes 83° and 88° W. In fact, in plantations well distributed over the longleaf pine range, stock from longitude 88° W. excelled local stocks in both survival and height.

The most striking thing about Figure 5 A, however, is that the 83° west longitude stock had lower than average survival wherever planted, but made average or better growth in a higher percentage of plantations than did local stock. By contrast, the 93° west longitude stock had above-average survival wherever planted, but above-average growth in a smaller percentage of plantations than local stock.

Figure 5 B makes similar comparisons for the 1956-57 longleaf plantations at 3 years. The 4 individual stocks compared with local stocks are essentially the same as in figure 5 A.



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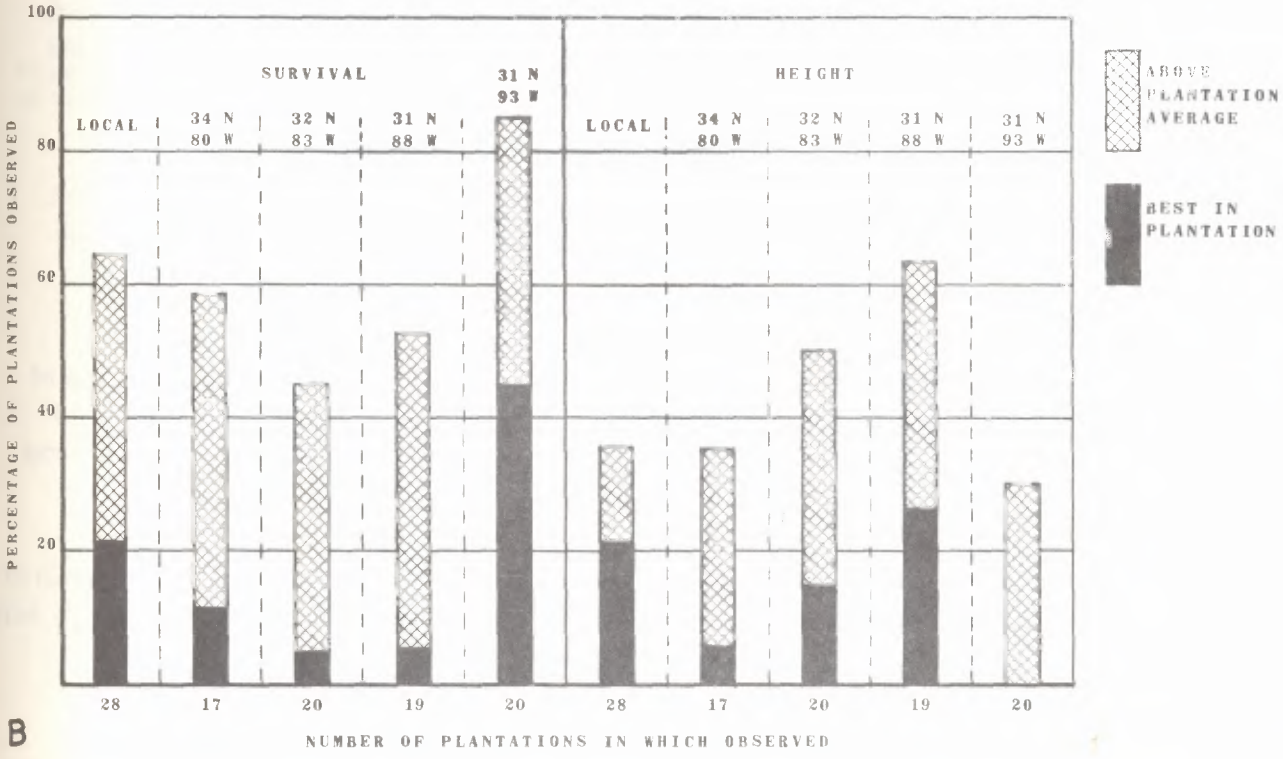

B

Figure 5.--Comparison of survival and height of local longleaf stocks with those of widely planted stocks representing individual sources. A, in 1952-53 and 1953-54 plantations at 5 years; B, in 1956-57 plantations at 3 years.

Contrasts are less extreme, as might be expected from the history of establishment and the age of the trees. Local stocks show up more favorably in survival and less favorably in height than in figure 5 A. Again, however, the stock from longitude 83° W. has fallen behind the local in survival but has excelled it in growth, and the stock from longitude 93° W. has excelled the local in survival but fallen below it in growth.

Figure 6 compares local loblolly stocks at 5 years with 3 other stocks representing

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Figure 6.-- Comparison of survival and height of local loblolly stocks, at 5 years, with those of widely planted stocks representing individual sources.

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longitudes of 77°, 91°, and 93° W., at various latitudes.

On the whole, local loblolly stocks performed considerably better than local longleaf stocks.

One individual loblolly stock, from longitude 77° W., equalled or excelled the local stocks in both survival and height.

Again, individual stocks excelled local stocks in one characteristic and fell behind them in the other. The stock from longitude 91° W. survived less well than the local but made better height growth. The 93° west longitude stock survived far better than the local but made average or better height growth in a far smaller percentage of all plantations in which observed.

In shortleaf at 5 years, local stocks make the best showing yet observed (figure 7 A). Even here, however, the growth of 1 individual stock, from longitude 85° W., although

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Figure 7.-- Comparison of survival and height of local shortleaf stocks with those of widely planted stocks representing individual sources. A, in 1952-53 and 1953-54 plantations at 5 years; B, in 1956-57 plantations at 3 years.

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not equalling that of local stocks, was relatively better than its survival, and the survival of another, from longitude 92° W., although inferior to that of local stocks, was relatively bette

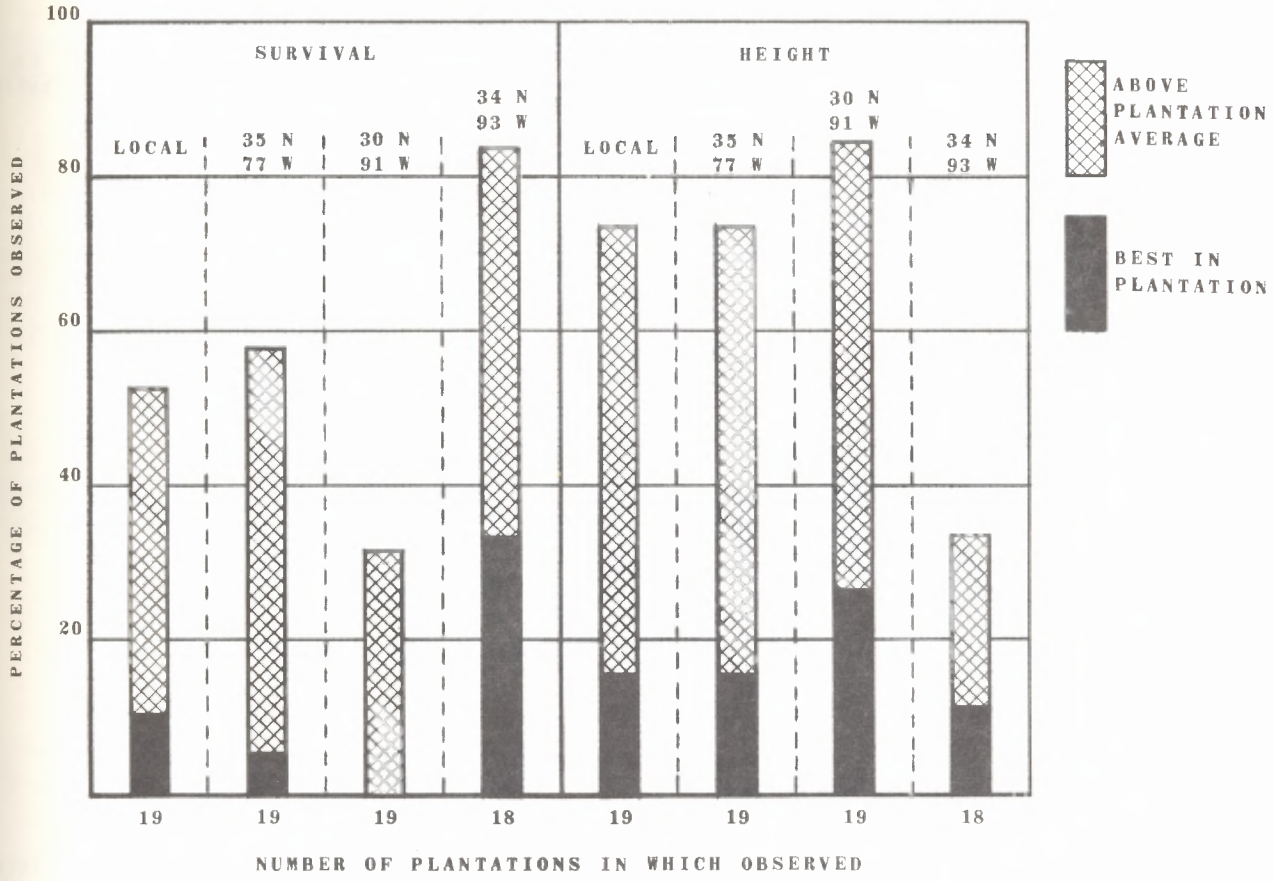
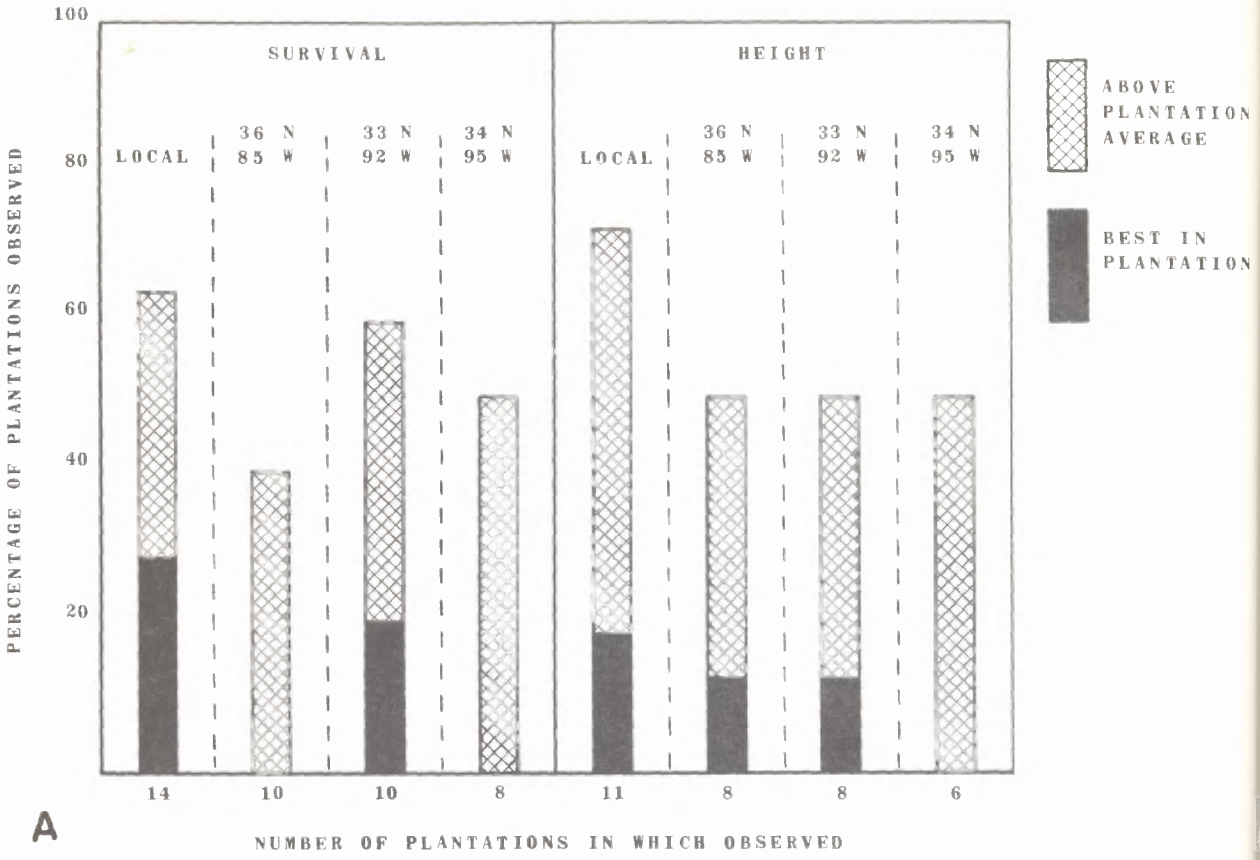


Figure 6.--Comparison of survival and height of local loblolly stocks, at 5 years, with those of widely planted stocks representing individual sources.



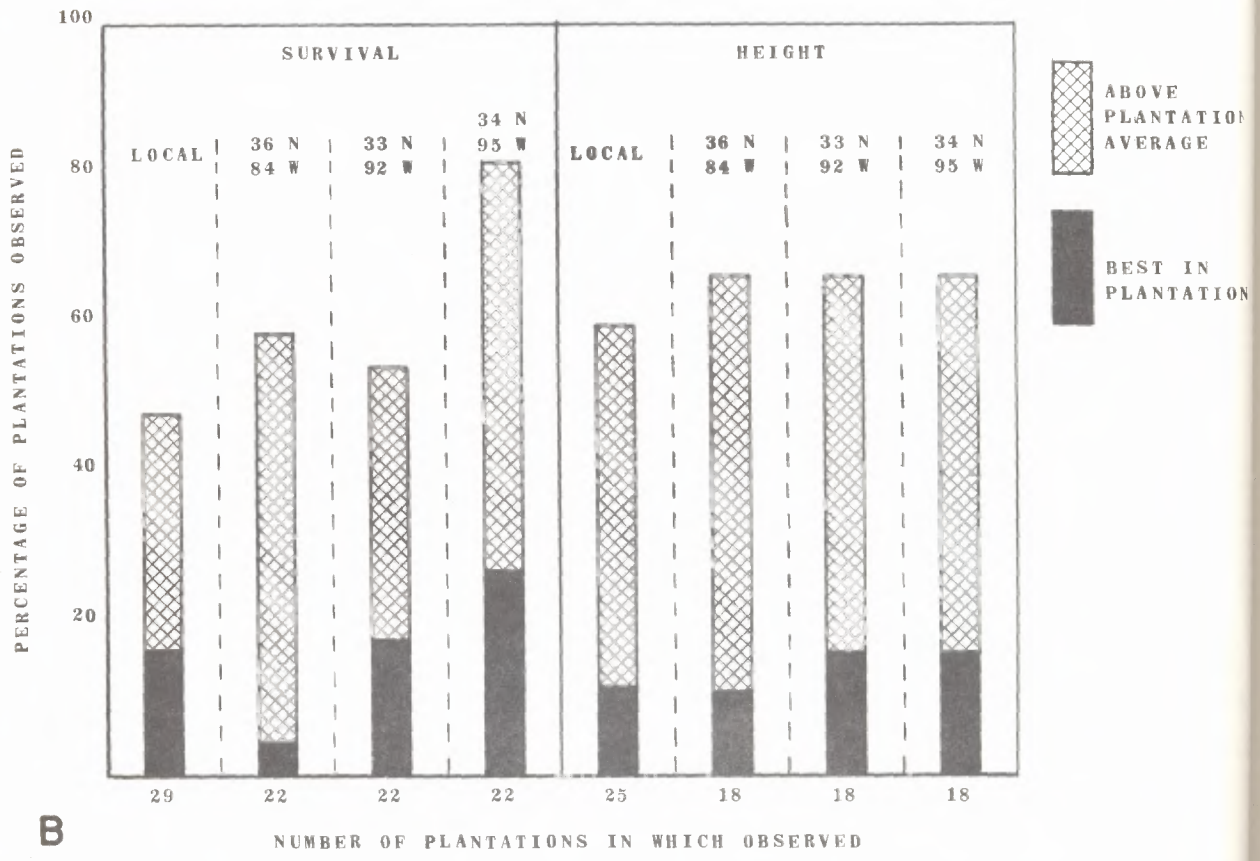


Figure 7.--Comparison of survival and height of local shortleaf stocks with those of widely planted stocks representing individual sources. A, in 1952-53 and 1953-54 plantations at 5 years; B, in 1956-57 plantations at 3 years.

than its growth. For some unknown reason the stock representing the most westerly source, longitude 95° W., did not survive outstandingly well in the original shortleaf plantations.

In the 1956-57 shortleaf plantations, at 3 years, the stock from longitude 95° W., survived outstandingly well (figure 7 B), being above average in a far larger percentage of plantations than local stocks, but its growth was only slightly better than that of local stocks, and was less good than its survival. Local stocks make a relatively poor showing in figure 7 B, perhaps because the trees were too young to show the adaptability of the local stocks in figure 7 A.

In figures 5 through 7 as a group, most of the individual stocks showing better survival but poorer growth than local stocks are from seed sources in the western part of the species ranges. Most of those showing better growth but poorer survival are from southern or eastern sources.

More Detailed Evaluations of Individual-Source Relationships

The comparisons in figures 5 through 7 are in very general terms. They include non-significant as well as significant variations in survival and height. The plantations observed are not uniformly distributed over the species' ranges; a majority of them are in the lower latitudes. Lastly, more by accident of seed supply than anything else, most of the individual stocks with which local stocks are compared represent east-west transects of the species' ranges. This preponderance of east-west comparisons minimizes attention to variation in a north-and-south direction, which figures 2 through 4, and especially 3 and 4, show to be more frequently significant. Adequate evaluation of the more important north-and-south variation requires a different form of analysis.

Figure 8 shows the mean 5-year heights of loblolly pine of 8 sources, in 2 plantations,

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Figure 8.-- Mean heights of loblolly stocks at 5 years, over latitudes of seed sources, in northern and southern plantations.

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plotted over latitudes of source.

In the Pearl River County, Mississippi, plantation, at latitude 30° 44' N., there is a negative regression of 5-year height over latitude of seed source. The slope falls somewhat

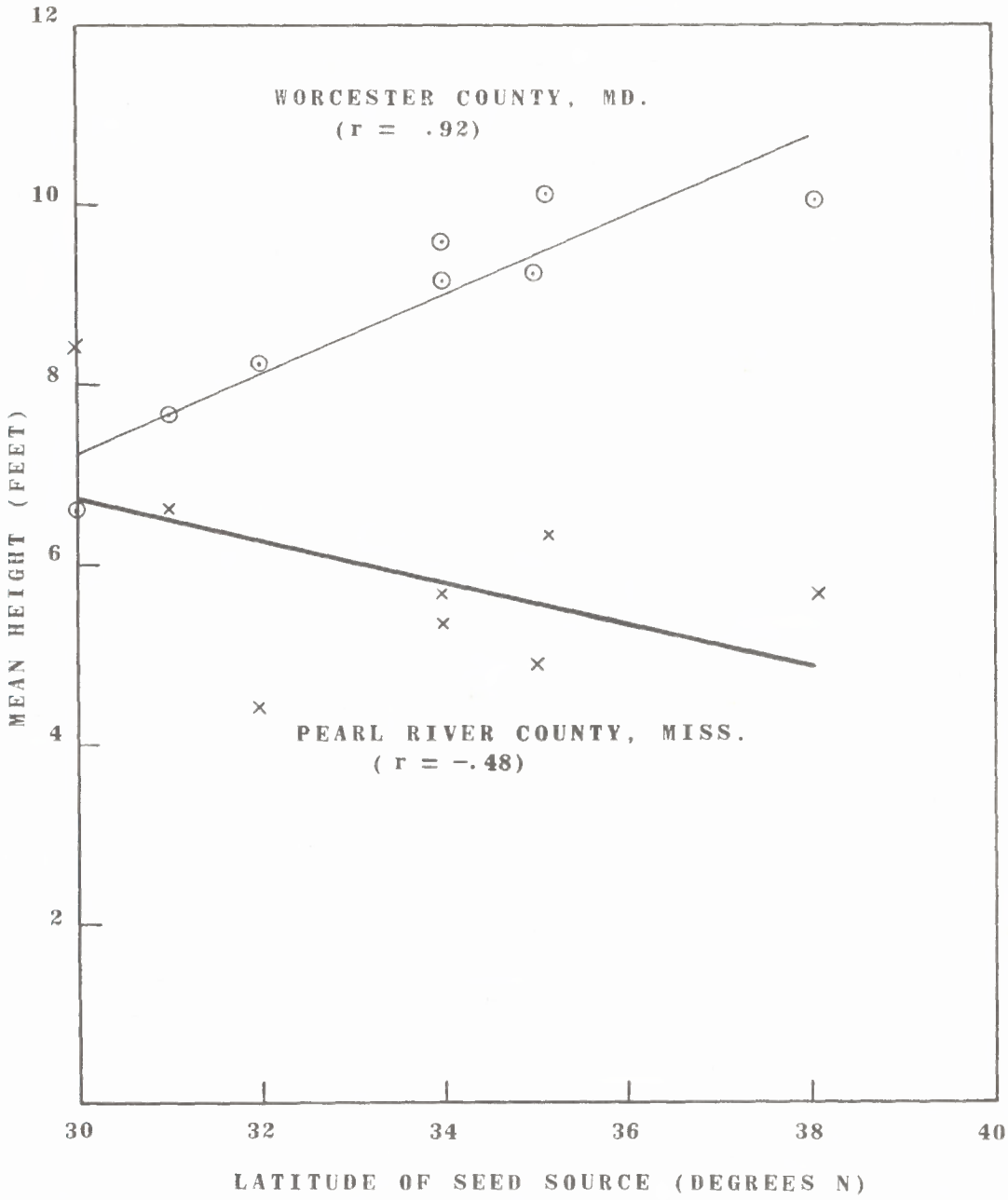

Figure 8.--Mean heights of loblolly stocks at 5 years, over latitudes of seed sources, in northern and southern plantations.

short of significance at the 5-percent level. The coefficient of correlation is -.48.

The same stocks in the plantation in Worcester County, Maryland, at latitude 36° 35' N., show a strong positive regression of 5-year heights over latitude of source. The degree of slope is highly significant, and the coefficient of correlation is +.92.

The striking thing about figure 8 is the reversal of the slope of the curve when stocks representing a north-south transect of the species' range are planted near opposite ends of the transect.

The 1952-53 and 1953-54 shortleaf plantations do not afford quite so good an example of this reversal of slopes, because all the northern-most plantations failed. Nevertheless, figure 9 suggests the same trend. Seven stocks planted in St. Helena Parish, Louisiana,

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Figure 9.--- Mean heights of shortleaf stocks at 5 years, over latitudes of seed sources, in plantations at southern and intermediate latitudes.

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at latitude 30° 58' N., show a highly significant negative regression of 5-year heights over latitude of seed source; the coefficient of correlation is -.97. The same stocks planted in Morgan County, Tennessee, at the intermediate latitude of 36° 00' N. (and an elevation of 1,280 feet) show a non-significant positive regression of 5-year height over latitude of source, with a coefficient of correlation of only +.34.

Figure 10 shows the same relationship as figures 8 and 9, in terms of 3-year heights of

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Figure 10.--- Mean heights of shortleaf stocks at 3 years, over latitudes of seed sources, in plantations at northern, southern, and intermediate latitudes.

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younger shortleaf plantations.

In figure 10, 7 stocks planted in Washington Parish, Louisiana, at latitude 30° 42' 30" N., show a highly significant negative regression of 3-year height over latitude of seed

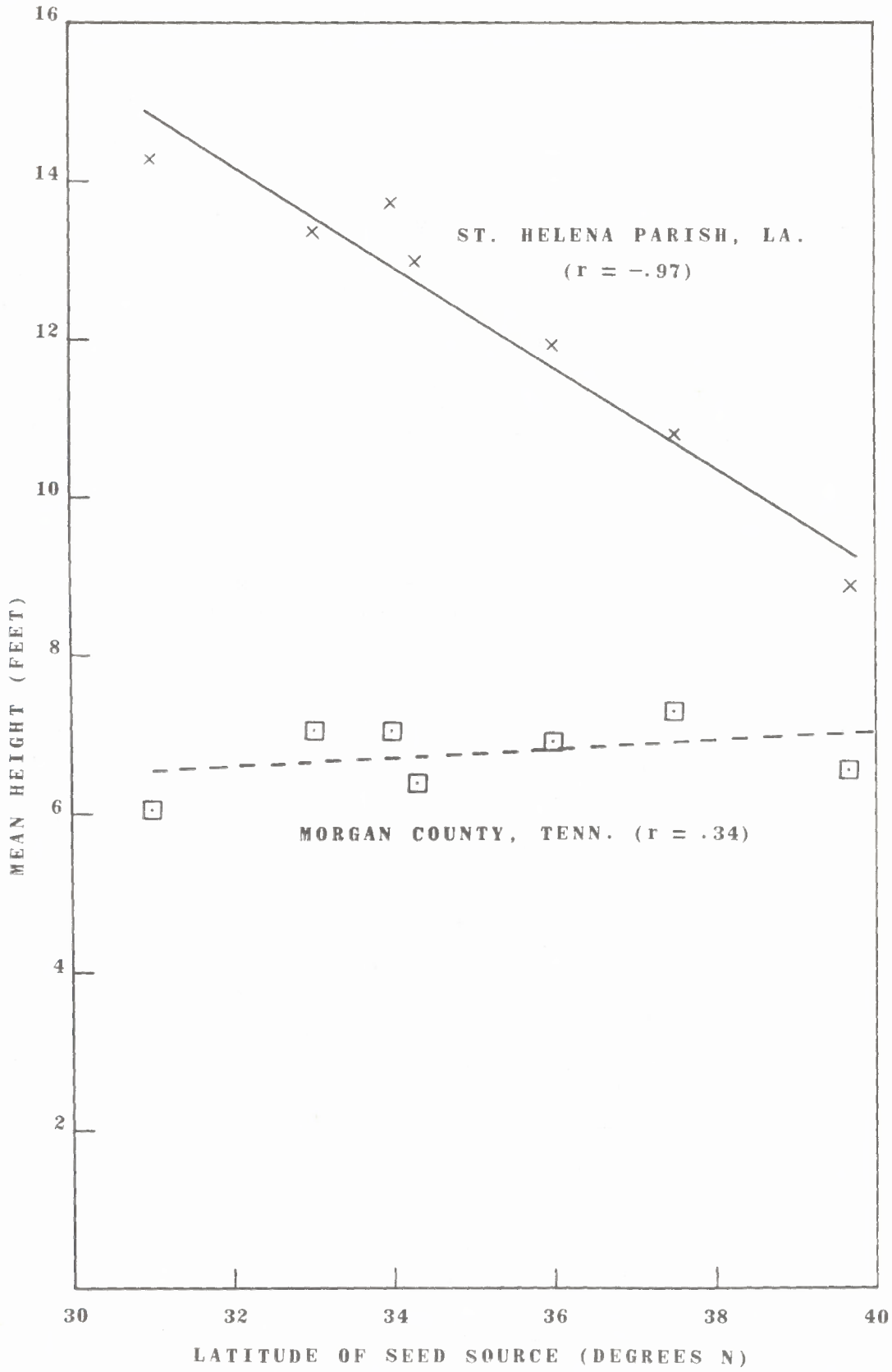

Figure 9.--Mean heights of shortleaf stocks at 5 years, over latitudes of seed sources, in plantations at southern and intermediate latitudes.

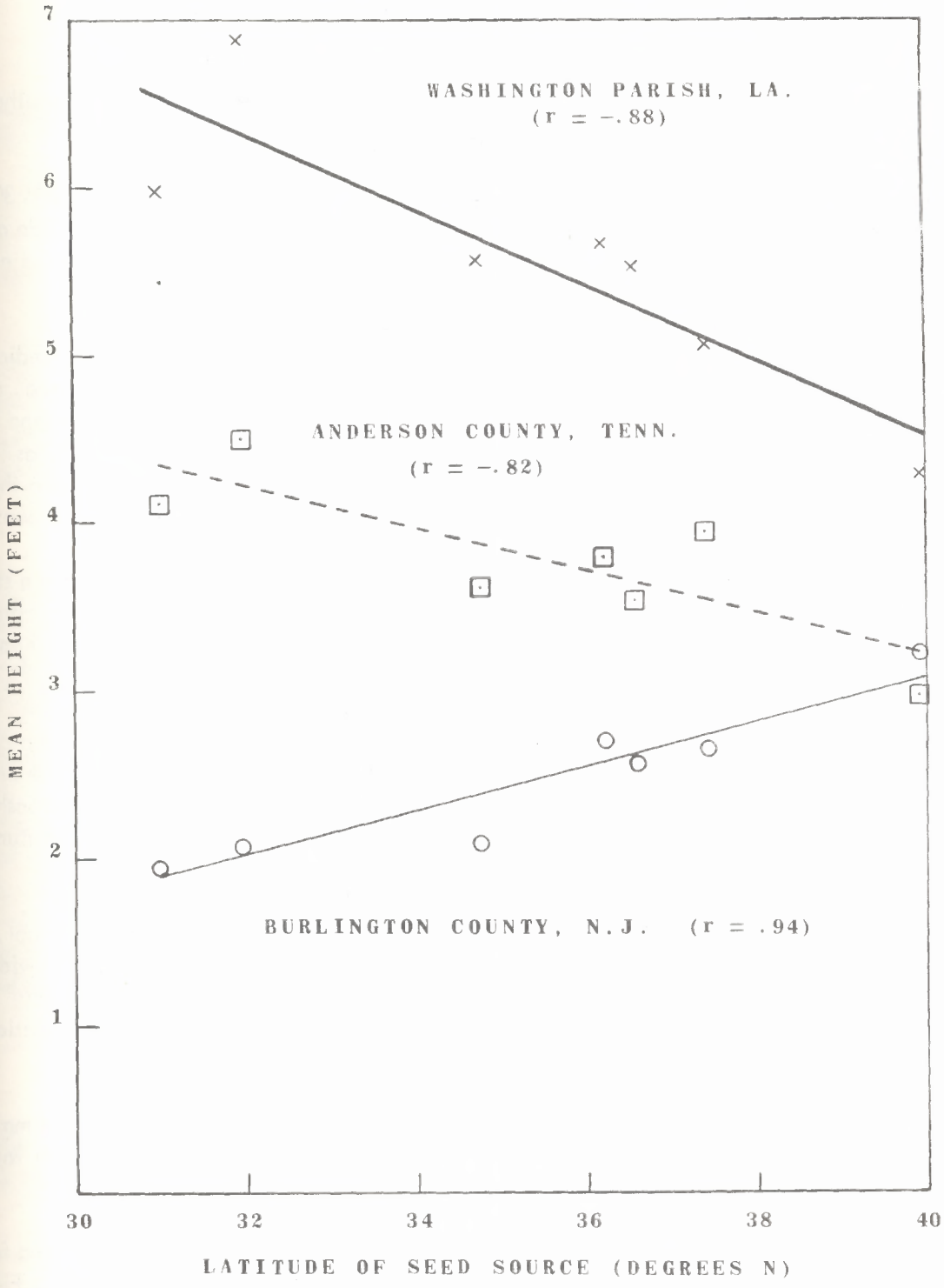

Figure 10.--Mean heights of shortleaf stocks at 3 years, over latitudes of seed sources, in plantations at northern, southern, and intermediate latitudes.

source, with a coefficient of correlation of -.88. This parallels the results of the southern plantations of loblolly and shortleaf in figures 8 and 9.

The same 7 stocks planted in Burlington County, New Jersey, at latitude 39° 36' 30" N., show an even more highly significant positive regression of 3-year height over latitude of seed source, and a coefficient of correlation of +.94. This parallels the results in the northern loblolly plantation in figure 8.

In figure 10, the curve for the Anderson County plantation alone, at the intermediate latitude of 36° 13' N., fails to parallel the corresponding Morgan County, Tennessee, curve in figure 9. In the Anderson County curve the slope is negative instead of positive and highly significant instead of non-significant. Its coefficient of correlation is -.82, as against only +.34 for Morgan County. Part of the discrepancy may be attributable to the nearly 400-foot lower elevation and probably higher temperatures of the Anderson County site.

To sum up, figures 8 through 10 show in general that, when northern and southern stocks are planted together, the southern ones excel significantly in height growth if the plantation is in a southern locality, and the northern ones if it is in a northern locality. At intermediate latitudes the differences in height growth may be less significant or nonsignificant.

These crisscrossing regression curves derived from similar or identical stocks in matched plantations at different latitudes suggest that the stocks represent points along a cline or a series of similar clines. The data show that up to 5 years, at least, the clinal relationship to latitude tends to be highly significant. The joint correlations of latitude, temperatures, and day-length are, of course, too obvious to require discussion.

The variation of height growth with latitude of seed source and of plantation is not, however, the only type of clinal variation evident from the first 5 years of the Southwide Study. The pattern of susceptibility of loblolly pine to southern fusiform rust, already mentioned under Occurrence of Significant Variation, represents a very different relationship.

At the Fifth Southern Conference in Raleigh 2 years ago, Henry (1959) reported maximum rates of rust infection on loblolly stocks from sources in and near Georgia, and lower rates on stocks from sources farther west and north.

Loblolly Series 2 consists of 9 sources from longitudes 77° 00' to 93° 00' W., and from latitudes on, and in one instance south of, the 62° - 63° F. mean annual isotherms. Figure 1 shows the regressions of mean rust infection percent at 5 years, over longitude of seed source,

in plantations of this series in Craven County, North Carolina, and in Washington Parish, Louisiana.

Figure 11.-- Fusiform rust infection of loblolly at 5 years, over longitude of seed source, in western and eastern plantations.

The Craven County plantation is the easternmost in Series 2. It is at longitude 77° 00' W., in an area of relatively low incidence of rust. The curve of infection percent over longitude of seed source has a highly significant negative slope, and the coefficient of correlation is -.93.

The Washington Parish plantation is at longitude 89° 57' W., near the western end of the transect represented by Loblolly Series 2, in an area where the incidence of rush is high. The first-degree curve of infection-percent over longitude for this plantation falls just short of significance at the 5-percent level--a second-degree curve would give a closer fit--and has a coefficient of correlation of only -.62. The slope is nevertheless negative, like that of the Craven County curve. The curves for other Series-2 plantations at intermediate longitudes also have negative slopes.

The clinal relationship shown by these consistently negative regressions of infection percent over longitude of seed source is entirely different from that of the 5- or 3-year heights over latitude, in which planting at the opposite end of the transect reverses the slope of the curve. The consistently lower rust suspectibility of stock of western sources, regardless of where planted, is the main reason for recommending that non-local loblolly seed be obtained west rather than east of the planting locality.

Summary and Tentative Conclusions

The relationships so far worked out from the 5- and 3-year reexaminations of the Southwide Pine Seed Source Study may be summarized as follows:

> Although slash pine (Pinus elliottii elliottii) is represented by the fewest seed sources and plantations, numerous variations in both survival and height, significant at the 5- or 1-percent level, had developed at 5 years. With very few exceptions, however, the significant variation

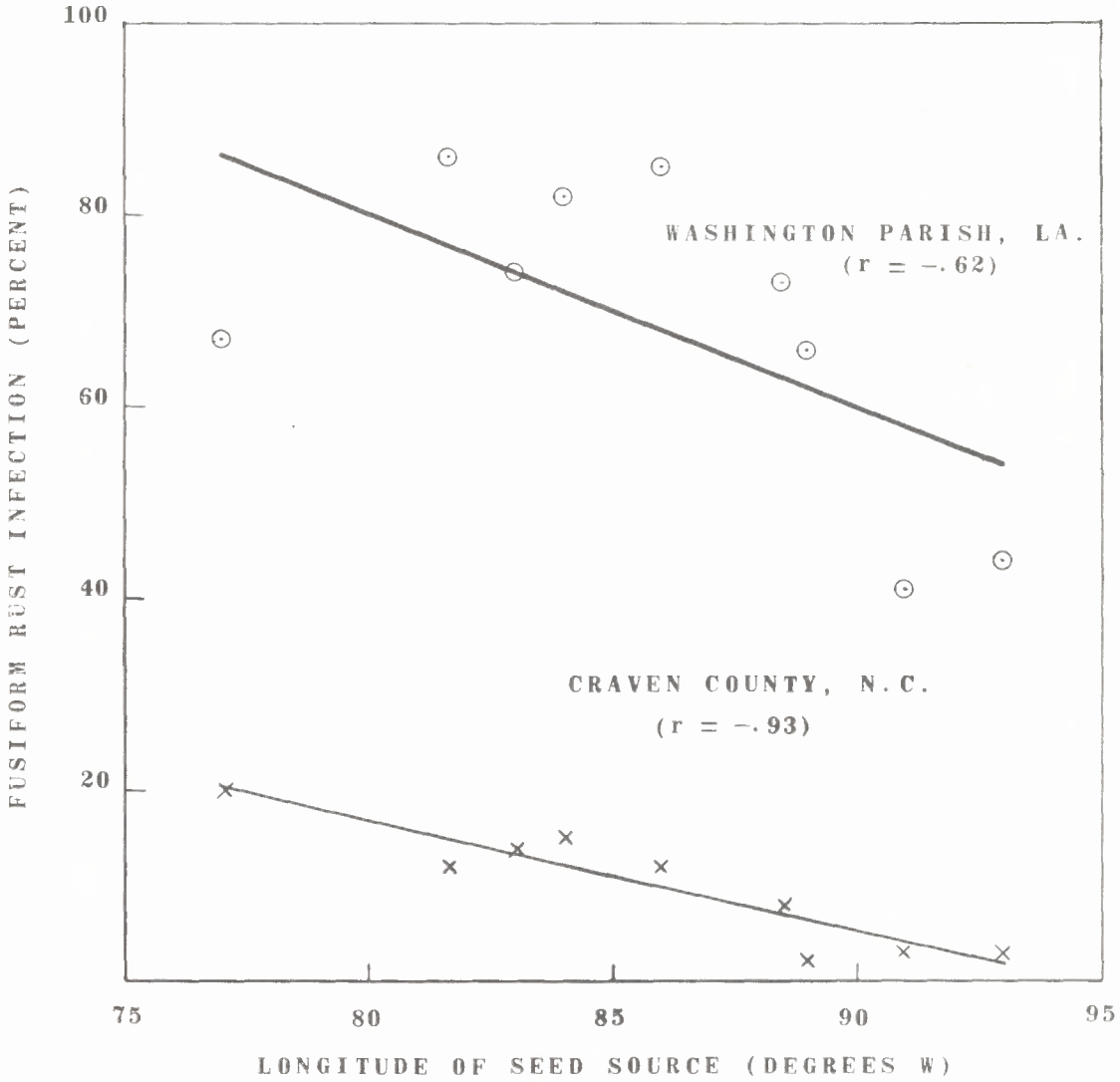

Figure 11.--Fusiform rust infection of loblolly at 5 years, over longitude of seed source, in western and eastern plantations.

was attributable to a single source, the seed from which is suspected of contamination with a recognized botanical variety, P. elliottii densa. If this one source is discounted, much less racial variation is evident in slash pine than in the other 3 species studied.

In longleaf pine, both at 5 years in the older plantations and at 3 years in the younger ones, fully as much variation in survival and height, significant at the 5- or 1-percent level, occurred among sources lying in an east-and-west direction as among those lying north and south. Variation among north-south sources was nevertheless very high in some instances. The results with longleaf must be accepted with caution because nursery conditions influenced survival in some of the older plantations, and because height relationships are unstable in longleaf up to age 5.

In loblolly pine at 5 years, and in separate plantings of shortleaf pine at 5 and 3 years, significant variations in both survival and height occurred far more frequently among stocks representing north-and-south transects of the species' ranges than among those representing east-and-west transects.

Stock from seed 'local' to the planting site was by no means always the best, or even always above the average of all stocks in the individual plantation. In a few plantations the local stock was the poorest in survival, growth, or both.

In longleaf, loblolly, and shortleaf, the design of the study permits comparison of local stocks with a limited number of other stocks planted throughout the species' ranges. In survival and height combined, local stocks compared favorably with most of these other stocks. Local longleaf stocks compared least favorably, and in each of the 3 species at least 1 other stock tended to excel local stock, in both survival and height, wherever planted.

In longleaf, loblolly, and shortleaf alike, there was a conspicuous tendency for certain individual, widely planted stocks to excel local stocks in survival but not in height, and of others to excel them in height but not in survival. In general, stocks surviving better but growing less well than local stocks represented the western parts of the species' ranges, and stocks outgrowing the local stocks but surviving less well were from southern, southeastern, or eastern sources.

A clinal relationship of height growth to latitude proved common to loblolly at 5 years and to separate plantings of shortleaf at 5 and 3 years. When like sets of stocks were compared, curves of height over latitude of seed source had nearly significant to highly significant negative slopes in southern plantations and highly significant positive slopes in northern plantations. In plantations at intermediate latitudes the slopes were variable in direction, and less significant or non-significant. The dominant characteristic of this clinal relationship is the reversal of the slope of the curve when planting of the same stocks is replicated at the opposite end of the species' north-and-south range.

In its susceptibility to southern fusiform rust, loblolly pine from the central and southern parts of its range showed a clinal relationship to longitude of seed source. This relationship differs strikingly from that of height growth to latitude, in that curves do not reverse direction of slope with change of planting location. The curves of rust infection percent at 5 years over longitude of seed source are negative in slope in plantations near both east and west sides of the species' range, and in those at intermediate points.

Only tentative and very general recommendations can safely be based on the study so far. The latest remeasurements are of survival and growth after only 5 years in plantatio and this period is far too short to permit final conclusions.

While the results to date do not strongly reinforce the traditional recommendation to u local seed, they do substantiate it to some extent. They certainly do not justify preferring seed of specific non-local sources to local seed.

With loblolly and shortleaf in particular, and to a certain extent with longleaf, the findings indicate that when local seed is not available, substitues should be obtained east or west of the planting locality, rather than north or south of it. In the central and south part of the loblolly pine range, the pattern of fusiform rust susceptibility indicates that it safer to go west than east for loblolly seed.

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