IMPORTANCE OF GEOGRAPHIC STRAINS 1/

By

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A geographic strain of forest trees consists of individuals which, because of their origin in some particular place, share certain inherited physiological tendencies that enable them to thrive better in certain locations than individuals of the same species from other places. The fact that these tendencies are inherited makes such strains a genetical problem. The often serious loss in thrift when the wrong strain is planted on a given site makes the problem economi cally important.

Geographic strains became a matter of concern rather early in the development of forest planting. According to Baldwin (1942), their importance was first expressed correctly by a Swedish author in 1769, and some experiments on the effect of seed source were a casualty of the French Revolution. Proof that geographic source of seed is of tremendous significance in forest planting is now practically world-wide. In the European countries in which forest genetics research has progressed the farthest, both hybridizing and the selection of superior individual trees has been done with careful regard to, and within the framework of, geographic strains. The progeny of even the most superlative tree in a given region may fail if planted somewhere else.

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There is a voluminous literature on geographic strains of forest trees. Several general summaries of the problem, and most of the available results of studies of American species, are included in the literature cited in the supplementary notes.

I have personally seen striking variations in root habit in longleaf seedlings, directly attributable to Louisiana versus Georgia origin of seed. I have seen equally distinct variations in foliage development of longleaf seedlings, directly attributable to origin of seed on clay and on deep sands within sixty miles of each other. I have seen shortleaf seedlings from Pennsylvania and Texas seed, in the same bed in a Louisiana nursery, differ by 2 months in the time at which they completed growth in the fall, by 3 inches in average height in September and by 6 inches in November, and to a great extent in the development of secondary needles and winter buds. Regardless of any economic importance, such variations are evidence of geographic strains in southern pines.

At Bogalusa, Louisiana, in the winter of 1924-25, I saw the Great Southern Lumber Ccmpany plant 5,000 acres of loblolly pine--fortunately with stock grown from local seed. One year later the Southern Forest Experiment Station established a study at Bogalusa which has since shown that if the company had used loblolly seed from certain parts of Georgia or Arkansas, it would have lost over $100,000 worth of growth on its 5,000 acres during the first 22 years after planting. Few would question the economic importance of this difference between geographic strains.

The first 15 years' results of the Bogalusa experiment with geographic sources of loblolly pine seed have been published in the Journal of Forestry, and the results at 15 and 22 years are summarized in table 1 of the supplementary notes. The differences in disease resistance among the 4 geographic strains tested have been as noteworthy as the differences in growth. The trees from the one eastern source of seed (Georgia) included in the study have proved far more susceptible to southern fusiform rust than the stock from Texas, Arkansas, or local Louisiana seed. Infection of the Georgia stock continues annually. Infection of the other three strains ceased at an early ago.

The weakness of this study is that it included only one species of southern pine, and tested this species in only one place. While it showed that the stock from local Louisiana loblolly seed excelled that from Georgia seed when both were planted at Bogalusa, it gave no clue as to which would be better if both were planted in Georgia, or else where.

To remedy this defect, the Southern Station arranged, in 1935, with the help of federal, State, forest school, and industrial cooperators, a comprehensive study of longleaf seed from 11 sources, slash from 7, loblolly from 12, and shortleaf from 14. Seed came from as far north as Pennsylvania and New Jersey, as far south as northeastern Florida, and as far west as Arkansas and Texas. It was distributed to 12 different nurseries in this country for sowing, and surplus slash pine seed from 6 sources and loblolly from 11 sources was sent to the Union of South Africa.

The original plan was to plant stock from each seed lot at or near its point of origin and also at the point of collection of every other lot of the same species, but some lots were too small to permit this. Despite the best intentions, some of the experimental plantations were laid out poorly, some were correctly designed but failed to survive well, and others, initially successful, were injured or destroyed during or after the war by fire or hogs. For these reasons, only very meager data from the 1935 study can be presented here to supplement the results of the original Bogalusa study.

The best data, published by Sherry in 1947, were obtained in South Africa, where plantations had been established at 4 widely separated localities, at latitudes 25^{0} to 31^{0} S. (The seed had been collected at latitudes 30^{0} to 38^{0} N) The average heights attained at 9 years in South Africa are given in table 2 of the supplementary notes.

In South Africa, loblolly pine developed differences in average heights far more striking than those shown in the original Bogalusa study. On the best of the 4 sites, average heights at 9 years ranged from 35 to 46 feet, depending on seed source. On the poorest, they ranged from 21 to 37, with the stock of least suitable geographic origin making only 57 percent of the height growth of the most suitable. In general, growth was better the lower the latitude of origin, but there were a few conspicuous exceptions. Seed from Onslow County, North Carolina showed superior vigor for its latitude of origin, and seed from the Kisatchie National Forest in Louisiana and from the Crossett Experimental Forest in Arkansas, showed inferior.

Slash pine from seed collected in the United States did not, in the South African tests, show evidence of geographic strains comparable to those found in loblolly. The greatest range in average heights of slash from seed source to seed source, in any one South African test, was from 36 to 40 feet; that is, stock from seed from the least suitable source made 90 percent of the growth of the most suitable. Little evidence of distinct strains has appeared in American plantations of slash pine stock from the same sources and from one more northerly (South Carolina) source.

After 13 years in the few undamaged or only lightly damaged experimental plantations in the United States, loblolly from the different sources varied much less in average height than it had at 9 years in South Africa. At Jasper, Texas, average heights ranged from 29 to 34 feet; the lerst well-adapted stock had made 85 percent of the height growth of the best adapted, whereas in South Africa it had made only 57 percent. At Athens, Georgia, average heights ranged from 31 to 35 feet. At Jasper, overage height decreased much less rapidly with increasing northern latitude of seed source than it did in South Africa, and at Athens the trend of decreasing average height over latitude of source practically disappeared. At both Jasper and Athens, however, the relatively good performance of the North Carolina strain and poor performance of the Louisiana and Arkansas strains showed up as they had in South Africa, although somewhat less conspicuously. Even though they confirm the original Bogalusa study less strongly than do the South African results, these differences in growth in the American plots of the 1935 study keep the issue of loblolly seed source very much alive.

As in the Bogalusa study, conspicuous differences in fusiform rust infection were associated with geographic source of seed in the American plantations of the 1935 study. The North Carolina stock, for example, had 22 percent of all living trees infected at both Athens, Georgia, and Jasper, Texas. The South Carolina stock had 8 and 16 percent infected at the same two places. Two western strains, those from the Kisatchie National Forest in Louisiana and from Trinity County, Texas, showed only 3 and 1 percent infection, respectively, at Athens, and 7 and 2 percent at Jasper. These results parallel those from the Bogalusa study, in which the one eastern strain of loblolly (Georgia) was much more heavily infected than the three western strains (Louisiana, Arkansas, and Texas). But strains from northeastern sources, which were not tested in the original Bogalusa study, also proved relatively unsusceptible in the 1935 study. Virginia stock was infected only 4 percent at Athens and only 6 percent as Jasper, and Maryland stock showed no infection at either place.

In the earlier study at Bogalusa, and in both South African and American plantations in the 1935 study, loblolly pine from southern sources tended to outgrow, or at least to equal, that from northern sources. This may have been because the experimental plantations were nearer the Equator than was the middle of the range from which seed was collected, and in some cases nearer the Equator than most or all of the seed sources. An opposite tendency has appeared in shortleaf pine in the 1935 study, in Pennsylvania. Here, in both growth and survival, seed from the southern part of the species range has given less good results than that from the central part and both have done far less well than local, northern seed (Aughanbaugh, 1950).

In 1939 the Chiefs of the Soil Conservation Service and of the Forest Service, together with the Secretary of Agriculture, approved a Forest Seed Policy, binding upon all Bureaus in the U.S. Department of Agriculture and strongly urged upon all agencies cooperating with the Department. Its purpose is to prevent gross losses through use of tree seed of unsuitable geographic source . In simplest terms, it calls for use of local seed unless seed from some more distant source has been proved definitely better, and defines local seed as seed collected within 100 miles of the planting site and within 1,000 feet of the planting-site elevation.

Adherence to this policy should prevent many serious losses, such as that which the Great Southern Lumber Company might hive incurred had it planted 5,000 acres with Georgia or Arkansas seed instead of with local seed in 1924-25. It is not always possible, however, to get the amount of seed needed, when it is needed, within 100 miles of the planting site. Some of the data presented here indicate that for many sites, slash pine seed (or even in some cases loblolly pine, seed) from more distant sources may be just as suitable. In some instances it may possibly be better.

Where does all this leave us?

We know that geographic strains exist in loblolly, and probably also in longleaf and shortleaf. They are not wholly disproved in slash.

We do not know what has given rise to these geographic strains whether differences in temperature, rainfall, day-length, or soil, or migration from different centers of botanical distribution, or long periods of exposure to different races of rust, or some combination of these influences.

We do not know, from field tests, where we may safely go for seed of any southern pine for use on any given planting site. The Department's Tree Seed Policy, although a laudable step in the right direction, is admittedly an arbitrary, makeshift guide. Its applica tion may be unnecessary in some cases,

Barring total war, we may expect 20 to 30 years aggressive planting of southern pine--and then a marked tapering off. To avoid very serious economic losses, we must clarify the question of geographic source of seed for southern pine plantations as near the beginning of this 20-to 30-year period as we can.

What do we propose to do about it?

First, it is proposed to launch a new, comprehensive, cooperative study of geographic strains of the four principal southern pines, under study of geographic strains of the four principal southern pines, under the guidance of a committee to be set up at this meeting. The study should be carefully planned to permit useful generalizations concerning suitable sources of seed; to standardize choice of seed trees at the various seed sources; to standardize designs of test plantations; to permit early evaluation of results in terms of height and later evaluation in terms of yield and of disease resistance; and to minimize the burden placed upon any one cooperator. The plan, and negotiations for the establishment of the study, should be completed in ample time to make use of seed from the 1951 crop.

Second, it is proposed to distribute a simple plan whereby any interested individual can make an effective, independent, 1- or 2-acre test of the relative suitability of feasible seed sources for his on planting sites. The release of such a plan would make available a considerable research background of experimental technique and design, reference reading and experience, at a saving to many planters. Simultaneous use of the same plan by a number of planters would permit fairly direct comparison of their results. Any such comparison would be a valuable supplement to the proposed cooperative study.

Early solution of the problem of geographic strains of southern pines is urgently needed to insure best results in hybridization and tree selection, and maximum returns from routine planting. Any contribution you can make, either by cooperating in the comprehensive study or through independent tests, will help.