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Contributions of Tops and Roots to Variation in Height Growth of Geographic Sources of Shortleaf Pine

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Introduction

Studies such as WELLS and WAKELEY's (1965) with Pinus taeda L. have demonstrated a relation between climate at the seed source and height variation among geographic races. Because the selection pressures on the above-ground tree parts are not necessarily the same as those on the roots, the tops and roots may not contribute equally to such variation. The present study was designed to determine the possible contributions of the tops and of the roots to the variation in height growth attributable to geographic origin of seed. It represents a continuation of efforts to assess the variation in height growth of southern pines and the contribution of tree parts to this variation (ALLEN, 1964 and 1967).

Methods

Tops of seedlings from seven geographic seed sources of shortleaf pine (P. echinata MILL.) mere grafted on seedling rootstocks from their own source and a local source (Stone County, Mississippi), and on slash pine (P. elliottii ENGELM.) rootstocks. Local scions were also grafted onto rootstocks from the other six sources. Heights of tops were compared after 4 years in the field in this study conducted near Gulfport, Mississippi.

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Shortleaf pine was selected as the source of geographic variation in height growth for this study because seeds were available from the same collections that had already demonstrated significant racial variation in the field (WAKELEY, 1961), but another species might have served equally well. The seeds had been collected in Burlington County, New Jersey; Southampton County, Virginia; Anderson County, Tennessee; Union County, South Carolina; Clarke County, Georgia; Cherokee County, Texas; and Stone County, Mississippi. The seed sources are described in more detail in another report (ALLEN, this issue).

The seeds were germinated in flats, and seedlings were transplanted to the nursery, then lifted and transplanted to pots. Potted seedlings were approach-grafted in the beginning of their second growing season, March 1963. In April the appropriate cuts were made to produce four combinations:

A) Source top/source root. Scions from each of the seven sources grafted onto the roots of seedlings of the same source.
B) Source top/local root. Scions from each of the foreign sources grafted on Stone County, Mississippi, shortleaf rootstocks.
C) Source top/slash root. Scions from each geographic source grafted on slash pine stocks.
D) Local top/source root. Mississippi scions grafted onto rootstocks from each of the other geographic sources.

Slash rootstocks were included as one of the combinations because growth of shortleaf scions on slash rootstocks is often increased over that on shortleaf rootstocks. However, this growth difference sometimes disappears with time (ALLEN, 1967).

Each rootstock included a short stem because the graft unions were about 5 inches above groundline.

The seedlings were outplanted in May 1963 at 11- by 11-foot spacing in a randomized complete block design with one tree per plot and 10 replications.

Growing conditions were improved by cultivating and fertilizing. Two ounces of slow-release 8-40-0 fertilizer were applied per tree in 1963 and in 1964. In 1965, the per-acre equivalent of 280 pounds of 6-8-8 fertilizer was broadcast over the area. The trees were sprayed monthly from February through September each year with a 1-percent DDT emulsion plus malathion to prevent damage by tip moths (*Rhyacionia frustrana* COMST.) and red spider mites (probably *Tetranychus telarius* L.).

Heights of seedlings were measured after 4 years in the field and variance was analyzed. Trees that had pronounced swelling at the graft union, indicating incompatibility, were excluded from the analysis. Exclusions due to mortality, incompatibility, and mechanical damage amounted to 11 percent. Exclusions were quite uniformly distributed among sources and combinations — at least 7 of the 10 trees of each root-top combination survived. Missing data were calculated by missing plot techniques.

Results and Discussion

Scions grown on slash roots were significantly (0.05 level) taller than those grown on roots from their own source and those grown on local roots. However, heights of scions grown on roots from their own source were not significantly different from heights of scions from the same source grown on local roots. *Table 1* gives the average height of trees by geographic source and root-top combination. Differences in height were analyzed by DUNCAN'S multiple range test; means opposite the same line do not differ significantly at the 0.05 level of probability.

Table 1. — Average heights of 4-year-old composite trees.

Source tops / Source roots		Source tops / Local roots		Source tops / Slash roots		Local tops / Source roots	
Origin	*Cm.*	*Origin*	*Cm.*	*Origin*	*Cm.*	*Origin*	*Cm.*
Miss.	359	Miss.	(359)	Miss.	403	Ga.	382
Tenn.	351	Texas	350	Tenn.	375	Tenn.	366
Texas	338	Tenn.	348	Texas	372	Va.	360
S. C.	333	Va.	346	S. C.	355	Miss.	(359)
Va.	300	Ga.	313	Va.	350	Texas	356
Ga.	300	S. C.	309	Ga.	322	S. C.	348
N. J.	266	N. J.	281	N. J.	322	N. J.	338
Average	321		329		357		358

[1]) Values connected by the same vertical line do not differ at the 0.05 level of confidence.

Statistically significant differences attributable to geographic origin of tops were found in the root-top combinations (A) source tops/source roots, (B) source tops/local roots, and (C) source tops/slash roots. The pattern of geographic variation was quite similar in each of these combinations. In the other combination — (D) local tops/source roots — differences attributable to geographic origin of roots were not statistically significant.

Therefore, roots contributed little to geographic variation in height growth under the conditions of this study. The geographic variation in height was primarily a function of tops rather than roots.

The results were most likely influenced by the wide spacing, fertilizing, and cultivating, which probably reduced the effects on height growth of differences in root extent and absorbing surface. Differences due to root source may appear later, when the stand closes and competition for water and minerals increases. The lack of geographic variation attributable to roots indicates that there are no large differences among the geographic sources in the metabolites affecting height growth that are manufactured by roots.

Summary

Geographic variation in the height growth of shortleaf pine (*Pinus echinata* MILL.) seedlings from different seed sources may be primarily a function of tops rather than roots. In a study near Gulfport, Mississippi, scions from seven geographic sources across the species' range were grafted on rootstocks from the same source and a local source, and on slash pine (*P. elliottii* ENGELM.) rootstocks. Local scions were also grafted onto rootstocks from the other six sources. Four-year height growth varied by source but there was little evidence that the roots contributed to the variation.

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