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Variation in Fiber Length of Eastern Cottonwood in the Lower Mississippi Valley

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In the research reported here, variation in fiber length within and between trees of *Populus deltoides* Bartr. was studied to obtain data essential to a breeding program. Samples were obtained by taking increment cores from trees growing in natural stands in Louisiana, Mississippi, and Tennessee. Most of the variation proved to be associated with individual trees within stands. Fiber lengths were greater than those previously reported.

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METHODS

Wood samples were removed from 10 cottonwood trees in each of three transects at each of three locations: east-central Louisiana (lat. 31°19′), west-central Mississippi (lat. 33°25′), and west Tennessee (lat. 35°54′). Two transects in Tennessee (1 and 3), one in Mississippi (6), and all three in Louisiana (7, 8, and 9) were on good loam soils. One transect in Tennessee (2) and one in Mississippi (5) were on very sandy riverfront sites. Transect 4 in

Mississippi was on Sharkey clay, a dark, poorly drained soil with a clay content of 74–85%. Distance between transects at a given location varied from 1 to 15 miles.

Two cores were taken with an 11-mm increment borer from opposite sides of each tree at points 3 ft above ground. As indicated by ring counts, trees averaged 41, 35, and 33 years in age on the three transects in west Tennessee. The average of 35 years on the second transect is for eight trees; two 41-year-old trees were dropped from the analysis because they represented a different age class than the others. Tree ages were 30, 20, and 20 years on the three transects in west Mississippi and 33, 30, and 34 years in east Louisiana.

The 8–10th, 18–20th, and, where possible, 28–30th rings were removed from the cores. Each three-ring sample was measured to the nearest millimeter, and a radial section 1 mm wide was cut through the entire sample for fiber length determinations. These sections were macerated, stained, and mounted on glass slides. Sixty whole fibers from each sample were measured to the nearest 0.1 mm at 52 ×, and the sample mean was the unit of analysis for all the data.

An analysis of variance was computed to determine if differences in fiber length for the three growth periods were significant. The variance component analysis outlined in Table I was used to assess amounts of variation attributable to location, transect, tree, and samples within tree. Factors were tested at the 0.01 level of probability.

Table I. Summary of Analyses of Variance in Fiber Length

Source of variation	Degrees of freedom	Mean square			Estimated variance components		
		8–10 rings	*18–20 rings*	*28–30 rings*	*8–10 rings*	*18–20 rings*	*28–30 rings*
Locations	2	0.0132 NS	0.0317 NS	0.0390 NS	±0.0	0.00012	0.00028
Transects/ locations	6 (4)[a]	0.0238[b]	0.0244 NS	0.0272 NS	0.00083	0.00051	0.00048
Trees/transects/ locations	79 (61)	0.0076[b]	0.0145[b]	0.0202[b]	0.00135	0.00495	0.00765
Samples/ trees/ transects/ locations	88 (68)	0.0029	0.0046	0.0049	0.00290	0.00460	0.00490

NS = Mean square not statistically significant.
[a]Values in parentheses apply to analysis of 28–30-ring data.
[b]Statistically significant at the 0.01 level.

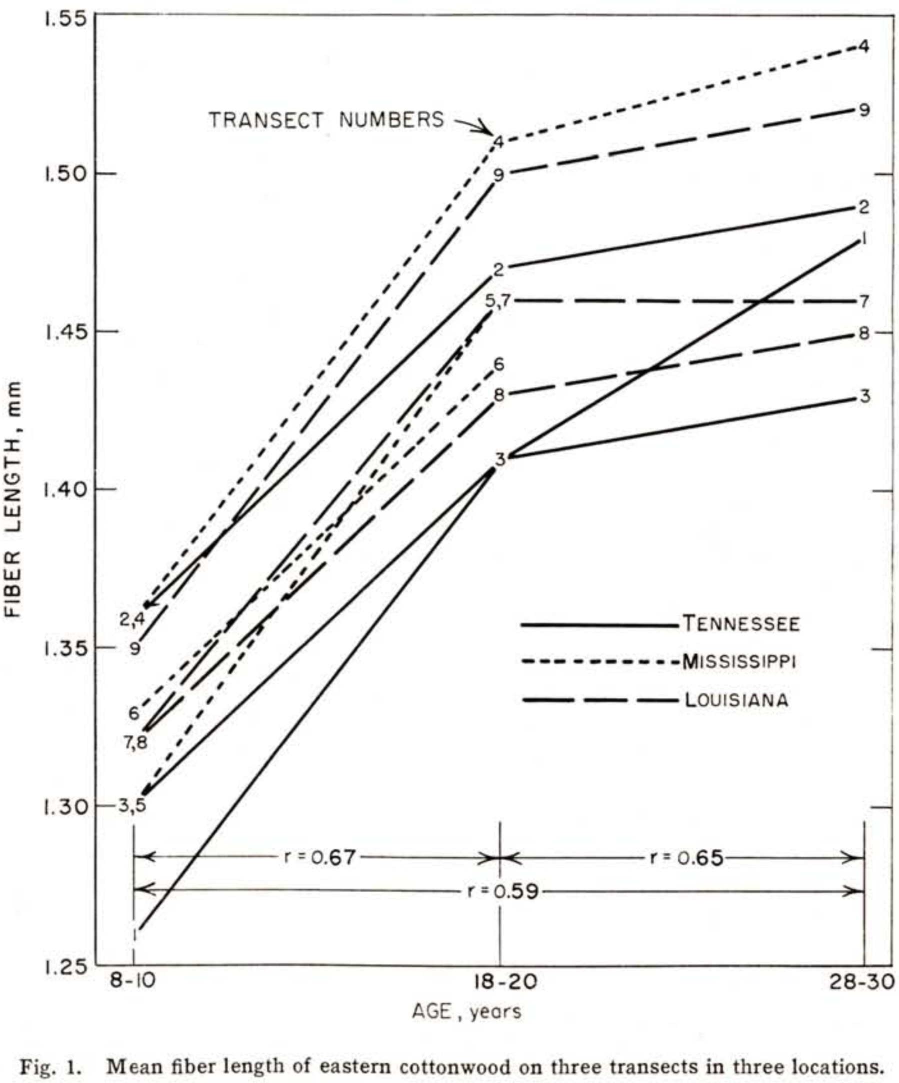

Fig. 1. Mean fiber length of eastern cottonwood on three transects in three locations.

RESULTS AND DISCUSSION

Mean fiber length, based on data from all trees, was 1.32 mm for the 8–10th rings, 1.45 mm for the 18–20th rings, and 1.48 mm for the 28–30th rings. Fiber length for the first period of growth was significantly shorter than for the last two periods. This pattern of rapid increase in fiber length during the first 20 years of growth followed by a reduced rate of increase is in agreement with the general trend in forest trees, including *Populus* species (*1–7*).

Boyce and Kaeiser (*1*) found that, if age was held constant, width of ring accounted for a small but statistically significant amount of the variation in fiber length of eastern cottonwood. Rate of growth has also been found to influence fiber length in other *Populus* species (*4, 8–10*). In the present study, however, the regression coefficient of fiber length on average ring width for each period of growth did not differ significantly from zero. Differences in mean fiber length among locations were not significant for the three growth periods.

Mean fiber lengths for each transect at each growth period are graphed in Fig. 1. The mean for transect 1 (1.26 mm) differed significantly from lengths for transects 9 (1.35 mm) and 2 and 4 (1.36 mm) at 8–10 years. However, none of the remaining values differed significantly within growth periods. Since the transects within each location were on radically different sites, the data demonstrate that site *per se* has little influence on fiber length. In other studies, also, site quality has had negligible effect on fiber length variation of eastern cottonwood (*1*).

Means for individual trees ranged from

1.13 to 1.50 mm at 8–10 years, from 1.19 to 1.66 mm at 18–20 years, and from 1.24 to 1.72 mm at 28–30 years. These values are considerably higher than those previously reported for eastern cottonwood. Boyce and Kaeiser (*1*) sampled 83 trees in southern Illinois, southern Indiana, western Kentucky, and eastern Missouri and reported that average fiber lengths of individual growth rings measured in a single tree ranged from 0.70 to 1.38 mm. In a study of four cottonwoods in southern Illinois, Kaeiser (*3*) found that the average length of 100 fibers from two-ring samples ranged from 0.90 to 1.20 mm.

Correlation coefficients in Fig. 1 show the relationships between mean fiber length for the three growth periods. The three *r* values are all significant, of about the same magnitude, and similar to those reported by Boyce and Kaeiser (*1*), who concluded that the 20th ring from the pith would be the best one for making comparisons among trees.

Variance components attributable to locations, transects, trees, and samples within trees for the three growth periods are included in Table I. At 8–10 years, most of the observed variation was among samples within trees—an indication that two samples may not be adequate to define fiber length accurately at this age. The components associated with trees and transects, although smaller than those due to samples, were statistically significant. At 18–20 and 28–30 years, an increasingly larger proportion of the total variation was associated with individual trees, and the components due to transects and locations were not significant.

Since effects of transects, or site, were negligible after 10 years, much of the variation among trees appears due to inherent differences. The range in fiber lengths among trees is considerable, offering good opportunities for selection and further evaluation. Selection for fiber lengths seemingly should be on an individual-tree basis, with little regard to stands or sites. The greater proportion of the total variation attributable to individual trees at increasing ages, coupled with the similar *r* values for the different ages, suggests that comparisons among trees of similar age be made on wood samples from the outermost rings.

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