CLONE-SITE INTERACTION OF EASTERN COTTONWOOD

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Superior clones of eastern cottonwood (*Populus deltoides* Bartr.) are being sought for extensive plantations that are being established in the Lower Mississippi Valley. Site quality in this region varies from excellent on loamy soils to poor on heavy clay soils. Where there are large variations in site productivity, crop breeders have found important genotype-environment interactions. In the study reported here, clone-site interactions for cottonwood were sufficiently large to be considered in a breeding program.

MATERIALS AND METHODS

Seventy-nine cottonwood clones were planted on two sites near Greenville, Mississippi. Thirty-nine clone were selected from preliminary clonal tests, and 40 were randomly selected. 2/ All clones came from the natural population along the Mississippi River near Greenville, Mississippi.

One plantation was established on Commerce silt loam, one of the best cottonwood soils in the Mississippi Valley. The site index is 122 feet at age 30 (Broadfoot 1960). The other plantation was established on Sharkey clay, which is considered poor for cottonwood; the site index is 91 feet.

Both sites were cleared of vegetation in the summer and fall of 1964 and planted in February 1965. Maisenhelder's (1960) procedures were followed in planting and in subsequent cultivations. Standard 20-inch cuttings were treated with a systemic insecticide (44D Thimet) 3/ before planting. At each site four-ramet linear plots were arranged in a randomized complete block with five replications. Spacing was 10 by 10 feet. Height was measured to the nearest 1/10 foot after 1, 2, and 3 years, and diameter (d.b.h.), to the nearest 1/10 inch after 1, 2, 3, and 4 years. The 0.05 level was used in all tests of significance and in establishing the confidence limits.

Clone-site interactions were first examined by a combined analysis of variance using heights and diameters from the two sites. To further evaluate the interactions, the individual clone means at each site were ranked in descending order for both diameter and height. For each clone the absolute difference in rank positions between sites was used as an indicator of clone-site interaction.

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2/ Mohn, C. A., and Randall. W. K. Preliminary selection of eastern cottonwood clones. These proceedings.

3/ Mention of trade names is solely to identify material used and does not imply endorsement by the U.S. Department of Agriculture.

Initially, the eight tallest clones (10 percent) and the eight with largest diameters on each site were selected. Then, for each character, a population of eight clones was selected that had the highest mean rank for both sites combined.

RESULTS AND DISCUSSION

Height and diameter differed significantly among clones, among replications, and between sites for all ages. The clone-site interaction was significant for both height and diameter growth for all ages. The analyses of variance are summarized in table 1.

Table 1.--Combined analysis of variance for diameter and height

Source	Degrees of freedom	Mean squares				
		Diameter			Height	
		1 year	3 years	4 years	1 year	3 years
Site	1	17.9024*	213.9436*	321.8411*	648.4261*	14,674.7801*
Error I	8	.0572	.1142	.2987	2.0747	6.3847
Clones	78	.0720*	.2574*	.4263*	1.7687*	5.8851*
Site × clones	78	.0116*	.1123*	.1092*	.3503*	1.3605*
Error II	624	.0051	.0164	.0330	.1358	.8111

Mean diameter of all trees at age 4 was 5.7 inches (range 4.1 to 7.3) for the plantation on Commerce silt loam and 2.8 inches (range 2.0 to 3.9) for the plantation on Sharkey clay. The select clones had slightly larger diameters than the random clones.

Clone-site interaction was evaluated by comparing the change in rank of each clone between the two sites. For diameter growth, out of 79 positions, the mean clone movement between the two sites was 14 positions (range 0.5 to 42.0). The correlation coefficient (r) for diameter between the sites was 0.662.* Forty-five percent of the clones moved 0 to 10 positions, 24 percent 11 to 20, 23 percent 21 to 30, and 8 percent more than 31 places.

The mean change for height growth was 16 positions (range 0 to 51; r=0.619*). Forty-two percent of the clones moved 0 to 10 positions, 29 percent 11 to 20, 10 percent 21 to 30, and 19 percent more than 31 positions.

Table 2 gives the loss in mean diameter associated with planting on one site when selection was on another site or a combination of sites. The greatest loss in growth occurred when clones were selected on Sharkey clay and grown on Commerce silt loam. Table 3 summarizes the results of selection for height growth on single sites and a combination of two sites. There was very little difference in height growth of clones selected from sites other than the ones on which they were grown. As with diameter growth, the greatest loss of height growth occurred when selection was made on Sharkey clay for clones to be grown on Commerce silt loam. The diameter-growth responses are probably more important than those in height in a selection program because small changes in diameter greatly influence volume.

* Significant at the 0.05 level.

Table 2.--Results of selecting top 10 percent of clones from a single site and from mean performance on two sites for diameter growth

Site for selection	Planting site	Population mean	Mean difference	Increase of selected clones over population mean
		Inches	Inch	Percent
Sharkey	Sharkey	3.46	...	24
Commerce	do.	3.35	0.11±0.16	20
Combination	do.	3.38	.08± .15	21
Commerce	Commerce	6.81	...	20
Sharkey	do.	6.25	.55± .26	10
Combination	do.	6.68	.12± .22	17

Table 3.--Results of selecting top 10 percent of clones from a single site and from mean performance on two sites for height growth

Site for selection	Planting site	Population mean	Mean difference	Increase of selected clones over population mean
		Feet	Feet	Percent
Sharkey	Sharkey	21.45	...	16
Commerce	do.	20.82	0.62±0.74	12
Combination	do.	21.06	.38± .66	13
Commerce	Commerce	41.20	...	9
Sharkey	do.	39.98	1.22± .83	6
Combination	do.	41.14	.06± .79	9

Although the trees are still very young, the difference in diameter growth caused by clone-site interaction has practical significance. Because of this interaction, a particular genotype or group of genotypes may not be best for all environments. In crop breeding, two approaches have been used to reduce the effects of such interactions (Breese 1969). The first exploits the interactions by breeding and selecting for specific sites or soils. The second aims at development of a population that performs well over a broad spectrum of sites. The present data indicate that selection for specific sites may be more advisable than development of highly adaptable clones.

LITERATURE CITED

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