EVALUATION OF EARLY GROWTH AMONG HYBRID POPLAR CLONAL TESTS IN THE NORTHEASTERN UNITED STATES

by Maurice E. Demeritt, Jr., research plant geneticist, USDA Forest Service, Northeastern Forest Experiment Station, Durham, New Hampshire 03824

ABSTRACT.--It is possible to select a few hybrid poplar clones which grow well on a number of sites. However, coefficients of rank correlation between locations are not large enough to warrant early selection of a large number of clones for planting over large regions. Full-sib family data indicate that family selection followed by mass selection and clonal propagation should be considered as an alternate improvement method following any further hybridization efforts with Populus species.

THE U.S. FOREST SERVICE has been breeding, selecting, and testing hybrid poplar for many years. This program was initiated in the spring of 1924 by the Oxford Paper Company in cooperation with the New York Botanical Garden. The Northeastern Forest Experiment Station received all of the poplar hybrids and took over the project in 1936. Approximately 14,000 hybrid seedlings were obtained from 99 crosses representing 34 different types of poplars. In 1927 and 1928, 600 of these 14,000 hybrid seedlings were selected for pedigree and clonal tests. The remaining seedlings were outplanted on a hillside at a cutover hardwood site in Frye, Maine. In 1929, 58 of the 600 seedlings in the nursery were selected for increased propagation and further testing. From 1937 to 1950, 189 new hybrids were selected from the seedling plantation on the basis of their rate of growth, growth habit, and parentage. Since 1950, two additional hybrids have been selected for further propagation. In 1949, replicated clonal tests of selections were initiated.

Clonal materials have been distributed across the United States and throughout the world (Schreiner 1975). User groups in the United States include federal, state, and private nurseries, research organizations, arboretums,

universities and schools, and private industries. Most foreign distributions have been to public and university research organizations.

Tree improvement by nature requires long-term and expensive programs. The hybrid poplar program is no exception. Any procedure that can predict the genetic potential of a tree or clone at the earliest possible age would be desirable since it would save valuable time, space, and labor. Shortening a test rotation by early selection of clones, if effective, would save money. However, early growth and mature growth measurements are not well correlated (Wilkinson 1973, 1974). The growth rate of clones can change greatly over a relatively few years (Zsuffa 1975).

It also has been reported that poplar clones differ in site requirements. Some clones grew relatively well on a number of sites; othersperformed extremely well on some sites, but showed poor growth on others (Zufa and Zivanov 1966).

This report evaluates the possibility of selecting 2-year-old clones which grow well on sites separated by some distance.

Analyses of variance of 2-year height of clonal plot means reveal significant differences among clones to make clonal selection possible. Rank correlation analyses between clonal test locations reveal clones that perform similarly across locations and those that rank among the best at a number of locations.

METHODS AND MATERIALS

Plantings were evaluated at three locations: Hopkins Forest, Williamstown, Massachusetts; Miles Fry and Son, Inc., Ephrata, Pennsylvania; and King's Men Tree Farms, Hampstead, Maryland. Each planting is a sampling clonal test, a small plot experiment that provides information for 5 to 8 years. This represents the time needed to select the best clones for long-term tests at a location.

At the Massachusetts site, 50 clones were established in sapling tests each year from 1949 to 1953, at a 4 x 4 foot spacing in four randomized blocks of 16-tree plots, 4 rows of 4 trees. At both the Pennsylvania and Maryland sites, 199 clones were established in 1974 at a 6 x 6 foot spacing in five randomized blocks of 4-tree plots, 2 rows of 2 trees.

The 2-year total height of all trees at each location was measured after the second growing season. However, there were only 134 clones common to all three locations.

Analyses of variance were conducted on clonal 2-year height plot means for each planting. Five separate analyses of variance were conducted on data from the Hopkins Forest, one for each planting year. Spearman's coefficients of rank correlation were calculated for 2-year height of clones in common between test locations. Coefficients of rank correlation examine whether two variables (clonal height) are independent or whether the clones vary in the same or in opposite directions. The rank correlation can range from -1 (complete discordance) to +1 (complete concordance) (Snedecor and Cochran 1967).

RESULTS AND DISCUSSION

There were significant differences among clones for all plantings at all locations except the 1952 Hopkins Forest planting, which just missed being significant at the 5 percent level. Spearman's coefficients of rank correlation between planting locations were significant in most instances (Table 1). However, correlations were not strong enough to allow selection of a large group of clones that consistently ranked among the best clones at all three locations. Coefficients of rank correlation for 2-year height are generally higher between the Fry and King locations than either is with the Hopkins Forest plantation. These correlations probably are higher because the Fry and King planting locations are more environmentally similar than either is with Hopkins Forest (Table 1).

It also should be noted that correlations of rank correlation were negative but nonsignificant in three evaluations in which data from the Hopkins Forest plantation were used. These three evaluations show a slight discordance of ranking of mean clonal heights, but they could not be distinguished from being independent statistically. Two of the negative correlations occurred in conjunction with the 1952 clonal test at Hopkins Forest, where clones were not significantly different. The lack of correlation is most likely associated with the lack of difference among the clones at the Hopkins Forest.

Six clones ranked within the upper 25 percent of their respective plantation clones at all three locations for 2-year height (Table 2). These same six clones

Table 1.--Spearman's coefficients of rank correlation for 2-year height of hybrid poplar clones between test locations.

Test locations in 1974 plantings	Year of Planting (Hopkins Forest)				
	1949 (31 clones)	1950 (36 clones)	1951 (26 clones)	1952 (25 clones)	1953 (16 clones)
Miles Fry and Son Ephrata, Penn.	0.2091^{ns}	0.4860^{*}	0.3988^{*}	-0.3123^{ns}	0.8059^{*}
King's Men Tree Farms Hampstead, Maryland	-0.0681^{ns}	0.4692^{*}	0.6051^{*}	-0.0802^{ns}	0.6725^{*}
King-Fry[a/] [b/]	0.6950^{*}	0.6015^{*}	0.3974^{*}	0.4337^{*}	0.7441^{*}

[a/] Coefficients of rank correlation for the same clones at Williamstown, Massachusetts, but now between Fry and King Tests.

[b/] Coefficient of rank correlation for 180 clones in Fry and King tests is 0.6219^{*}.

Table 2.--Hybrid poplar clones that rank within the upper 25 percent of the clones tested at all three locations and their height, in feet.

Clone number	Parentage	Miles Fry and Son	King's Men Tree Farms	Hopkins Forest	
		2-year height	2-year height	2-year height	15-year height
NE-17	'Charkoviensis' X 'Caudina'	11.33	6.65	7.93	52.71
NE-19	'Charkoviensis' X 'Caudina'	12.06	8.75	5.75	49.93
NE-20	'Charkoviensis' X 'Caudina'	12.16	7.00	9.33	55.62
NE-21	'Charkoviensis' X 'Caudina'	10.98	9.79	10.75	55.70
NE-308	'Charkoviensis' X 'Incrassata'	11.08	8.50	8.38	53.80
NE-351	*P. deltoides* X 'Caudina'	11.88	8.69	8.42	57.75

also ranked within the upper 25 percent of their respective plantation clones for 15-year height at Hopkins Forest, the only location where the plantations have existed long enough to provide long-term data. The six clones that grew rapidly for 2 years at all three locations represent only three full-sib families from among 42 full-sib families that are in common to all three locations. Clones from these three full-sib families represent only 20 percent of the clones in common under test, but they represent approximately 60 percent of the clones in common in the upper 25 percent for 2-year height at each of the three test locations.

This full-sib family data suggest large variation among families and probably less variation within families. To take advantage of the large variation among families, family selection followed by mass selection and clonal propagation should be considered as an alternative to clonal selection. It must be remembered that clonal selection includes an extra test rotation per generation. Intrafamily differences should be as large as interfamily difference to justify the extra expense and time of clonal selection (Wright 1976).

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