PRELIMINARY RESULTS OF COMPETITION AMONG HYBRID POPLAR CLONES

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ABSTRACT.--The effects of intergenotypic competition on the growth of hybrid poplar clones established from unrooted cuttings were investigated. Results based on experimental plot means in a greenhouse study indicate that competitive interactions are of minor importance in their effect on early growth. Initial cutting weight was an important determinant of early growth. A long-term field study of similar design will assess the importance of intergenotypic competition under actual planting conditions.

INTRODUCTION

Intergenotypic competition in crop plants is often quite strong and must be considered in breeding programs to accurately appraise genotypes (Allard and Adams 1969; Lin and Torrie 1968; Shutz and Brim 1967) and to exploit competitive effects in maximizing yields (Allard and Adams 1969; Brim and Shutz 1968).

Experiments to detect intergenotypic competition in forest trees apparently have been restricted to only two greenhouse studies, one among clones of black cottonwood (Tauer 1975), the other among families of loblolly pine (Adams et al. 1973). These studies showed that the effects of intergenotypic competition on early growth are variable and, in some cases, may be pronounced.

To further evaluate the importance and potential exploitation of intergenotypic competitive effects in breeding programs of forest trees, we investigated competition among hybrid poplar clones, under short-term greenhouse conditions and in long-term field testing. Preliminary results of the greenhouse study are reported here.

MATERIALS AND METHODS

Two groups of six hybrid poplar clones were selected for study. The DN group consists of Ontario clones DN-7, DN-16, DN-25, DN-30, DN-31, and DN-70. The letters DN signify that the clones were derived from *P. deltoides* x P. *nigra* crosses. The NE group consists of clones NE-8 *(P. nigra* x *P. Zaurifolia);* NE-296 (P. x *'Betulifolia'* x *P. trichocarpa);* NE-316 *(P.* x *'Charkoviensis'* x *P.* x *'Robusta');* NE-367 *(P. deltoides* x *P.* x *'Caudina');* NE-387 *(P.* x *'Candicans'* x *P.* x *'Berolinensis');* and Ontario clone JACK11-4 *(P. balsamifera* x *P. deltoides).* The letters NE signify that the clones originated from the Northeastern Forest Experiment Station program.

A simple but functional method was needed to evaluate clonal mixes and pure stand plantings. We decided on a six-tree plot as the experimental unit for both the greenhouse and field studies. Three types of six-tree plots were used; 2-clone mixes (three trees of each of 2 clones), 3-clone mixes (two trees of each of 3 clones), and pure stands (all six trees of the same clone). For each 6-clone group (experiment), all six pure stands as well as all possible two-way (15 combinations) and three-way mixes (20 combinations) of 6 clones were formed, making a total of 41 treatments in each experiment. While both the DN and NE groups were included in the greenhouse study, only the DN group was planted in the field; clone DN-55 was substituted for clone DN-7.

Six-tree plots in the greenhouse study were planted in standard 8-inch plant pots filled with Jiffy Mix.[1] Before planting, 4-1/2-inch cuttings of each clone were soaked for 24 hours in room temperature tap water and then weighed individually to determine the saturated cutting weight. The cuttings were then placed 6 cm apart in the pots in a hexagonal pattern, with cuttings of the same clone occurring every other spot in 2-clone mixes and every third spot in 3-clone mixes.

The statistical design was a randomized complete block with eight replications. The 41 treatments in each block were assigned to positions on the greenhouse bench. Cuttings that did not sprout or that died during the first 4 weeks of the study were replaced with unrooted cuttings of the same clone. After 6 weeks of growth, cuttings were cut back, leaving only the most dominant single leader.

[1] Mention of a trade name does not constitute endorsement or approval of the product by the U.S. Department of Agriculture or the Forest Service.

The DN hybrids were planted on April 5 and the NE hybrids on April 8, 1977. Shoot heights were measured 45 days after planting and then every 2 weeks thereafter until Day 115, when the experiment was terminated. The final green weight of each cutting was determined by clipping off the new growth from the original cutting and weighing it immediately.

Our initial analysis of the treatments in this experiment has been with pot or plot means (six trees) of the measurements of final height and green weight. Pots with fewer than five surviving trees at the end of the experiment were considered as missing plots. The average of the five or six survivors in all other pots made up the pot means. Since overall mortality in both experiments was very low and apparently was not correlated with clone, any bias resulting from using five-tree plots in our analysis probably is slight. Analyses of variance of final shoot height and green weight were computed for each clone group after adjusting pot means for initial cutting weight by covariance analysis. The mean saturated cutting weight was used as a linear covariate.

Intergenotypic competition occurs when the performance of a clone in mixture differs from its performance in pure stand. To measure competitive effects with pot means, the mean height or green weight of a clonal mixture was compared to the mean yield of the component clones in pure stand. If the difference in yields between the clonal mixture and the mean of the component pure stands exceeds the L.S.D. calculated at the 5 percent level, a competitive interaction that is either overcompensatory (mixture yields greater than mean of pure stands) or undercompensatory (mixture yields less than mean of pure stands) is indicated.

Clonal mixes not significantly different from the mean of their component pure stands are either neutral with regard to competitive effects or are interacting in a complementary fashion, for example, the increased yield of one clone in competition is exactly counterbalanced by a decrease in yield of the other clone or clones in the mixture. Thus, by basing the analysis on pot means, only competitive effects resulting in an overall increase or decrease in mixture yields can be investigated. A more complex appraisal of competitive effects, which makes possible the detection of complementary interactions, requires analyses based on individual clones in the mixtures.

RESULTS AND DISCUSSION

A significant reduction (range of 4 to 14 percent of total) in pot means sum of squares for both clone groups was obtained with the covariant for both final height and green weight. Initial saturated cutting weight was positively correlated with the characters (range of r = 0.28 to 0.41) in all cases. Thus initial weight is closely related to final size. Cutting weight has also been shown to strongly influence early growth in black cottonwood (Tauer 1975).

Of the two traits analyzed for each group, only final height analysis for the DN hybrids had significant differences among treatments. In addition, there were few cases in which clonal mixes had yields significantly different from the mean of their component pure stands (Table 1).

Table 1.--Analyses of variance of total height and green weight for DN and NE hybrid poplar clone groups.

Source of Variation	Height			Green weight	
	DF	MS	F	MS	F
		DN GROUP			
Block	7	1303.7	38.1*	141.7	23.3*
Treatment	40	73.8	2.2*	8.7	1.4^{ns}
Covariance	1	2208.6	64.6*	173.7	28.5*
Error	279	34.2		6.1	
		NE GROUP			
Block	7	2019.6	19.3*	168.8	8.8*
Treatment	40	79.6	0.8^{ns}	16.2	0.8^{ns}
Covariance	1	3546.6	33.9*	1207.5	63.0*
Error	262	104.6		19.2	

*P <0.05.

The small variation among treatments relative to experimental variance in these experiments is disappointing from the standpoint that it may indicate that there are no competitive effects. On the basis of these results, we are not sure whether there are no differences between clonal mixes and pure stands or if our experimental design is not precise enough to measure differences. Since pot means are strongly related to initial saturated cutting weights, the effect of cutting weight on individual tree performance also must be large.

Thus, in the interest of improving precision, we are currently adjusting the initial wet weight covariate on an individual-tree basis before analyzing final height and green weights. This will give us an opportunity to separate individual clone performance in each pot so that a more complete characterization of competitive effects can be made (for example, complementary effects can be measured). This analysis requires more coding than we originally intended, but the additional information and increased precision will probably warrant the effort.

The large effect of cutting weight on early growth should be an important consideration in future studies. If cuttings cannot be graded to an approximate equal weight over the study before planting, then at the very least they should be graded for each block.

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