EVALUATION OF CLONE-NITROGEN INTERACTIONS TN POPULUS *DELTOIDES*

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Abstract.--Cottonwood (Populus deltoides Bartr.) growth response to three levels of fertilizer nitrogen was nonsignificant for nine cottonwood clones (three good, three average, three poor growers) evaluated on a Convent soil in a greenhouse study. Clone differences were significant for some growth characters and foliar nutrient levels. Clone X nitrogen interaction was nonsignificant. For 8 of 15 characters measured, the good clone class was significantly better than the poor clone class. Only for leaf weight and foliar nitrogen did nitrogen variance exceed clonal variance. Results of this greenhouse study do not support known nitrogen response from the same soil under field conditions. Thus greenhouse results must be viewed with caution and field tests undertaken prior to nutrient and clonal recommendations.

Additional keywords: Cottonwood, fertilization, foliar analysis.

Cottonwood (Populus deltoides Bartr.) growers are interested in the possibilities of using fertilizer to speed tree growth. Plantations composed of genetically mixed material have responded markedly to nitrogen fertilization (Blackmon 1973, Blackmon and White 1972). But it is possible that some clones will respond favorably to additions of nitrogen fertilizer while others will not. Indeed, there is evidence to indicate that such a varied response is true. For example, Curlin (1967) reported a clone X fertilizer interaction for young cottonwood. Randall and Mohn (1969) found a significant clone-site interaction in the Mississippi River floodplain, and more recently Baker and Randall (1974) found foliar nitrogen to be associated primarily with a clone X soil interaction. The present study was designed to investigate a possible genotype X nitrogen interaction in eastern cottonwood.

METHODS

Soil used was a Convent silt loam (Aeric Fluvaquent) collected from the surface foot in an old field on the Fitler Managed Forest (west-central Mississippi). This soil is known to be low in nitrogen, having only 0.058% total N, although some Convent soils which are not deficient contain up to twice this concentration of N. After air drying, the soil was shredded to

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pass a 1/4-inch screen, thoroughly mixed, and 22 pounds were placed in 3-gallon earthenware glazed crocks.

Nine clones were selected on the basis of prior field performance to represent three clone classes as follows: good--Stoneville 66, 240, and 244; average--Alton 1, Stoneville 213 and 153; poor--Rosedale 8, Stoneville 29 and 171.

Terminal, greenwood cuttings 4 inches long were taken from nursery stock in mid-May. The cuttings were placed in a 2-inch-square peat pot filled with a 2:1 mixture of sand and perlite and placed in a mist chamber for approximately 2 weeks, by which time roots were about 1 inch in length. Two cuttings were then transplanted to each of the 3-gallon crocks. As soon as the plants became established (about 2 weeks), the poorer plant was removed from each crock. Three rates of nitrogen equivalent to 0, 150, and 300 pounds per acre were applied by spreading ammonium nitrate onto the soil surface, stirring the soil surface with a small garden spade, and watering immediately. Moisture content was maintained within the range of 50 to 80 percent of field capacity.

Plant heights and groundline diameters were measured immediately before nitrogen application. Ten weeks later, final measurements were taken which consisted of height, groundline diameter, number of leaves, oven-dry weight of leaves, stem, branches, roots, total stem, and total plant. Leaves were analyzed for nitrogen by the micro-Kjeldahl method. Phosphorus was determined by absorption spectrophotometry, and potassium, calcium, and magnesium concentrations were determined by atomic absorption spectrophotometry.

Experimental design was a randomized complete block with factorial arrangement within blocks, resulting in 27 treatments replicated 3 times. Clone and nitrogen were considered as fixed factors. All statistical tests were made at the 0.05 level. Means were compared by Duncan's new multiple range test.

RESULTS

Clones differed significantly for all characters except leaf weight and foliar Mg and P concentrations. For 8 of the 15 characters, means of the good and average clone classes were the same. The good and poor clone classes were significantly different for eight of the characters (Table 1).

The good clone class was taller, had more leaves, greater stem and branch weight, greater root weight, greater total stem weight, and greater total plant weight than the poor clone class. Good clones had lower foliar Ca and N concentrations than did the poor clones. The average clone class was generally not significantly different from either the good or poor class.

Before nitrogen was applied, there were no height or diameter differences among fertility level plots. Final measurements indicated no positive diameter or height response to N, but the number of leaves increased and root weight decreased with increasing rates of N. The total aboveground portion of the plant and the total plant remained unchanged. Foliar nutrient levels of N, P, K, Ca, and. Mg *were* increased by the addition of N (Table 1).

Clonal variance generally far exceeded variance due to nitrogen levels. Only for foliar N and leaf weight was the fertilizer variance larger than clonal variance. The clone X nitrogen interaction was nonsignificant for all characters, and in most cases the amount of variance was extremely small.

Table 1.--Means for three levels of nitrogen fertilizer and three clone classes

Character	Fertilizer N level (lbs/ac)			Clone class		
	0	150	300	Good	Average	Poor
Initial height (cm)	10.7a[1/]	10.9a	10.5a	10.8ab	11.8a	9.4 b
Initial diameter (mm)	5.4a	5.0a	5.2a	5.4a	5.3a	5.0a
Final height (cm)	77.2a	77.8a	72.1 b	78.9a	80.5a	68.0 b
Final diameter (mm)	7.8a	7.8a	7.6a	8.0a	8.2a	7.0a
Number of leaves (no)	16.3 b	18.2ab	19.1a	19.4a	16.8 b	17.5 b
Leaf weight (gr)	8.4 b	9.4a	8.6ab	9.6a	9.2a	7.4a
Stem & branch weight (gr)	6.4a	6.6a	6.0a	6.6a	7.3a	5.2 b
Root weight (gr)	6.4a	5.5 b	5.2 b	6.4a	5.5 b	5.1 b
Total stem weight (gr)	15.9a	17.5a	16.9a	17.4a	17.7a	15.2 b
Total plant weight (gr)	22.3a	22.9a	22.1a	23.8a	23.3a	20.3 b
Foliar nitrogen (percent)	2.14a	2.85 b	2.99 c	2.56 b	2.73a	2.69a
Foliar phosphorus (percent)	0.18a	0.20 b	0.20 b	0.20a	0.20a	0.19a
Foliar potassium (percent)	2.40a	2.56 b	2.55 b	2.41 b	2.63a	2.47 b
Foliar calcium (percent)	1.65a	1.84 b	1.93 c	1.75 b	1.82ab	1.85a
Foliar magnesium (percent)	0.49a	0.54 b	0.54 b	0.53a	0.51a	0.53a

[1/] Character means with the same letter are not significantly different at the 0.05 level.

DISCUSSION

This study produced two major surprises: one was the lack of a growth response to fertilizer N, and the other was that the clone X nitrogen interaction was nonsignificant. Even though field studies of the N-deficient Convent soil have shown substantial growth increments with the addition of N (Blackmon 1973), a lack of response in the greenhouse perhaps does not conflict with what is known about this soil. Blackmon (1974) stated that cottonwood trees are unlikely to respond to fertilization until they fully utilize the site and are competing with each other for nutrients. The small amount of available nitrogen was probably sufficient to allow for 12 weeks of thrifty growth. A foliar N level of 2 percent was determined as minimum for good cottonwood growth (Blackmon and White 1972). In our study, even the leaves of the unfertilized plants had N concentrations above the 2-percent level. Foliar N levels plus the general plant vigor indicated that there were no N deficiencies.

Curlin's (1967) work provided ample evidence that cottonwood clones do interact with levels of N. More recently, Baker and Randall (1974) found a strong clone X soil interaction. The former reported on nursery plants for two growing seasons and the latter with 4-year-old trees on two contrasting sites.

The results reported here indicate that caution should be used in interpreting greenhouse results since they may be poorly correlated with field responses. Curlin (1967) concluded that the geneticist must be careful to carry out individual selection in the nutritional environment in which the tree will ultimately grow. Baker and Randall (1974) concluded that fertility tests should be conducted on more than one soil.

Future greenhouse tests to screen clones for nutrient-clone interactions should employ a growth medium known with certainty to be nutrient-deficient. One possibility would have been to use sand culture and nutrient solutions as employed by Steinbeck (1971) in his work with genotype-nutrient interactions in sycamore. Another way would have been to mix soil with an inert substance such as sand. The growth medium would probably have been nitrogen-deficient even for young plants. Then, nitrogen responses and perhaps nitrogen-clone interactions would likely have been observed.

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