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Cottonwood seed source trials in central Kansas

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Cottonwood trees from 133 sources and 17 states were tested in eastern Kansas provenance study as part of the North Central regional forest Tree improvement Project (NC-99). Sources from the central region of the study grew well. Northern latitude sources had the poorest height growth. Southern source survival was very low. Trees from Missouri grew best. Twenty eight sources had 50 percent or better survival. Height growth had a strong relationship to seed source origin. Populations from latitudes similar to Kansas appear to be best for growth in Kansas.

Keywords: Populus deltoides*, provenance, growth, seed source.*

Introduction

Cottonwood (P*opulus deltoides* var. *occidentalis* Bartr. ex Marsh.*)* has many desirable wood quality characteristics and wide genetic diversity. The species and its hybrids play a major role in poplar culture throughout the world (Jokela and Mohn 1977). The natural distribution of cottonwood ranges from southern Quebec Canada westward into South Dakota and southward to Texas and northeastern Florida and gives rise to the expectation of substantial genetic variation related to geographic origin. Within this range, the species occurs primarily on alluvial sites.

The first systematic sampling in wild populations was made between 1947 and 1950 by S. S. Pauley (Pauley and Perry 1954), who established frost-free season length and day length as environmental factors that activate genetic mechanisms controlling the onset of dormancy, a prerequisite for selection and breeding. This has been supported by Mule-Larson (1970 and Wright (1976). Avanzo and Sekawin (1975) previously summarized the progress from seed collections and distributions made in 1967, 1973, and 1974 under sponsorship of the Poplar Council. Foster 1986 and Stringer et al. 1987*,* presented reviews for southern areas of the United States on the species. Mohn and Radsliff (1976) reported that local cottonwood sources grew best after 17 years in a Minnesota NC-99. Planning Ying and Bagley (1976) found Missouri sources similar to sources growing in Minnesota grew best after 7 years in an eastern Nebraska test site.

The purpose of this study was to investigate the variability of growth of cottonwood seed sources outplanted in the central Great Plains with the objective of determining the best sources for breeding and plantings in plains region of the United States. This report presents the results of the Kansas portion of the (NC-99) cottonwood project in Manhattan, KS. Other cottonwood provenance tests have been established throughout the Midwestern United States, but few results have been reported.

Site Description and Location

The planting site was a flat, alluvial, old field site in the central Great Plains near Manhattan, KS. The area is very suitable for cottonwood growth - site index of the stand at 25 years is 120 ft.

Precipitation averages about 30 inches a year with 75 % coming during the growing season. The soil is classified in the Eudora silt loam series (coarse-silty, mixed, mesic, Fluventic Hapudolls) and consists of 9.8 inches of silt loam soils underlain by very fine sandy loam.

The area was cultivated for 3 years after planting. Survival and tree measurements were made at the 4th, 7th and 13th years.

Methods

Seed collection zones for a series of provenance tests were planted as part of the range-wide provenance test initiated in 1964 by the North Central Regional Forest Tree Improvement Project, NC-99 to define genetic variability within *P. deltoides*. Personnel at the Illinois Agricultural Experiment Station coordinated the collection of open-pollinated seed throughout most of the natural range of cottonwood, handled the production of the seedlings, and distributed stock to cooperators in several Midwestern states. Seed collections were made from 133 mother trees in 17 states. The most intensive sampling was made in the central portion of the species range (i.e., the Mississippi River Valley). The seed sources were separated into three collection zones for testing: north (above 40 degrees north latitude), central (between 37 and 40 degrees), and south (below 37 degrees).

Seedling stock was distributed to several cooperators in 1965. Sampling of the eastern and western extremes of the natural range was less than desired. Availability of materials did not allow equal distribution of origins to all cooperators, and field tests were established using a variety of designs and techniques.

The Manhattan KS provenance planting consisted of 798 trees spaced 12 feet apart in a randomized design with six trees per source. Bare root 1-0 seedlings of cottonwood were hand planted.

Data were analyzed by using the PROC GLM analysis of variance statistical procedure (SAS 1996, which accounts for unbalanced data. Significance was set at the 5% level, and Duncan's multiple range test was used to separate means. In addition, correlation analyses were applied to height, diameter, and survival.

Results and Discussion

Survival

Survival strongly reflects influence of seed origin. Early loss of seedlings was severe. Overall mortality was high, increasing from 74% after 4 years of planting, 76% after 7 years, and 79% after 13 years. High survival losses were also found for some of the sources at 99 provenance test sites (Jokela and Mohn 1977). Losses were moderate to extremely high (40 to 100%) at Rosemont, MN (Mohn and Radsliff 1976). In Mead, Nebraska average survival was high (about 91%), with high winter mortality mostly in the southern source (Ying and Bagley 1976); and moderate (about 20%) at Urbana IL and Dixon Springs (Jokela and Mohn, 1977). Mortality at the Kansas site was high. The most likely cause of low survival was low soil moisture amounts during the growing season. In 1966, precipitation was only ½ the normal amount with long dry spells in 1966 and 1967.

Survival differences in this Kansas planting between the three collection zone categories were significant at the P = 0.0001 level and seed source differences were significant at P=0.0001 level. After 13 years (1979), overall survival was only 21%. Out of 133 sources, 52 sources were gone, 25 had 18% survival, 27 had 33%, 15 had 50%, 13 had 67%, and 1 had 83% survival. If fifty percent survival is considered sufficient for a successful planting, then 19 sources would be considered acceptable for planting.

Height growth

Significant differences among sources in height were found for the 4th, 7th, and 13th year measurements. The overall mean height for all sources was 62.6 ft at 13 years. The two tallest sources were 234 and 237 at 82.0 and 81.0 ft, respectively from Missouri. Also the tallest trees were generally from Missouri. This was also true in the Mead, Nebraska planting where tree height at 7 years increased from northern

to southern sources. The southern and central zone trees with mean heights of 69.1 and 66.1 ft, respectively, were significantly taller than trees from the northern zone, which had a mean height of 58.6 ft in the 13th year of growth. Cottonwood, like many other tree species, responds to increased day length with increased rate of growth. Thus, when plants of southern origin are planted in a more northerly latitude, they will respond to the longer days and produce more total growth during the growing season because the day length for these origins is shorter (Vaartja 1954).

Diameter growth

Mean diameter differences among sources were significant for 1979 measurement period. Seed source accessions did not necessarily perform closely to relative sizes found in later years. Patterns were highly correlated between years 4 and 7 (0.73338, P = 0.0001, and years 7 and 13 (0.59448 P = 0.0001), but not between years 3 and 13 (0.40788, P =0.0001). Tree size at age 4 is not a good predictor of size at age 13.

The largest diameters for trees were in the north zone during the 13th year, but there were no significant differences among zones. The overall mean diameter for all sources was 14.7 inches at age 13. The largest trees were from sources 254, 42, 232, 73, 52, 70, and 255 with diameters ranging from 17.1 to 21.8 inches. Because mean survival was so low (21%), sufficient growing space was available for all trees to grow. Age-age correlations for diameter were good. The correlation for diameter at 4 years to 7 years was 0.7338, and for 7 years to 13 years was 0.59448.

Summary and Conclusions

Genetic studies were initiated earlier in both Europe and North America by the World Poplar Council to determine growth parameters for Populus species. Information would provide guidelines for breeding superior cottonwood for commercial growers.

This study provided information on the variability of the early growth of eastern cottonwood in the plains region of the United States.

Seed sources having climatic conditions similar to Kansas did well in this study. A provenance trial of cottonwood in Minnesota suggested that local populations may be the most appropriate source for Minnesota (Mohn and Radsliff 1976). Trees from the central zone in the Kansas study had the best survival. And generally, the tallest sources were from Missouri. Those from the northern zones grew poorly. Exceedingly poor survival of the southern sources is most likely due to very low soil moisture during the 2nd and 3rd growing seasons. Soil moisture in the south is higher and more evenly distributed during the growing season.

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