A COMPARISON OF POPLAR CLONE PERFORMANCE IN NEBRASKA'

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Eastern cottonwood, *Populus deltoides* Bartr., and plains cottonwood, *P.* deltoides var. *occidentalis* Rybd., native over most of the United States east of the Rocky Mountains, are normally found along streams on the bottomlands *(4).*

Demand for wood fiber and cellulose has focused attention on fast-growing tree species such as cottonwood, which is already an important source of pulp for high quality magazine paper. Cottonwood is used as core stock for furniture plywood and for boxes, baskets, and pallets. It is rapidly becoming a tree of considerable commercial importance in the southern part of this country *(5,7).* Paper mills in southern Texas are obtaining cottonwood logs from Kansas to supply the present demand. Plantations are being established near the mills on cleared brushland and agricultural land at considerable cost. Experiments in growing cottonwood under irrigation are underway.

Large investments in land, site preparation and improved varieties justify planting on fertile soils and using intensive cultural methods. As a result, a type of silviculture termed "monoculture" is evolving which resembles corn or cotton farming except that trees are the crop. Row plantings which serve the dual purposes of protection and timber production are planted in southern Europe. Adapted cottonwood or poplar varieties respond to intensive monoculture with a very fast rate of growth *(3,11).*

Intensive cultural practices on good sites increase the importance of selection and breeding of superior strains of trees. After our native cottonwood was introduced into Europe 250 years ago, natural hybridization between *P.* deltoides and the European black poplar, *P.* nigra L., resulted in a few clones of unusual vigor designated as *P.* X *canadensis* Moench *(12).* For many years southern Europeans have been planting outstanding selections from this cross *(3,12).*

Selected clones of hybrid poplars and "cottonless" cottonwood are now being sold in the United States by private nurseries with great claims for success wherever they may be planted. In some cases, these clones are not identified. Each has inherent characteristics which interact with environmental conditions to affect its growth and development. Insect and disease resistance varies from clone to clone. Thus, differences in performance can be expected among different clones on a specific *site (4,5,6,7,10,12).*

Plantations of selected poplar hybrids and a selection of *Populus deltoides* were established in 1961 at Horning State Farm (Fig. 1), Plattsmouth, Nebraska, and in 1964 at the University of Nebraska Field Laboratory, Mead, for comparisons of survival, growth and pest resistance.

Methods

The poplar clones were planted as non-rooted ten-inch cuttings. Three hybrid clones were selected for the Horning State Farm planting from among the most vigorous in a stool bed at Lincoln, Nebraska, established by the U.S. Forest Service in 1955. They were *P.* X canadensis Moench from the Northeastern Forest Experiment Station designated by numbers NE-222, NE-228, and NE-237. Four-tree plots were randomized in 16 replications. The planting made three years later at the University of Nebraska Field Laboratory included two additional clones, P. X canadensis 'NE-273' and P. X canadensis "Robusta," a selection from Europe. A rust-resistant strain of *P. deltoides,* "Siouxland," selected at the South Dakota Experiment Station was included in both plantings *(8).* Table 1 shows the parentage of the clones. First-year failures in both plantings were replaced the second year. The planting at Horning State Farm was on a cultivated upland site. The Mead planting was on a non-cultivated valley site with a high water table. Weeds were controlled by herbicides in the tree row and by mowing between rows.

Table 1. Parentage of poplar clones in the two Nebraska plantations

Clone number or name	
NE-222, 228	*P. deltoides* x *P. nigra* cv. Caudina
NE-237	*P. deltoides* x *P. nigra* cv. Volga
NE-273	*P. deltoides* var. *occidentalis* x *P. nigra* cv. Italica
"Robusta"	*P. nigra* x *P. deltoides*
"Siouxland"	*P. deltoides*

Fig. 1. The hybrid poplar planting at Horning State Farm was thinned to 12 x 12 foot spacing after eight years.

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Results

First-year establishment from the field-planted cuttings of NE-222 and NE-237 was significantly better than for the other clones. Mortality of these two clones in subsequent years has also been less than all others except "Robusta."

Total height was very similar for all clones within each planting except for the poor showing of NE-273. The leader in diameter growth in both plantings was NE-237 (Table 2) (Figure 2). Significant differences in bark thickness, texture, and color were also noted (Table 3) (Figure 3). However, the bark of NE-273, "Siouxland," and "Robusta" were very similar in color, texture, and thickness.

Fig. 2. NE-237 (left) was significantly larger in diameter than "Siouxland" (right) in the Horning planting in 1972. Broken tops such as in upper right of the photo are fairly common in all clones except NE-237.

Multiple stems developed on 53 percent of the trees of clone NE-237 at Horning State Farm. Ten and fifteen percent of "Siouxland" and NE-228 trees, respectively, were multiple stemmed in the same plantation. Only 3 percent of NE-222 exhibited this trait. The Mead plantation was pruned at the end of the second year to eliminate all multiple stems. The branches of NE-222 were slightly smaller and shorter than those of the other clones. "Siouxland" and NE-237 have similar branching characteristics.

The leaves of all six clones were very similar. No significant differences were found in the ratio of leaf length to width. These clones may be divided into three groups by petiole length. Petioles of NE-222 and NE-228 were about two-thirds the length of those of the other four clones.

Table 2. Diameter breast high (4½ feet) at the end of the 1971 growing season

	Locations	
Source	*Plattsmouth* DBH 11 years (inches)	*Mead* DBH 8 years (inches)
NE-237	8.8 a [1]	5.4 a
"Robusta"	--	4.5 b
NE-222	7.3 b	4.3 b
"Siouxland"	5.8 c	4.3 b
NE-228	6.0 c	3.8 b
NE-273	--	2.0 c

[1] Those averages sharing a common letter within columns are not significantly different at the 5-percent probability level.

Table 3. Bark thickness at breast height (4½ ft.) for two diameter classes

	Thickness	
Source	*3" diameter class (inches)*	*6" diameter class (inches)*
NE-237	.24 a [1]	.41 a
NE-228	.17 b	.27 b
NE-222	.15 b	.24 b
NE-273	.14 b	--
"Robusta"	.14 b	--
"Siouxland"	.13 b	.19 c

[1] Those averages sharing a common letter within columns are not significantly different at the 5-percent probability level.

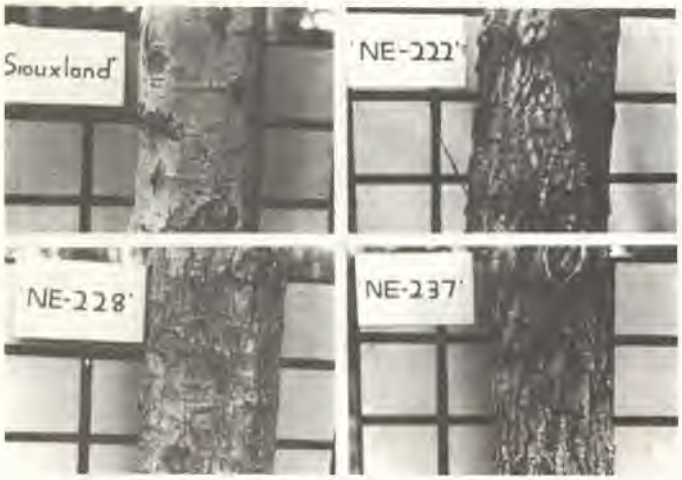

Fig. 3. The bark of four different poplar clones varies in roughness at age eight for the 6-inch diameter class at the Horning State Farm Plantation.

Leaf rust, *Melampsora* sp., infected the Horning State Farm planting in 1961. By late summer that year, NE-222 and NE-228 were heavily infected, but "Siouxland" and NE-237 displayed only slight infection. No significant outbreaks of this disease have been observed since this date.

Stem cankers were not evident on trees of clone NE-237 in either planting. Crowns were large with few dead twigs, indicating vigorous growth. More stem cankers (active, dormant, or healing) appeared on clones NE-222 and NE-228 in the Horning planting than at Mead with up to 25 percent of the trunk from 8 to 12 feet above ground showing active and dormant cankers. In the younger planting at Mead, less than 10 percent of the lower stem on trees of these two clones was covered with canker scars. In the Horning plantation, a large number of dead twigs was evident in the upper crowns of NE-222, NE-228, and "Siouxland." In the younger planting, full crowns were an indication that these clones were still high in vigor.

At Horning State Farm, the "Siouxland" clone has been injured by cankers which covered about 50 percent of the bark area of the lower 12 feet of stem (Figure 4). Also, the crowns on most trees were deteriorating to the extent that they were becoming spike-topped. In the younger planting, less than 25 percent of the bottom 12 feet of stem of most trees of "Siouxland" and "Robusta" clones was covered with canker scars, both active and dormant. NE-273 at Mead was severely cankered within three years after planting.

Fig. 4. Eleven-year-old "Siouxland" tree badly scarred by cankers.

Leaf buds of NE-237 and "Siouxland" break dormancy at nearly the same time each spring. They have usually broken dormancy a few days ahead of NE-222 and NE-228. On April 16, 1969, flowering was observed at Horning on the NE-237 and "Siouxland" clones for the first time. The pistillate flowers of NE-237 appeared to be at about the same stage of anthesis as the staminate flowers of the adjacent "Siouxland." However, capsules collected June 1, 1969, from NE-237 contained no viable seed. Native cottonwoods growing near the Mead planting failed to fertilize the flowers of NE-237 in 1972. No flowers have been observed on the other clones in the plantings.

Discussion

Some clones have greater ability to establish themselves from cuttings or rooted seedlings than others. The high survival and good diameter growth of NE-237 in both eastern Nebraska plantations make it a good choice for protection plantings and production of wood on sites suitable for this species. This statement is made on the assumption that this hybrid will grow best on the sites suitable for native cottonwood (9). Generally these are deep, moist, permeable, and fertile soils. The tendency of NE-237 toward multiple stems and relatively large branches may reduce the quality of lumber produced from this clone as compared to NE-222 which has small branches. Further observations are necessary to determine whether these clones will attain saw-log size without serious defects or high mortality.

The difference in performances of NE-222 and NE-228 points out the variability that is possible among hybrids of the same species but of different parent trees. The poor showing of NE-273 indicates that all hybrids are not high in vigor and performance on all sites. Other experiments comparing selections of native cottonwood with hybrids have had similar results *(6,10).* Read *(10)* compared the same and additional clones, with the exception of "Robusta" in five field plantings in the Nebraska Sandhill region. On these sites, NE-237 was rated only fair, lower than "Siouxland," and NE-222 was rated one of the best after 10 years. He also reported low initial survival for "Siouxland" and the best initial survival for NE-222 and that rooting percentage of NE-237 cuttings in the nursery was one of the highest.

Although "Siouxland" is resistant to leaf rust, its susceptibility to stem cankers slows its rate of growth and shortens its life. In fact, serious breakage and mortality have occurred on many trees of this clone in the Horning plantation and in other plantings of similar age in eastern Nebraska (Figure 5).

Research has indicated that differences in the anatomy of the stem affect rate of moisture loss and, therefore, susceptibility to some diseases *(1,2).* The relative freedom of thick-barked NE-237 from cankers in these plantings to date tends to substantiate this theory.

The decline in vigor of some trees in the Horning plantation is not unusual for eleven-year-old cottonwood on an upland site in eastern Nebraska. Rainfall is not always adequate for maintaining sufficient soil water to support this water-loving, fast-growing species. Drouth stress in this planting was probably a major contributing factor to the incidence of canker and crown dieback in the less vigorous clones. Even the most vigorous trees on this site may die in a few more years. Most of the clones in the planting at Mead should live longer because damaging drouth will never be experienced on the sub-irrigated bottomland site once they have their roots established in the zone of permanent soil water.

Fig. 5. Serious deterioration of the 12-year-old "Siouxland" cottonwood in this Lancaster County, Nebraska, windbreak first became evident at age eight.

since the first two seed crops produced by NE-237 have not been viable, it is possible that this clone will never produce seedling progeny. The seedless characteristic is desirable in plantings where natural reproduction is not wanted.

The hybrid clones of NE-222 and NE-237 are promising enough to warrant establishment of additional plantings for evaluation and comparison with other hybrid and native clones of *P. deltoides* not yet tested under the same site conditions. Research here and elsewhere, with both inter- and intra-specific hybrids will continue in the search for clones of *Populus* spp. best adapted to specific site conditions.

LITERATURE CITED

1. Bloomberg, W. J. 1962. Cytospera canker of poplars: factors influencing the development of the disease. *Can. Jour. Bot.* 40: 1271 - 1280

2. Bloomberg, W. J. 1962. Cytospera canker of poplars: the moisture relations and anatomy of the host. *Can. Jour. Bot.* 40:1281 - 1292..

3. Castellani, E., and M. Prevosto. 1969. Effects of research on the economy of poplar culture. *Proceedings of Second World Consultation on Forest Tree Breeding.* FAO and IUFRO, Washington, D.C.

4. Fowells, H. A. 1965. Silvics of forest trees. of the United States. *U.S.D.A. Forest Service, Agr. Handbook No. 271.*

5. Posey, Clayton E., and Rex B. McCullough. 1968. Cottonwood research in the Great Plains. *Proc. of the 20th Ann. Meeting, Forestry Corn., Great Plains Agr. Council.*

6. Merritt, Clair, and W. C. Bramble. 1966. Poplar plantation research in Indiana-a five-year report. *Res. Bul. No. 818,* Purdue University Agr. Exp. Sta. 15 pp. illus.

7. McKnight, J. S., and B.C. Biesterfeldt. 1968. Commercial cottonwood planting in the southern United States. *Jour. Forestry* 66 (9): 670-675.

8. Nagel, C. M. 1955. Siouxland, a new rust resistant cottonwood. S. Dak. Farm and Home Research 6: 38-40.

9. Read, R. A. 1964. Tree windbreaks for the Central Great Plains. *U.S.D.A., Forest Service, Agr. Handbook No. 250.*

10. Read, R. A. 1967. Hybrid poplar performance at 10 years in the Nebraska Sandhills. *U.S. Forest Service Res. Note. RM-91,* Rocky Mt. Forest and Range Exp. Sta., 8 pp. illus.

11. Rostlund, Erhard. 1956. The outlook for the world's forests and their chief products. American Geographical Soc., *A World Geography of Forest Resources.* Ronald Press Co.

12. Schreiner, E. J. 1959. Production of poplar timber in Europe and its significance and application in the United States. *Agr. Handbook No. 150,* U. S. Forest Service, U.S.D.A. 124 pp. illus.

13. Vaartja, 0. 1954. Evidence of photoperiodic ecotypes in trees. *Ecological Monographs* 29:91-111.