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Results of a 20-Year Test of Hybrid Poplars in West Virginia

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AT THE END of 20 years, several hybrid poplar clones test-planted in West Virginia have attained an average diameter (d.b.h.) of more than 9 inches and heights of more than 70 feet.

In 1951, as part of a region-wide test of hybrid poplars, the Northeastern Forest Experiment Station established two outplantings in West Virginia—one on the Nursery Bottom near Parsons, and the other at Horseshoe Run near Leadmine. The 50 hybrids used (table 1) were developed by Stout and Schreiner (*1933*).

After 7 years, the Nursery Bottom plantation was destroyed to provide more nursery space. As of that time, the performance of the clones in both outplantings was reported on by Eschner (*1960*). Because of reduced manpower, subsequent measurements were continued on only the 13 clones at Horseshoe Run that were making the best growth in 1959.

This is a report on growth of these clones 11 years later.

THE STUDY

The study was begun in the spring of 1951 on a bottomland site along Horseshoe Run near Leadmine, West Virginia. Two complete blocks were planted, each with cuttings from 50 different hybrid poplar clones randomly distributed within each block. Each clone was represented in each block by a 16-tree plot. Dormant cuttings, 12 inches long, were planted at a spacing of 4 by 4 feet.

The planting is on a Pope gravelly silt loam, a well-drained alluvial soil. The area was plowed before planting, and the plantation was cultivated three times during the first growing season.

Total height measurements were recorded for all clones annually during the first 3 years of the study. From 1957 to 1965, d.b.h. and total-height measurements were taken at 2-year intervals on the 13 clones that were making the most rapid height growth as reported by Eschner (*1960*).

Table 1.—Clone numbers and parentage of material used in the Horseshoe Run hybrid poplar planting, 1951

Clone numbers	Parentage[1]
NE-2, -5, -279, -282	*P. nigra* L. x *P. laurifolia* Ledeb.
NE-9, -10	*P. nigra* x *P. trichocarpa* Torr. & Gray
NE-12, -301	*P. nigra* cv. Betulifolia x *P. trichocarpa*
NE-14	*P. nigra* cv. Charkowienses x *P. deltoides* Bartr.
NE-18, -21	*P. nigra* cv. Charkowienses x *P. nigra* cv. Caudina
NE-29, -322	*P. nigra* cv. Charkowienses x *P. trichocarpa*
NE-31	*P. nigra* cv. Charkowienses x Unidentified Cottonwood
NE-305	*P. nigra* cv. Charkowienses x *P. nigra* cv. Plantierensis
NE-33	*P. deltoides* cv. Angulata x *P.* x *berolinensis* Dipp.
NE-34, -259	*P. deltoides* cv. Angulata x *P. nigra* cv. Incrassata
NE-251, -256, -258	*P. deltoides* cv. Angulata x *P. trichocarpa*
NE-261	*P. deltoides* cv. Angulata x *P. nigra* cv. Plantierensis
NE-264	*P. deltoides* cv. Angulata x *P. Nigra* cv. Volga
NE-41, -42	*P. maximowiczii* Henry x *P. trichocarpa*
NE-43, -44, -46, -47, -48, -49, -50	*P. maximowiczii* x *P.* x *berolinensis*
NE-51, -52	*P. maximowiczii* x *P. nigra* cv. Plantierensis
NE-53	*P. maximowiczii* x *P. nigra* cv. Caudina
NE-200, -205, -206, -209, -212, -213, -219	*P. deltoides* x *P. trichocarpa*
NE-223, -224, -227	*P. deltoides* x *P. nigra* cv. Caudina
NE-229	*P. deltoides* x *P.* x *berolinensis*
NE-235	*P. deltoides* x *P.* x *canadensis* Moench cv. Incrassata
NE-239	*P. deltoides* x *P. nigra* cv. Volga
NE-241	*P. deltoides* x *P. nigra* cv. Plantierensis
NE-333	*P. simonii* Carr. x *P.* x *berolinensis*

[1] Full names are in accordance with the International Code of Nomenclature for Cultivated Plants.

The 13 clones were remeasured for the last time at the end of the 1970 growing season.

Two thinnings—one in 1960 and one in 1965—have reduced the number of trees in each plot from 16 to 4. In 1960, the 8 largest and most vigorous trees were retained; and in 1965, the best 4 of these were retained.

In the winter of 1970-71, 29 trees ranging in size from 5 to 12 inches d.b.h. were cut and measured, and a local volume table was prepared. Each 1-inch diameter class was represented by at least three trees.

GROWTH

An analysis of variance showed that clones differed significantly (1-percent probability level) in d.b.h. and total height at the end of 20 years (table 2). The Student-Newman-Keuls multiple-range test (*Steel and Torrie 1960*) was used to determine which clones were significantly different. In this test, means underscored by the same line do not differ significantly at the 5-percent probability level.

Diameter growth.—The Student-Newman-Keuls test showed that clones NE-50, -43, -41, -46, -42, and -51—which averaged between 9.4 and 10.0 inches d.b.h. at 20 years—differed significantly from clones NE-256, -53, -29, -49, and -206—which averaged between 5.7 and 6.9 inches d.b.h. (table 3). Two clones, NE-52 and -47—8.0 and 7.5 inches d.b.h. respectively—did not differ significantly, but did overlap and were judged not significantly different from some of the clones in the slower growing group.

Clone NE-50 had the greatest average d.b.h. —10.0 inches—but the largest single tree—13.0 inches—occurred in clone NE-41. The smallest trees occurred in clones NE-49 and NE-206; trees in each of these two clones averaged about 5.7 inches.

Average annual d.b.h. growth ranged from 0.29 inch for clones NE-49 and NE-206 to 0.50 inch for clone NE-50 (table 3).

Total height growth.—When tested for sig-

Table 2.—Analysis of variance tables for total height and d.b.h. at the end of 20 years

Source of variation	D.F.	Sums of squares	Mean square	F
		AVERAGE D.B.H.		
Blocks	1	0.34	0.34	1.50
Clones	12	72.89	6.07	26.74**
Error	12	2.73	.23	—
Total	25	75.96	—	—
		AVERAGE TOTAL HEIGHT		
Blocks	1	2.10	2.10	.110
Clones	12	1,976.73	164.73	8.68**
Error	12	227.63	18.97	—
Total	25	2,206.46	—	—

Table 3.—Twenty-year d.b.h. and total-height data on 13 hybrid poplar clones at Horseshoe Run

Block	Clone NE-												
	206	49	29	53	256	47	52	51	42	46	41	43	50
	D.B.H. *(Inches)*												
I	6.1	5.8	5.9	7.1	7.2	7.3	8.1	9.4	8.9	9.3	9.9	10.4	10.2
II	5.2	5.6	6.0	5.7	6.6	7.6	7.8	9.3	10.1	9.7	9.8	9.4	9.8
Average	5.65	5.70	5.95	6.40	6.90	7.45	7.95	9.35	9.50	9.50	9.85	9.90	10.00
Average annual d.b.h. growth $S_x = 0.3391$	0.29	0.29	0.30	0.32	0.35	0.38	0.40	0.47	0.48	0.48	0.49	0.50	0.50

Block	Clone NE-												
	49	256	206	29	47	52	53	42	43	41	51	46	50
	TOTAL HEIGHT *(Feet)*												
I	54.2	52.5	60.5	54.0	60.1	56.2	62.3	62.2	74.3	69.7	71.5	74.0	81.5
II	54.5	57.2	50.7	60.0	54.5	62.5	58.5	71.3	65.5	70.7	75.0	80.5	79.5
Average	54.4	54.9	55.6	57.0	57.3	59.4	60.4	66.8	69.9	70.2	73.3	77.3	80.5
Average annual height growth $S_x = 3.08$	2.7	2.7	2.8	2.9	2.9	3.0	3.0	3.3	3.5	3.5	3.7	3.9	4.0

nificant differences in total heights, the clones fell in two groups: the faster growing group—NE-50, -46, -51; and the slower growing clones NE-53, -52, -47, -29, -206, -256, and -49. Three clones—NE-41, -43, and -42—overlapped and were not significantly different from either group (table 3). Within the groups, total height did not differ significantly at the 5-percent level of probability.

Total heights ranged from 54.4 to 60.4 feet in the shorter group and from 73.3 to 80.5 feet in the taller group. The tallest tree—87.0 feet—was in clone NE-50, which averaged 80.5 feet (fig. 1). The shortest tree was in clone NE-49, which averaged 54.4 feet. Two intermediate groups of clones did not differ significantly in total height and overlapped both the faster and slower growing groups (table 3).

Average annual height growth ranged from 2.7 feet for clones NE-49 and NE-29 to 4.0 feet for clone NE-50 (table 3).

Volume table.—Volume in cubic feet was computed (*Hampf and Bickford 1959*) for 29 trees ranging in size from 5.0 to 12.0 inches d.b.h. By regression methods, equations were calculated for estimating cubic-foot volume to a top diameter of 4 inches inside bark (equations 1 and 2).

$$\text{Cubic-foot volume (including bark)} = 1.237417 + 0.002726\,(D^2H) \qquad [1]$$

Figure 1.—Clone NE-50 at the end of 20 growing seasons.

$$\text{Cubic-foot volume (without bark)} = 1.042011 + 0.002531\,(D^2H) \qquad [2]$$

In equation 1, volume included the bark; in equation 2, bark volume was not included. Then, with the equations, the volumes for various combinations of d.b.h. and merchantable stem length were determined (tables 4 and 5). The underlined portions of the tables indicate the range of the data.

For both equations, the coefficient of determination was 0.993; the standard error of estimate for equation 1 was 0.59 cubic feet and for equation 2 was 0.55 cubic feet.

DISCUSSION

The study showed that clones NE-50, -41, -43, -46, -42, and -51 grew better than the other clones during the 20 years of the test. With the exception of clone NE-42, these were also the fastest growing (in height) in 1959 (*Eschner 1960*). These same clones also had the largest annual diameter growth for the 20-year period.

Since the test was made on one site, we can expect similar growth only if these clones are planted on areas having the same soils and subject to the same climatic conditions. For example, these same clones, planted on an upland site, might not grow as well as others that ranked lower in this test.

Table 4.—Cubic-foot volumes, outside bark, for hybrid poplars[1]

D.b.h.	Merchantable height (feet)											
	10	15	20	25	30	35	40	45	50	55	60	65
5	1.9	2.3	2.6	—	—	—	—	—	—	—	—	—
6	—	—	3.2	3.7	4.2	4.7	—	—	—	—	—	—
7	—	—	3.9	4.6	5.2	5.9	6.6	—	—	—	—	—
8	—	—	—	—	6.5	7.3	8.2	9.1	10.0	—	—	—
9	—	—	—	—	—	9.0	10.1	11.2	12.3	13.4	—	—
10	—	—	—	—	—	—	—	13.5	14.9	16.2	17.6	18.9
11	—	—	—	—	—	—	—	16.1	17.7	19.4	21.0	22.7
12	—	—	—	—	—	—	—	18.9	20.9	22.8	24.8	26.8

[1] Merchantable length, to a top diameter of 4 inches, inside bark.

Table 5.—Cubic-foot volumes, inside bark, for hybrid poplars[1]

D.b.h.	Merchantable height (feet)											
	10	15	20	25	30	35	40	45	50	55	60	65
5	1.7	2.0	2.3	—	—	—	—	—	—	—	—	—
6	—	—	2.9	3.3	3.8	4.2	—	—	—	—	—	—
7	—	—	3.5	4.1	4.8	5.4	6.0	—	—	—	—	—
8	—	—	—	—	5.9	6.7	7.5	8.3	9.1	—	—	—
9	—	—	—	—	—	8.2	9.2	10.3	11.3	12.3	—	—
10	—	—	—	—	—	—	—	12.4	13.7	15.0	16.2	17.5
11	—	—	—	—	—	—	—	14.8	16.4	17.9	19.4	20.9
12	—	—	—	—	—	—	—	17.4	19.3	21.1	22.9	24.7

[1] Merchantable length to a top diameter of 4 inches inside bark.

A possible limitation to rotations longer than 20 years is the occurrence of stem cankers caused by *Fusarium solina*. (Personal communication from F. R. Berry, USDA Forest Service, Forest Insect and Disease Laboratory, Delaware, Ohio, 12 August 1971.) The cankers are fairly common on the upper stem, often girdling the stems and causing the tops to die. Schreiner (*1959*) recommends that random mixtures of clones of different parentage be used in plantations to provide assurance against extensive disease losses.

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