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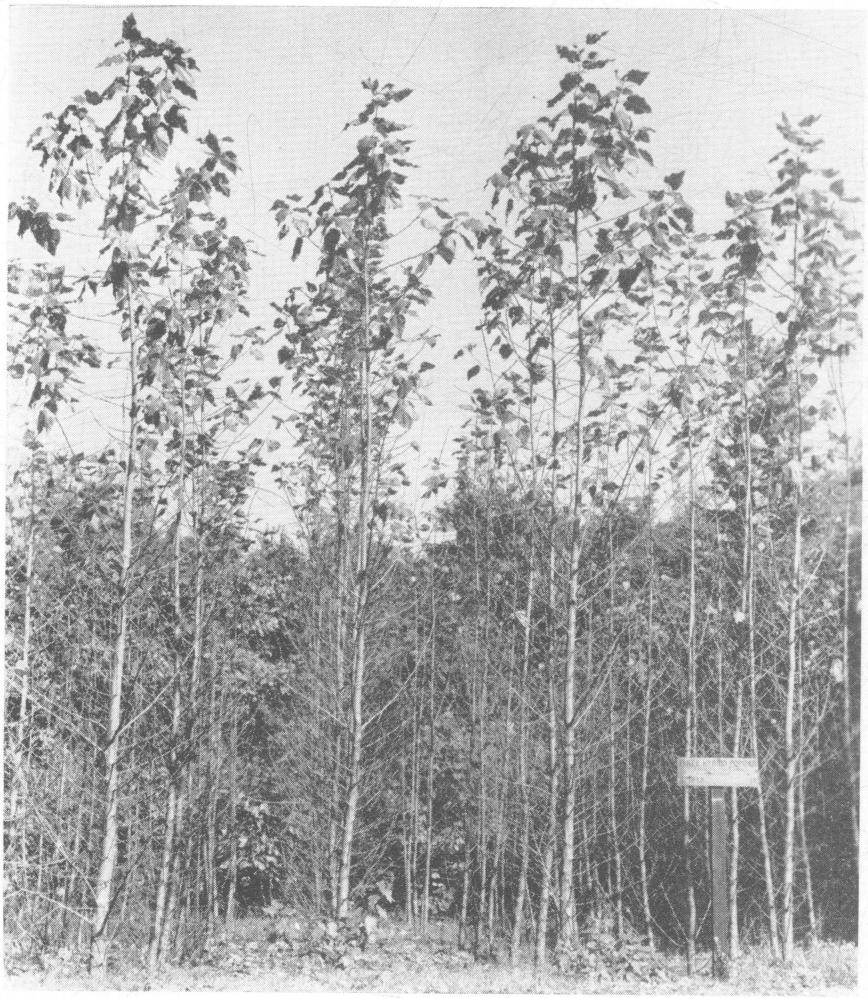

OHIO AGRICULTURAL EXPERIMENT STATION - - WOOSTER, OHIO

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This is a plot of McKee hybrid poplars in the Secrest Arboretum at the Ohio Agricultural Experiment Station in Wooster, Ohio.

RELATIONSHIP OF SITE CONDITIONS TO ESTABLISHMENT AND EARLY GROWTH OF McKEE HYBRID POPLAR

H. B. KRIEBEL, G. L. LOWRY and W. K. MURPHEY

Some of the early crosses of **Populus trichocarpa** × **Populus angulata** resulted in the production of the so-called "McKee" hybrid poplar, a series of patented clones which have good form and a rapid rate of growth. Although this hybrid is only one of a number having vigorous growth, it has received considerable publicity and cuttings have been purchased and planted by many individuals and organizations. Because of interest in poplar planting in Ohio and inquiries concerning the McKee hybrid, the Forestry Department of the Ohio Agricultural Experiment Station initiated field tests under various conditions throughout eastern Ohio with "Strain F" of the hybrid.

The first two plantings of unrooted cuttings were made at Wooster on upland soils in 1947 and 1949. Later, plantations were established on two bottomland sites and on strip-mined areas. In addition to records of initial survival, detailed records have been kept of tree height on all areas and of diameter in the older plantations. Additional observations include extent of cankering and breakage resulting from severe cankering. The performance of trees in these plots is described in the following discussion.

PLANTINGS ON UPLAND SITES

The oldest test plot of McKee hybrid poplar was established in the spring of 1947 in the Secrest Arboretum at the Ohio Agricultural Experiment Station. The plot covers approximately one-third of an acre, on both sides of a small intermittent stream in a depression surrounded by open fields. The soil is a moderately-drained phase of Lobdell silt loam, with a 2 percent slope and no erosion. It is actually an alluvial soil, rather than a strictly upland soil, although it is not comparable to the bottomland soils subsequently discussed.

The plantation was established with unrooted cuttings, on a spacing of 6 × 6 feet, with a very high rate of survival, exceeding 90 percent. Replacements were made where cuttings failed to became established. With the exception of removal of about a dozen trees at

the end of the fourth growing season, no thinning was made during the first 10 years. The plot was cultivated periodically during the first growing season to eliminate weed and grass competition, and mowed during the second year. A pruning was also made at the end of the fourth growing season; trees in the eastern third of the plot were pruned to two-thirds of the total height; trees in the middle third were pruned to one-half the total height; and trees in the western third of the plot were left unpruned as a check.

Measurements of the 1947 plot were taken at the ages of 6 and 7 years by sampling a part of the stand, and at the age of 10 years by a 100 percent inventory.

The second plot is smaller and in another part of the arboretum. The soils is Wooster silt loam, with a 10 percent slope, and has good internal drainage. The plot was established in the spring of 1949 in the same manner as the 1947 planting. About 95 percent of the cuttings survived, and failures were replaced. The plot was cultivated three times during the first growing season and was mowed during the second year. Measurements were taken in this plot at the age of 4, 5, and 8 years. The plot had two light thinnings from below, one in the fourth year and one in the sixth year after establishment. A total of 46 of the original 117 trees were removed.

Thinning in the 1949 plot concentrated on removal of low vigor, suppressed trees, resulting in a normal distribution of tree heights around a mean for the plot. There were no very small trees far below the mean in height. In the 1947 plot, on the other hand, in the absence of thinning, there were scattered suppressed individuals much below the mean in height, resulting in a "skewed" non-normal distribution when heights were tabulated. Consequently, an arithmetic mean does not give a precise representation of height for the 1947 plot, and a measure of dispersion such as the standard deviation cannot be used without transformation of the data to obtain a normal curve. The better height growth in Area 2 could be the result of thinning, site differences, or a combination of the two.

Table 1 summarizes height and diameter growth, and indicates the amount of cankering in each stand. Both height growth and diameter growth were greater at a given age in Area 2 than in Area 1.

TABLE 1.—Early growth of two upland plantations of McKee poplar at Wooster, Ohio

Area No.		Mean DBH in.	Range of DBH	Mean height feet	Range of height	Percentage of trees cankered
1	(Moderately-drained; stand thinned)					
	Age 6	3.1	0.3–5.2	26	13–33	18
	Age 7	3.7	0.4–5.9	28	15–35	91
	Age 10	5.0	1.5–7.3	36	15–48	100
2	(Well-drained; stand unthinned)					
	Age 4	2.5	1.5–3.9	22	18–27	0
	Age 5	3.0	1.6–5.1	28	22–32	11
	Age 8	4.5	1.8–8.1	37	27–47	84

Response to date shows that this hybrid is susceptible to cankering (genera unidentified). Most trees were cankered several times during the second five years. In a few trees, a canker caused sufficient weakening for the tree to break in a windstorm. On the other hand, there was some resistance, as demonstrated by the capacity of the tree to outgrow cankers, which actually healed over in many cases. There was no apparent effect of pruning on extent of cankering.

This early evaluation of the hybrid on upland soils leads to the tentative conclusion that rapid height and diameter growth can be maintained during the first ten years on a well-drained soil. Thinning may be partly responsible for the good response, although the relative importance of thinning versus site conditions cannot be determined from these unreplicated plots. It is possible that a wider initial spacing would have given equally good results. Cankering, although very prevalent, does not seem to prevent satisfactory stand development on good sites during the first decade.

PLANTINGS ON BOTTOMLAND SITES

The third planting of McKee hybrid poplar cuttings was made in 1951 at Wooster. Trees were spaced 8 × 8 feet apart and the plantation was disked twice during each of the first three growing seasons. Initial survival was approximately 80 percent; no replacements were made.

The planting is on bottomland along a small creek and covers five acres. The soil is on imperfectly-drained Lobdell silt loam, with a one percent slope. The area has been subject to occasional flooding of very short duration. However, no flooding has been observed during recent years.

Growth rate of this planting was moderately high during the first seven years, although not as high as in Areas 1 and 2. Mean height and diameter at age 6 are slightly lower than comparable measurements in the best of the upland plots (Area 2) at age 4.

Area 4 was planted in 1951 at the Southeastern Substation near Carpenter, in Meigs County, Ohio. The spacing is 9 × 9 feet and the area was disked periodically during the first growing season. The soil is classified as Moshannon silt loam with a one percent slope and is recent alluvium. It is a very poorly drained area which has been flooded several times each year since the plot was established.

Early growth was rather poor on this area, presumably because of the poor drainage. A summary of measurements taken in the two areas is presented in Table 2.

TABLE 2.—Early growth of two bottomland plantations of McKee poplar in eastern Ohio

Area No.		Mean DBH in.	Range of DBH	Mean height feet	Range of height
3	(Wooster)				
	Age 3	--	------	6	1–13
	Age 4	--	------	12	3–19
	Age 5	--	------	16	4–24
	Age 6	2.4	0.2–4.0	21	8–29
	Age 7	3.1	0.6–5.0	23	9–33
4	(Carpenter)				
	Age 3	--	------	3	1– 8
	Age 4	--	------	5	1–10
	Age 5	--	------	8	3–16
	Age 6	--	------	10	4–19

Fig. 1.—Plantation of hybrid poplar on a very poorly-drained soil in southeastern Ohio, photographed during the sixth growing season (Area 4).

PLANTINGS ON COAL STRIP-MINE SPOILS

Planting of McKee hybrid poplar on spoil banks was begun in 1951 with small test plots. Additional plantings were made in 1952 and 1953, using larger plots. The primary purpose of these plantings was to evaluate this strain over the wide range of edaphic conditions which are typical of strip-mine spoils as well as to determine whether any special planting practices were necessary for successful establishment.

The 1951 test plots were designed to determine whether or not fertilizers were necessary for establishing this strain. Two plots on each area were established, one with and one without fertilizer, using unrooted cuttings planted with a planting bar. The fertilized trees received one tablespoonful of a commercial 10-6-4 fertilizer in the hole with the cutting.

On all of the areas trees in the fertilized plots failed to survive. Results are presented in Table 3, Areas 1 to 6. Reasons for poor survival on untreated areas are not readily understandable. The excellent growth recorded on Areas 4 and 6 seems to be the result of good internal drainage of the spoil material.

In the spring of 1952 it was decided to plant on areas exhibiting different site conditions. Various establishment practices were tried with the hope that better survival rates could be obtained. These included prerooting cuttings, planting cuttings in boxes of organic soil, and surface applications of mulches, fertilizer and lime. Area 7 to 12 were established for these purposes during the late spring. Statistical analysis of the data revealed that the only real differences in survival and growth were due to site characteristics and not to treatment differences. The poor growth and survival on Area 7 was attributed to excess acid toxicity and severe sheet erosion. Better than average growth was again noticed where excellent internal drainage was present (Area 8).

The following year (1953) tests were begun to see if the presence of cover crops on the planting area would have any effect on establishment and growth. In addition, lime and fertilizer trials were continued. The only treatment effects noted were a slightly lower survival where fertilizers were applied (Area 13) and a lower survival where excess lime was applied to sandy spoil material (Area 15). Again, the major differences in survival and growth were due to inherent spoil conditions and not to treatment differences.

Analysis of the five-year data in Table 3 indicates that McKee hybrid poplar survives best on medium to heavy-textured spoils where spoil reaction is between pH 4.0 and 7.0. There is also some indication that sandy spoils as low as pH 3.5 may allow sufficient trees to survive to produce closed stands at a later time. The best growth was made on plots where sands made up 40% – 50% of the spoil material and the pH was between 4.0 and 4.5. Growth was less in spoils above these ranges of sand and pH. Field observations were in agreement with the results of these laboratory analyses, since the tallest trees in any plot usually occupied well-drained sites. Figure 2 shows the typical form and height of a five-year-old plantation. Gully erosion was a significant factor on this area with respect to tree survival.

TABLE 3.—Summary of five-year survival and growth of hybrid poplar on Ohio spoil banks

Area Description			Total trees planted	Mean survival all treatments %	Mean height (ft.)	Range of height
Area No.	pH range	Spoil texture				
		1951 Fertilizer Trials*				
1	2.5–4.0	Clay	50	0	0	
2	3.0–4.5	Clay	50	2	5.0	5.0
3	5.5–7.5	Clay	50	20	0.8†	0.4– 1.2†
4	3.5–5.0	Loam	50	10	11.3	7.4–17.5
5	3.2–4.5	Clay loam	50	0	----	--------
6	3.5–4.5	Sandy-clay loam	50	8	11.4	8.4–13.6
		1952 Soil, Mulch, Fertilizer and Lime Trials				
7	2.0–3.5	Sand-clay loam	70	7	0.9	0.4– 1.5
8	3.7–5.2	Loam	21	100	8.0	3.5–11.4
9	4.3–5.5	Clay loam	70	87	5.8	0.5–10.0
10	4.3–5.5	Clay loam	21	71	6.8	1.3–10.3
11	3.7–5.0	Clay loam	70	90	5.7	1.6–10.8
12	3.7–5.0	Silty clay	103	65	6.6	2.6–10.4
		1953 Cover Crops, Lime and Fertilizer Trials				
13	3.5–4.5	Silty-clay loam	210	24	6.3	1.4–17.3
		1953 Lime Placement Trials				
14	3.2–4.5	Sandy-clay loam	52	39	3.7	0.4– 6.3
15	2.2–4.0	Sandy-loam	52	25	7.7	3.0–11.7
16	2.7–6.7	Clay-loam	50	38	6.0	3.0– 8.8

*Poor survival on Areas 1-6 due to fertilizer application.
†Area grazed by cattle.

In conclusion, special planting procedures such as pre-rooting, boxing, mulching, or liming are not considered necessary for establishing this strain. The use of fertilizers in or around the planting hole is not recommended. Within the range of conditions studied, survival was consistently lower on fertilized areas than on unfertilized areas.

Fig. 2.—This is the typical form and height of a five-year-old plantation. Gully erosion was a factor in tree survival.

CONCLUSIONS

Reports presented on trials on upland and bottomland sites are based on fairly large plots, and include periods up to ten years. Reports of strip-mine trials are based on smaller plots of five-year-old trees growing under a wide range of site conditions. In no case can final conclusions be drawn. It can be stated, however, that on a well-drained silt loam soil with moderate thinning, a more rapid growth was obtained than on moderately or imperfectly-drained soils with little or no thinning. Rate of growth in height and diameter seems to be related to drainage conditions on normal soils. Five-year height on these soils ranged from a mean of 8 feet on a very poorly-drained soils to 28 feet on a well-drained soil. Growth in height in these plots during the second five years was considerably less than that during the first five years (Tables 1 and 2).

On spoil banks, fertilizer was not beneficial in tests described—in fact, it was detrimental to survival. The site conditions were much more important than any treatment which was applied. On these areas, too, good internal drainage, as indicated by spoil texture, appeared to be a necessary condition for satisfactory height growth. Mean height at five years on the best of the spoils was comparable to that on the very poorly-drained bottomland area.

Cankering, as judged by the older plots, begins at about the fifth year and affects all the trees by the tenth year. In these plots, a few trees broke off at the point of cankering, but many cankers healed over at an early age, and the majority of the trees maintained vigor and did not show serious stem decay during this stage of growth.

This report is only a comparison of a single hybrid poplar clone on varying sites. Results are of interest because differences are known to be the effects of site factors, and not of any genetic differences between trees in different plots. It is therefore a report of the growth capacity of this tree on various sites. The report does not present any comparison with other poplar species or hybrid selections, some of which might give superior results under these conditions.

The absolute genetic uniformity of all the trees compared in these tests should be kept in mind by the tree planter. A plantation of a single clone is likely to be uniformly susceptible to any injury or mortality caused by insects, diseases, adverse nutritional conditions, or other external factors. It would therefore be advisable in reforestation projects to establish mixtures of several clones, rather than to make large plantings of this hybrid alone, or of any other single clone. For this reason also, a single clone planting should not be used as a source of seed for general use.

These plots will be measured and evaluated periodically, and another report will be made at a later date.