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# SECOND-YEAR RESULTS OF HYBRID POPLAR TEST PLANTINGS ON BITUMINOUS STRIP-MINE SPOILS IN PENNSYLVANIA

During the period 1946-49, The Pennsylvania State University established 22 experimental plantings of trees and shrubs on strip-mine spoil banks in the Bituminous Region of Pennsylvania to determine which species were best suited for revegetating such sites. When 10-year growth on the experimental plots was evaluated, a clone of hybrid poplar was found to have outgrown all the other species tested.[1] The performance of this one hybrid poplar suggested that other hybrid poplars might be well adapted for growing on strip-mine spoils, so we planned a screening test of as many hybrid poplar clones as possible to determine which ones were worth further consideration for use in large-scale plantings.

More than 70 hybrid poplar clones are being grown in the Northeast, but some of these exist only in small experimental plots. Enough cuttings for the screening test were available in 1961 from 60 of these clones. In April of that year, test plantings of these 60 clones were made on six strip-mine spoil areas in Pennsylvania's Bituminous Region.[2] This note summarsizes the survival and height growth of the 60 clones after 2 growing seasons.

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[1]Hart, George, and William R. Byrnes. TREES FOR STRIP-MINED LAND. U. S. Forest Serv. Northeast. Forest Expt. Sta., Sta. Paper 136, 36 pp., illus. 1960.

[2]This study is part of a cooperative effort to investigate all aspects of the problem of revegetating strip-mine banks in Pennsylvania. The cooperating agencies are: The Pennsylvania Department of Forests and Waters; The Pennsylvania Department of Mines and Minerals Industries; School of Forestry, The Pennsylvania State University; Independent Mineral Producers Association; Central Pennsylvania Open Pit Mining Association; West Virginia Pulp and Paper Co.; and Northeastern Forest Experiment Station, U. S. Forest Service.

## The Experimental Areas

The plots were established on the six areas at places that had been stripped and graded in accordance with state laws. Each of the six areas was associated with one of the Region's major coal seams.

Samples of spoil material collected from each plot were subjected to textural and acidity tests (table 1). It was evident that the different spoils provide a variety of conditions, especially with respect to acidity, which ranges from pH 3.1 to 5.7. Spoils from the Middle and Lower Kittanning seams (pH 3.1 and 3.3) are the most acid, but the two Clarion spoils (pH 3.6 and 3.7) also are extremely acid. The Lower and Upper Freeport spoils (pH 4.9 and 5.7) are in an acidity range that is considered favorable to tree growth.

Table 1.—*Characteristics of strip-mine spoil material*

| Coal-seam | Spoil texture | | | Texture class | Spoil acidity |
|---|---|---|---|---|---|
| | Sand | Silt | Clay | | |
| | *Percent* | *Percent* | *Percent* | | *pH* |
| Clarion (Clarion Co.) | 62 | 17 | 21 | Sandy clay loam | 3.6 |
| Clarion (Clearfield Co.) | 61 | 19 | 20 | Sandy clay loam | 3.7 |
| Lower Kittanning | 64 | 17 | 19 | Sandy loam | 3.3 |
| Middle Kittanning | 41 | 30 | 29 | Sandy loam | 3.1 |
| Lower Freeport | 67 | 17 | 16 | Sandy loam | 4.9 |
| Upper Freeport | 60 | 18 | 22 | Sandy loam | 5.7 |

## The Clones Tested

Of the 60 hybrid poplar clones tested, four were planted as 1-year rooted cuttings; all others were planted as unrooted and untreated cuttings. Unrooted cuttings were 12 inches long and ranged from 1/4 to 1/2 inch in mid-point diameter.

Parentages of the clones tested are listed in table 2. The clone used by the University in the original plantings was included in the experiment and is designated "X" because its exact parentage is uncertain. However, it is known to be a Northeastern Station clone, and it appears to be either *P. maximowiczii* X *trichocarpa* or *P maximowiczii* X cv. Berolinensis.

Table 2.—*Clone numbers and parentages of hybrid poplars tested on strip-mine spoil areas*

| Clone numbers[1] | Parentage |
|---|---|
| NE-32 | *P.* cv. Angulata X cv. Berolinensis |
| NE-245, -246, -247, 258 | *P.* cv. Angulata X *deltoides* |
| NE-35 | *P.* cv. Angulata X cv. Plantierensis |
| NE-249, -251, -252, -253, -254, -374 | *P.* cv. Angulata X *trichocarpa* |
| NE-12, -302 | *P.* cv. Betulifolia X *trichocarpa* |
| NE-327 | *P.* cv. Candicans X cv. Berolinensis |
| NE-17, -313, 314 | *P.* cv. Charkoviensis X cv. Caudina |
| NE-28, -29 | *P.* cv. Charkoviensis X *trichocarpa* |
| NE-221, -223, -224, -228, -353, -359 | *P. deltoides* X cv. Caudina |
| NE-241, -242 | *P. deltoides* X cv. Plantierensis |
| NE-206, -207, -208, -211, -213, -214, -215, -216, -346, -350 | *P. deltoides* X *trichocarpa* |
| NE-43, -44, -47, -48, -49, -50 | *P. maximowiczii* X cv. Berolinensis |
| NE-53 | *P. maximowiczii* X cv. Caudina |
| NE-52 | *P. maximowiczii* X cv. Plantierensis |
| NE-41, -42, -388 | *P. maximowiczii* X *trichocarpa* |
| NE-277 | *P. nigra* X cv. Italica |
| NE-4, -5, -8, -279 | *P. nigra* X *laurifolia* |
| NE-11 | *P. nigra* X *trichocarpa* |
| X (parentage uncertain) | Either *P. maximowiczii* X *trichocarpa* or *P. maximowiczii* X cv. Berolinensis |
| PLANTED AS 1-YEAR ROOTED CUTTINGS | |
| M-86 or NY-3139 | Populus robusta (Robusta poplar) |
| M-87 or NY-3140 | Populus species (Siouxland poplar) |
| M-88 or NY-3141 | Populus species (Norway poplar) |
| NY-2555 | Populus canescens (Curly poplar) |

[1]NE = Northeastern Forest Experiment Station; M = Michigan; NY = New York.

## Methods

At each experimental area, plots were placed on graded and ungraded surfaces of both upper and lower portions of the spoil banks. This plot arrangement was replicated 3 times, giving a total of 12 plots on each area. Clones were assigned at random to each plot, and two cuttings of each clone were placed adjacent to each other within the plots. The spacing was 6 x 6 feet. For some clones, only enough cutting stock was available for one or two replications.

The plots were established between April 11 and 19, 1961. Weather conditions were good during planting and continued good through the

first growing season. However, the growing season of 1962 was one of the driest on record.

Survival tallies and height measurements were taken in October 1961 and October 1962. Causes of mortality were noted during each measurement.

## Results

Both survival and height varied considerably from bank to bank. To show the differences in clone performance among banks, survival and height of the 10 best clones on each bank are listed in table 3. Ratings were based on both height and survival. Greater emphasis was placed on survival on banks where mortality was heavy and on height where survival was adequate.

As might be expected, some clones appear among the 10 best on several banks, but only NE-388 appears in all 6 lists. Nine clones are listed among the 10 best on 3 or more banks: NE 11, 41, 42, 44, 47, 50, 279, 388, and X. Seven of these clones are hybrids of *P. maximowiczii.*

Survival and height growth varied so much from bank to bank that general statements applicable to performance on all banks are almost impossible. For instance, on the worst bank, survival was less than 25 percent for all but 3 of the 60 clones, whereas on the two best banks survival exceeded 75 percent for all but 3 clones. Height growth was extremely variable too, ranging from less than 1 foot to more than 7 feet.

An attempt was made to relate the performance of the clones to some spoil characteristic. The only factor that showed a close relationship to survival and height growth was bank acidity: height growth and survival generally increased as pH increased (table 4). On the two most acid banks, mortality not only was high during the first year, but also continued to occur during the second year. Survival of the 10 best clones dropped from 25 percent at the end of the first year to 18 percent at the end of the second year on the Middle Kittanning spoil and from 43 percent to 37 percent on the Lower Kittanning spoil. Even greater drops in survival were noted in clones not listed among the 10 best. Very little second-year mortality occurred on the other four spoils.

To get a better measure of the effects of grading and slope position than would be provided by averages of all clones, data were averaged for a selected group of 13 clones that were consistently among the better ones in all replicates in all areas. Average survival for this group was 63 percent on the graded portions of the banks and 53 percent on

Table 3.—*Survivals and heights of 10 best hybrid poplar clones on each spoil area*

| Clarion Clarion Co. | | | Clarion Clearfield Co. | | | Lower Kittanning | | |
|---|---|---|---|---|---|---|---|---|
| Clone | Survival | Height | Clone | Survival | Height | Clone | Survival | Height |
| | % | *Ft.* | | % | *Ft.* | | % | *Ft.* |
| 11 | 75 | 2.2 | 11 | 63 | 2.8 | 4 | 33 | 1.5 |
| 42 | 71 | 3.3 | 29 | 69 | 2.8 | 41 | 25 | 3.9 |
| 43 | 67 | 2.5 | 42 | 75 | 2.8 | 42 | 25 | 1.8 |
| 44 | 67 | 2.5 | 44 | 86 | 2.5 | 216 | 30 | 2.9 |
| 47 | 100 | 2.0 | 47 | 75 | 2.4 | 241 | 67 | 1.5 |
| 49 | 87 | 2.5 | 50 | 79 | 2.9 | 251 | 40 | 1.4 |
| 252 | 71 | 2.3 | 214 | 63 | 2.4 | 253 | 43 | 1.4 |
| 279 | 100 | 3.2 | 279 | 87 | 2.4 | 327 | 27 | 3.6 |
| 388 | 63 | 3.2 | 388 | 63 | 2.9 | 359 | 50 | 2.0 |
| X | 58 | 3.0 | X | 75 | 3.4 | 388 | 29 | 3.0 |
| Ave. | 76 | 2.7 | — | 74 | 2.7 | — | 37 | 2.4 |

| Middle Kittanning | | | Lower Freeport | | | Upper Freeport | | |
|---|---|---|---|---|---|---|---|---|
| Clone | Survival | Height | Clone | Survival | Height | Clone | Survival | Height |
| | % | *Ft.* | | % | *Ft.* | | % | *Ft.* |
| 50 | 17 | 0.6 | 11 | 100 | 4.2 | 8 | 100 | 7.9 |
| 207 | 17 | .4 | 41 | 100 | 5.3 | 11 | 100 | 7.6 |
| 214 | 13 | 1.0 | 42 | 100 | 4.5 | 41 | 100 | 8.5 |
| 216 | 17 | .4 | 44 | 96 | 4.0 | 42 | 100 | 6.3 |
| 223 | 25 | .6 | 47 | 100 | 4.0 | 47 | 100 | 8.5 |
| 249 | 13 | 1.0 | 50 | 95 | 3.8 | 53 | 100 | 6.5 |
| 277 | 13 | 1.0 | 208 | 100 | 4.0 | 224 | 100 | 6.3 |
| 279 | 25 | .6 | 314 | 86 | 4.6 | 228 | 83 | 7.7 |
| 302 | 18 | .8 | 388 | 100 | 3.5 | 388 | 96 | 6.3 |
| 388 | 25 | .4 | X | 91 | 4.0 | X | 96 | 6.5 |
| Ave. | 18 | 0.7 | — | 97 | 4.2 | — | 98 | 7.2 |

the ungraded outslopes. This difference was statistically significant at the 5-percent level. Sliding rocks were the most common cause of the higher mortality on the outslopes. Survival on upper and lower slopes was almost identical.

Heights for the same 13 clones were averaged for all but the Lower and Middle Kittanning banks, where poor survival made statistical tests

Table 4.—*Average survival and height of the 10 best hybrid poplar clones on each spoil area as related to spoil acidity*

| Coal-seam | Average spoil acidity | Survival | Height |
|---|---|---|---|
| | *pH* | *Percent* | *Feet* |
| Middle Kittanning | 3.1 | 18 | 0.7 |
| Lower Kittanning | 3.3 | 37 | 2.4 |
| Clarion (Clarion Co.) | 3.6 | 76 | 2.7 |
| Clarion (Clearfield Co.) | 3.7 | 74 | 2.7 |
| Lower Freeport | 4.9 | 97 | 4.2 |
| Upper Freeport | 5.7 | 98 | 7.2 |

impossible. On the other four areas, average height on the outslopes was 3.6 feet, which was significantly greater than the average of 3.2 feet attained on the graded portions. Thus, as in other species studied, grading has a slightly depressing effect on height growth.[3] However, hybrid poplars reacted just the opposite of most species in one respect—response to slope position. Average height of the 13 clones was significantly greater on upper slopes than on lower slopes (3.5 vs. 3.3 feet).

## Discussion

Two growing seasons is an inadequate period of time to evaluate the performance of individual clones, but striking differences in growth among spoil areas are already evident. Spoil acidity appears to be the most decisive factor. Evidently poor survival may be expected on spoils more acid than pH 3.6. Although the average height of 2.7 feet attained by the 10 best clones on the 2 Clarion spoils (pH 3.6 and 3.7) is not considered good growth for hybrid poplars, it still exceeded the growth of 10 other species that had been planted on these same spoil areas.

Other factors also may affect the performance of hybrid poplars on strip-mine spoils. Compaction of the spoil by grading reduces height growth by a small amount. Moisture relationships and the vagaries of weather undoubtedly account for some of the variation in survival and height growth. To what extent the dry weather of 1962 increased mor-

[3]Davis, Grant, and Rex E. Melton. TREES FOR GRADED STRIP-MINE SPOILS. Pa. State Forest School Res. Paper 32, 4 pp., 1963.

tality or hindered height growth is difficult to determine. However, it is relevant to note that the supervisor of a state nursery where hybrid poplar cuttings are produced reported a definite reduction in height growth in his unirrigated beds in 1962. Any instances of mortality, reduced vigor, or increased susceptibility to disease due to long-range effects of the drought will be noted in future observations.

It is of some interest that none of the 4 clones planted as rooted cuttings was listed among the 10 best. This means that, genetically, these clones were not so well adapted to the sites as some others. But their relatively low rating also indicates that rooted cuttings do not possess any great advantage over unrooted ones — at least not enough advantage to justify the extra expense of growing and planting them.

In summary, the early results from this test of hybrid poplars are encouraging. It appears that a number of the clones will be suitable for revegetating all but the most acid spoil banks. Obviously it is still too early to draw conclusions as to the ultimate value of hybrid poplars on mine spoils in Pennsylvania. Only time will tell which clones, if any, can maintain rapid growth and resist disease and insect attacks to the degree necessary to develop into productive forest stands.

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