EVALUATION OF FOUR 25-YEAR-OLD OPEN-POLLINATED FAMILIES OF CHINESE CHESTNUT*

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In the early 1900's, chestnut blight caused a catastrophic loss of our native American chestnut, Castanea dentata (Marsh.) Borkh. With the realization among research workers that there appeared to be little, if any, blight resistance in the American chestnut population, an expedition was sent to the Orient to collect seed of the Chinese chestnut, C. mollissima Bl., that appeared to have resistance to the blight organism, Endothia parasitica (Murr.) A. and A. (Diller, 1950).

Some 250 bushels of seed were shipped to the United States during the period from 1927 to 1930 by R. K. Beattie, who headed the expedition. Plantations from this seed were established in eight eastern states from "Massachusetts along the Alleghenies, southward to the southern Appalachians in southwestern North Carolina, and from the Atlantic seaboard in southeastern South Carolina through the middle west to southeastern Iowa." (Diller, 1947).

Selections subsequently were made in these plantings for further testing. From a plantation established near Philema, Georgia, several numbered selections were made. Three of these were released under the names of Nanking, Meiling, and Kuling varieties. [2]

Seeds from the numbered selections were collected and planted at Beltsville, Maryland. From the resultant seedlings progenies from four mother trees (7861, 7881, 7938, and 8174) were sent in 1952 to West Virginia University for planting as part of the Hill Culture Program of the Agricultural Experiment Station.

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About 600 seedlings were planted by Dr. W. Childs, Horticulturist, West Virginia Agricultural Experiment Station, on a well-drained slope (15%) characterized by good agricultural soil, at a spacing of four feet within rows and 10 feet between rows. The plantation was disced for the first few years to control competing vegetation. Survival averaged 49% (Table I).

In 1959 all surviving trees were inoculated with E. parasitica by Dr. R. P. True, Horticulturist, West Virginia Agricultural Experiment Station. These inoculations resulted in target-like cankers unlike natural infections (Fig. 1). Even though all inoculations were successful, no mortality occurred from the resultant cankers. By 1963 there were visible differences in cankering, but still no mortality.

The plantation was subsequently left without evaluation until 1973. At this time, survivors not only had been artificially inoculated with the blight fungus, but also had been exposed to natural infection by E. parasitica. The degree of cankering, tree form, and growth rate varied between trees, and survival was lower than the initial survival shown in Table I. The stand canopy had been closed for several years and the interior trees had been subjected to intense competition.

Although the planting was unreplicated and not randomized it seemed appropriate to evaluate the surviving trees to determine whether there were any which could be used for further breeding attempts.

EVALUATION

On August 1, 1973, the planting was evaluated for form, disease resistance, diameter, and height. Form was evaluated according to straightness and branchiness. Very well-formed trees were given a value of 0 and very poorly-formed trees were given a value of 3. Disease resistance was determined by the number of cankers on each tree. Trees with no cankers were given a value of 0 and trees with 8 or more cankers were given a value of 3. Separate evaluations were made by two researchers and the values were averaged for each tree. Diameter-breast-height was measured to the nearest 0.1 inch (0.25 cm.) and height was measured to the nearest 0.5 feet (0.15 m.),

Following evaluation the poorer trees were removed from the planting.

Table I.--Initial survival of four open-pollinated chestnut families.

Accession Number	Number Planted	Number Surviving	Percent Survival
8174	56	36	64
7938	165	58	35
7881	197	87	44
7861	183	114	62
Total	601	295	49

Table II.--Average form, disease resistance, diameter and height before roguing.

Family	Number of Trees	Average Form	Average Disease Resistance	Average Diameter(cm.)	Average Height(m.)
7861	73	1.9	1.3	14.7	11.73
7881	37	2.0	1.3	14.7	11.70
7938	19	2.3	2.3	16.0	11.09
8174	22	2.1	1.8	17.0	10.30

Table III.--Average form, disease resistance, diameter, and height after roguing.

Family	Number of Trees	Average Form	Average Disease Resistance	Average Diameter(cm.)	Average Height(m.)
7861	33	1.3	1.0	16.0	12.2
7881	19	1.3	1.1	16.5	12.3
7938	5	2.6	1.8	15.5	11.4
8174	11	1.5	1.1	18.5	11.9

Figure 1. Abnormal cankers from artificial inoculations.

RESULTS

Results of the evaluation are shown in Table 11. Families 7881 and 7861 are the better families with little apparent difference between the two. These families were best in form, averaging 2.0 and 1.9, respectively; in disease resistance, both averaging 1.3; and in height, averaging 11.70 and 11.73 meters, respectively. No trees in family 7861 were given a disease resistance rating of 3, and only one tree in family 7881 was given this rating (Table IV). Family 8174 had the largest average diameter (17.0 cm.), but also the smallest average height (10.3 m.). Family 7938 had the poorest ratings for form, averaging 2.3, and disease resistance, averaging 2.3.

Average form, disease resistance, diameter, and height of the trees remaining after removal of the poorer trees (roguing) are shown in Table III.

Table IV shows average form value, height, and diameter according to disease resistance value within families. There is a definite trend for average form value to become higher, and average height and diameter to be lower, as disease resistance value becomes higher.

DISCUSSION

Since no randomization or replication was employed in establishing this planting, a valid statistical analysis could not be applied to the results. Conclusions drawn from these results are based upon visual examination of the data and firsthand observation in the field. Therefore, discretion should be used when applying this information.

Families 7881 and 7861 contain the most promising forest-type trees (Figures 2 and 3). Our data show that approximately 50% of the remaining trees in these families could be useful for further breeding for forest-type trees. Utilizing the best parent trees also may result in further improvement.

Researchers have usually assumed that disease resistance and poor form are genetically linked when comparing interspecific hybrids of Castanea (Jaynes and Graves, 1963). However, the data in Table IV suggest that, within C. mollissima, good form is correlated with higher resistance. This could be mostly a developmental phenomenon, with leaders becoming infected and lateral branches taking over, resulting in crook. However, lateral branch dominance seems unlikely since the main bole is usually fairly well established before severe infection occurs. If this form-resistance phenomenon is a genotypic relationship, then early selection for form could result in genetic gain in disease resistance. In addition, these data show that diameter and height growth decrease as a result of infection.

Table IV. Average form, diameter, and height by disease resistance rating.

Family	Resistance	Number of Trees	Average Form	Average Diameter(cm.)	Average Height(m.)
7861	0	1	1.0	16.5	13.71
	1	47	1.6	15.7	12.03
	2	24	2.4	12.7	11.00
	3	0	-	-	-
7881	0	1	1.0	17.0	12.80
	1	24	1.9	16.0	12.03
	2	11	2.2	11.9	10.82
	3	1	3.0	10.7	11.88
7938	0	0	-	-	-
	1	1	3.0	15.5	13.10
	2	11	2.3	17.3	10.94
	3	7	2.3	14.0	11.09
8174	0	0	-	-	-
	1	8	1.6	19.6	11.06
	2	8	2.6	17.5	10.30
	3	5	2.6	11.4	8.62

Figure 2. Four trees of family 78 81. Note the variation in feathering.

Figure 3. Two rows of family 7861.

There are a number of individuals which could be used advantageously as parents either in interspecific crosses or in intraspecific crosses. If only trees rated 0 or 1 in form and disease resistance are retained and the largest of these are used in a breeding program, significant improvement in all four characteristics might be attained. For example, in family 8174, two of the four trees which satisfy the form and disease criteria would be usable. Tree 8174-31 is the tallest, has good diameter growth, and rates 0-0 for form and disease resistance. Tree 8174-15 would also be a good selection, rating 0-1 for form and disease with good height and diameter growth. There are no trees in family 7938 which meet the basic criteria, but there are 12 in family 7881 and 25 in family 7861. Further, it would seem advisable to return to the parent plantation and collect additional seed from the latter two parent trees for further testing.

Perhaps the information obtained from this stand would be of more value to nut growers. Family 8174 is moderately blight resistant, generally short with a spreading crown, and is an abundant nut producer (Fig. 4). Family 7938 is similar to 8174 in all respects, but seems to be too blight susceptible. Families 7881 and 7861 are taller, less branchy, and are presently producing fewer nuts than 8174. The growth habit of these trees could be a result of their position in the planting. Family 8174, comprising the first row of the planting, has no competition on one side. Since the stand canopy is closed and an adjacent plot of trees is providing competition to the lower row (family 7861), all the other families are competing for light. These latter trees may grow differently under less competition.

Since little information is available on the great number of plantations established in the 1950's, it seems reasonable that a concentrated effort should be made to relocate and evaluate as many of these plantings as possible. A considerable amount of germ plasm is likely to be available for additional efforts at breeding for form and blight resistance with considerable possibility for further improvement.

ABSTRACT

Four 25-year-old open-pollinated families of Chinese chestnut located at West Virginia University, Morgantown, West Virginia, varied in form, disease resistance, height, and diameter, both within and between families. Families 7881 and 7861 were best for average form, average disease resistance, and average height. Family 8174 had the largest average diameter. Some of these trees could be used for further breeding.

LITERATURE CITED

Diller, Jesse D. 1947. Growing chestnuts for timber. USDA For. Path. Special Rel. #31.

Diller, Jesse D. 1950. The planting and care of blight-resistant chestnuts for forest trees. USDA For. Path. Special Rel. #15.

Jaynes, R. A.and A. H. Graves. 1963. Connecticut hybrid chestnuts and their culture. Conn. Agr. Exp. Sta. Bull. 657.

McKay, John W. Personal communication, June, 1976. USDA Plant Industry Station, retired.