SURVIVAL, GROWTH, AND RESISTANCE TO CHESTNUT BLIGHT OF CHESTNUT HYBRIDS AND SELECTED FAMILIES OF CHINESE CHESTNUT, 20 YEARS AFTER ESTABLISHMENT[1]

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The American chestnut (Castanea dentata (Marsh.) Borkh.) has been almost destroyed by the chestnut blight caused by Endothia parasitica (Murr.) A and A, All efforts to find resistant native chestnuts have failed. The use of Oriental species in breeding programs was initiated in 1925 (Diller, Clapper and Jaynes, 1964; Diller and Clapper, 1965; Bingham, Hoff, and MacDonald, 1971; Saucier, 1973).

From 1947 to 1955, Jesse D. Diller of the U. S. Department of Agriculture, Division of Plant Pathology, established a series of test plots in 13 eastern states. These plots included several chestnut hybrids and some Chinese chestnut (Castanea mollissima BI.) families. Reports on these plots were made by Diller and Clapper (1969). A more recent evaluation of the Table Rock, South Carolina plot was made by Nichols, Schoenike, and Witcher (1971).

THE PRUNTYTOWN, WEST VIRGINIA PLOT

One test plot was established on the West Virginia Industrial School for Boys in Preston County, The site is a farm woodlot with a northeast exposure. It is a moist, but extremely rocky site. Arboreal species around the test plot include black cherry, hickory, sassafras, and black walnut. The site index (base age, 50 years), according to adjacent black cherry, is 70.

The seedlings used in this planting were grown by the U. S. Department of Agriculture at Glenn Dale, Maryland, and by the Connecticut Agricultural Experiment Station at Hamden, Connecticut. A total of 150 seedlings were planted in the spring of 1953. Of these seedlings, 50 were hybrids developed by Russell B. Clapper, 49 were hybrids developed by Authur H. Graves, and the rest were Chinese chestnut. The seedlings were randomly planted in ten 15-tree rows at a spacing of 10 x 10 feet.

COLLECTION OF DATA

On August 15, 1973, total height and diameter-at-breast height were determined for all surviving trees. Heights were determined to the nearest foot using a Blume-Leisse altimeter. Diameters were measured with a

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diameter tape to the nearest 0,1 inch. In October 1974 most of the trees were evaluated for blight resistance, epicormic branching, natural pruning, and straightness. Resistance and epicormic branching were evaluated according to the number of cankers and branches respectively. Natural pruning was evaluated using the best tree in the plot as a standard s traightness was a purely subjective evaluation depending on the degree and number of crooks.

RESULTS

Overall survival was 39,3%, This includes 54,0% of the original Chinese 58602 source, 27.4% of the Maryland hybrids, and 36,7% of the Connecticut hybrids (Table 1). It is interesting to note that none of the Maryland hybrids with C, henryii parentage survived.

The data for height and diameter are presented in 10-foot and 1-inch classes, respectively, Means are weighted according to the number of trees in each class. The Chinese 58602 source was best in these two traits. One of the Connecticut hybrids (JAXC) was the tallest tree in the plot (Tables 2 and 3),3

Blight resistance data are presented in 5 classes from "blight free" to "severely blighted," these being given values from 5 to 1, respectively. Means are weighted according to the number of trees in each class. It should be kept in mind that trees killed by the blight are not included in the results. Again the Chinese 58602 source is superior. The Maryland hybrids show greater resistance than the Connecticut hybrids, possibly due to a greater amount of Chinese chestnut genes. The single Connecticut hybrid in the blight-free class is the one previously mentioned as the tallest tree in the plot (Table 4).

Epicormic branching, natural pruning, and straightness are presented in 5 classes from "excellent" to "poor," presented as 5 to 1, respectively. Again means are weighted according to the number of trees in each class. Connecticut hybrids generally showed less epicormic branching. None of these trees, however, were completely devoid of epicormic branches. The Chinese 58602 trees were better natural pruners, and the Maryland hybrids generally exhibited a straighter bole than the other sources (Tables 5, 6, and 7).

RATING FOR BREEDING PURPOSES

In 1963, the "best 25" trees were selected using a minimum average annual height growth of 2 feet as the main criterion. Using the 1973-74 data, the "best 25" were selected using total scores after weighting the scores for straightness (x2) and resistance (x3), since these are considered the two most important breeding characteristics (Table 8) (Fig. l).

[3] A = American chestnut, C = Chinese chestnut, J = Japanese chestnut. JAXC is a Japanese x American hybrid crossed with a Chinese chestnut,

Table 1.--Survival?

Group	Number planted	Number surviving	% survival
Chinese	50	27	54.0
Maryland hybrids	51	14	27.4
Connecticut	49	18	36.7
Total	150	59	39.3

Table 2.--Trees by 1-inch diameter class October, 1973.

	Diameter Class									
Group	1	2	3	4	5	6	7	8	Total	Mean
Chinese	4	1	2	5	10	3	1	1	27	4.26
Maryland	1	4	2	2	2	1	2	0	14	3.79
Connecticut	2	1	5	1	5	2	2	0	18	4.11
Total	7	6	9	8	17	6	5	1	59	4.10

Table 3.--Trees by 10 height class.

	Height Class								
Group	0-9	10-19	20-29	30-39	40-49	50-59	60-69	Total	Mean
Chinese	1	3	3	3	11	5	1	27	39.4
Maryland	0	2	4	5	3	0	0	14	30.7
Connecticut	1	1	3	9	3	0	1	18	33.9
Total	2	6	10	17	17	5	2	59	35.9

Table 4.--- Blight resistance.

Group	5	4	3	2	1	Total	x
Chinese	3	9	3	5	1	21	3.38
Maryland	2	3	3	1	2	11	3.18
Connecticut	1	3	5	4	4	17	2.59
Total	6	15	11	10	7	49	3.06

Table 5.--- Natural pruning.

Group	5	4	3	2	1	Total	x
Chinese	1	1	4	8	8	22	2.05
Maryland	0	0	3	2	6	11	1.73
Connecticut	0	0	3	5	9	17	1.65
Total	1	1	10	15	23	50	1.84

Table 6.--Straightness.

Group	5	4	3	2	1	Total	x
Chinese	0	3	6	6	7	22	2.23
Maryland	2	2	2	3	2	11	2.91
Connecticut	1	0	5	3	8	17	2.00
Total	3	5	13	12	17	50	2.30

Table 7.--Epicormic branching.

Group	5	4	3	2	1	Total	x
Chinese	1	4	4	5	8	22	2.32
Maryland	0	2	2	4	3	11	2.27
Connecticut	1	3	5	2	6	17	2.82
Total	2	9	11	11	17	50	2.36

Only 14 of the 1963 "best" remain under the new rating system, 8 of these being in the top ten. The tallest tree in the plot, a JAXC hybrid, was in this group. The tallest tree in 1963, a Chinese 58602, is now the second-tallest but has the greatest diameter, Three of these 14 now fall below the 2-feet per year requirement set in 1963; a CAXC hybrid, a JAXC hybrid, and an AXCJA hybrid.

Of the 11 trees that failed to meet the new criteria, 3 Chinese 58602 and a CXCJA hybrid were still growing more than 2 feet per year. An AXCJA, a JAXC, and a CAXC hybrid fell below the 2-feet mark. One Chinese 58602 and one AXCJA hybrid had died back and sprouted. A CAXH and an AXC hybrid had died.

In the 1974 rating, 4 Connecticut hybrids (2 JAXC, a CXCJA, and an AXCJA) and 7 Chinese 58602 trees had moved into the "best" category. Of the hybrids, a JAXC had become second-ranked, and one of the Chinese trees had become eighth-ranked.

These 25 trees will probably be used in future breeding work.

SUMMARY

The average of the Chinese 58602 source was superior to the hybrids in survival, diameter, height, resistance, and natural pruning. The Maryland hybrids were generally the slowest growers. However, these hybrids included most of the straighter trees indicating a high percentage of American chestnut genes. The Connecticut hybrids excelled only in their lack of epicormic branches. However the two best formed and most promising trees in the plot were JAXC Connecticut hybrids.

Figure 1 - 3 Best Trees

A. Tree No. 74
JAXC Hybrid

B. Tree No. 85
JAXC Hybrid

C. Tree No. 9
Chinese 58602

Table 8.--Twenty-five best trees.

Rank	Tree Number	Source	1973 Height (ft.)	1973 Diameter (in.)	Epicormic Branching	Resistance	Natural Pruning	Straightness
1	* 74	JAXC	61	7.6	4	15	3.5	10
2	85	JAXC	48	7.4	5	15	2	10
3	* 9	58602	60	8.2	4	12	2	8
4	* 15	58602	56	6.6	3	12	4.5	8
5	* 14	58602	47	6.2	2	12	3.5	9
6	* 80	CAXC	40	7.0	1	12	2	10
7	*148	CAXC	46	7.4	2	12.5	3	8
8	38	58602	48	5.5	1	15	2	6
9	* 47	58602	56	5.6	2	12	3	6
10	* 19	CAXC	36	4.8	2	15	1	8
11	* 8	CJAXCJA	48	5.3	4	12	1	6
12	6	58602	48	5.7	1	13.5	2	6
13	41	58602	43	4.8	5	12	2	4
14	* 73	58602	51	6.5	4	10.5	3	2
15	91	CXCJA	32	5.0	4	13.5	3	2
16	* 13	58602	42	4.7	2.5	13.5	2	4
17	136	58602	48	7.1	2	7.5	3	6
18	60	58602	45	5.0	3	12	1	4
19	* 95	CXC	40	6.7	2	12	1	4
20	127	JAXC	39	5.7	3	9	3	6
21	68	58602	38	4.5	4	15	1	2
22	*128	AXCJA	37	6.3	3.5	7.5	3	6
23	87	58602	43	5.7	3	7.5	1	6
24	*144	JAXC	38	5.2	3	10.5	1	4
25	2	AXCJA	33	3.1	3.5	9	2	6

* Were in the "Best 25" in 1963.

LITERATURE CITED

Bingham, R. T., R. J, Hoff and G, I. MacDonald. 1971. Disease resistance in forest trees. Ann, Rev. Phytop, 9:433-452.

Diller, J. D., R. B. Clapper, and R. A. Jaynes. 1964. Cooperative test plots produce some promising Chinese and hybrid chestnut trees. U.S. Forest Service, Res. Note NE-25, 7 pp.

Diller, J. D., and R. B. Clapper. 1969. Asiatic chestnut trees in the eastern United States. Jour. For. 67(5)328-331.

Hampt. F. E. 1965. Site index curves for some forest species in the eastern United States. U.S. Forest Service, Upper Darby, Pa., p.25.

Nichols, C. R,, R. E. Schoenike, and W. Witcher. 1971. Evaluation of the 24-year-old Table Rock (South Carolina)chestnut plot for growth and disease resistance and a proposed breeding program for its use. Northern Nut Growers Assoc. 62:62-68.

Saucier, J. R. 1973. American chestnut...an American wood. U.S. Forest Service FS-230, 6 pp.