SEVEN-YEAR RESULTS FROM BLACK CHERRY AND BLACK WALNUT PROVENANCE TESTS IN MICHIGAN

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Black cherry *(Prunus serotina* Ehrh.) and black walnut *(Juglans nigra* L.) are among our most valuable cabinet woods. Both are valuable enough that they are often sold as single trees rather than on a per-acre basis. Both grow rapidly enough that their planting and management are realistic possibilities. Therefore, they were among the first of our native hardwoods to receive attention from tree breeders.

This paper is a progress report on two provenance test plantations planted in 1967 in southwestern Michigan. Our work is a part of two much larger studies. The black cherry experiment is one of several plantations of the provenance test initiated by Kingsley Taft of TVA, and the black walnut experiment is one of several plantations comprising the rangewide provenance test started by Calvin Bey [2] of the U.S. Forest Service. We are indebted to those people for furnishing the planting stock and for their continued cooperation.

The large, many-plantation experiments started by Taft and Bey are the most definitive studies of geographic variation in these two species. We do not need to review the literature on similar work in the past because the reports they are now preparing will quickly make most past work out of date.

In the present paper we wish to draw attention to the contrasts between the two species. The experiments are roughly similar and are growing well. But the results have not been the same. That shows why it is necessary to actually do such experiments rather than to theorize about what might happen. It also shows some very real gaps in our evolutionary thinking.

METHODS

Both test plantations are located on the W. K. Kellogg Forest near Battle Creek, southwestern Michigan. They were established in late April, 1967. with 1-0 stock shipped from Norris, Tennessee (cherry) or Ames, Iowa (walnut). Prior to planting, the areas were covered with a slight amount of brush (killed by 2,4,5-T before planting) and a heavy grass sod. Weed control was accomplished by spraying 2-foot (cherry) or 4-foot (walnut) strips with aminotriazole (2 gallons per acre) the autumn before planting and simazine (4 pounds active ingredient per acre) soon after planting. The strips were subsequently kept weed-free until 1971 (cherry) or the present (walnut) with annual fall applications of simazine or a simazine-atrazine mixture. In some respects the plantations differed, as shown in the following paragraphs.

Black cherry: Black cherry plantation No. 9-67 includes open-pollinated offspring of 33 trees located in 7 stands scattered from North Carolina to southwestern Michigan. There are 4 replications, each containing one 10-tree plot per seedlot; spacing was 8 x 8 feet. The experiment uses what is known as a "compact family design" in which the offspring of all parents in the same stand were grouped together. That design facilitated measurement and analysis but prevented compensation for site variability. If the experiment were to be repeated, a randomized complete block design would be used.

The 1-0 seedlings were tall and sturdy but some were in poor condition because of a 14-day (8 in transit, 6 in cold storage) delay between shipment and field planting. Many seedlings—particularly of Tennessee origin—had started to grow and were etiolated. That probably contributed to much of the mortality.

This plantation is situated partly in a cove and partly on the lower slopes of gravelly moraines. The soils are sandy loams to loams . Growth was noticeably better in the hollows than on knolls.

The black cherries were measured in 1968, 1971 and 1972. Traits measured were mortality, height, forking, crown width, and fruiting. The forks were removed in 1971.

Black walnut: Black walnut plantation No. 5-67 includes the offspring of 20 natural stands located in 13 eastern states. Seeds were collected from several average trees in each stand. There are 6 replications, each containing one 4-tree plot per seedlot; spacing was 10 x 10 feet. The experiment follows a randomized complete block design.

These walnuts were planted on a nearly level hilltop sheltered on one side by a 40 to 50-foot tall pine stand. Although the planting stock was sturdy and the sandy loam soils were seemingly uniform, the variability in tree growth was almost as great as in the black cherry experiment. Some of the variability was associated with distance from the pines—rows closest to the pine stand averaged 1.7 feet taller at age 6 than rows without side shelter.

The walnuts were measured in 1968, 1971, and 1972. Traits measured were mortality, height, date of leafing out, and amount of leader deflection.

RESULTS

Black cherry: Major results of the black cherry experiment are presented in Table 1. Most mortality

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[2] Bey, Calvin G. Growth of black walnut trees in 8 midwestern states—a provenance test. Manuscript in preparation.

occurred during the first growing season, and the differences are probably due to differences in condition of the growing stock at time of planting rather than to inherent ability to survive in Michigan.

At the time of planting, North Carolina trees were tallest and Virginia trees were shortest. That was true also the second growing season. Then the growth trends changed, and by the end of the 7th growing season North Carolina trees were next to shortest whereas Michigan trees were tallest.

The average heights presented in Table 1 tell only part of the story. Michigan trees were apparently the most adaptable and were capable of growing nearly as well on knolls as in low areas. This is shown by a comparison between extremes. The plantation contained 28 plots of Michigan trees. The 7 tallest and 7 shortest plots averaged 14.2 and 11.2 feet in height respectively. In contrast the 6 (of 24) tallest and 6 shortest plots from Anderson County, Tennessee, averaged 14.8 and 6.2 feet in height respectively, a difference of 58 percent. The other non-Michigan seedlots also exhibited large differences in response to poor and good site conditions.

The most dramatic seed source differences were in fruit production at age 6 when the trees flowered for the first and only time. Fruiting was practically limited to trees from Franklin and Anderson Counties in Tennessee. Each of the 12 half-sib families from those counties contained trees which produced abundant crops of seed, whereas no cherries were produced by any other trees except a few from Michigan.

When the trees were 6 years old they were pruned lightly to reduce each one to a single stem. The number of branches removed to accomplish this was recorded as number of forks per tree in Table 1. The best- and worst-formed trees were from Tennessee.

By age 7 there were evident differences in crown form among vigorous trees growing at the same rates. Michigan trees had the longest branches emerging from the trunk at the least acute angle. As a result, most Michigan trees had slightly interlacing crowns. In contrast, there was a 1 to 2-foot aisle between the crowns of the Tennessee trees planted on the same 8 x 8-foot spacing. These differences are reflected in the crown widths shown in Table 1.

The black cherry experiment includes open-pollinated offspring of 33 parent trees in 7 stands. In no trait were the differences among half-sib families from the same stand statistically significant; the F values for within-stand variation ranged from 0.5 to 1.5. In height, for example, the 7 Michigan families differed only by 4 percent whereas there was a difference of 10 percent between the Michigan and the next tallest group of families. Pitcher [3] also found much larger differences due to region of origin (Pennsylvania trees grew faster than West Virginia trees) than among the offspring of selected individuals within the same stand. Thus, this provenance-progeny test, even though relatively small, gives valuable information on the best way to approach black cherry improvement.

Black walnut: The results of the black walnut provenance test are summarized in Table 2. The most important differences are in growth rate. Walnuts from the northern and western parts of the range grew more slowly than walnuts from the southeast. They owe their growth superiority in part to a slightly longer growing season—trees from the southeast leafed out 4-7 days earlier than trees from the north.

There were significant differences in the height/diameter ratio, but these were not large enough to prevent a high correlation (r = .92) between height and

Table 1. Growth characters of black cherry grown from seed collected in different parts of the natural range. Differences among offspring of different trees in the same stand were small and non-significant (10% level) statistically.

Place of origin State, county	Elevation feet	Mortality percent	Height age 7 feet	Trees with fruit age 6 percent	Crown width age 7 feet	Forks per tree age 6 number
Mich., Cass	700	9	12.6	5	7.1	0.9
Pa., Cambia & Elk	2000	21	9.6	0	5.7	.7
Tenn., Monroe	3800	13	11.3	0	5.4	.6
Tenn., Franklin	1900	49	10.4	18	6.2	1.1
Tenn., Anderson	800	25	10.8	37	6.2	1.2
Va., Wise	400	23	9.9	0	5.8	.8
N.C., Macon	3800	15	9.7	0	5.0	.9
F value			2.7*	20.6**	5.7**	12.0**

*, ** = statistically significant at 5 or 1% level respectively. There were 6 and 96 degrees of freedom for stand of origin and family x block (= error) respectively. The significance levels of the between-stand differences were the same whether family x block, stand x block or family-within-stand mean squares were used as error terms.

[3] *Pitcher, John A.* 1971. Parental and family selection in *Prunus serotina* Ehrh. Ph. D. thesis, Michigan State University.

diameter. In other words, seedlots which were tallest had the largest diameters, and vice versa.

Leader deflection was measured in 1971. In most trees the top of the leader was offset 0.5-1 foot from the bottom of the leader. After an additional year of growth, however, these vent leaders became nearly straight. Hence, the rather small differences among seedlots in leader straightness are probably of little economic importance.

THE SPECIES CONTRAST

This paper is intended as a contrast between the two species rather than as a complete treatment of either one. The results are alike in some respects. Both experiments cover about the same geographic area—the Lake States to North Carolina. The range of genetic variability in growth rate, the average growth rates, and the error variances were similar.

There is a definite contrast in geographic variation pattern. Trees from the most northerly and coldest test area grew fastest in black cherry whereas the reverse was true in black walnut. Bey noticed that southern seedlots also grew fastest in several other black walnut plantations.

It is tempting to explain this contrast in terms of nearness of the test site to the species' northern limits—to postulate that the southern black cherry was under more stress than the southern black walnut. That explanation seems untenable, however, because the test site is about 300 miles south of the northern limit for black cherry and only 100 miles south of the northern limit for black walnut.

The crown-width differences in black cherry were also a surprise. We have provenance tests in several species at the Kellogg Forest, and in most of them the tallest origins had the broadest crowns. We have not previously noticed such large differences between trees growing at the same rate as between the narrow-crowned Tennessee and broader crowned Michigan cherry.

The fruiting data present a contrast to trends ob served in other species. Normally, the first fruiting i light, but in black cherry it was heavy and practicall confined to two middle-latitude groups of families intermediate growth rate. In eastern white pine *(Pint strobus* L.) early fruiting was heaviest on slow-growin northern trees, and in Scotch pine *(P. sylvestris* L.) ear fruiting was heaviest on one fast-growing middle latitude variety and one moderately fast-growing south ern variety.

Thus, our data tend to emphasize the inadequacies present theoretical knowledge concerning evolutiona processes more than they help to explain evolution

Table 2. Growth characters of black walnut grown from seed collected in different parts of the natural range. Each seedlot includes offspring of several average trees in a stand.

Seedlot No., state and county of origin	Place of origin N. Lat. °	W. Long. °	Elevation feet	Mortality %	Date of leafing out May	Height age 7 feet	Ht./diam. ratio ft./in.
2503 Minn. Brown	44.3	94.5	1000	8	15	7.7	48
1803 Iowa Delaware	42.3	91.2	900	12	15	8.4	51
1602 Ill. Rock Island	41.5	90.4	600	0	15	8.5	47
1903 Kan. Leavenworth	39.1	94.9	900	16	16	8.4	54
2703 Mo. Cedar	37.9	93.9	900	20	14	8.5	50
2405 Mich. Washtenaw	42.5	83.8	800	12	16	8.5	50
2403 Mich. St. Joseph	42.0	85.8	800	20	17	8.3	50
1702 Ind. Putnam	39.8	87.0	700	38	17	7.8	53
1704 Ind. Jackson	39.0	86.1	800	16	16	8.5	50
1708 Ind. Perry	38.2	86.6	800	62	13	6.9	53
3502 Pa. Union	41.0	77.2	600	38	18	7.8	50
4202 W. Va. Greenbrier	37.9	80.2	1900	0	16	10.7	51
4101 Va. Rockbridge	37.8	79.5	1000	8	14	9.4	46
4103 Va. Halifax	36.9	78.7	400	16	14	9.3	47
2002 Ky. Menifee	38.0	83.5	1000	4	12	9.3	49
2004 Ky. Laurel	37.0	84.3	1100	4	12	8.7	49
2001 Ky. Logan	36.9	86.8	500	8	12	9.2	52
3803 Tenn. Union	36.3	83.7	1300	4	11	8.8	45
3804 Tenn. Johnson	36.4	82.0	2000	4	15	8.4	45
3102 N.C. Graham	35.4	83.7	2900	0	12	9.9	45
F value					5.9**	2.7**	2.2*

*, ** = Significant at 1% or 5% level respectively.

Certainly, if only selection pressure was involved, the results should have been more consistent. Fully satisfactory explanations must take into account many facets of evolution and be based on much more extensive data.

The information contained in Tables 1 and 2 is of practical value. Its use is somewhat restricted, however, because of the absence of good theoretical explanations. Without knowing why black cherry from two places in Tennessee fruited earliest, we are not in a good position to forecast which untested provenances of black cherry might also fruit early. And without knowing why cherry from the two most northern localities grew fastest and slowest, we are in no position to forecast how fast other northern origins might grow.

Thus, these two experiments show that genetic improvement is possible in both species and also show the need for a great deal more empirical research to achieve the maximum amount of improvement.