



United States
Department of
Agriculture

Forest Service

Northeastern Forest
Experiment Station

Research Paper
NE-569

1985



Survival and Growth of Black Walnut Families After 7 Years in West Virginia

G. W. Wendel
Donald E. Dorn



The Author

G. W. Wendel, research forester, received a B.S. degree in forestry from Iowa State University in 1951, and an M.S. degree in forestry from Yale University in 1957. He joined the Northeastern Forest Experiment Station's Timber and Watershed Laboratory at Parsons, West Virginia, in 1962.

Donald E. Dorn is a zone geneticist with the Allegheny National Forest at Warren, Pennsylvania.

Manuscript received for publication 18 October 1984

Abstract

Average survival, 7-year stem diameter, and stem diameter growth differed significantly among 34 black walnut families planted in West Virginia. Average total height, height growth, and diameter at breast height were not significantly different among families. Families were from seed collected in West Virginia, Pennsylvania, North Carolina, and Tennessee. The 7-year results indicated that although survival was significantly different among families, differences in height growth were not well enough defined to recommend sources for planting.

Introduction

Black walnut (*Juglans nigra* L.) grows well on many sites in West Virginia and is native to all parts of the state. However, it is only a small part of timber resource in West Virginia. The most recent forest survey for West Virginia shows that only about 43,000 acres of the 11.5 million acres of commercial forest land are classed as black walnut type (Bones 1978). The estimated volume of black walnut is 107 million cubic feet in trees larger than 5 inches in diameter at breast height (d.b.h.), and 207 million board feet in trees larger than 9 inches in d.b.h. Seventy-three percent of the cubic volume and 50 percent of the board-foot volume is in trees less than 15 inches in d.b.h.

Because of heavy cutting of individual trees, and disregard for regeneration, black walnut seed sources have been eliminated from many of the sites where they occurred naturally in West Virginia. However, under proper management on suitable sites, the amount of black walnut in West Virginia forests probably can be increased substantially.

This paper reports on the 7-year growth and survival of black walnut seedlings planted on the Fernow Experimental Forest near Parsons, West Virginia. The seedlings were grown from seeds collected at several locations in or near the southern and central Appalachians.

The objective of the outplanting is to bring together genetically different seedlings from several locations for the development of a black walnut seed orchard in West Virginia. Also, performance of black walnut plantations, in West Virginia has not been well documented. This report provides early growth data and cultural information that could be useful to those interested in growing walnut.

Methods

Families

Thirty-four families of 1-0 black walnut were outplanted in the spring of 1976 on the Fernow Experimental Forest near Parsons, West Virginia. Families from four states are represented in the West Virginia outplanting; 21 are from West Virginia, 7 from Pennsylvania, 4 from North Carolina, and 2 from Tennessee (Table 1). The spread between the most easterly and westerly family is approximately 600 miles. The distance between the most northern and southern family is about 350 miles. The outplanting site is about 100 miles north of the center of the collection areas.

As far as is known, all of the collections were from single trees and many were located around farmsteads. It is possible that some of parent trees are not native to the locale where they are growing, because farmers often planted varieties of nursery stock for nut production rather than for timber. Differences in elevation among families ranged from 600 feet for some of the bottom-land sites to more than 2,350 feet for upland and mountain sites.

Study Area

Because of space limitations, two areas were logged and cleared of slash for the outplanting. Both areas are relatively level, with slopes not exceeding 10 percent. The first area is at an elevation of 2,800 feet above sea level. The soil is a Belmont silt loam derived from the Greenbrier limestone formation. The other area is at an elevation of 2,720 feet. The soil on this area is mapped as a Meckesville silt loam, which is colluvial in origin. The soil has some limestone influence because it lies just downslope from the limestone-derived Belmont series.

Annual precipitation on the Fernow Experimental Forest is 58 inches and is well distributed throughout the year. Mean annual temperature is 48° F and the length of the frost-free season is about 145 days. The Belmont soil study area has an oak site index between 80 and 85; the Meckesville site is about site index 80 for oak.

Both areas were forested before planting. The stands were 70- to 75-year-old mixed hardwoods, and included a high proportion of black cherry (*Prunus serotina* Ehrh.), yellow-poplar (*Liriodendron tulipifera* L.), northern red oak (*Quercus rubra* L.), sugar maple (*Acer saccharum* Marsh.), and white ash (*Fraxinus americana* L.). On the Belmont area there were a few scattered black walnut trees.

Sawtimber and pulpwood trees larger than 5 inches in d.b.h. were harvested. The remaining stems were felled and removed along with the slash by winching with a tractor from the perimeter of the area.

Planting and Culture

The study design was a randomized complete block. Six rectangular blocks were laid out parallel with the contour. Four were on the Belmont soil and two were on the Meckesville soil. Trees were planted in 5-tree row plots at a spacing of 6 by 12 feet, i.e., trees were 6 feet apart in rows 12 feet apart; 1-0 seedlings were planted in 8-inch diameter holes prepared with a power auger. Average height of seedlings was about 1.0 foot at planting time and roots were pruned to about 10 inches. To keep the trees in a free-to-grow position, competing vegetation was mowed four times during the early life of the plantation. Hand-held power brush cutters were used.

Results

Site Differences

At the end of seven growing seasons, seedlings growing on the Belmont soil and those on Meckesville soil did not differ significantly in total height, 7-year height growth, d.b.h., stem diameter at 1.0 inch above ground, or stem diameter growth.

Survival

At the end of 7 years, average survival was 84 percent for all blocks and families (Table 2). Survival among families was significantly different at the 5-percent level. Fifty percent of the families exceeded the mean survival for all families and blocks. Plotting

showed no apparent correlations between survival and latitude and longitude of the parent trees.

Height Growth

Average total height for all blocks and families was 6.4 feet at the end of 7 years (Table 2). There was no significant difference in

Table 2.—Performance of black walnut families at the end of 7 years

Family	County and state	Average height	Percent mean height	Average 1980-82 height growth	Percent mean height growth	Average stem diameter	Percent mean stem diameter	Average stem diameter growth	Percent mean stem diameter growth	Percent survival	Percent mean survival
		<i>Feet</i>		<i>Feet</i>		<i>Inches</i>		<i>Inches</i>			
1652	Boone, WV	7.4(1) ^a	116	2.2	129	1.3	118	1.0	125	87	104
1660	Tucker, WV	7.4(1)	116	2.3	135	1.4	127	1.1	138	97	115
1600	Berks, PA	7.2(3)	113	2.4	141	1.2	109	1.0	125	90	107
1589	Alexander, NC	7.1(4)	111	2.0	118	1.1	100	0.9	113	97	115
1666	Greene, PA	7.1(4)	111	2.1	124	1.4	127	1.1	138	93	111
1588	McDowell, NC	6.9(6)	108	1.9	112	1.2	109	1.0	125	83	99
1649	Monroe, WV	6.9(6)	108	1.8	106	1.1	100	0.9	113	93	111
1607	Buncombe, NC	6.7(8)	105	1.9	112	1.2	109	0.9	113	87	104
1638	Pendleton, WV	6.7(8)	105	1.5	88	1.2	109	1.0	125	80	95
1641	Pocohontas, WV	6.7(8)	105	2.0	118	1.1	100	0.9	113	70	83
1655	Kanawha, WV	6.7(8)	105	2.1	124	1.1	100	0.9	113	83	99
1604	Chester, PA	6.6(12)	103	1.9	112	1.1	100	0.9	113	80	95
1628	Braxton, WV	6.6(12)	103	1.6	94	1.2	109	0.9	113	77	92
1646	Greenbrier, WV	6.6(2)	103	1.6	94	1.1	100	0.8	100	80	95
1642	Pocohontas, WV	6.5(15)	102	2.1	124	1.1	100	0.9	113	87	104
1615	Wayne, TN	6.4(16)	100	1.5	88	1.0	91	0.8	100	87	104
1625	Upshur, WV	6.4(16)	100	1.6	94	1.1	100	0.8	100	93	111
1627	Lewis, WV	6.4(16)	100	1.8	106	1.1	100	0.8	100	87	104
1632	Braxton, WV	6.4(16)	100	1.8	106	1.0	91	0.7	88	97	115
1578	Morgan, TN	6.3(20)	98	1.5	88	1.1	100	0.8	100	83	99
1653	Boone, WV	6.3(20)	98	1.6	94	1.2	109	0.9	113	97	115
1654	Boone, WV	6.3(20)	98	1.8	106	1.1	100	0.9	113	83	99
1661	Monongalia, WV	6.3(20)	98	1.6	94	1.2	109	0.9	113	83	99
1603	Chester, PA	6.2(24)	97	1.6	94	1.1	100	0.8	100	70	83
1582	Rowan, NC	6.1(25)	95	1.4	82	0.9	82	0.7	88	73	87
1630	Braxton, WV	6.1(25)	95	1.5	88	1.1	100	0.8	100	87	104
1633	Gilmer, WV	6.1(25)	95	1.6	94	1.0	91	0.8	100	87	104
1636	Tucker, WV	6.1(25)	95	1.1	65	1.0	91	0.7	73	67	80
1658	Clay, WV	6.0(29)	94	1.8	106	1.0	91	0.7	73	80	95
1605	York, PA	5.9(30)	92	1.6	94	1.0	91	0.8	100	73	87
1606	Cumberland, PA	5.7(31)	89	1.5	88	1.0	91	0.8	100	93	111
1650	Summers, WV	5.1(32)	80	1.2	71	0.8	73	0.6	75	87	104
1602	Cumberland, PA	4.6(33)	72	1.4	82	0.8	73	0.6	75	67	80
1645	Greenbrier, WV	4.6(33)	72	1.5	88	0.7	64	0.5	63	73	87
	Average	6.4		1.7		1.1		0.8		84	

^a Numbers in parentheses are family rank.

total height among families. Thirty-eight percent of the families exceeded the plantation mean height of 6.4 feet. Of the five families whose average height exceeded 7.0 feet, two were from West Virginia, two from Pennsylvania, and one from North Carolina.

From 1980 to 1982, height growth ranged from 1.1 to 2.4 feet and averaged 1.7 feet. There was no significant difference in 2-year height growth among families. In general, families with the best 2-year growth also were the tallest families.

Seven-year average height growth for all families and blocks was 5.4 feet; there was no significant difference in 7-year average height growth among families. Average annual height growth for the 7-year period was 0.77 foot.

Stem Diameter Growth

Stem diameter 1.0 inch above ground ranged from 0.7 to 1.4 inches and averaged 1.1 inches over all blocks and families (Table 2). There was significant difference in average stem diameter among families. The Tucker County, WV, (1660) and Greene County, PA, (1666) families were significantly different only from family 1645, Greenbrier County, WV, according to Tukey's studentized range test. Average stem diameter of the Tucker and Greene County families was 1.4 inches. The average stem diameter of 68 percent of the families exceeded the plantation mean of 1.1 inch.

Average 7-year stem diameter growth was 0.8 inch for all blocks and families and differed significantly among families at the 5-percent level. The Berks County,

PA, (1600), Tucker County, WV, (1660), and Greene County, PA, (1666) families were significantly different only from the Greenbrier County, WV, (1645) family; the latter had the slowest stem diameter growth. Average 7-year stem diameter growth was 1.0 inch for the Berks County family and 1.1 inches for the Tucker and Greene County families.

Diameter at Breast Height

Diameter at breast height ranged from 0.3 to 0.7 inch and averaged 0.6 inch for all families. There were no significant differences in d.b.h. among families.

Stem Form

At this time, many of the seedlings have widely divergent forks (Fig. 1). According to Schlesinger and Funk (1977), much of this type of forking is due to lateral branch



Figure 1.—Black walnut tree showing a widely divergent fork.

Summary and Discussion

development after leader tips have been killed back by late spring frosts, deer browsing, or insect attacks. Corrective pruning has been advocated to develop better walnut form, but Schlesinger (1982) recommended allowing trees to straighten naturally if possible. Lateral pruning is recommended to remove branches and stubs that might cause defects in the wood on the lower bole. In view of Schlesinger's recommendation, we decided against corrective pruning to see if family differences in form will develop in later years.

Family Ranking

When families were ranked by total height, there were no great differences among the top 16 families (only 1 foot). Nor did ranking by height result in differences among families by geographic origin. The two best performing families were Tucker County, WV, (1660) and Boone County, WV, (1652), though progeny from several locations in Pennsylvania and North Carolina also ranked high.

At the end of 7 growing seasons, some differences among families are apparent. Survival, average stem diameter, and average 7-year stem diameter growth differed significantly among families, but average total height, 1980-82 height growth, and d.b.h. did not.

Some of the best performing families have origins considerably distant from the planting site. The 7-year results indicated that seed collections from most of the 34 sources, probably would grow well in West Virginia.

In general, survival in West Virginia compares favorably to a plantation on a cleared forested site in southern Illinois and on an old field in Maryland (Krajicek 1975; Little et al. 1975). However, total height at the Illinois and Maryland sites was considerably better than that in the West Virginia outplanting for a similar period. The apparent slower growth in West Virginia can be attributed partially to top dieback of

undetermined origin that affected many trees during the first 5 years. Top dieback has declined during the past 2 years; this should result in increased height growth.

Current seed-source recommendations for black walnut state that sources from 200 miles south of the intended planting site and 50 miles north can be planted and expected to grow well (Schlesinger and Funk 1977). Deneke et al. (1980) stated that it appears safe to move seed from untested black walnut trees south to north but never from north to south. They add that for optimum growth, seedlings can be moved at least 100 miles (but no more than 200 miles) from south to north. The more conservative figure should be used in the northern one-half and western one-third of the species range. Deneke et al. (1980) also suggested that unless seed needs are critical, east to west transfer of seeds other than between adjacent zones should be avoided.

The Tucker County, WV, outplanting is situated approximately 100 miles south of the most northern source, 250 miles west of the most easterly source, 250 miles north of the most southern source, and 280 miles east of the most westerly source. In addition, because the West Virginia site is somewhat higher in elevation than most of the family origin sites, movement distances must be adjusted to account for this. Nevertheless, most of the families have survived and performed reasonably well in West Virginia. All of the surviving trees are in a free-to-grow position and this condition will be maintained. Stem form on many trees is less than desired but corrective pruning will not be undertaken at this time. Natural straightening is occurring on some trees and this will be documented for future family correlations.

Literature Cited

- Bones, James T. **The forest resources of West Virginia.** Res. Bull. NE-56. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1978. 105 p.
- Deneke, Frederick J.; Funk, David T.; Bey, Calvin. **Preliminary seed collection zones for black walnut.** NA-FB/M-4. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Area State and Private Forestry; 1980. 5 p.
- Krajicek, John E. **Planted black walnut does well on cleared forest sites—if competition is controlled.** Res. Note NC-192. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station; 1975. 4 p.
- Little, Silas; Bey, Calvin; McConaughy, Daniel. **Local sources of black walnut recommended for planting in Maryland.** Res. Note NE-185. Upper Darby, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1975. 3 p.
- Schlesinger, Richard C. **Pruning for quality.** In: 72nd Annual Report of the Northern Nut Growers Association; 1982: 135-139.
- Schlesinger, Richard C.; Funk, David T. **Manager's handbook for black walnut.** Gen. Tech. Rep. NC-38. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station; 1977. 22 p.

Wendel, G. W.; Dorn, Donald E. **Survival and growth of black walnut families after 7 years in West Virginia.** Res. Pap. NE-569. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1985. 6 p.

Average survival, 7-year stem diameter, and stem diameter growth differed significantly among 34 black walnut families planted in West Virginia. Average total height, height growth, and diameter at breast height were not significantly different among families. Families were from seed collected in West Virginia, Pennsylvania, North Carolina, and Tennessee. The 7-year results indicated that although survival was significantly different among families, differences in height growth were not well enough defined to recommend sources for planting.

ODC 232.11:176.1

Keywords: Progeny test; black walnut; height growth

Headquarters of the Northeastern Forest Experiment Station are in Broomall, Pa. Field laboratories are maintained at:

- Amherst, Massachusetts, in cooperation with the University of Massachusetts.
 - Berea, Kentucky, in cooperation with Berea College.
 - Burlington, Vermont, in cooperation with the University of Vermont.
 - Delaware, Ohio.
 - Durham, New Hampshire, in cooperation with the University of New Hampshire.
 - Hamden, Connecticut, in cooperation with Yale University.
 - Morgantown, West Virginia, in cooperation with West Virginia University, Morgantown.
 - Orono, Maine, in cooperation with the University of Maine, Orono.
 - Parsons, West Virginia.
 - Princeton, West Virginia.
 - Syracuse, New York, in cooperation with the State University of New York College of Environmental Sciences and Forestry at Syracuse University, Syracuse.
 - University Park, Pennsylvania, in cooperation with the Pennsylvania State University.
 - Warren, Pennsylvania.
-