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Growth of Black Walnut in Southeast Nebraska

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Technical Report

INTRODUCTION

Black walnut (*Juglans nigra* L.), within the family *Juglandaceae,* is a premier hardwood timber species in the United States. Its native range encompasses most of the eastern U.S., roughly extending from eastern South Dakota and eastern Texas on its western edge to Massachusetts and western Florida in the east (Figure 1). The occurrence and productivity of black walnut on the western edge of its native range, including eastern Nebraska, is largely a function of available water during the growing season. However, black walnut has been extensively planted west and north of its native range. Studies have shown black walnut can withstand moving 200 miles northward from its native range without likelihood of cold injury (Bey, 1980).

Black walnut is sensitive to soil conditions. It grows best on deep, well-drained, nearly neutral soils that are generally moist and fertile (Williams, 1990). Black walnut grows in many mixed mesophytic forests, but it is seldom abundant (Schlesinger & Funk, 1977). Usually it is found scattered among other tree species. Pure stands are rare, relatively small, and usually located on the edge of its native range (Williams, 1990). Although there is no universal vegetative indicator, the presence of Kentucky coffeetree (*Gymnocladus dioicus*) seems to indicate a good walnut growing site (Brinkman, 1965). In general, where white ash, red oak, sugar maple, slippery elm, or yellow-poplar grow well, black walnut also thrives.

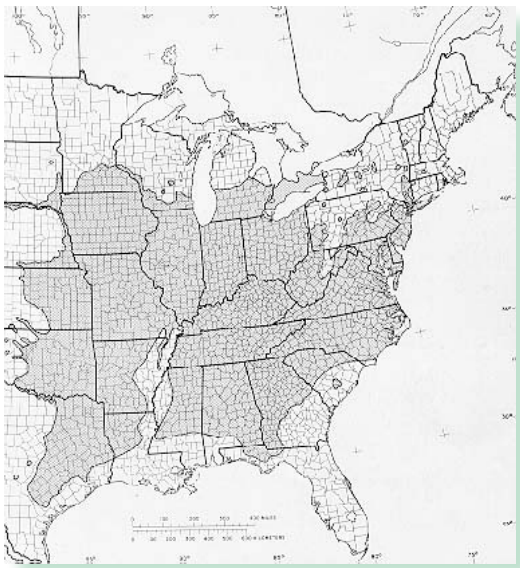


Figure 1. Native Range of Black Walnut.

The majority of black walnut trees occur in natural stands. Walnut plantations (ca. 13,800 ac) account for only about 1 percent of the black walnut timber volume harvested in the U.S. each year (Shifley, 2004), even though black walnut has been cultivated since 1686 (Michler, Woeste & Pijut, 2007). Eight states currently have the greatest volume of black walnut growing stock on timberland: Missouri, Ohio, Iowa, Indiana, Illinois, Tennessee, West Virginia, and Michigan (Shifley, 2004).

Black walnut is classified as a "shade intolerant" tree. It tends to develop a straight, limb-free trunk when growing as a dominant and/or co-dominant tree under competition with other forest trees. It typically forms a taproot and wide-spreading lateral roots.

The growing season of black walnut ranges from 140 days in the north to 280 days in western Florida. Annual precipitation in its native range varies from less than 25 inches in northern Nebraska to more than 70 inches in the Appalachian Mountains of Tennessee and North Carolina (Williams, 1990).

Black walnut is prized for its chocolate-brown, straight-grained wood which is used to make fine furniture, expensive gunstocks, and high-quality veneer products.

The nuts of the black walnut are relished as food by humans and animals. Black walnut nutmeats are often used in baked goods (cookies, cakes, etc.) and ice cream products. The healthful nutmeats are low in sugar and saturated fats, high in polyunsaturated and monounsaturated fats, a good source of protein and fiber, and contain no cholesterol (USDA-ARS, 2004).

Even the nut shells are made into useful products. During World War II, engine pistons were cleaned with a "nut shell" blaster. Later, the automobile industry used ground black walnut shell to de-burr precision gears (Williams, 1990). Today, ground black walnut shell is used in a variety of products—a soft abrasive to clean jet engines, electronic circuit boards, ship and automobile gear systems, a filler in dynamite, a filter agent for smokestack scrubbers, and in oil drilling.

PURPOSE

The purpose of this study was to document the growth rate of black walnut timber trees in southeast Nebraska. No other known study in the Midwest has collected black walnut growth data from multiple sites over such a long period of time, i.e. from 25 to 45 years. The results of this study will form the basis for recommendations to landowners concerning planting and managing black walnut timber in Nebraska and the western edge of its native range.

Because each site represented a different population (at least partially), only comparisons of trees within each site were made.

Tree trunk diameters were measured at the standard 4.5 feet above ground, called diameter breast height (DBH), using a specially calibrated "diameter tape." Occasionally, the diameter measurement for a particular tree may have been missed in one or more years. In these cases the annual increment was calculated by dividing the increment by the number of years between measurements. Height measurements were also recorded on selected measurement trees, but the data was insufficient to statistically analyze height.

The number of years that measurement data was collected at each of the five study sites ranged from 26 years at Site 2 (Horning Farm) to 46 years at Site 3 (Stevens Farm). These measurements yielded annual DBH growth increment data for from 25 to 45 years (Table 1). The number of measurement trees at each study site varied from 9 to 15. The starting measurement diameters of trees in the study varied widely; from 3 to 25 inches. However, a consistent starting diameter was not deemed important because we were mainly focusing on the linear growth pattern of trees on different sites.

All statistical analyses were performed using SAS/STAT Version 9.2 and Microsoft Excel.

Table 1. Growth Study Summary.

Site No.	Site Name	County	Soil Type	No. of Trees Measured	Years Measured	No. of Growing Seasons	Ave. Growth Rate (Inches/Year)	Range of Growth (Inches/Year)
1	Walnut Grove Farm	Lancaster	Nodaway silt loam	9	1984 - 2010	26	0.248	0.02 - 0.59
2	Horning Farm	Cass	Judson & Marshall silty clay loam	15	1985 - 2010	25	0.308	0.00 - 0.65
3	Stevens Farm	Gage	Silty alluvial	9	1965 - 2010	45	0.241	0.00 - 0.75
4	Shrader Farm	Gage	Silty-Alluvial & Hobbs silt loam	10	1975 - 2010	35	0.326	0.00 - 0.94
5	Rogers Farm	Lancaster	Nodaway silt loam & Colo-Nodaway silty clay loam	13	1981 - 2010	29	0.342	0.03 - 1.00
All Sites				56			0.293	0.00 - 1.00

METHODS

For this study, selected black walnut trees were measured annually during the dormant season (usually January through April) on five sites in southeast Nebraska—Walnut Grove Farm and Rogers Farm in Lancaster County, Horning Farm in Cass County, and Stevens Farm and Shrader Farm in Gage County (Figure 2).

Each site varies significantly in topography, precipitation and soil type. Measurement trees were growing under natural conditions and varying degrees of silvicultural management.

Figure 2. Site Study Locations.

RESULTS

Although we were unable to combine or statistically analyze growth data, there were obvious differences in average annual DBH growth increments between study sites. The site with the highest average annual DBH growth rate was Rogers Farm (0.342 inches per year). The lowest was Stevens Farm (0.241 inches per year). The average annual DBH growth rate for all five sites combined was 0.293 inches per year (Table 1).

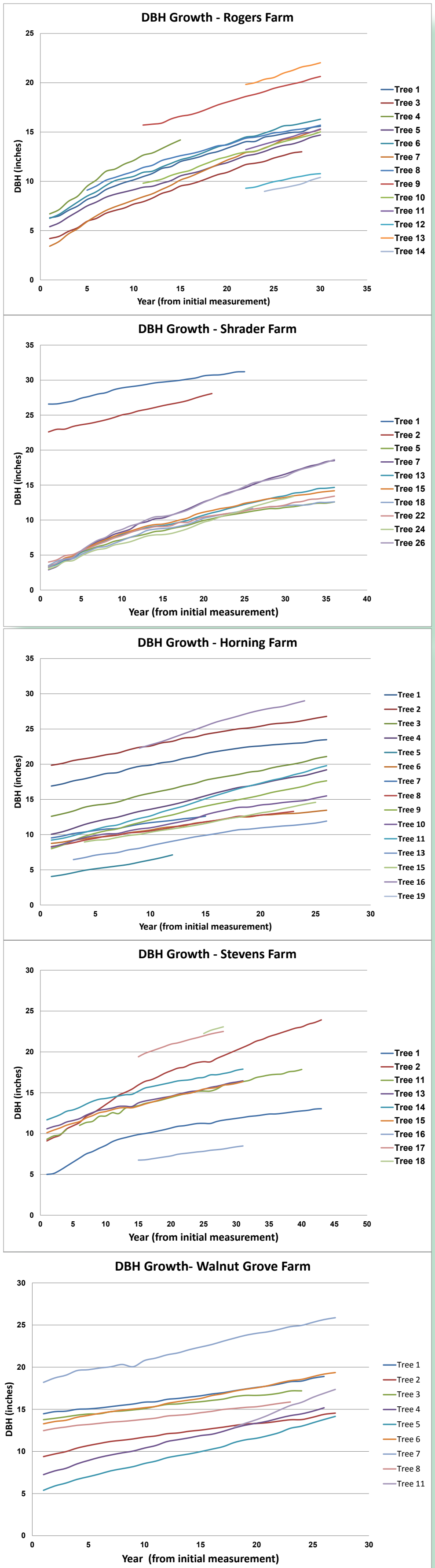
With few exceptions, the measurement trees exhibited linear diameter growth throughout the study, particularly the last 25 years. The analysis of DBH growth rate on each of the five sites clearly shows consistent linear diameter growth over the measurement intervals. The difference in starting DBH on measured trees did not seem to show a lesser or greater growth rate. When the annual DBH growth measurements for each tree were graphed, the slope for each tree was very similar, and didn't appear to be dependent upon beginning DBH (Figure 3).

Generally, when average annual DBH growth increment was graphed for each study site, the annual increment slowly decreased as the measurement trees aged (Figure 4). The only exception was Walnut Grove Farm, which exhibited a slightly positive slope to its average annual growth increment curve (+0.0016). The site with the next best annual growth increment slope, but slightly negative, was Horning Farm (–0.0031). The other three sites also showed decreasing growth patterns with negative slopes ranging from –0.0066 to –0.0100.

DISCUSSION

An analysis of the annual growth rates on all five sites indicates that several factors may be affecting the growth of the trees. Each of the study sites was managed differently, from minimal to

Figure 3. DBH Growth.



intensive silvicultural management. In general, regardless of site, measurement trees exhibited very steady linear growth (Figure 3). Several individual trees had much higher annual diameter growth increments, which may have been the result of periodic thinning of competing trees or other silvicultural practices affecting the growth of the trees. While growth was slower on some sites, one could argue that uniform growth results in higher-quality wood.

When plotting the average annual DBH growth of individual trees from each site, a consistent pattern emerged. Generally, in the years when the trees on one site exhibited limited growth, the trees on the other sites showed a similar growth pattern (Figure 5). It is interesting to note that all five sites showed similar spikes and declines in growth. However, several sites showed a much larger decline or increase compared to others, which indicates that walnut trees growing under optimal conditions are less impacted by a poor growing season.

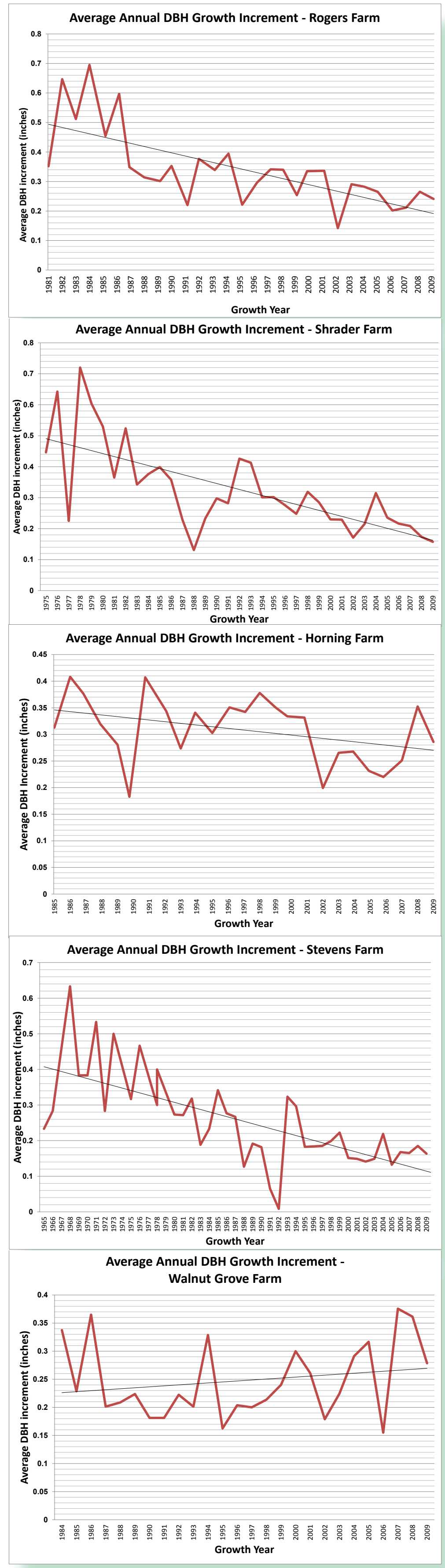
Most notably, even after analyzing many years of measurement data, the DBH growth of almost all trees increased at a linear rate. However, on four of the five study sites, we found that as the trees mature, their diameter growth rate slowly decreased (Figure 4).

The only site which showed increasing annual diameter growth increment over time was Walnut Grove Farm. Of the five study sites, it was the most intensively managed, primarily for walnut timber production. Data from the other less intensively managed sites shows slow decreases in annual growth increments. Thus, it is reasonable to assume that good silvicultural management can have a positive influence on annual diameter growth rates throughout the life of trees.

CONCLUSIONS

Optimum growth of black walnut trees is a function of multiple factors, including climate

Figure 4. Average Annual DBH Growth Increment.



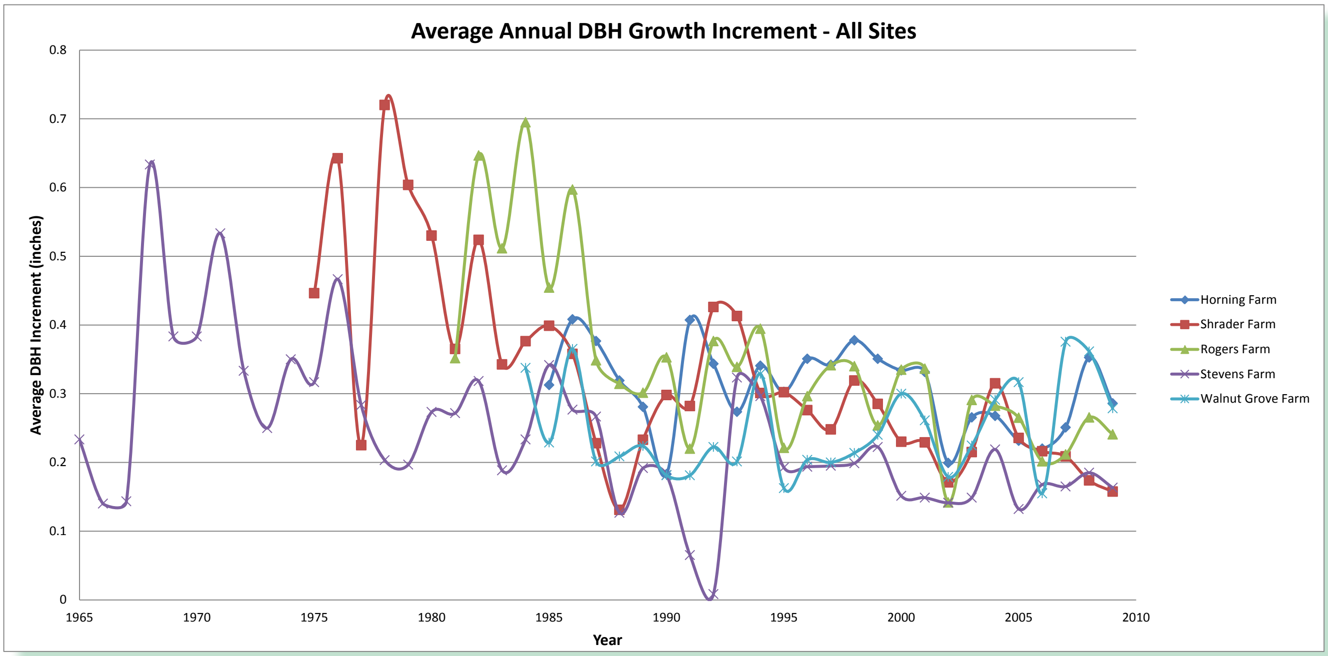


Figure 5. Average Annual DBH Growth Increment - All Sites.

(i.e., precipitation, temperature, wind, etc.), site characteristics (i.e., soil texture, fertility, depth, pH, etc.), and silvicultural management regime (i.e., stocking, thinning, weeding, etc.).

Although the empirical data from this study was obtained from a relatively small sample of black walnut trees, and the individual site data could not be reliably combined or statistically compared, **the data indicates that an average annual DBH growth increment of one-fourth to one-third inches per year can be conservatively projected for black walnut trees in southeast Nebraska** (Table 1). These conclusions may not apply in other regions of the U.S.

Before making a substantial investment in planting and/or managing black walnut trees for timber, one should investigate all available information concerning black walnut management in your area and consult with a local forester to develop a silvicultural management strategy that best fits your situation and expectations.

References

Bey, C.F. (1980). Growth Gains from Moving Black Walnut Provenances Northward. Journal of Forestry, 78(10): 640-645; http://bit.ly/14pJ9W6

Fowells, H.A. (1965). Black walnut (Juglans nigra L.). In Silvics of Forest Trees of the United States. pp. 201–207. USDA Forest Service, Agriculture Handbook No. 271. Washington, D.C.; http://1.usa.gov/1bppBXW

Michler, C.H., Woeste, K.E., & Pijut, P.M. (2007). Genome Mapping and Molecular Breeding in Plants: Vol. 7. Forest Trees, pp. 189-198; http://bit.ly/1d0qpUS

Schlesinger, R.C., & Funk, D.T. (1977). Manager's Handbook for Black Walnut. USDA Forest Service, General Technical Report NC-38, 22p., North Central Forest Experiment Station. St. Paul, MN; http://1.usa.gov/19odTzn

Shifley, S.R. (2004). The Black Walnut Resource in the United States. In Proceedings 6th Annual Walnut Council Research Symposium. pp. 168-176. USDA Forest Service, General Technical Report NC-243. North Central Research Station, St. Paul, MN; http://1.usa.gov/11ZUhMH

USDA-ARS. USDA, Agriculture Research Service, USDA nutrient data lab. (2004) USDA national nutrient database for standard reference, release 17. Retrieved from http://www.nal.usda.gov/fnic/foodcomp; http://bit.ly/13TgIo1

Williams, R.D. (1990). Juglans nigra L. Black Walnut. In Silvics of North America, Vol. 2. Hardwoods. pp. 391-399. USDA Forest Service, Agriculture Handbook 654. Washington, D.C.; http://1.usa.gov/sB9lv6

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