Girdling Eastern Black Walnut to Increase Heartwood Width

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ABSTRACT—Eastern black walnut (*Juglans nigra L.*) has often been planted at spacings that require pre-commercial thinning. These thinnings are deemed pre-commercial due to the small diameter of the trees and the low ratio of dark wood to light wood. As a consequence of size and wood quality, these thinnings are often an expense rather than a source of revenue. In an effort to increase the value of these thinnings it would be beneficial to increase the ratio of dark wood to light wood. One way to increase the amount of dark wood is through costly processing using steam. However, several non-scientific studies have reported that dark wood can be increased by girdling small trees and allowing them to remain on the stump for a certain period of time. This study was designed to test this idea. In a black walnut plantation scheduled for thinning, 10 trees were randomly selected and double-girdled. At that time, increment cores were taken 30.48 cm above the top girdle. These trees were allowed to remain on the stump for 21 months before they were harvested. Results of this study will describe changes in dark wood content following the girdling treatment. The results will compare light to dark wood ratios of the initial increment cores to the boards sawn from the harvested logs.

For many Missouri landowners, the idea of planting eastern black walnut (*Juglans nigra L.*) trees for the saw log or veneer market may seem like a poor investment, since it takes 60 to 80 years before a return is realized. From a financial perspective, the uncertainty and risk involved with a 60 to 80 year investment make it unfeasible. Although harvesting black walnut nuts can generate some cash flow, the prospect of selling marketable saw logs or veneer is often the deciding factor for choosing black walnut for planting.

In Missouri, markets for small diameter hardwood timber are being explored. By marketing smaller diameter trees, the investment period can be shortened considerably. Small diameter markets may work for native oaks (*Quercus* spp.); however, black walnut's appeal in the market is due to its dark colored heartwood. Small diameter black walnut logs have a large amount of light colored sapwood in relation to the darker colored heartwood (Panshin and DeZeeuw 1980). Because of this ratio of light wood to dark wood, black walnut may be an unlikely candidate for the small diameter market.

Although there are commercial methods, such as steaming (Chen and Workman 1980), that increase the amount of coloration in black walnut, these methods are often too expensive for small sawmills. The search is on for a low cost method of increasing the dark colored wood in small diameter black walnut. One method that has been rumored for many years is to kill the tree by girdling, and then leave it standing for a period of time. When the girdled tree is harvested, the light colored sapwood will have been darkened to match the color of the heartwood, thus increasing the quantity of useable wood (Chen and others 1997, 235). This study was designed to test the potential for increasing the amount of dark colored wood in black walnut through girdling.

METHODS

This study was conducted at the Sho-Neff Plantation near Stockton, Missouri. Sho-neff consists of about 194.2 ha with 123.8 ha of eastern black walnut trees of various ages planted at

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various spacings. The plantation is divided into 25 areas for research and management.

In 2001, Hammon's Products Company, owner of the Sho-Neff, conducted a thinning to remove approximately one-third of the plantation. Ten trees (Table 1) marked for thinning were chosen at random for this study from Area 16A of Sho-Neff. These trees were native seedlings, planted in 1976 at a spacing of 6 m x 12 m. Annual crops of soybeans, wheat, and milo had been grown between the rows of trees from 1977-1988. A traveling gun system irrigated the area for several years while crops were being grown.

On April 4, 2001, these 10 trees from Area 16A were double girdled with a chainsaw. Girdling started at about 25.4 cm from the ground. Approximately a 7.62 cm space was left between each girdle. An increment core was taken at approximately 30.48 cm above the top girdle at the time of girdling. The trees were left standing until January 2003. On January 24, 2003, the trees were felled, cut to 2.4 m to 3 m lengths, hauled to the Horticulture and Agroforestry Research Center at New Franklin, Missouri and placed inside a storage shed.

On July 8, 2003, a Woodmizer sawmill was used to cut the logs lengthwise. Slabs of about 2.54 cm thickness were removed from the logs until the approximate center of the log was exposed. By cutting the logs lengthwise, any color change could be examined in terms of consistency along the length of the log. Photographs of the slabs were taken for reference purposes. The slabs were numbered the same as the logs.

Table 1.—Location, reference number, and DBH for the 10 black walnut trees analyzed to measure colored wood movement after girdling and standing for 22 months.

Location	Ref. Number	DBH (cm)
Row 4 - #22	I	24.64
Row 4 - #18	II	24.89
Row 4 - #14	III	28.70
Row 2 - #16	IV	23.37
Row 2 - #18	V	27.18
Row 2 - #20	VI	25.91
Row 2 - #22	VII	27.43
Row 2 - #25	VIII	22.61
Row 3 - #19	IX	26.42
Row 3 - #24	X	26.92

In order to analyze the logs, measurements were taken from the center of the log to the edge of the dark colored wood (C-D) and then from the center of the log to the beginning of the bark (C-B). These measurements were taken using a digital caliper, and were taken at about 30.48 cm above the top girdle on the half-log that was left after the slabs were cut off. Each log was measured twice, from the center out to the left and from the center out to the right. After measuring C-D and C-B on both sides of the log, an average estimate of the relationship between dark colored wood to total wood was calculated. Averaging the measurements in two directions out from the center allowed for any elliptical distortion in the proportion of heartwood to sapwood.

The increment cores were also measured using a caliper and measured from the center to the edge of the dark wood (C-D), and from the center out to the beginning of the bark (C-B). Dark colored wood was calculated as a percent of total wood. A comparison of the C-D/C-B ratio from the increment cores was compared to the average C-D/C-B ratio from the logs to determine if any color change had occurred.

RESULTS

To analyze color movement, changes in the percentage of dark colored wood to total wood were compared from the increment borer samples and the logs. At the time of the girdling, dark colored wood and heartwood were synonymous. However, after waiting the 22 months from the time of girdling, dark colored wood could be a combination of heartwood and wood that may be dark in color due to stain or various other reasons (e.g., movement of the dark heartwood color into the lighter colored sapwood) (Bamber and Fukazawa 1985).

Table 2 shows the ratio of dark wood (C-D) to total wood (C-B) from the increment core readings taken at the time of girdling. Log VII had no reading because a portion of the increment borer sample was missing. This made it impossible to determine where the center of the log would have been. It is interesting to note the variance in the percentage of heartwood in trees that are of the same age. One of the trees had as much as 78% heartwood, while another had as little as 49%. Most of the trees had about 72% heartwood; however, the mean ratio was approximately 65% heartwood to total wood. The proportion of heartwood to total wood was inversely related to the DBH of the tree, which supports other studies on this topic (Nelson 1976). For example, the tree with 49% heartwood had the largest DBH.

Table 2.—Log number, increment borer reading taken at the time of girdling at approximately 30.48 cm above the girdle, and ratio of heartwood to total wood for each log girdled and let stand for 22 months.

Log Number	Increment Borer		% D-B3
	C-D1 (cm)	C-B2 (cm)	
I	7.8	10.9	71.56%
II	7.1	9.95	71.36%
III	6.7	13.65	49.08%
IV	7.4	9.5	77.89%
V	8.1	11.2	72.32%
VI	7.0	12.5	56.00%
VII		No reading	
VIII	7.3	10.2	71.57%
IX	6.25	10	62.50%
X	5.3	10.5	50.48%

[1] *C-D: dark colored wood (heartwood) width in cm measured from center of stem to edge of dark colored wood.*
[2] *C-B: total width in cm measured from center of stem to inside of bark.*
[3] *% D-B: ratio of heartwood width to total width in cm.*

Caliper measurements taken from the cut logs after the trees were allowed to stand for 22 months are shown in Table 3. Those measurements show that the percent of dark colored wood ranged from 49% to 86%. The mean ratio of dark colored wood to total wood is approximately 73%.

Table 3.—Log number, colored wood widths; and average dark wood to total wood ratios measured from the center of the log to inside the bark on both sides of the stem 22 months after girdling.

Log Number	Log Readings			
	C-D[1]	C-B[2]	% D-B[3]	Avg. %
I	8.84	10.24	86.33%	86.37%
	9.6	11.11	86.41%	
II	6.81	10.21	66.70%	67.12%
	7.45	11.03	67.54%	
III	6.61	13.8	47.90%	49.48%
	5.75	11.26	51.07%	
IV	6.73	8.68	77.53%	77.48%
	7.17	9.26	77.43%	
V	10.26	11.71	87.62%	80.67%
	9.93	13.47	73.72%	
VI	10.16	10.49	96.85%	80.77%
	7.86	12.15	64.69%	
VII	10.38	13.9	74.68%	72.52%
	8.88	12.62	70.36%	
VIII	7.01	8.96	78.24%	76.48%
	7.83	10.48	74.71%	
IX	7.94	10.73	74.00%	69.09%
	6.61	10.3	64.17%	
X	7.25	10.8	67.13%	65.80%
	7.13	11.06	64.47%	

[1] *C-D: dark colored wood width in cm measured from center of stem to both edges of dark colored wood.*
[2] *C-B: total width in cm measured from center of stem to inside of bark on both sides of the cut log.*
[3] *% D-B: ratio of dark wood width to total width*

DISCUSSION

The purpose of this study was to determine if girdling and leaving trees standing for a period of time would provide a cheap, effective way to increase the colored wood content in small diameter eastern black walnut trees. This idea stemmed from many discussions regarding the marketing of trees grown in agroforestry configurations that require thinning prior to the trees reaching a commercial size.

This study was an attempt to answer two main questions. First, does killing a black walnut tree by girdling and allowing it to dry on the stump increase the amount of colored wood? Second, what effect does this method have on the market value of the small diameter eastern black walnut log?

Looking at the change in dark wood to total wood ratios (Table 4) for both the increment borer samples taken at the time of girdling and the log readings taken 22 months later, it is evident that some of the logs experienced significant increases in the amount of dark wood content. Logs VI, I, and X showed the most change in dark wood to total wood ratio. Log VI had a change in colored wood of nearly 25%, whereas logs I and X had a change of approximately 15%. The remainder of the logs showed very little change in the amount of colored wood, with some logs even showing a loss in colored wood percentage. This may be attributed to shrinkage.

Seven of the nine logs that were compared showed at least a slight increase in the proportion of dark wood to total wood. However, out of the seven logs showing an increase in colored wood, none of the logs had consistent color change throughout the length of the log. In fact, the color increase in log VI was only present in an area approximately 33 cm long and only on one side of the log. This significant increase in colored wood was in the area of the

Table 4.—Comparison of dark wood to total wood ratios at the time of girdling (Increment borer) and 22 months later (Log).

Log Number	Dark Wood to Total Wood Ratio: Increment Borer	Dark Wood to Total Wood Ratio: Log	Color Change
I	71.56%	86.37%	14.81%
II	71.36%	67.12%	-4.24%
III	49.08%	49.48%	0.40%
IV	77.89%	77.48%	-0.41%
V	72.32%	80.67%	8.35%
VI	56.00%	80.77%	24.77%
VII	No reading	72.52%	---
VIII	71.57%	76.48%	4.91%
IX	62.50%	69.09%	6.59%
X	50.48%	65.80%	15.32%

log where bark had been separated and fallen off during the early stages of the girdling treatment.

The inconsistency in the color along the length of the log leads to the second question regarding the economic potential for this type of treatment. If the color is inconsistent along the length of the log, then the log is no more valuable than it was before the treatment was applied. Likewise, the log may be less valuable because the coloration may be considered a defect.

Also, although several of the logs showed an increase in colored wood, this same increase could possibly have been experienced if the trees were allowed to grow for another 22 months. These trees were growing at a rate of approximately 1 cm per year, indicating that they could have been increasing heartwood at a rate of 1 cm per year as well. It is noted that tree growth and heartwood formation may only have a correlation coefficient of 0.56 (Bamber and Fukazawa 1985). Table 5 shows the amount of heartwood measured on the increment borer samples compared to the amount of dark wood measured in both directions from the center of the logs 22 months after girdling. An average change in dark wood content is calculated for each log.

Three of the logs averaged about a 2 cm increase in colored wood. However, looking at log VI, there was 7 cm of heartwood at the time of girdling and 22 months later the log had 7.86 cm measuring from one side of the log center and 10.16 cm measuring from the other side. It is unclear from which side of the log the increment bore sample was taken: however, the side that had 10.16 cm of dark wood was the side that had significant bark loss. The other side had only gained .86 cm in dark wood. Dividing that growth rate by nearly 2 years makes that a 0.43 cm growth in dark wood per year.

Another visible factor affecting marketability of the logs was the distinct presence of insect damage to the logs. All the logs that had significant damage to the bark had significant insect damage. Stain, or spalt, was another problem with the logs. The logs had been stored in a dry, protected building after they were felled; however, some of the logs showed dark stains.

In conclusion, based on this study, it appears that increasing dark colored wood in eastern black walnut by girdling the trees and leaving them standing does not increase the marketability of the log or the market value of the tree. Any abnormal increases in dark wood formation are

Table 5.—Average change in dark wood content from the time of girdling (Increment borer) to the time of cutting 22 months later (Log).

Log Number	Dark Wood (cm): Increment Borer	Dark Wood (cm): Log	Change[1] (cm)	Avg Change (cm)
I	7.8	8.84	1.0	1.4
		9.6	1.8	
II	7.1	6.81	-0.3	0.0
		7.45	0.4	
III	6.7	6.61	-0.1	-0.5
		5.75	-1.0	
IV	7.4	6.73	-0.7	-0.5
		7.17	-0.2	
V	8.1	10.26	2.2	2.0
		9.93	1.8	
VI	7.00	10.16	3.2	2.0
		7.86	0.9	
VII	No Reading	10.38	--	-----
		8.88	--	
VIII	7.3	7.01	-0.3	0.1
		7.83	0.5	
IX	6.25	7.94	1.7	1.0
		6.61	0.4	
X	5.3	7.25	2.0	1.9
		7.13	1.8	

[1]Log measurement minus increment borer measurement from both sides of the stem.

counterbalanced with increased risk of insect infestation and stain formation. Steaming the logs to increase dark wood formation would be the recommended method of increasing marketable wood. More research should be directed at finding cheaper methods of steaming and/or utilization of small diameter black walnut logs including the sapwood.

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