# EFFECTS OF SELECTED MANAGEMENT PRACTICES ON LUMBER GRADE AND DRYING PROPERTIES OF TWO CENTRAL HARDWOOD SPECIES

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Problems associated with the utilization of short-rotation softwoods from plantations (5) have caused similar concerns about the suitability of faster grown and shorter rotation hardwoods for various products. Little research has been done to address these concerns, primarily because of the relative abundance of most hardwood species and the lack of emphasis on plantation culture of hardwoods in the past. However, such research is needed to meet the increasing demand for high-value hardwood species.

This paper, part of an ongoing research effort to examine various management influences on wood and processing properties, describes the effects of selected management practices on lumber grade and drying properties of two commercially important central hardwood species--black walnut and white oak.

## MATERIALS AND METHODS

### American Black Walnut (Juglans nigra L.)

Ten black walnut trees were selected for this study: five from a plantation and five from an adjacent natural stand of timber. The trees were growing in southern Illinois on a bottomland terrace that was subject to periodic flooding. The stands were chosen to minimize site and topographic differences.

The plantation-grown trees were originally planted at a spacing of 25 feet by 25 feet. The spacing of competing trees in the naturally grown area ranged from 3 to 29 feet at the time of harvest.

The first two logs from each tree were harvested and processed into lumber. A total of 400 BF 4/4 lumber was dried in one charge, using the standard schedule T6D4 for black walnut (3). The boards were 8 feet long and 4, 5, or 6 inches wide (Fig. 1).

All boards were graded before and after kiln drying to determine changes in grade. Thickness and width of all the 30 sample boards from the five butt logs of each stand were measured at three different points, before and after drying, to determine the difference, if any, in the drying properties of lumber from plantation and natural stands. After drying, these sample boards were also measured for twist, bow, crook, and cup.

### White Oak (Quercus alba L.)

Forty white oak trees, 20 from a thinned stand and 20 from an unthinned stand, were harvested for this study. Ten trees each of two different size classes (10 and 13 inches d.b.h.) were randomly selected from each stand. These two stands, similar in site index, were about 2 miles apart and located on the Crab Orchard National Wildlife Refuge in southern Illinois. These stands were planted during 1938 to 1941 by the Civilian Conservation Corps. One stand was thinned in 1973 to a 20-by-20-foot spacing (from the original 6-by-8-foot spacing).

The butt log of each tree was sawn into two 2/4 and four 4/4 boards (Fig. 2). A total of 700 BF of white oak lumber was dried in one charge using the standard schedule T4C2 (3). All 2/4 boards were 4 feet long and 3 or 4 inches wide. All 4/4 boards were 8 feet long and 4, 6, or 8 inches wide. Ten 2/4 boards per size class per stand were measured before and after kiln drying to examine the effect of thinning on drying properties of lumber. All the 4/4 lumber was graded before and after kiln drying. Ten boards per size class per stand were also measured before and after drying to evaluate the effect of drying on lumber grade. After drying, both 2/4 and 4/4 sample boards were also measured for twist, bow, and crook.

## RESULTS AND DISCUSSION

### Black Walnut

On the average, the naturally grown black walnut trees were 8 years older and 7 feet taller than the plantation-grown trees; however, the average d.b.h. of plantation-grown trees was nearly 2 inches larger than that of the naturally grown trees (Table 1).

The thickness and width shrinkage values found in this study differed from published radial and tangential shrinkage values of 5.5 and 7.8 percent, respectively, for black walnut (6). The thickness shrinkage (mainly radial) was found to be slightly greater than the width shrinkage (mainly tangential) for lumber from both plantation-grown and naturally grown trees probably because the lumber sawn from these relatively small diameter logs (11 to 13 inches d.b.h.) was a mixture of flatsawn and quartersawn lumber (Table 2).

Thickness shrinkage and width shrinkage were found to be significantly greater for lumber produced from the plantation stand than for lumber from the natural stand (Table 2). This greater shrinkage was probably caused by the faster growth rate and, thus, greater proportion of sapwood of plantation trees (Table 3). The difference in shrinkage between lumber from the plantation stand and lumber from the natural stand may be related to the greater amount of extractives present in heartwood, which tend to restrict shrinkage by their bulking action on the cell wall (1).

The warpage data showed a mixed pattern (Table 2). While the lumber from plantation trees showed a greater twist and cup than the lumber produced from naturally grown trees, the lumber from naturally grown trees showed a greater crook after drying than lumber produced from plantation trees. Lumber from plantation and natural stand did not differ in bowing.

Lumber sawn from the naturally grown trees was, on the average, one grade above lumber from the plantation-grown trees (Table 2). The lower lumber grades resulted from the presence of more knots in the plantation-grown trees. Because the plantation stand used for this study was a control plot for a pruning study, the trees were planted at a relatively wide spacing and lateral branches were not pruned. As a result of the wider spacing, branches were retained until they were naturally pruned after crown closure. Had artificial pruning been practiced, the wood would have had fewer knots at an earlier age and the lumber from subsequent growth would have been clearer.

A closer spacing of the planted black walnut trees in the first 10 to 15 years to encourage height growth with less branches and, thus, less knots), followed by a thinning to maintain a uniform diameter growth rate, could produce more and better quality logs at harvest time.

Kiln drying did not alter lumber grades of boards from either stand.

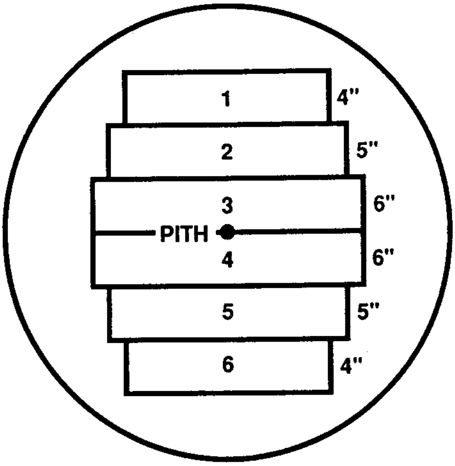


Figure 1. Location and width of boards for black walnut.

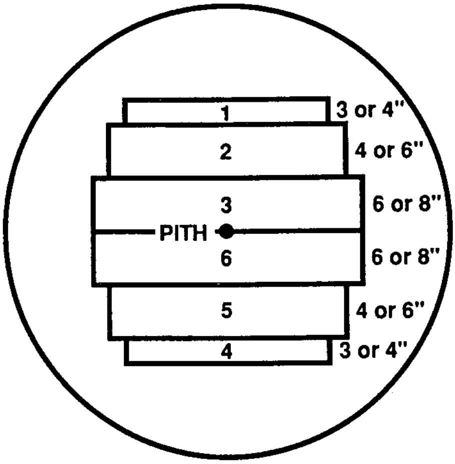


Figure 2. Location and width of boards for white oak.

Table 1. Average tree characteristics of black walnut.[a]

| | Plantation | Natural |
|---|---|---|
| Age (yr.) | 22 | 30 |
| D.b.h. (in.) | 12.8 | 10.9 |
| Height (ft.) | 51 | 58 |

[a]Data from Phelps and Chen (2).

Table 2. Drying data for 4/4 black walnut lumber from plantation-grown and naturally grown trees.[a]

| | Plantation | Natural |
|---|---|---|
| MC (%) | | |
| Green | 72.6 | 88.4 |
| Dry | 8.7 | 8.8 |
| Drying time (days) | 12 | 12 |
| Shrinkage (%) | | |
| Thickness | 6.6* | 5.8 |
| Width | 6.3* | 5.5 |
| Volume | 12.5 | 11.0 |
| Warpage (in.) | | |
| Twist | 0.12** | 0.6 |
| Bow | 0.22[NS] | 0.29 |
| Crook | 0.33* | 0.51 |
| Cup | 0.12** | 0.09 |
| Average lumber grade | | |
| Green | 2.4 | 1.7 |
| Dry | 2.4 | 1.7 |

[a]Some data from Phelps and Chen (2).
* = Indicates that the data within the row were signficantly different at the 5 percent level.
** = Significant at the 1 percent level.
NS = Not significant.

Table 3. Average wood properties of the black walnut.[a]

| | Plantation | Natural |
|---|---|---|
| Percent heartwood | 41 | 61 |
| Growth rate (rings/in.) | 3.4 | 4.9 |
| Specific gravity | 0.56 | 0.57 |

[a]Data from Phelps and Chen (2).

**White Oak**

On the average, the intermediate trees (10 inches d.b.h.) harvested from the thinned stand were 7 percent larger in d.b.h. than trees from the unthinned stand (Table 4). However, there was no difference in d.b.h. of codominant trees (13 inches d.b.h.) harvested from either stand (Table 4).

The intermediate trees harvested from the thinned stand grew more in diameter during the last 15 years than intermediate trees from the unthinned stand, after correction for their difference in total diameter at harvest time (Table 5). Codominant trees in the thinned and the unthinned stands did not differ in diameter growth for the last 15 years. These findings confirmed the prevailing theory: thinning causes a greater diameter growth rate in suppressed trees than in dominant trees (4).

Table 4. Average d.b.h. of white oak trees.

| Tree class | Thinned | Unthinned |
|---|---|---|
| Intermediate (in.) | 10.03** | 9.39 |
| Codominant (in.) | 13.38[NS] | 13.60 |

** = Significant at the 1 percent level.
NS = Not significant.

Table 5. Average d.b.h. growth of white oak trees for the last 15 years.

| Tree class | Thinned | Unthinned |
|---|---|---|
| Intermediate trees (in.) | 0.81* | 0.62 (0.58)[a] |
| Codominant trees (in.) | 1.08[NS] | 1.18 |

[a]Figure in parenthesis was before correction.
* = Indicates that the data within the row were significantly different at the 5 percent level.
NS = Not significant.

Thinning significantly reduced thickness shrinkage (mainly radial) in both intermediate and codominant trees but did not cause any difference in width shrinkage (mainly tangential) in both intermediate and codominant trees (Table 6). This finding was unexpected because the shrinkage phenomena observed cannot be explained by the specific gravity of wood grown during the last 15 years or by the growth rate during the last 15 years after thinning.

Thinning also did not cause any difference in warpage in both size classes, with one exception (Table 6). The unthinned codominant trees showed a smaller twist than the thinned trees, but the difference was extremely small (0.04 inch). No cupping was tested because of the narrowness of the boards.

Kiln drying did not alter any grade of 4/4 lumber from both thinned and unthinned stands.

Table 6. Drying data for 2/4 white oak lumber from last 15 years' growth.

| | Thinned | Unthinned |
|---|---|---|
| MC (%) | | |
| Green | 58.4 | 59.3 |
| Dry | 5.4 | 5.3 |
| Drying time (days) | 17 | 17 |
| --Intermediate trees-- | | |
| Shrinkage (%) | | |
| Thickness | 4.0* | 4.8 |
| Width | 8.8NS | 8.8 |
| Volume | 12.4 | 13.2 |
| Average warpage (in.) | | |
| Twist | 0.4NS | 0.5 |
| Bow | 0.16NS | 0.23 |
| Crook | 0.14NS | 0.17 |
| Specific gravity | | |
| --Codominant trees-- | | |
| Shrinkage (%) | | |
| Thickness | 4.2* | 4.9 |
| Width | 9.6NS | 9.6 |
| Volume | 13.4 | 14.0 |
| Average warpage (in.) | | |
| Twist | 0.04** | 0.00 |
| Bow | 0.12NS | 0.11 |
| Crook | 0.13NS | 0.11 |
| Specific gravity | 0.59NS | 0.60 |

* = Indicates that the data within the row were significantly different at the 5 percent level.
** = Significant at the 1 percent level.
NS = Not significant.

## CONCLUSIONS

### Black Walnut

1. Plantation-grown trees had a faster diameter growth rate and a greater percentage of sapwood than naturally grown trees.
2. Lumber from wider spaced plantation trees was of lower grade than lumber from naturally grown trees because of knots.
3. Thickness shrinkage and width shrinkage were greater in lumber from the plantation stand than in lumber from the natural stand.

### White Oak

1. Thinning caused the intermediate trees, but not the codominant trees, to grow faster in diameter than the unthinned intermediate trees.
2. Thinning reduced the thickness shrinkage of lumber from both intermediate and codominant trees for an unknown reason.
3. Thinning did not cause any significant difference in warpage of kiln-dried lumber.

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