The Silviculture-Wood Quality Connection in Eastern Black Walnut

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ABSTRACT.—The known effects of silvicultural practices on eastern black walnut (Juglans nigra L.) wood quality are reviewed. Since desirable quality differs from end user to end user, no specific recommendations are made.

INTRODUCTION

In this paper we review the body of knowledge relating wood quality in eastern black walnut (Juglans nigra L.) to stand management activities. The latter can be broadly defined as whatever the landowner undertakes that influences the growth of the trees and/or the stand. This includes no action as well since, as we will see, failure to control weeds, remove diseased trees, or to thin also will influence the growth of the stand. A quick review of the literature indicates that black walnut quality-site knowledge is lacking in many areas. While there have been many examples of guidebooks discussing walnut stand management—USDA General Technical Report NC-38 by Schlesinger and Funk (1977) as an example—none of these discuss wood quality. In the Fourth Black Walnut Symposium, Phelps (1989) addressed the tree growth-wood quality relationship from the wood properties perspective.

Wood quality is measured by several parameters whose importance vary from end-user to end-user. These parameters might include cell length, density or specific gravity, growth rate, earlywood-latewood ratio, or, particularly in the case of black walnut, heartwood color. While there will be some exceptions, strength is usually not a concern in black walnut utilization since the majority of the wood is used for decorative veneers and furniture. The notable exception is in the gunstock market where a certain minimum strength may be required for safety in the trigger grip area.

In most wood technology or wood utilization texts, three general sources of variation in wood (and wood properties) are listed: genetics, tree (cambial) age, and environment. The latter includes all the factors typically assumed to be environmental such as climate, soil fertility, moisture, photoperiod, etc. What many people overlook is that deliberate (or accidental!) management activities undertaken by the landowner constitute an environmental impact as well. Typical or traditional forest management activities might include thinning, pruning, fertilization, irrigation, etc. Less activities might include mechanical agitation by shakers to hurry nut drop as is common in harvesting English walnuts or pecans (Reid 1993). Another atypical management activity might be agroforestry alleycropping where alleyways are used for rowcrops and grazing lanes (Garrett et al. 1991).

While the bulk of this paper is devoted to management activities, we will first spend a few minutes briefly reviewing the other two sources of wood quality variation—genetics and tree age.

GENETICS AND TREE AGE

Proper selection of planting stock for the desired end purpose may be considered a management activity. There has been considerable time and
effort expended over the years in black walnut tree improvement programs with modest results (Beineke 1985; Bey 1973; Chenoweth 1995; Rink 1987; Rink and Phelps 1989; Rink et al. 1994a, 1994b). Most of the work has been aimed at improving growth and form or at increasing nut yield (Garrett et al. 1994, Jones et al. 1995). Rink et al. (1994a) evaluated wood quality in a thinning of plantation-grown walnut and found that selection for timber growth showed modest genetic advantage. Rink (1987) also has found low heritability for heartwood color in black walnut suggesting that environmental/management factors play a significant role in determining this important wood quality parameter.

Chen et al. (1995) examined knots, pin knots, and pin knot clusters in walnut boards cut from logs obtained from a precommercial thinning of a walnut-agroforestry plantation. They found no advantage over selection for either nut or timber characteristics with respect to knots, pin knots, or pin knot clusters. They suggested that retention of suppressed buds was controlled by environmental factors, not genetics.

There were early efforts to produce figured walnut by grafting (Lamb 1940). Walters (1951) reported that grafted trees had more figure in the outer section of the stem than the inner section.

In most tree species, the early years of growth produce wood that is variously termed "immature wood" or "juvenile wood" (Panshin and de Zeeuw 1980, Haygreen and Bowyer 1989). This wood also has been referred to as "crown-formed wood" since it is associated with the live crown section of the tree stem. Typically, this wood is characterized by shorter cells, steeper S<sub>2</sub> cell wall microfibril angles, and altered chemical composition. As a result of these changes, some physical and mechanical properties are altered as well—increased longitudinal shrinkage, decreased density, decreased strength. Walnut does not appear to be an exception. Cutter and Garrett (1993) found that fiber length increased from pith to bark in a study of 15-year-old thinnings from an agroforestry plantation, i.e., immature wood was composed of shorter cells. Juvenile wood characterization in walnut has been limited to date.

MANAGEMENT ACTIVITIES

FERTILIZATION AND IRRIGATION

Explicit references to the influence of either walnut fertilization or irrigation vis-a-vis walnut wood quality in the literature are lacking. Insofar as improving the growth and vigor of the trees, it is difficult to say that either of these practices would be detrimental to tree and/or wood quality. Certainly, based on the results from other species, one could infer that the results would be at best favorable (Murphey et al. 1973a, 1973b; Scowcroft and Stein 1986). Black walnut fertilization research has focused on the effect of fertilization on nut yield (Jones et al. 1995).

GRAZING

In many areas of the United States, forest grazing of cattle is a common practice (Lundgren et al. 1983). Some agencies explicitly recommend against grazing (Hershey 1991, Williams 1933). Much of the evidence cited against grazing appears to be either anecdotal or based on uncontrolled grazing of not only cattle, but hogs, sheep, goats, etc. and is related to soil erosion and watershed degradation (Patrie and Helvey 1986). Cutter et al. (1996) found that controlled grazing had no influence on tree grade in slash pine.

PRUNING

Pruning is done for several reasons including the production of a clear stem, corrective pruning to improve tree form, and (in alleycropping regimes) removal of low branches that might impede the access of agricultural equipment. While there have been numerous studies showing the proper way to prune to minimize bole damage, it is important to remember that this is a deliberate wounding of the tree, regardless of the desirability of the end result. While pruning is frequently done to correct a misshapen stem. Reeves (1984) found that the tree will try to correct this on its own, and, if left alone, will do a very good job.

The time of year that pruning occurs has been shown to play a role in both wound healing and scarring. Armstrong et al. (1981) and Smith (1980) found that fall pruning/wounding produced more scarring and discoloration in walnuts than did late winter/early spring pruning.
Studies by Clark and several of his co-workers indicated that pruning, while stimulating growth, sometimes produced undesirable results including epicormic branching (Clark 1955, 1961; Clark and Seidel 1961). Indeed, even 25 years following pruning, the pruning wounds had not healed on some stems in one study (Shiga et al. 1978, 1979). Shiga and his co-workers noted that dark bands of discolored heartwood were associated with pruning wounds. If the production of clear, uniform color wood is the desired result, this is clearly undesirable.

The general recommendation that may be made is that pruning should be done at an early age and limited to small diameter branches (say less than 1 in. in diameter). Early pruning will allow the production of the maximum amount of clear wood.

THINNING

Typically, thinning is thought of as removal of poorly formed trees, low vigor trees, diseased trees, etc. From a traditional forest management standpoint, thinning is either pre-commercial (i.e., the cut trees are left on the ground) or commercial (the removed trees are large enough for product recovery). In either event, the result is increased water and nutrient availability for the residual stand. In some instances, there have been reports of increased levels of limb-related defects associated with heavily thinned hardwood stands (Sonderman 1986).

Paul (1943) reported that open-grown black walnut had higher density than did forest-grown walnut. Open-grown was defined at that time as “trees growing singly or in small scattered groups in pastures and relatively open farm woodlots.” This might be analogous to stand densities seen in many agroforestry configurations. In a latter paper, Paul (1963) recommended that management practices producing conditions similar to those where open grown walnut occurs be followed.

On the other hand, Landt and Phares (1973) suggested that open grown walnut would tend to be forked and limbly while forest grown walnut would have a straight, clear stem. According to them, the forest grown stems would have a dark colored heartwood with a narrow sapwood band while open grown trees would have lighter heartwood and wider sapwood rings.

Phelps and Workman (1992) compared vessel element area in naturally-grown walnut against plantation grown walnut trees. They found that the faster-growing plantation trees had wider growth rings which in turn have wider latwood zones. This results in a reduction in vessel area in the cross-section that causes poorer wood texture. On the other hand, stand management favors more uniform wood texture.

Other literature suggests that trees growing in a crowded stand may have greater height to diameter ratios. In a study of the effect of stand density, Holbrook and Putz (1989) found that sweetgum (Liquidambar styraciflua L.), which like walnut is a light-demanding tree, apparently allocated more wood to height growth than to diameter.

WEED CONTROL

Weed control also could be termed “competing vegetation control” since, under some scenarios, the competing vegetation may be rowcrops or other tree species. Numerous papers have shown that vegetation control during establishment phases of walnut stands is necessary for optimum growth response (Schlesinger and Van Sambeek 1986, Van Sambeek et al. 1989). What many do not realize is that the competition for available nutrients and water continues once the tree is into the sapling or pole stage. If the competing vegetation is other trees, be they walnut or some other species, then vegetation control is termed thinning. If the competing vegetation is an annual (such as corn or soybeans) or a perennial (such as clover or lespedeza), then the tree line may need to be kept vegetation-free in order for the tree to successfully compete for water and nutrients. This can be done either through chemical or mechanical means (Jones et al. 1990). Cutter and Garrett (1993) indicated that declining growth in an agroforestry plantation on an exceptional site (SI=90+) was coincident with conversion of the alleyways to a perennial cover crop.

PARTIAL BIBLIOGRAPHY


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