ANNOTATED BLACK WALNUT LITERATURE

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Many of the publications on establishment, management, and utilization of black walnut and other high-value hardwoods are printed in conference proceedings or scientific journals that are not readily available at most public libraries or on the internet. As Chair of the Education Committee of the Walnut Council, I have tried to summarize the findings from the following technical articles or books, especially as they may relate to black walnut or butternut. If available, I have also indicated where to write for reprints or given an address where the articles can be downloaded if on the internet. As an additional service, I have placed copies of these materials in the Walnut Council Library. Members of the Walnut Council can borrow these materials for two weeks by sending a written request or email to the above address.

ORIGIN OF FROST CRACKS IN STEMS OF TREES by Hans Kubler in the Journal of Arboriculture (1987) 13(4): 93-97.

This article is a non-technical version of the author's original review and synthesis of the information on the mechanism of frost crack formation in trees originally published in Forest Science. Frost cracks are a concern to walnut growers because the defect is essentially permanent and significantly lowers the value of the butt log. Frost cracks are so named because the crack is most evident when temperatures drop far below freezing and later as a bulging vertical frost rib formed by wound callus initiated to close the wound. Once a crack forms, this is the weakest point around the trunk of a tree so that in subsequent winters the wound is likely to crack again and form additional wound callus. Kubler indicates the primary cause of the stresses leading to frost cracks is associated with movement of water from plant cell walls into the cell lumens under freezing temperatures that causes cell walls to shrink and is not the expansion of freezing water within the cells. The internal drying and thinning of cell walls causes the wood to shrink such that the shrinkage perpendicular to the radius is twice as great as in the radial direction (stem surface to pith). As temperatures decrease the amount of internal drying increases and can lead to tension within the wood that is sufficiently high to break wood causing a V-shaped crack from bark to the pith. Once cracked, as temperatures decrease, the crack widens. When temperatures are above freezing the crack gradually closes and wound callus is initiated. Several other factors can also influence the extent of frost cracking. When temperatures are rapidly falling, the outside of a tree cools rapidly creating greater tension near the outside than the warmer center of the tree. In trees like black walnut where wood shrinkage is nearly equal in both directions (tangentially and radially), temperature differences contribute more to the tension stresses than differential shrinkage. This may explain the observation of growers that frost cracks in black walnut appear to develop following winters in which there was a large temperature drop from above freezing to sub zero over a few days. It also explains why painting the stem white reduces amount of frost cracking. On cold sunny days, dark bark absorbs radiation and warms the stem. At sunset, heat is rapidly lost from the outer wood placing it under increasing tension as the outer wood freeze-shrinks over the warmer wood on the inside of the stem. Bark painted white absorbs less radiation keeping the center cooler and allowing it to freeze-shrink with the wood on the outside of the stem. Kubler believes the reason some trees in a planting have frost cracks while others do not appears to be the "notch" effect resulting from earlier wounds to the stem, branch stubs, epicormic sprouts, or pockets of diseased wood. As a tree calluses over a branch or wound, callus grows mostly from the opposite sites. When the callus meets, it abuts but does not grow together nor does it connect to the damaged wood below the callus. The small radial separation in the new wood is a weak zone were the wood more easily separates under tensions created during freeze-shrinkage.

BLACK WALNUT ON IROQUOIAN LANDSCAPES by M. William Wykoff in The Nutshell (2005) 59(3): 7-23.

Close examination of the natural range map for black walnut prepared by E. L. Little for the Atlas of United States Trees shows almost a dozen small discontinuous walnut populations in New York and surrounding states. The author makes the argument that these populations correlate closely with the locations of the late prehistoric Iroquoian archeological sites. Early historians documented the growing of tree crops including peach, shellbark hickory, and nut trees by the various tribes. Although walnut was documented, it is unclear whether the authors were writing about black walnut, butternut, or, possibly, hickory. At the time of European settlement, walnut trees were found growing in straight lines suggest native Americans had planted and managed tree plantings for their fruit. Early explorers, missionaries, and settlers frequently noted the extensive Native American activities centering on nut food and oil processing including the use of fire to facilitate the harvesting of nuts. There is an excellent record of hammer stones and stone mortars being found in areas where black walnut was plentiful. Apparently, nuts were crushed, boiled in water, and then the nutmeat and oil skimmed off to be stored in gourds or ceramic pots. The author discusses the cultural and ecological implications as to the similarity between the soil and moisture requirements of black walnut and maize. Taxonomic evidence indicates that both black walnut and maize originated in Central America with good evidence that the Paleo-Indians are in part responsible for the northward movement of corn and possibly walnut following the last ice age. At some archeological sites, nut shell is more abundant than maize. Other large mast species showing discontinuous populations that correlate well with locations of Iroquoian archaeological sites include pawpaw, mockernut, shellbark hickory, white oak, and bur oak. If you like early American history as viewed through archeological evidence, you'll find this article on the propagation and spread of walnut in the Northeast to be quite fascinating otherwise just appreciate the fact native Americans are at least in part what we believe to the native range for many of our large edible mast crops.

GROWTH AND NUT PRODUCTION OF BLACK WALNUT IN RELATION TO SITE, TREE TYPE, AND STAND CONDITIONS IN SOUTH-CENTRAL UNITED STATES by Adrian Ares and David Brauer in Agroforestry Systems (2004) 63(1): 83-90.

Black walnut is frequently used in several agroforestry practices because of its valuable wood, the production of nuts for human and wildlife consumption, and relative thin crowns that allow light to penetrate to crops, forages, or native vegetation. The authors examined dominant height (DH) and diameter at breast height

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(DBH) of black walnut in 54 stands located on 20 farms or research stations in Missouri, three sites in Arkansas, one site in Iowa, one site in Nebraska, and 2 sites in Tennessee. Stands ranged in age from 3 to 40 years of age and ranged from 3 to 65 feet for DH (tallest 30% of trees in the stand) and 0.5 to 16 inches in DBH. These sites included around 20 stands grafted to improved varieties. Although 28 varieties or cultivars were found, Emma K, Sparrow, Football, Kwik Krop, and Surprise were the most common in that order. No clear differences in DH or DBH growth were found between stands with improved varieties and native stock which might indicate growth is determined more by the rootstock than the scion. Although no veneer quality stems were found in any of the older stands, stands with improved varieties had more trees with large, low branches, irregular wood in graft region, and stem damage from orchard machinery which will limit their future value as sawlogs. Stand density did not help explain variation in diameter growth indicating most stands were in a "free-to-grow" condition. Density averaged 64 trees per acre in stands grafted to improved varieties and 123 trees per acre in native stands. Tree DBH was linearly related to tree age (DBH in inches = 0.754 + 0.314 AGE in years). In stands with previous measurements, DBH growth closely followed published site index curves for black walnut. Although some stands were probably in need of fertilization, insufficient understory vegetation control appeared to be the most common problem limiting tree growth, especially if the dense understory vegetation was tall fescue grass. Trees established in an agroforestry practice had similar growth rates to trees established in stands without such practices. Agroforestry practices were mostly either alleycropping systems with corn and beans or silvopastural systems with seeded grasses or legumes harvested as hay or grazed. Nut yields in 2002 were highly variable both within and among stands for both improved varieties and native stands. Nut yields of trees grafted to improved varieties exceeded estimates while nut yields from planted seedlings or natural stands followed estimates based on Kincaidís model (Yield as nuts per tree = -81.2 + 14.2 DBH in inches). More studies will be needed to adequately predict nut production for inclusion in economic and biological models. Published site index curves appear to be adequate to predict long-term DH and DBH growth within such models.

TREE WOUND REACTIONS OF DIFFERENTLY TREATED BOREHOLES by Dirk Dujesiefken, Andreas Rhaesa, Dieter Eckstein, and Horst Stobbe in Journal of Arboriculture (1999) 25(3): 113-123.

Although this research did not include black walnut or butternut other research suggests the response of walnut to similar wounding and wound treatments would be intermediate between that for horse chestnut and silver birch as described in this paper. The authors examined the long-term (10 years after treatment) reaction of four hardwoods to wounding with an increment borer and protection given by three wound treatments. The hardwoods included in the study were two species of basswood (also known as Tilia, linden or lime), horse chestnut (Aesculus), and silver birch (Betula). An increment borer was used in the spring to make four wounds approximately 4 inches deep on large branches of three to six trees for each species. Wound treatments included untreated control wounds, coating the wound with a commercial product called LacBalsam, filling the wound with polyurethane based wood filler (Sikaflex), or inserting creosote-impregnated wooden dowels into the boreholes. When the study was initiated, creosote-containing treatments were commonly applied to tree wounds to prevent microorganisms from entering the tree through the injured wood. With untreated wounds, the cambium died in an area approximately 1 to 1.5 inches in width around the boreholes for all four species. Coating the wounds with LacBalsam or filling with polyurethane-based wood filler neither decreased or increased the amount of dead cambium. Inserting creosote-impregnated wooden dowels increased the amount of dead cambium to as much as 5 inches in the axial directions (up and down the tree or branch) on large-leafed basswood and horse chestnut, but not small-leafed basswood (this treatment was not tested on silver birch). Ten years after wounding, the wood surrounding the 4-inch deep boreholes was cut into thin section to examine the compartmentalization response and possible interactions with the wound treatments. During compartmentalization certain cells in the wood produce a boundary layer that normally prevents microorganisms from invading the entire stem. The cells between the wound and the boundary layer are filled with accessory or phenol compounds producing an elliptically shaped discolored area along the axial direction. The maximum length of the discoloration was smallest near the dead cambium and gradually increased with increasing depth of the original boreholes for all four hardwoods. Fungi were isolated from the discolored areas but not the wood outside the darkly stained boundary layer for all four hardwoods. High levels of starch were found in the cells outside the boundary layer suggesting that starch is used to produce the accessory compounds responsible for sealing off certain tissues and preventing spread of microorganisms into healthy tissues. Basswood produced the strongest compartmentalization response and had the shortest length of the discolored wood ranging from 0.3 to 1.5 inches in length for untreated wounds. Discoloration in horse chestnut ranged from 1 to 2.5 inches in length. Silver birch had the weakest response with discoloration extending for 20 to 40 inches in both directions from untreated wounds. Coating wounds with LacBalsam or filling the borehole with polyurethane based wood filler did not significantly decrease the length of the discoloration. Inserting creosote-impregnated wooden dowels significantly increased the length of discoloration. From the results of this long-term study, the authors confirm results found in other short-term studies (less than three years after wounding) that wound treatments have few benefits and trees are best left to naturally wall off injured tissues through a process called compartmentalization.

This article can be downloaded of the internet at the following address: http://www.treelink.org/joa/1999/may/01dujesiefken.pdf

RESPONSE OF EASTERN BLACK WALNUT AND NORTHERN CALIFORNIA BLACK WALNUT SEEDLINGS TO WATERLOGGING by P. B. Catlin and E. A. Olson. HortScience (1986) 21(6): 1379-

Although we now know walnut seedlings are relatively intolerant of water-saturated soils, much of the older literature described walnut as tolerant to very sensitive to flooding. In this mid-1980's paper, the authors examined survival of 12-week-old walnut seedlings grown in sand and flooded 1 inch deep for 0 to 22 days. Wilting of leaves and stem epinasty occurred within 6 to 10 days after partial inundation indicating root damage had already occurred from which seedlings did not recover when soils were allowed to dry. Approximately 20 percent of the seedlings survived 16 to 22 days of flooding with minor differences among seed sources. Seedling of northern California black walnut and the cultivar "Ohio" were slightly more flood tolerant than seedlings of the cultivar "Thomas" which in turn were more tolerant than seedlings of a unknown cultivar from the Tennessee Valley Authority.

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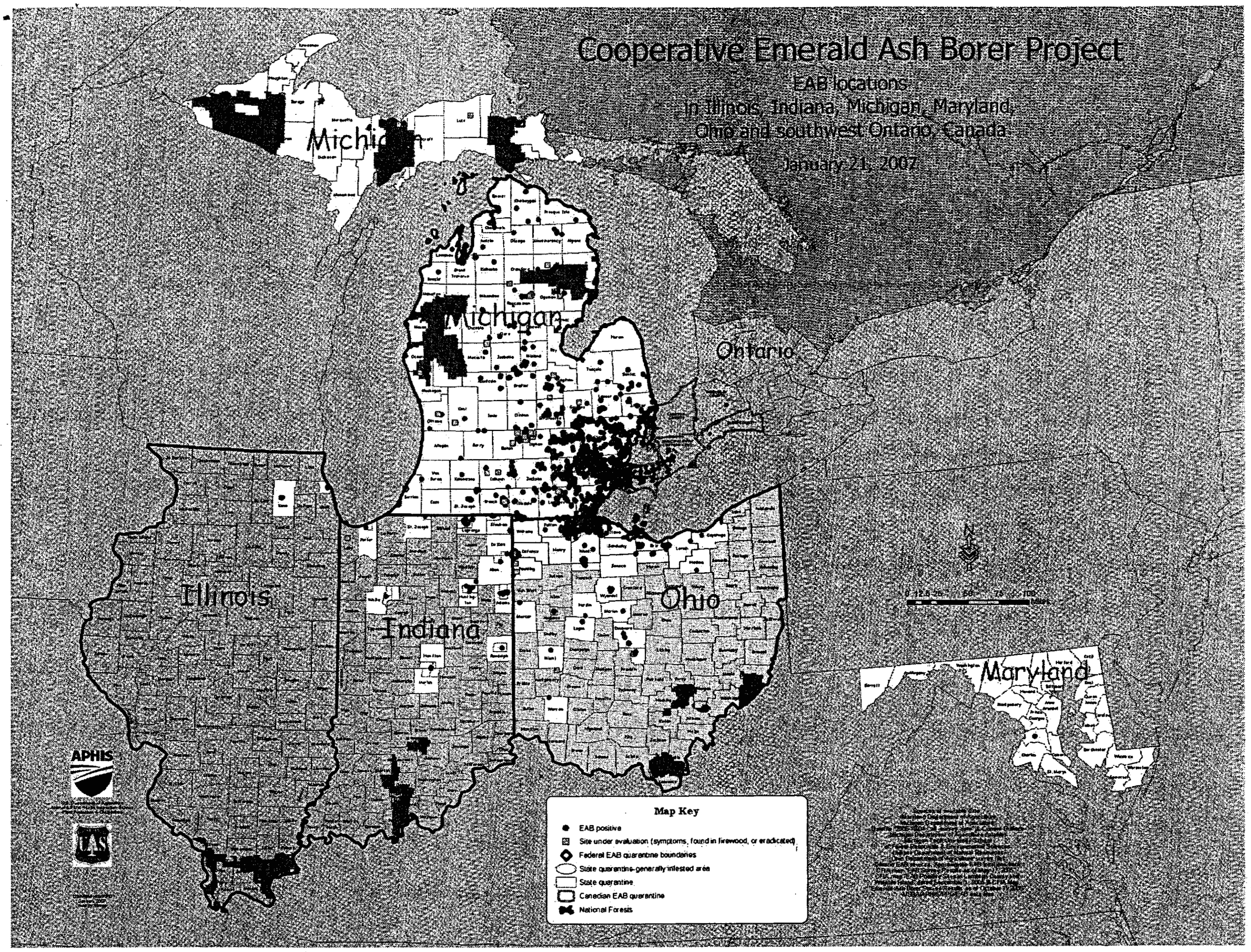

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EFFECTS OF TOP-PRUNING ON SURVIVAL OF SOUTHERN PINE AND HARDWOODS

by David B. South in 1999 on pages 3-8 in Proceedings of the Ninth Biennial Southern Silvicultural Research Conference edited by Thomas A. Waldrop and published by the US Department of Agriculture, Forest Service, Southern Research Station in Ashville, NC.

The author compiled the results from a number of studies that examined field survival and growth of seedlings top-pruned in the nursery bed or when field planted for loblolly pine, longleaf pine, slash pine, eastern white pine, and various hardwoods (no information was provided on how many studies included black walnut). Top-pruning in the nursery results in more uniform seedling heights and planting stock with a higher root-to-shoot ratio. Top-pruning in the nursery bed also results in more plantable seedlings both because pruning of the tallest seedlings will release slower growing seedlings so they can also grow to a plantable size and because there will be fewer tall seedlings damaged by the seedling lifter or culled in the packing shed. Survival of top-pruned seedlings planted on good sites is similar to non-pruned seedlings; however, as the amount of environmental stress increases at the planting site, seedling survival is increased by top-pruning in the nursery. From 18 studies comparing top-pruned to non-pruned hardwood seedlings, three studies showed slightly lower survival rates for top-pruned seedlings while six studies showed increases from 3 to 42 percent in survival for top-pruned seedlings. In most cases, pruned hardwood seedlings show increased annual height growth and will be taller than or as tall as non-pruned seedlings at the end of two or three growing seasons. Although top-pruning will result in more forked seedlings in the year after field planting, these forks apparently do not persist as there was no studies that showed top-pruning increased the frequency of low forked trees in established hardwood plantations. The author concludes that proper top-pruning of tree seedlings is a beneficial nursery practice to improve seedling uniformity and the root-to-shoot ratio making seedlings easier to handle seedlings in the nursery and when field planting as well as increasing seedling survival on less than ideal sites.

This article can be downloaded from the internet at the following address: http://treesearch.fs.fed.us/pubs/2481

JUGLANS NIGRA - THE PRIZED BLACK WALNUT

by Jeff Ball in American Forests (2002) 108(2): 44-47

The author asserts that either you love or you hate eastern black walnut, i.e., if you're a craftsman it offers some of the finest wood available and if you're a vegetable gardener it can make your life miserable. The article succinctly summarizes general knowledge about the species in lots of non-technical information as well as perpetuating a number of folktales without supporting documentation.