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Sustaining Natural Resources on Private Lands in the Central Hardwood Region

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Current Topics in the Processing and Utilization of Hardwood Lumber

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Current Topics in the Processing and Utilization of Hardwood Lumber

Edited by
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National Hardwood Lumber Association
Memphis, Tennessee



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BLACK WALNUT AT THE HARDWOOD TREE IMPROVEMENT AND REGENERATION CENTER (HTIRC)

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INTRODUCTION

Black walnut research at the Hardwood Tree Improvement and Regeneration Center (HTIRC) is focused on genetic improvement, but our ultimate goal is much broader. Simply put, our goal is more and better black walnut for the Central Hardwoods Region (CHR). To reach this goal, our research has to be both very basic and practical, long and short term. If landowners are to make use of outstanding new selections that we develop, the tree must have a reasonable cost, they must be adapted to a diverse growing region or have clearly defined zones in which they can be expected to do well, nurseries must have had a chance to work with them to develop the technologies to produce a large number of high quality plants, and we need to be able to recommend procedures for establishing plantings and best management practices to maximize their value. Thus, we are performing research on everything from the application of herbicides to the latest molecular genetic techniques. This paper will present an overview of the current black walnut improvement program at the HTIRC, with a focus on the practical implications and applications.

BREEDING AND SELECTION

The black walnut improvement program at the HTIRC will contribute to two principle types of genetic products in the future: low-cost improved seed for state nurseries in the region and higher value, grafted, clonal selections that will be sold by local nurseries at a reasonable cost. Controlled crosses among a small population of elite clones will produce the very best selections. Seedlings from these crosses will be evaluated and tested in field trials around the CHR. The release of superior clones will be an ongoing process. We have identified an outstanding tree for release in the next couple of years, and we are continuing to evaluate trees that appear to be the 'best of the best' for future releases. We are using a classical population improvement approach to produce improved seed. From almost 450 trees selected in the Purdue black walnut improvement program over the last 35 years, we have identified 50 that have the most promise as parents. Some of these are the second and third generation seedlings of selections made in the 1960s. These 50 trees are being propagated into a new seed orchard at the Martell Forest (maintained by the Department of Forestry and Natural Resources) at Purdue University. The area around the seed orchard has been cleared of walnut so that the trees in the seed orchard can intercross without contamination from the pollen of wild, unimproved trees. Seedlings that are produced in this seed orchard will form the basis of future genetic improvement efforts. We expect to establish similar seed orchards in other parts of the CHR.

WALNUT PROPAGATION

In 2001, HTIRC collaborated with the Southeast Purdue Agricultural Center (SEPAC) to produce over 500 grafted trees for use in our research. The grafting and propagation of selected walnut can bottleneck tree improvement because the efficiency of grafting is low and the cost is high. To help overcome this bottleneck, HTIRC will be adding both faculty and staff who specialize in walnut propagation. In addition, researchers at HTIRC are working on techniques for propagating and rooting walnut selections using tissue culture. I expect these developments to improve our ability to produce and evaluate large numbers of high quality trees.

Walnut trees often take many years to begin producing seed. Even as trees mature and begin to produce large numbers of seeds, production can be drastically affected by alternate bearing. We have begun research on the use of trellis systems as methods to overcome these limitations. Walnut trees growing on trellises begin to bear large numbers of seeds in only a couple years. Trees on trellises are easier and less costly to manage, and they can be pruned and fertilized more efficiently to control alternate bearing. These advantages are especially important for trees on which we hope to make controlled crosses. It is faster, easier, and safer to cross walnut flowers that are on trellis wires five feet off the ground than flowers that are at the top of 35-foot trees.

IMPROVEMENT OF WOOD QUALITY TRAITS

Wood quality is an important factor in determining the value of a log, but the genetic control of hardwood quality is poorly understood. We have two goals with respect to improving the quality of walnut wood: the first is to increase the percent heartwood in logs; the second is to produce logs with wavy or interlocked grain. Over the past year, we have investigated heartwood formation in 16, 25 and 26-year old trees in plantations in Indiana and Missouri. We have determined that the faster a tree grows, the more heartwood it tends to produce. In even-aged trees, the correlation between diameter at breast height (dbh) and the amount of heartwood is very high ($r = 0.80$ or higher). More importantly, among even-aged trees there was a positive correlation between dbh and the percent area of heartwood. The fastest growing trees in all three plantations not only had more heartwood (in part owing to their greater size), but the heartwood comprised a higher percentage of the cross sectional area of the log than for trees that grew more slowly. Also, the analysis showed that there is a significant genetic component to both the amount of heartwood formed and the percent heartwood in a log. We predict that both of these traits can be improved by our selection program at a rate of about $\frac{1}{2}$ to 1 percent per year, at least in the initial cycles of selection. A 1 percent increase in the percent heartwood of a walnut translates into about a 1 percent reduction in rotation age, and this percentage increases if harvest is delayed to obtain larger-diameter trees.

Trees with outstanding figure (interlocked or wavy grain) are a rare, and often valuable, surprise. HTIRC maintains one of the largest collections of walnut clones with figured grain in the world. Our long-term goal with these trees is to understand the genetics underlying grain formation in trees. Our short-term goals include the ability to identify at the seedling stage which trees will develop potentially valuable grain patterns. Ultimately, we expect the availability of low-cost seeds that will grow into trees with figured grain at a predictable frequency.

DISEASE RESISTANCE

Walnut anthracnose is the most obvious and widespread disease of walnut. In many years, the symptoms of the disease are dramatic: leaves turn yellow and begin to fall in mid-August, sometimes leading to complete defoliation by early September. We do not know the long-term effects of repeated defoliations caused by walnut anthracnose, but the physiological cost to the trees may be significant. By analyzing data taken at the Martell Forest over the past 15 years, we have identified several selections that appear to have good resistance to walnut anthracnose. These trees will be used in a long-term experiment to determine the cost of walnut anthracnose on growth. This data, in turn, will inform an analysis of the costs and benefits of including resistance to walnut anthracnose as a criterion for selection in our breeding program.

WEED CONTROL FOR PLANTATION ESTABLISHMENT

Weed control is critical to the successful establishment and early growth of hardwood plantings. We are collaborating with SEPAC on a long-term study to determine how herbicides such as Pendulum, Princep (Simazine), Milestone, and Oust compare in terms of weed control and phytotoxicity for 10 species of tree seedlings. In the first year, Milestone performed exceptionally well overall, but the right chemical and the right rate depend on the species or species mix one is trying to grow. Data from future years should shed light on the importance of the amount and timing of rainfall and local environment on herbicide performance.

GENETIC DIVERSITY IN NATURAL STANDS

Many years of selective harvesting in the CHR have led some to express concern over the possibility of high-grading. We have begun several studies designed to shed light on this issue, and to help us understand the long-term effects of clear-cutting, selective harvest and other timber management practices. These studies should clarify the ways in which genetics and silviculture must work together to maintain high quality in repeatedly harvested stands. We have initiated several studies that will quantify how genes flow between and within hardwood forests and across generations. Over the next few years we hope to have a much better picture of genes that determine quality in black walnut can be conserved in natural forests.

APPLICATIONS OF GENETIC MARKERS

In the past 20 years there has been a biotechnological revolution that has changed the ways we study and

improve plants. One of the most fundamental tools of biotechnology is the use of genetic markers. Genetic markers are bits of DNA that can be used like mileposts on the DNA highway. They also can be used to separate the genetic code of one individual from another. Over the past year we have identified and characterized over 200 such genetic markers from walnut. Our goal is to have 500 of them within a couple years. What can we do with them? Earlier this year we began a project with the ultimate goal of quantifying the genetic diversity of black walnut throughout its entire range. This will enable us to understand how local populations of walnut relate to a larger picture of genetic diversity for the species. On a practical level, this will mean that if we are looking for new genes or for some particularly interesting trait, we can focus our sampling on parts of the country where the walnut is genetically diverse and unique genes are common.

Genetic markers have other uses as well; the FBI uses genetic markers of this type to create what have been called DNA fingerprints. These DNA fingerprints are like genetic bar codes that are unique to each individual. We are developing similar fingerprints for black walnut. Their uses include the prevention of timber theft (a DNA fingerprint can match a log on a truck with a stump in the field), the prevention of mix-ups and mislabeling in the nursery and the breeding orchard, and the determination of the pedigree of promising seedlings, to name a few.

Are the walnuts in Indiana substantially different genetically from those in Illinois? We are going to find out using our genetic markers. The answer to this and related questions will help us develop seed zones for walnut. Trees in the same seed zone are similarly adapted to the local climate and environment. Trees and seeds moved across seed zones are at increased risk for poor growth. The more seed zones a seed or grafted tree crosses, the greater the risk. Thus seed zones can serve as a practical guide for how widely nursery trees from one zone should be planted. They will also help breeders develop varieties that are regionally adapted for superior growth.

ROOTSTOCK DEVELOPMENT

If the most productive walnut plantations of the future will contain grafted trees, then we cannot overlook the value and importance of rootstocks. There is every reason to believe that roots have an important role in the ultimate value of timber trees. Hybrids of Eastern black, Persian, Arizona black, and Northern California black walnuts often grow with unusual vigor, and they impart this vigor to the scions grafted onto them. While some of these hybrids may have promise as timber trees in their own right (Eastern black x Persian walnut hybrids are grown for timber in Europe), the HTIRC will focus on their potential to improve tolerance to drought and stress. The ultimate goal of this research is to expand the types of sites on which walnut can be grown profitably to include upland sites with shallower soils.

SUMMARY

The black walnut improvement program at the HTIRC is multifaceted, integrating genetics, molecular biology, physiology and silviculture. The diversity of our clients, the landowners in the CHR, makes this approach necessary; but we also believe that this approach will pay the greatest dividends over the long-term.

DISCLAIMER

The use of trade names is for the information and convenience of the reader and does not imply official endorsement or approval by the United States Department of Agriculture or the Forest Service of any product to the exclusion of others that may be suitable.