The Hardwood Tree Improvement and Regeneration Center: Notes from the Field
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- NHLA
- ArborAmerica Inc.
- Indiana Forestry and Woodland Owners Association
- IDNR-Division of Forestry
- Walnut Council
- Steelecase
The HTIRC is a regional research center based at Purdue University

- Improve the regeneration, growth, quality and management of fine hardwood trees.
- Conventional tree screening/breeding
- Genetic modification for desirable traits.
- Cloning techniques for mass propagation.
- Tree nursery technology.
- Forest regeneration and management.
- Resistance/management of insect and disease threats.
We partner with many groups and individuals to achieve similar goals

- Purdue University Department of Forestry and Natural Resources
- USDA Forest Service
- Northern Research Station
- Northeastern Area State and Private Forestry
- NFS Region 8 Cooperative Forestry
- Indiana Department of Natural Resources, Division of Forestry
- Walnut Council
- Indiana Hardwood Lumbermen's Association
- American Chestnut Foundation
- Indiana Forestry and Woodland Owners Association
- National Hardwood Lumber Association
- ArborAmerica, Inc.
- Steelcase
- American Forest Management, Inc.
Historically, we have depended on mostly unmanaged, native forests to provide the bulk of our forest products in Indiana and the Midwest. Significant gains in productivity, time to maturity, consistent product quality, and profitability might be realized by carefully managing and eventually domesticating trees.
Reduced height growth

No reaction to competition

Less extensive root system

Pest resistance

Greater carbon allocation to stem

Phytoremediation

TREE DOMESTICATION
Indiana Strategy

1. Improve Indiana Hardwood Forests
2. Assure availability of raw materials
3. Maintain Competitiveness of Indiana Manufacturers
4. Brand/Market Indiana Hardwood Products

- Hardwood Tree Improvement and Regeneration Center
- Right to Practice Forestry Bill
- Advanced Manufacturing Techniques (Log Scanning...)
- Wood Cluster Development-logo marketing campaign, web site
Relative Number of Accessions for Each Hardwood Species by the HTIRC
(Woeste and McKenna)

- Red Oak: publicly available
- Black Walnut: publicly available
- Butternut: publicly available as Select seedlings from IDNR-DoF
- White Oak: publicly available
- Black Cherry: publicly available
- Butternut hybrids: publicly available
- American Chestnut: publicly available

Specialty woods
Select Seedling Sales from Indiana State Nurseries

- Select seedlings come from seed orchards established for improving the growth rate and timber quality of high value hardwood species.

- Species available are black walnut, red and white oak, and black cherry.

- Hybrid butternuts with enhanced resistant to butternut canker.
Select Seedlings Sold Through Indiana State Nurseries

<table>
<thead>
<tr>
<th>Seedling Type</th>
<th>Sold ’08-09</th>
<th>Seedlings ’09-10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black Walnut</td>
<td>15,300</td>
<td>15,000</td>
</tr>
<tr>
<td>Red Oak</td>
<td>8,650</td>
<td>0 *</td>
</tr>
<tr>
<td>White Oak</td>
<td>3,150</td>
<td>0 *</td>
</tr>
<tr>
<td>Hybrid Butternut</td>
<td>4,850</td>
<td>4,000</td>
</tr>
<tr>
<td>Black Cherry</td>
<td>1,900</td>
<td>4,000</td>
</tr>
<tr>
<td>Total</td>
<td>33,850</td>
<td>23,000</td>
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</tbody>
</table>

* no seed crop in ‘08
Black walnut continues to be a priority target of conventional tree breeding to produce trees of high potential for veneer and high quality sawlog production. Progeny testing and seed orchard establishment and management continue.
**Black Walnut Improvement – Progeny Testing**

**Progress from 2002 to 2008 – Our goal is to test each family at 6 sites over 2 different years**

<table>
<thead>
<tr>
<th># Families</th>
<th># Tests</th>
<th># Seedlings</th>
</tr>
</thead>
<tbody>
<tr>
<td>32</td>
<td>6</td>
<td>11,289</td>
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<tr>
<td>25</td>
<td>5</td>
<td>5,635</td>
</tr>
<tr>
<td>21</td>
<td>4</td>
<td>3,890</td>
</tr>
<tr>
<td>19</td>
<td>3</td>
<td>2,291</td>
</tr>
<tr>
<td>18</td>
<td>2</td>
<td>1,298</td>
</tr>
<tr>
<td>32</td>
<td>1</td>
<td>1,507</td>
</tr>
<tr>
<td><strong>147</strong></td>
<td><strong>21</strong></td>
<td><strong>25,910</strong></td>
</tr>
</tbody>
</table>

**The outcome:**
Families that perform well are retained in seed orchards & seed is bulked for select and future improved seed lots. Average & poor families are cut out of seed orchards.
Some results of walnut progeny testing

- 147 Families and > 25,900 seedlings in tests
- Tests are spread over several sites across the Midwest and Great Lakes regions.
- Select vs. Standard seedlings comparisons after 5 years:
  - Height – 9 to 15% gains
  - DBH – 17 to 18% gains
  - Quality rating – 13 to 18% gains
Phase 1 Grafted Walnut Clone Trials

Indy, IN ‘03

Union City, MI ‘05

Delano, TN ‘05

Columbia, MO ‘06

LaCrosse, WI ‘07
Annual height growth of the Indy clone trial. Significant differences in yrs. 3 & 4 for the hybrid (*) vs. J. nigra clones.
5th yr. timber quality at the Indy clone trial.

5=excellent; 4= above average; 3= average; 2= below average; 1= poor timber form. Checkered columns are hybrids; check (CK) are non-grafted rootstocks. Bars = 1 SD.
5th yr height of 7 seed populations at Fishers, IN. Yellow & Orange are seed orchard populations and the other 5 represent typical bed-run IN seed sources. Soil is average for walnut growth (10 Blocks). Bars = 1 SD.
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Off-Campus Test Plantings on Private Land

2003 Walnut PT 1, B-nut PT, Walnut Pop & Clone Test

2004 Walnut PT 2

2005 Walnut PT 3

2006 Cherry Prov. & Walnut PT 4

Current Plantings at Martinsville, IN as of 2006
- 20 acres -
5th yr height of 7 seed populations at Martinsville, IN. Yellow & Orange are seed orchard populations and the other 5 represent typical IN seed. Light bars are good walnut soil (4 Blocks) and dark bars are poor to moderate walnut soil (6 Blocks).
Black Walnut Tissue Culture

Clonal propagation and rooting from nodal explants

Adventitious shoot regeneration from leaf explants of black walnut
Black Walnut Tissue Culture

- Herbicide Tolerance
- Sterility
- Wood Quality

54 to 100% Transformation rate
21% mature and germinate into plants
Select black cherry from Allegheny NF being evaluated for inclusion in HTRIC improvement program. Scion wood from these trees is now being used to improve Indiana black cherry.
Cherry selections comparison between Pennsylvania and Indiana / S. Michigan

- Testing selections of elite phenotypic black cherry from the Allegheny Plateau and Southern and Central Indiana and Southern Michigan for comparison of growth rate, form characteristics, and gum spot.

- The causes and management of gum spotting are being investigated.
Gummosis or gum spots are a significant defect in cherry veneer.

Several factors may cause gum spots, but the predominant cause appears to be insects, particularly the peach bark beetle.

*Adult peach bark beetle.* (Bradley D. Barnd)
Recommendations to Manage Gummosis

- Stressed trees are more likely to be infested by peach bark beetle – site/soil selection.
- Thin to promote tree vigor.
- Remove dead or dying cherry and cherry slash.
- If peach bark beetle populations are high, they will infest even healthy cherry, so sanitation and limiting feeding/breeding material is important.
Black Cherry Tissue Culture

Gummosis
Borer Resistance
Flowering Control
Clonal Propagation

78% rooting with 3.4 roots per shoot

Seedling and mature trees
36% rooting; 3.1 roots per shoot
86% plantlet survival
Black Walnut Heartwood Formation

- Isolated genes from sapwood, heartwood, and sapwood-heartwood transition zone
- Discovered >2000 new genes
- Will determine genes that control and function in heartwood formation
- Goal: Add economic value to hardwoods by breeding and engineering trees for less sapwood in walnut and less heartwood in maple
Propagating Trees with Figured Wood

- We are running tests to determine if trees with figured wood can be propagated from scion wood or by cloning.
- Curly/fiddleback
- Birdseye
- Black Walnut
- Sugar Maple
The first round of tests on grafted trees from figured walnut parents did not yield consistent figure.

Most samples had no figure, some had scattered figure in the board, which generally counts as a defect in veneer.

These grafts were placed on nursery-run rootstock - Roots may exert some control on wood fiber orientation.

New tests will look at rooted seedlings from the parent tree, or sprouted seed from the parent tree.

Lines of figured maple test trees are not yet old enough to check for figure.
Poplar (Populus) hybrid with figure
The tree was selected and planted by Dr. Samuel Grober and donated to Purdue for continued research.

Early tests indicate this tree has passed figured grain characteristics to grafts placed on straight-grained rootstock.

Further testing will determine potential applications in plantations as a fast growing tree for specialty figured veneer and lumber.
Phyto-remediation: Trees Can Absorb Pollution?

Trees are capable of cleaning the air, water, and soil of a variety of pollutants.

Trees are being used to clean up the soil and water in abandoned industrial sites, a process called phyto-remediation.

The tree roots absorb harmful chemicals and metals and convert them to harmless compounds inside the tree.

Poplars are overtaking this old mine site, and perhaps cleaning up some pollution.

Dr. Richard Meilan examines poplars being developed for phyto-remediation.
Butternut Conservation (Woeste)

- Plantings of selections to test for resistance.
- Identification of pure vs. hybrid butternut.
- Providing management guidelines for butternut conservation and propagation.
1st HTIRC Butternut Breeding Orchard – Established 2002

Photo July ‘06

Inoculation of butternut with canker disease to screen for resistance
Chestnut Field Tests

- Once blight resistant American chestnut is readily available, how should it be propagated and managed?
- How does Am. chestnut perform compared to other hardwood trees?
- Cooperating with American Chestnut Foundation
Field Test to Compare Chestnut Growth to Black Cherry and Red Oak (Jacobs and Gauthier)
Back-crossed Trees Are Screened for Disease Resistance. Resistant Trees will be used for seed production and continued research.

Chestnut blight culture is placed in the stem.

Plug of blight culture is placed in the stem.
Chestnut growth study in a mixed plantation in WI

- Seven and eight year old American Chestnut, Red Oak, and Black Walnut evaluated for total height, basal diameter, and DBH.

- American Chestnut dominated all measurement categories:
  - Height – AmCh 6.4 m    BLW 4.4 m    REO 3.6 m
  - DBH – AmCh 6.4 cm    BLW 4.3 cm    REO 2.7 cm

- Am. Chestnut was able to grow quickly from the start to dominate the surrounding trees.
White Oak Improvement Program

- In Cooperation with IN Division of Forestry, selections from 20+ year old white oak plantings will be used to start grafted seed orchards.
- White oak lines will be selected for early seed bearing for wildlife, and fast growth and good stem form for timber production.
The naturally-occurring bacterium Bacillus thuringiensis – Bt – is an intestinal toxin of EAB and other insect species. If the gene expressing this toxin can be introduced into ash, resistance to EAB damage may be imparted.

Reproductive sterility may also be required for any deployed plants, to prevent genetic flow into native populations.

Cloning techniques are required to reproduce exact copies of the transgenic ash – tissue culture and rooted cuttings.
Some other work in progress

- Examining the impact of controlled-release fertilizer, and deer browse protection on growth of nursery-run and Select hardwood seedlings.
- Examining the differences in performance of container-grown and nursery bed-grown hardwood seedlings
- Engagement with the Thousand Cankers disease issue in black walnut.
Some Additional Projects

- Symposium on Ash in North America
  March 9-11, 2010 in West Lafayette, IN

- Natural Resource Enterprises programs
  Sept. 2, 2009 near Linden, IN and Sept. 3, 2009 near Unionville, IN

- Visit www.htirc.org for details
HTIRC Outreach: Publications and Newsletter

- Planting and Care of Fine Hardwood Seedlings at www.htirc.org – under publications
- Semi-annual email newsletter
  Contact Lenny Farlee or go to the website to subscribe:
  lfarlee@purdue.edu
Thank You! Questions?

If you wish to contact us:

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