The Pawpaw: Its Past, Present, and Future

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Adjunct Associate Professor of Horticulture/ Univ. of Kentucky
The North American Pawpaw

- Asimina triloba (L.) Dunal.
- Slow growing, moderate sized tree; pyramidal in full sun
- Fruit:
  - Clusters of 1-13 fruit
  - Fruit up to 2 lbs.
Native Range (Asimina triloba)

http://plants.usda.gov
Pawpaws in the Wild

- A. triloba is usually found in the forest understory in hardwood forests
- Clonal reproduction by root suckering
- You may not find many fruit (shade, self-incompatibility, lack of pollinators)
The Pawpaw Fruit

- Tropical-like flavor and aroma
  - banana, mango, and pineapple
- Nutritious and high in antioxidant activity
- Blended fruit drinks, ice creams, yogurt, etc.
Pawpaw Market Potential

- Farmers Markets
  - Fruit: $1 each
  - $2 to $3/pound
- Gourmet Market
  - Frozen pulp
  - Ice cream
- Restaurants
History of the Pawpaw

- In 1541 Spanish explorer Hernando de Soto found Native Americans growing and eating pawpaws in the valley of the Mississippi.
- Lewis and Clark recorded in their journal (18 Sept. 1806) how pawpaws helped save them from starvation.
- Daniel Boone and Mark Twain were pawpaw fans.
Pawpaw Tree Incident
(Marker Number: 2047)

County: Pike
Location: Near Buskirk, KY 1056

Description: This episode is result of August 1882 election-day fight. Tolbert, a son of Randolph McCoy, exchanged heated words with Ellison Hatfield, which started a fight. Tolbert, Pharmer and Randolph McCoy Jr. stabbed Ellison to death. Later the three brothers were captured by Hatfield clan, tied to pawpaw trees, and shot in retaliation. Presented by Pikeville-Pike County Tourism.
Domesticating Pawpaw

- In 1916, best pawpaw contest sponsored by the American Genetics Association
  - “intelligent breeding” would result in commercial quality varieties and an industry would begin (Popenoe 1916, 1917).

- An industry did not develop

- One reason for the failure of pawpaw to become popular could be rapid perishability of fruit
New Interest in Pawpaw

- From 1950 and 1985, interest grew nurtured by individuals in the Northern Nut Growers Association
- The PawPaw Foundation was founded in 1988, by R. Neal Peterson
- Ohio Pawpaw Festival (1999-present), Ohio Pawpaw Growers Association (2000), and Appalachian Pawpaw Growers Association (2008)
The Kentucky State University Pawpaw Research Program

- **Program Leaders:**
  - Brett Callaway (1990-1993)
  - Desmond Layne (1994-1997)
  - Kirk Pomper (1998-Present)

- **USDA National Clonal Germplasm Repository for Pawpaw; satellite of Corvallis, OR (1994)**

- 2000 accessions from 17 different States; over 45 cultivars
Establishing A Pawpaw Orchard

- “Pawpaw Planting Guide”

- Site
  - air drainage (frost)
  - deep, fertile, well-drained soil, pH 5.5-7.0
  - Weed control
    - Johnson grass
  - water source for irrigation
Pawpaw Propagation and the Nursery Industry

- High tree prices are limiting development of an industry
  - Seedlings $5-$10
  - Grafted trees $15-$30

- Grafted trees (named cultivars) produce fruit sooner after planting and have a known fruit quality.
If you do produce trees from seed: Historically, pawpaws have been a difficult tree species to propagate:
- Seed requires stratification (3 months of refrigeration)
- Desiccation sensitive (do not dry out)
- Seed is killed by freezing

Commercial clonal propagation of cultivars is via chip budding onto seedling rootstock

Many nurseries grow pawpaw seedlings in containers

Top working existing trees
What cultivars should I plant?
Variety Trial at KSU

- 28 selections, 10 named varieties, 224 total grafted trees on PPF seedling rootstock (half-sib seed)
- Spacing 2 m (6.5 ft) between trees, 5.5 m (18 ft) between rows
# Commercially Available Cultivars

<table>
<thead>
<tr>
<th>Clone</th>
<th>Genetic background</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘Middletown’</td>
<td>Wild seedling from Middletown, Ohio</td>
</tr>
<tr>
<td>‘Mitchell’</td>
<td>Wild seedling from Iuka, Ill.</td>
</tr>
<tr>
<td>‘NC-1’</td>
<td>‘Davis’ female × ‘Overleese’ male</td>
</tr>
<tr>
<td>‘Overleese’</td>
<td>Cultivated (open-pollinated) seedling from Rushville, Ind.</td>
</tr>
<tr>
<td>‘PA-Golden’</td>
<td>Second-generation seedling from G.A. Zimmerman collection</td>
</tr>
<tr>
<td>‘Sunflower’</td>
<td>Wild seedling from Chanute, Kans.</td>
</tr>
<tr>
<td>‘Wells’</td>
<td>Cultivated (open-pollinated) seedlings from Salem, Ind.</td>
</tr>
<tr>
<td>‘Wilson’</td>
<td>Wild seedling from Cumberland, Ky.</td>
</tr>
</tbody>
</table>
# Seedlings of Commercially Available Cultivars

<table>
<thead>
<tr>
<th>Clone</th>
<th>Genetic background</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-7-1</td>
<td>Shenandoah: Open-pollinated seedling of ‘Overleese’</td>
</tr>
<tr>
<td>1-23</td>
<td>Open-pollinated seedling of ‘Taylor’</td>
</tr>
<tr>
<td>1-68</td>
<td>Open-pollinated seedling from ‘Overleese’</td>
</tr>
<tr>
<td>8-20</td>
<td>Open-pollinated seedlings of ‘Sunflower’</td>
</tr>
<tr>
<td>Clone</td>
<td>Open-pollinated seedling of</td>
</tr>
<tr>
<td>-------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>1-7-2 Wabash</td>
<td>BEF-30</td>
</tr>
<tr>
<td>2-10</td>
<td>BEF-30</td>
</tr>
<tr>
<td>2-54</td>
<td>GAZ-V-A</td>
</tr>
<tr>
<td>3-11</td>
<td>BEF-33</td>
</tr>
<tr>
<td>3-21</td>
<td>BEF-43</td>
</tr>
<tr>
<td>4-2 Potomac</td>
<td>BEF-53</td>
</tr>
<tr>
<td>5-5</td>
<td>BEF-54</td>
</tr>
<tr>
<td>7-90</td>
<td>RS-2</td>
</tr>
<tr>
<td>8-58 Rappahannock</td>
<td>BEF-30</td>
</tr>
<tr>
<td>9-47</td>
<td>BEF-49</td>
</tr>
<tr>
<td>9-58</td>
<td>BEF-50</td>
</tr>
<tr>
<td>10-35</td>
<td>BEF-49</td>
</tr>
<tr>
<td>11-5 Susquehanna</td>
<td>BEF-53</td>
</tr>
<tr>
<td>11-13</td>
<td>BEF-53</td>
</tr>
</tbody>
</table>

**BEF** = Blandy Experimental Farm Collection, Boyce Va.

**GAZ** = George A. Zimmerman Collection., Linglestown, Pa.

**RS** = Ray Schlaanstine Collection, West Chester, Pa.
Fruit Production on Mature Trees 2004-2006 in Frankfort

<table>
<thead>
<tr>
<th>Clone</th>
<th>Average fruit weight (g)</th>
<th>Average number of fruit per tree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potomac</td>
<td>235 a</td>
<td>44 ghi</td>
</tr>
<tr>
<td>5-5</td>
<td>188 b</td>
<td>39 hi</td>
</tr>
<tr>
<td>Wabash</td>
<td>185 b</td>
<td>65 fg</td>
</tr>
<tr>
<td>Susquehanna</td>
<td>184 b</td>
<td>39 i</td>
</tr>
<tr>
<td>NC-1</td>
<td>179 bc</td>
<td>44 ghi</td>
</tr>
<tr>
<td>Overleese</td>
<td>170 bcd</td>
<td>54 fghi</td>
</tr>
<tr>
<td>8-20</td>
<td>170 bcd</td>
<td>59 fghi</td>
</tr>
<tr>
<td>1-68</td>
<td>167 bcd</td>
<td>90 cde</td>
</tr>
<tr>
<td>2-10</td>
<td>160 cde</td>
<td>52 fghi</td>
</tr>
<tr>
<td>Shenandoah</td>
<td>156 def</td>
<td>78 def</td>
</tr>
<tr>
<td>Sunflower</td>
<td>155 def</td>
<td>74 def</td>
</tr>
<tr>
<td>9-58</td>
<td>146 efg</td>
<td>79 def</td>
</tr>
<tr>
<td>10-35</td>
<td>145 efg</td>
<td>105 abc</td>
</tr>
</tbody>
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<td>137 efg'h</td>
<td>68 ef</td>
</tr>
<tr>
<td>7-90</td>
<td>135 fghi</td>
<td>74 def</td>
</tr>
<tr>
<td>1-23</td>
<td>126 ghij</td>
<td>90 cde</td>
</tr>
<tr>
<td>11-13</td>
<td>124 hij</td>
<td>75 def</td>
</tr>
<tr>
<td>Taytwo</td>
<td>121 hijk</td>
<td>73 def</td>
</tr>
<tr>
<td>2-54</td>
<td>121 hijk</td>
<td>73 def</td>
</tr>
<tr>
<td>3-21</td>
<td>115 ijk'l</td>
<td>60 fghi</td>
</tr>
<tr>
<td>Mitchell</td>
<td>112 jkl</td>
<td>58 fghi</td>
</tr>
<tr>
<td>PA-Golden</td>
<td>108 jkl'm</td>
<td><strong>118 ab</strong></td>
</tr>
<tr>
<td>Taylor</td>
<td>106 jkl'm</td>
<td>68 efg</td>
</tr>
<tr>
<td>Wells</td>
<td>104 klm</td>
<td>64 fgh</td>
</tr>
<tr>
<td>9-47</td>
<td>100 lm</td>
<td>74 def</td>
</tr>
<tr>
<td>Rappahannock</td>
<td>96 lm</td>
<td>96 bcd</td>
</tr>
<tr>
<td>Wilson</td>
<td>89 mn</td>
<td><strong>128 a</strong></td>
</tr>
<tr>
<td>Middletown</td>
<td>75 n</td>
<td>74 def</td>
</tr>
</tbody>
</table>
NC-1

- Fruit weight: 179 g
- Number of fruit/tree: 44
- Good flavor
- Available from many commercial nurseries
Overleese

- Fruit weight: 170 g
- Number of fruit/tree: 54
- Good flavor (melon)
- Available from many commercial nurseries
Sunflower

- Fruit weight: 155 g
- Number of fruit/tree: 74
- Mild flavor
- Available from many commercial nurseries
Potomac

- Fruit weight: 235 g
- Number of fruit/tree: 44
- Good flavor
- Fruit cracking?
- Available:
  - Nolin River Nut Tree Nursery
  - Forest Keeling
Shenandoah

- Fruit weight: 156 g
- Number of fruit/tree: 78
- Mild flavor
- Available:
  - Nolin River Nut Tree Nursery
  - Forest Keeling
Wabash

- Fruit weight: 185 g
- Number of fruit/tree: 65
- Dark flesh
- Cracking issues
- Available:
  - Nolin River Nut Tree Nursery
  - Forest Keeling
Establishing a Pawpaw Orchard

- Pawpaw will fruit in the shade, optimum yields are obtained in open exposure
- Grass and weed control!
- Shading recommended the first year
- Irrigation should be provided at least the first two years
Pawpaw Pruning
Field Planting Pawpaw

- 8' between trees, 18' between rows
- 295 trees/ac
- Tree seldom grow taller than 25 feet
Fertilization and Irrigation of Pawpaw

- **Trickle Irrigation:**
  - emitters (1 gal/hr) with 2 emitters/tree
  - about 240 gal/tree/yr.

- **Fertigation:** Peters 20-20-20 (3 times each yr.)
  - 0.6 oz N/tree/yr.

- **Granular (10-10-10)**
  - 1 oz N/tree/yr., 2 oz N/tree/yr. after two years
Pawpaw Pests and Diseases

- Leaf and fruit spot (*Phyllosticta*)
- Japanese beetles
- Leaf rollers
- Zebra swallowtail butterfly-not necessarily a pest
- *Talponia plumeriania* - pawpaw peduncle borer
Pawpaw Flowering and Harvest

- Flowers: male and female parts in a flower
- Cross-pollinate (self-fruitful?)
- Pollinated by flies and beetles
- Ripe fruit-soft
- Color change not a reliable indicator of ripeness
- Harvest from the same tree over several weeks
The Potential of Pawpaw

- Fresh market-unique flavor
- Appearance-not unappealing
- Post harvest handling issues
  - Bruising
  - Short shelf-life of about 7 days at room temp
  - Storage for 2-3 wks under refrigeration
The Potential of Pawpaw

- Processing pulp
  - Hand processing
  - Labor intensive
Roma Food Processor with Grape Spiral with Pumpkin Screen
Research Update from KSU

- New Cultivar development
- Fruit thinning
- Rootstock and Training trial
Further Germplasm Improvement

- Evaluation of:
  - Seedling populations from throughout the native range
  - Crosses from Neal Peterson
  - Hybrid material from Asimina triloba x A. reticulata
KSU-Atwood™
2011 Pawpaw Variety Trial

Hy3-120
aka ‘State Fair’
## 2011 Pawpaw Regional Variety Trial

<table>
<thead>
<tr>
<th>row</th>
<th>tree</th>
<th>Name &amp; comments</th>
<th>Total # fruit</th>
<th>avg frt wt oz</th>
<th>yield lbs/tree</th>
<th>% frt &gt;3.5 oz</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>20</td>
<td>Salem, IN (late flowering)</td>
<td>272</td>
<td>3.1</td>
<td>52.6</td>
<td>28%</td>
</tr>
<tr>
<td>4</td>
<td>25</td>
<td>Ithaca, NY (coconut flavor)</td>
<td>92</td>
<td>6.0</td>
<td>34.8</td>
<td>89%</td>
</tr>
<tr>
<td>9</td>
<td>109</td>
<td>11-13 x 1-23 (large fruit)</td>
<td>254</td>
<td>7.2</td>
<td>114.8</td>
<td>93%</td>
</tr>
<tr>
<td>9</td>
<td>111</td>
<td>11-13 x 1-23 (high yield)</td>
<td>500</td>
<td>5.4</td>
<td>168.0</td>
<td>79%</td>
</tr>
<tr>
<td>3</td>
<td>25</td>
<td>2-9 x 10-35 (firm?)</td>
<td>148</td>
<td>4.2</td>
<td>39.0</td>
<td>65%</td>
</tr>
<tr>
<td>5</td>
<td>23</td>
<td>Ithaca, NY (early ripening)</td>
<td>139</td>
<td>5.7</td>
<td>49.8</td>
<td>82%</td>
</tr>
</tbody>
</table>
Fruit Thinning to Increase Fruit Size
Average fruit weights of hand-thinned and unthinned pawpaw fruit in 2006 and 2008

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Fruit weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2006</td>
</tr>
<tr>
<td>Hand-Thinned</td>
<td>129</td>
</tr>
<tr>
<td>Control</td>
<td>88</td>
</tr>
<tr>
<td>significance</td>
<td>**</td>
</tr>
</tbody>
</table>

Planted spring 2004
Photo taken 1/28/08

Central leader

Minimal pruning
Planted spring 2004
Photo taken 4/21/10
## 2009 Growing Season

<table>
<thead>
<tr>
<th>Scion</th>
<th>Survival</th>
<th>TCA</th>
<th># of clusters</th>
<th># of Flower Buds</th>
<th># of Fruit</th>
<th>fruit per cluster</th>
<th>fruit wt (oz)</th>
<th>Yield (lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Susquehanna</td>
<td>61%</td>
<td>23.3</td>
<td>7.0</td>
<td>65</td>
<td>21</td>
<td>2.7</td>
<td>9.4</td>
<td>11.7</td>
</tr>
<tr>
<td>Sunflower</td>
<td>76%</td>
<td>22.1</td>
<td>17.0</td>
<td>136</td>
<td>36</td>
<td>2.1</td>
<td>6.7</td>
<td>15.2</td>
</tr>
<tr>
<td>P-value</td>
<td>NS</td>
<td>NS</td>
<td>***</td>
<td>***</td>
<td>*</td>
<td>***</td>
<td>(l)</td>
<td>NS</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rootstock</th>
<th>Survival</th>
<th>TCA</th>
<th>number of fruit</th>
<th>fruit weight (g)</th>
<th>Yield (kg)</th>
<th>fruit set</th>
</tr>
</thead>
<tbody>
<tr>
<td>RVT</td>
<td>73 ab</td>
<td>21.7</td>
<td>32</td>
<td>218 ab</td>
<td>6.3</td>
<td>15%</td>
</tr>
<tr>
<td>Sunflower</td>
<td>87 a</td>
<td>23.2</td>
<td>22</td>
<td>226 a</td>
<td>5.1</td>
<td>8%</td>
</tr>
<tr>
<td>PA-Golden</td>
<td>75 ab</td>
<td>25.3</td>
<td>33</td>
<td>235 a</td>
<td>7.2</td>
<td>17%</td>
</tr>
<tr>
<td>K8-2</td>
<td>57 bc</td>
<td>20.8</td>
<td>22</td>
<td>176 b</td>
<td>4</td>
<td>33%</td>
</tr>
<tr>
<td>Susquehanna</td>
<td>48 c</td>
<td>20.8</td>
<td>40</td>
<td>220 ab</td>
<td>8.2</td>
<td>13%</td>
</tr>
<tr>
<td>P-value</td>
<td>**</td>
<td>NS</td>
<td>NS</td>
<td>*</td>
<td>NS</td>
<td>NS</td>
</tr>
</tbody>
</table>

*P*-value: NS (not significant), ** (significant at 0.01 level), *** (significant at 0.001 level)
## 2009 Growing Season

<table>
<thead>
<tr>
<th>Scion</th>
<th>Survival</th>
<th>TCA</th>
<th># of fruit</th>
<th>fruit weight (g)</th>
<th>Yield (kg)</th>
<th>fruit set</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimal Pruning</td>
<td>60%</td>
<td>28.5</td>
<td>35</td>
<td>7.4</td>
<td>7.3</td>
<td>25%</td>
</tr>
<tr>
<td>Central Leader</td>
<td>76%</td>
<td>17.8</td>
<td>25</td>
<td>7.9</td>
<td>5.3</td>
<td>10%</td>
</tr>
<tr>
<td>P-value</td>
<td>*</td>
<td>***</td>
<td>NS</td>
<td>(l)</td>
<td>NS</td>
<td>*</td>
</tr>
</tbody>
</table>

*pawpaw.kysu* provides information on how to grow and use fruit from the North American pawpaw tree.
Questions?