Variation in Pawpaw (*Asimina triloba* L. Dunal) Cultivar Productivity and Quality Across a Biogeographic Gradient in Ohio

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Thank you!

Collaborating Farmers
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Committee
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Funders
• The Ohio Department of Agriculture
• What is a pawpaw?
• Chapter 1: Variation in pawpaw (*Asimina triloba* L. Dunal) cultivar productivity across a biogeographic gradient
• Chapter 2: Effects of the biogeographic gradient of Ohio and ripeness spectrum on fruit quality in ten pawpaw (*Asimina triloba* L. Dunal) cultivars
• Conclusions
Pawpaw Trees

Pawpaw fruit

Patch of pawpaw trees
Natural range of pawpaw in North America
Chapter 1: Drivers of Yield?

• Objectives
  – Develop allometric relationship for pawpaw fruit
  – Model total number fruit produced
  – Model total fruit mass
  – Model pulp mass
Methods - Site Selection
Method-Field Monitoring
Methods-Estimating Yield

1. Tallied fruit by size class for each tree
2. Allometric model to predict mass
   – Applied to size classes for each tree
   – Estimated total fruit mass
   – Estimated pulp mass
3. Estimated yield of each tree
## Allometric Relationships

<table>
<thead>
<tr>
<th>Model</th>
<th>Total Fruit Mass $R^2$</th>
<th>Pulp Mass $R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cultivar × Fruit size</td>
<td>0.94</td>
<td>0.76</td>
</tr>
<tr>
<td>Genetic Grouping × Fruit size</td>
<td>0.94</td>
<td>0.72</td>
</tr>
</tbody>
</table>
Total number produced by 20 cultivars

- Total Fruit
- Cultivar
  - Alle
  - G9-109
  - G9-111
  - Hi4-1
  - Hy3-120
  - KNSU2-11
  - Lynn
  - NC1
  - Over
  - PA
  - Pot
  - Quaker
  - Rap
  - Shaw
  - Shen
  - Sie
  - Sun
  - Sus
  - Wab
  - Well

- DBH
## Different types of Yield models

<table>
<thead>
<tr>
<th>Model</th>
<th>Cultivar</th>
<th>Group</th>
<th>DBH (cm)</th>
<th>Flower Count</th>
<th>R²c</th>
<th>R²m</th>
</tr>
</thead>
<tbody>
<tr>
<td># of Fruit</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>0.21</td>
<td>0.99</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.20</td>
<td>0.97</td>
</tr>
</tbody>
</table>

Within a row darker colors are larger effect sizes and asterisk in block indicates significant
Total Number of Fruit

Bars with different letters are significantly different
Comparing Total Fruit Mass per tree

Bars with different letters are significantly different.
Conclusions

• Allometric relationship allows for non-destructive estimation of yield
• Total number of fruit effected most by size of tree
• Total fruit mass and pulp mass effected most by flower counts
• Site effects substantial part of variance for all models
Objectives Chapter 2

• Objectives
  – Investigate how site, cultivar, and ripeness score effect fruit quality
  – Evaluate how site, cultivar, and ripeness score effect homogeneity of fruit
What is Quality?

• What is Quality?
  – Multivariate concept of best fruit possible for the market
  – Differs for each specific market

• Is homogeneity wanted?
  – Consistency across all marketed fruit
  – Desired by distributors
Methods-Ripeness

• OPGA ripeness chart developed by Terry Powell
• Score 1 least ripe
• Score 5 most ripe
Methods- Laboratory Assessments
## Fruit Quality Metrics Definitions

<table>
<thead>
<tr>
<th>Quality Metric</th>
<th>Description</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruit Moisture</td>
<td>% of water in pulp</td>
<td>Oven Drying</td>
</tr>
<tr>
<td>Length to Width ratio</td>
<td>Measurement of size (%)</td>
<td>Measured</td>
</tr>
<tr>
<td>Weight of Pulp</td>
<td>Pulp weighed after skin and seeds removed</td>
<td>Measured</td>
</tr>
<tr>
<td>Seed to Pulp ratio</td>
<td>Weight of seed to weight of pulp (%)</td>
<td>Measured</td>
</tr>
<tr>
<td>Fruit <em>Phyllostica</em> Abundance</td>
<td>% of skin covered</td>
<td>Photographic</td>
</tr>
<tr>
<td>Skin Hardness</td>
<td>Force to break skin (N)</td>
<td>Force gauge</td>
</tr>
<tr>
<td>Flesh Hardness</td>
<td>Resistance to flesh puncture (N)</td>
<td>Force gauge</td>
</tr>
<tr>
<td>Brix</td>
<td>Sugar Content (°)</td>
<td>Refractometer</td>
</tr>
<tr>
<td>L Average Flesh</td>
<td>Light to dark for flesh</td>
<td>Colorimeter</td>
</tr>
<tr>
<td>L Average Skin</td>
<td>Light to dark for skin</td>
<td>Colorimeter</td>
</tr>
<tr>
<td>pH</td>
<td>Acidity level</td>
<td>Meter</td>
</tr>
<tr>
<td>DeltaE</td>
<td>Browning potential</td>
<td>Colorimeter</td>
</tr>
</tbody>
</table>
PCA of Fruit Quality Metrics
PCA - Effect of Ripeness on Fruit Quality
PCA-Effect of Cultivar on Fruit Quality
PCA-Effect of Cultivar on Fruit Quality

Shenandoah

Susquehanna
PCA - Effect of Cultivar on Fruit Quality
PCA-Effect of Cultivar on Fruit Quality

Allegheny

Susquehanna
PCA-Effect of Site on Fruit Quality

Valley View
Partitioning of Variance

Cultivar

Site

Ripeness Score

Residuals=0.74

Values <0 not shown
Conclusions

• Predicted Total fruit mass and pulp mass show significant interaction between DBH and Flowering counts.

• Site is important factor in quality and yield
  – Cultural practices may lead to more homogenous fruit
  – More rigorous testing for some of the individual fruit metrics
  – Cultivar recommendations
    • Susquehanna and Potomac