Apple Tree Architecture Part 1: Field-testing new cultivars and rootstocks

Chris Walsh, Julia Harshman and Anna Wallis
University of Maryland
College Park, MD

Bryan Butler
University of Maryland Extension
Carroll County, Maryland

Douglas Price
Maryland Agricultural Experiment Station

Gennaro Fazio
USDA-ARS, Cornell-Geneva
Changes in the US Apple Orchard
Currently in the US:
No Ladders but a Lot of Labor
High Density Systems
Dependent on Location

Geneva NY ~1200 trees per acre
North Carolina ~450-600 trees per acre

What about here?
Released GENEVA® Apple Rootstocks Arranged by Tree Size

M.27 Size
M.9 T337
M.9 PAJ 2
M.26 Size
M.7-MM106 Size
G.65
G.11
G.41
G.935
G.202
G.30

Seedling Size

http://cornell.flintbox.com/public/project/21526
April 2010 (Latin Square)

- Cripps Pink and Brookfield Gala budded into all rootstock
- Trained to tall-spindle system: 6’x12’
Planting at Keedysville WMREC

Data
- Fruit Quality
- Tree Size
- Productivity
- Tree Survival
Tree Size

### Gala Circumference

<table>
<thead>
<tr>
<th>Year</th>
<th>G.202</th>
<th>G.202TC</th>
<th>G.41</th>
<th>G.935</th>
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<tbody>
<tr>
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### Cripps Pink Circumference

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### Gala Height

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Results: Fruit Quality

No significant differences were found in:
- Mean fruit weight
- % Red
- Color L*a*b*
- Soluble solids (°Brix)
- Firmness (kg)
- Starch content
- Size and shape (height & diameter)
Tree Survival

Storm Damage July 2011
Hail Storm August 2013
Storm Damage July 2014
<table>
<thead>
<tr>
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<th>41</th>
</tr>
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<tbody>
<tr>
<td>Gala</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(not significant)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G.202TC (3)</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>G.935 (1)</td>
<td></td>
<td>X</td>
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<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>G.41 (13)</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
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<td>G.935 (9)</td>
<td></td>
<td>X</td>
<td></td>
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**Key**
- **X** indicates presence
- **none** indicates absence

**Gala**
- (not significant)
- G.202TC (3)
- G.935 (1)

**Cripps Pink**
- G.202 and G.202TC nearly 100% survival
- G.41 (13)
- G.935 (9)
Anecdotal & Research Reports of graft union weakness

Keedysville
- Rootstock shank breaks
  Brittle rootstock?

Nursery in Virginia
- G.935 – significant losses

Penn State & Utah State Research
- Anatomical differences
Preliminary Conclusions

- No significant differences in fruit quality or size between these rootstocks
- Yield & efficiency
  Greater in G.935 for Gala
  No difference with Cripps Pink
- Tree Survival – Depended on scion
  G.202 and G.202TC exhibited near 100% survival
  G.41 and G.935 experienced significant losses

Cripps Pink is a fire blight susceptible weak scion
Trade-off? Fire blight tolerance vs wind damage
Maryland Tree Architecture Project Part 2: Breeding New, Grower-Friendly Apple Trees

Christopher S. Walsh
and
Julia M. Harshman
Plant Science and Landscape Architecture
University of Maryland
Although we immediately think about rootstock, tree size is more complicated...

Size = Scion x Rootstock
      Soil x Management

1. Develop long-season, heat-tolerant and fire blight-tolerant apple cultivars

2. Select scions with a structure that requires less hand-pruning labor
Dwarfism Present in Clones of Some Commercial Apple Cultivars

‘Goldspur’, ‘Redspur’, ‘MacSpur’

- Short internodes (although not in ‘MacSpur’)
- Enhanced lateral bud outgrowth into short shoots

Crosses with Redspur x Goldspur were made in the 1980s and 1990s but had limited commercial impact.

Precocity of all these clones appears similar to that found in their parent scions, and dwarf cultivars were not released.
Dwarfism Present in Clones of Some Commercial Apple Cultivars

‘McIntosh Wijcik’
- Shorter Internodes
- Enhanced shoot diameter and lateral bud outgrowth
- Undesirable upright growth habit
- Dominant gene with a visible trait (marker)

Served as the basis for a series of short-season, single-axis of growth apple cultivars which would be planted at > 10,000 trees per acre
The Original MD Cross

- McIntosh Wijcik
  - Cool-season cultivar
  - Fire blight tolerant
  - Not precocious, but genetic dwarfing (Co)

- Gala (Kidd’s D8)
  - Heat-tolerant fruit
  - Fire blight susceptible
  - Vigorous but precocious tree
‘McIntosh Wijcik’ x ‘Gala’ (1991)

‘CompactGalaMac’ or CGMx

1. Selected 250 ‘Wijcik’ types in the greenhouse
2. Initially evaluated trees in the field for precocity and productivity (freezes) and field tolerance to fireblight (multiple hailstorms)
3. Selected 30 best trees for horticultural characteristics of:
   - Moderate vigor
   - Short internode length
   - Open branching (not upright like ‘Wijcik’)
   - Fruit size, appearance and quality
Second Generation Seedlings

Thirty first-generation (CGMx) trees were transplanted using a Vermeer tree spade. These were used as putative ‘males’ in open pollinations.

Second generation seed parents/M9:
- Pink Lady and Fuji
- Commander York and Red Yorking
- Braeburn and GoldRush
‘CompactGalaMac’ 1W
Second Generation Trees at Keedysville: Fire Blight

- Bloom blight was assessed in early June
- Trauma blight was assessed after summer hailstorms
- Trees with more than 10 strikes were removed over a two-year period
Range of fire blight susceptibility
Range in Vigor in Co Phenotypes
Co seedling vs wild types at Keedysville
Second Generation Field Trial

Classified about 100 Fuji and Cripps Pink seedling trees as either Co or Wild types prior to fruiting in spring 2008. Leaders were headed and singled prior to fruiting. No other pruning was done. Measured fruit yield and fruit quality from each tree over four seasons (2008-2011).
Second Generation Field Trial

Data were analyzed as a 2 phenotype x 2 seed-parent factorial

Co phenotype trees were shorter and narrower than the wild-type trees, making them closer to the tall-spindle architecture.

There was no phenotype by seed parent interaction.
## Field Trial: 2008-2011

<table>
<thead>
<tr>
<th>Phenotype</th>
<th>Yield (kg)</th>
<th>Efficiency (kg/cm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Columnar</td>
<td>24.3</td>
<td>1.65</td>
</tr>
<tr>
<td>Wild Type</td>
<td>73.2</td>
<td>1.13</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>Seed parent</th>
<th>Yield (kg)</th>
<th>Efficiency (kg/cm²)</th>
</tr>
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<tbody>
<tr>
<td>Fuji</td>
<td>35.3</td>
<td>1.37</td>
</tr>
<tr>
<td>Cripps Pink</td>
<td>55.3</td>
<td>1.74</td>
</tr>
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Tree Architecture: Apple Phenotypes

- Co hybrids have an unexpectedly wide range of phenotypes

- Is it possible to sort out these variables?

- What would be the best architecture?
Second Generation Fuji: An Undesirable Co Phenotype
Second Generation Fuji: Open Branching, Unpruned
Second Generation Fuji: Open Branching, Unpruned
Second Generation Fuji: Horizontal Limbs, No Pruning
Second Generation Cripps: Open Branching Unpruned
Second Generation Cripps:
What’s Next?
In 2014

- Submitted a Patent Application for ‘Antietam Blush’. It is a productive seedling of Cripps Pink with field tolerance to fire blight. ‘Antietam Blush’ matures in mid-October.

- Contacted interested growers about budding and planting trees in 2016.
For 2015

- A series of Elite seedlings of Fuji, Cripps Pink and GoldRush have been budded onto M.111 for a field trial

- Starting to develop a group of third-generation seedlings which have Elite trees as their seed parent