Optimizing Watermelon Grafting Techniques

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Problem: Verticillium Wilt

- Caused by *Verticillium dahliae* (*Vd*)
- Symptoms are chlorosis, necrosis and wilting
- Management is difficult because:
  - Persistent in soil for up to 14 years (in the form of microsclerotia)
  - Wide host range of about 400 plant species
  - Soil fumigation with methyl bromide in the past but new fumigants are less efficient
  - Soil solarization has moderate efficiency
Verticillium wilt disease progress
Grafting as a biological disease management strategy

Non-grafted watermelon  Grafted watermelon

WSU NWREC Mount Vernon, September, 2017
Grafting – A propagation technique

Grafting is a technique that joins together two plants through their stem vascular tissues in order to take advantage of their combined characteristics.
Step 1. Cut the rootstock at 45° angle, under the cotyledon leaves
Step 2. Cut the scion at 45° angle, ensuring the diameter is the same as the rootstock
Step 3. Place a grafting clip onto the rootstock, rootstocks should occupy half the length of the clip
Step 4. Place the scion into the grafting clip
One cotyledon grafting method

Step 1. Cut the rootstock at a 60° angle with one cotyledon remaining on the plant
Step 2. Cut the scion at a 60° angle below the cotyledons, where its diameter matches that of the rootstock
Step 3. Join the two cut stems together
Step 4. Secure with a grafting clip.
Graft the plants

Place grafted plants in healing chamber

Monitor the healing process daily

Gradually reintroduce grafted plants to greenhouse environment conditions

Acclimate plants to natural environmental conditions

Seed scion and rootstock
Transplanting to Field

Plant the graft union well above the soil line
Efficiency of grafting as a disease management strategy

Soil infestation of *Verticillium dahliae*: 18.0 cfu·g$^{-1}$ at Mount Vernon, WA
Verticillium Wilt Progress

### Fruit Yield

Soil infestation with *Verticillium dahliae*: <1 cfu g\(^{-1}\) at Eltopia, 2.6 cfu g\(^{-1}\) at Othello, and 27 cfu g\(^{-1}\) at Mount Vernon

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Yield per plant (kg)</th>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Eltopia</td>
<td>Othello</td>
<td>Mount Vernon</td>
<td></td>
</tr>
<tr>
<td>TriX Palomar (non-grafted)</td>
<td>14.7</td>
<td>30.4</td>
<td>7.4 b</td>
<td></td>
</tr>
<tr>
<td>TriX (Super Shintosa)</td>
<td>12.2</td>
<td>28.1</td>
<td>14.6 a</td>
<td></td>
</tr>
<tr>
<td>TriX (Tetsukabuto)</td>
<td>11.0</td>
<td>28.7</td>
<td>11.8 a</td>
<td></td>
</tr>
<tr>
<td>TriX (Just)</td>
<td>11.1</td>
<td>23.4</td>
<td>12.7 a</td>
<td></td>
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<tr>
<td>P-value</td>
<td>0.37</td>
<td>0.17</td>
<td>0.009</td>
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</tbody>
</table>
## Fruit Quality

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Firmness (N)</th>
<th>Lycopene (µg.g⁻¹)</th>
<th>TSS %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eltopia</td>
<td>2.20 b</td>
<td>38.58 a</td>
<td>10.28</td>
</tr>
<tr>
<td>Othello</td>
<td>2.44 b</td>
<td>36.54 a</td>
<td>10.51</td>
</tr>
<tr>
<td>Mount Vernon</td>
<td>3.00 a</td>
<td>27.85 b</td>
<td>10.54</td>
</tr>
</tbody>
</table>

*P*-value: < 0.0001 < 0.0001 0.22
Current research on watermelon grafting at WSU
Problem: Availability of Rootstocks

- Grafting onto a resistant rootstock can help manage the disease for watermelon
  - BUT resistant rootstocks are not easily available
Solution: Screening germplasm for resistance

- Germplasm in USDA National Germplasm System is collected from all over the world
  - Potential sources of resistant rootstock
- Screened 56 germplasm accessions from 4 different rootstock species for resistance to Verticillium wilt
- 16 resistant accessions were used as rootstock for watermelon grafting and we assessed:
  - Yield
  - Fruit number
  - Fruit quality
Study conducted in 2017 at Mount Vernon, WA
Problem: Rootstock Regrowth

- Competition with scion for light, space, and water and nutrient uptake
- Decreases graft success
- Death of scion

Scouting plants in the greenhouse
- Time consuming
- Labor intensive

Removing rootstock regrowth in the field

The meristem tissue below the axillary bud

Squash leaves
Possible solution

Splice grafting can be more efficient and cost effective grafting method

➢ Eliminate rootstock regrowth
➢ 2-3 times faster than other available techniques
➢ Less labor cost

Limitation:
• Low carbohydrate level
• Dessication of the grafted seedling during healing
• Low survival rate
Past research

Ongoing research

**Greenhouse studies:** To increase survival of splice-grafted watermelon
Study 1. Effect of antitranspirant applied prior to grafting
Study 2. Effect of sucrose in combination with antitranspirant applied prior to grafting

**Field Study:** Effect of grafting method on fruit maturity and quality as compared to non-grafted watermelon
- Emergence of female flower
- Harvest date
- Hollow heart and hard seed formation
- Quality: fruit firmness, total soluble solids, lycopene content
## Commercially Available Rootstocks

<table>
<thead>
<tr>
<th>Rootstock</th>
<th>Species</th>
<th>Cultivar</th>
<th>Company</th>
<th>Website</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Interspecific squash hybrid</strong></td>
<td><em>Cucurbita maxima</em> x <em>C. moschata</em></td>
<td>Carnivor, Super Shintosa, Strong Tosa</td>
<td>Syngenta</td>
<td><a href="http://www.syngenta-us.com/crops/vegetables">http://www.syngenta-us.com/crops/vegetables</a></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cobalt, Ferro</td>
<td>Rijkzwaan</td>
<td><a href="https://www.rijkzwaanusa.com/crop/rootstock">https://www.rijkzwaanusa.com/crop/rootstock</a></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Flexifort</td>
<td>Enza Zaden</td>
<td><a href="http://www.enzazaden.us/">http://www.enzazaden.us/</a></td>
</tr>
<tr>
<td></td>
<td></td>
<td>RS 841</td>
<td>Seminis</td>
<td><a href="https://www.ahernseeds.com/products/rs841/?lang=en">https://www.ahernseeds.com/products/rs841/?lang=en</a></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bass BS-1, AQ</td>
<td>Origene seeds</td>
<td><a href="http://www.origeneeds.com">http://www.origeneeds.com</a></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Kardosa</td>
<td>Aruba seed</td>
<td><a href="https://www.arubaseed.com/rootstocks">https://www.arubaseed.com/rootstocks</a></td>
</tr>
<tr>
<td><strong>Calabash gourd</strong></td>
<td><em>Lagenaria siceraria</em></td>
<td>Pelop</td>
<td>Rijkzwaan</td>
<td><a href="https://www.rijkzwaanusa.com/crop/rootstock">https://www.rijkzwaanusa.com/crop/rootstock</a></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bingo, Valett F1, Savor</td>
<td>Takii seeds</td>
<td><a href="http://www.takiiseed.com/">http://www.takiiseed.com/</a></td>
</tr>
<tr>
<td></td>
<td></td>
<td>RS 3532</td>
<td>Aruba seed</td>
<td><a href="https://www.arubaseed.com/rootstocks">https://www.arubaseed.com/rootstocks</a></td>
</tr>
<tr>
<td><strong>Wax gourd</strong></td>
<td><em>Benincasa hispida</em></td>
<td>Round, Oblong</td>
<td>Kitazawa seeds</td>
<td><a href="https://www.kitazawaseed.com/seeds_winter_melon.html">https://www.kitazawaseed.com/seeds_winter_melon.html</a></td>
</tr>
<tr>
<td><strong>Citroides</strong></td>
<td><em>Citrullus lanatus</em></td>
<td>Carolina Strongback</td>
<td>Syngenta</td>
<td><a href="http://www.syngenta-us.com/crops/vegetables">http://www.syngenta-us.com/crops/vegetables</a></td>
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[www.vegetablegrafting.org](http://www.vegetablegrafting.org)
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Thank you.
Questions?

For more information on vegetable grafting, visit www.vegetablegrafting.org