Managing Soil-Borne Disease in High Tunnels with Vegetable Grafting

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http://vegetables.wsu.edu

Introduction

- High tunnels increase heat, extending summer production season
- Tomato primary crop grown in tunnels in the U.S.
- Soil-borne diseases build up over time if tunnel is not moved
Vegetable Grafting

Graft Union

Scion

Rootstock

Why Graft Vegetables

1. Soil-borne disease management
   - Verticillium wilt
   - Fusarium wilt

2. Increased vigor and yield
   - Heirloom tomatoes

3. Increased tolerance to environmental stress
   - Temperature extremes
   - Saline soils
**History of Vegetable Grafting**

- **500 A.D.** Chinese text described self-grafting squash
- **1600s** Korean text described grafting vegetables
- **1920s** Japanese watermelon farmer experimented with grafting
- **1946** Researchers in southeast U.S. promoted grafting solanaceous crops onto jimson weed (*Datura stramonium*)
- **1950s** Grafting adopted by commercial tomato growers in Japan
- **1990s** Grafting adopted by European vegetable growers
- **2000s** Grafting adopted by greenhouse tomato growers in Canada

**Commercial Vegetable Grafting**

BEVO Farms, Ltd. Milner, British Columbia, Canada

- Supplies B.C. hothouse tomato industry
- 95% grafting success rate
- 12 workers graft 30,000 plants per 8.5 hour day
Plug Connections
Vista, CA
Sells to home gardeners
Green Paradise Farm
Vista, CA
Grafts for their own use
Healing Grafted Vegetables

- 100% relative humidity desirable
  Plastic cover
  Minimize healing chamber volume

- Temperature 70 – 80 °F
  Shade cloth

- Darken chamber
  Reduce photosynthesis to reduce transpiration

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Healing Chambers

Washington State University NWREC

For Home
### Grafting Equipment

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Purpose</th>
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</thead>
<tbody>
<tr>
<td>Disposable double-edged stainless steel razor blade</td>
<td>To cut scion and rootstock plants</td>
</tr>
<tr>
<td>Silicone grafting clips</td>
<td>To secure scion and rootstock together.</td>
</tr>
<tr>
<td>Parafilm</td>
<td>To wrap the graft union for reinforcement during transplanting</td>
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<tr>
<td>Antibacterial soap or gel</td>
<td>To sanitize hands prior to grafting</td>
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<tr>
<td>Spray bottles</td>
<td>To mist plants with water during grafting</td>
</tr>
</tbody>
</table>

### Grafting Equipment Images

- Double-edged razor blades
- Silicone grafting clips

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### Splice Grafting Tomato and Eggplant

- **Cut the rootstock and scion at a 45° angle**
  - Cut rootstock stem below the cotyledons to prevent unwanted rootstock regrowth
  - Slip the grafting clip onto the rootstock stem
Splice Grafting

- Cut scion stem above or below cotyledons, match stem diameter with rootstock
- Slip scion into grafting clip – tight contact between cut surfaces of both stems, no trapped air

Watermelon Grafting

Size for grafting
If grafting for disease resistance, plant the graft union well above the soil line.
Managing Rootstock Regrowth

Monitor plants for rootstock growth, remove immediately

- Cucurbit rootstock
- Watermelon scion

Grafting Information

Vegetable Grafting Powerpoint Presentations
- Grafting Healing Chamber
- History of Vegetable Grafting
- How to Graft Tomatoes and Eggplant
- Transplanting Grafted Plants to the Field

Fact Sheets
- Vegetable Grafting: Eggplants and Tomatoes (FS052E)
- Vegetable Grafting: The Healing Chamber (FS051E)
- Vegetable Grafting: Watermelon (FS100E)

Handouts
- Grafting Supplies
- Retail Rootstock Seed Suppliers

http://vegetables.wsu.edu
Vegetable Grafting

http://vegetables.wsu.edu

WSU Vegetable Grafting Research

- Healing studies to improve graft survival
- Verticillium wilt (*Verticillium dahliae*) resistance of grafted eggplant, watermelon, and tomato:
  1. Identify rootstocks with resistance or tolerance
  2. Evaluate disease severity of grafted plants
- Cost-benefit analysis for use of grafted watermelons in Washington State
Field Research

- Replicated field trials at WSU Mount Vernon NWREC and commercial fields
- Fields naturally infested with *V. dahliae* (17 cfu g⁻¹ soil at NWREC)
- Rate plants weekly for disease incidence and severity

Field Trials

WSU Mount Vernon NWREC

Schreiber and Sons Farm Eltopia, WA
Eggplant 2013

Eggplant - End of Season
Watermelon Verticillium Wilt

Watermelon 2010 & 2011

Disease severity (% affected)

- Non-grafted
- Self-grafted
- Strong Tosa
- Emphasis
Watermelon Verticillium Wilt

'Crisp’n Sweet' watermelon grafted onto 'Emphasis' rootstock

Non-grafted 'Crisp’n Sweet' watermelon

Watermelon - Commercial Rootstocks AUDPC 2013
Watermelon - NPGS Accessions AUDPC 2013

Field Trial WSU Mount Vernon

2 August 2013
Tomato 2010 & 2011

No Verticillium detected either year

cv. Cherokee Purple, rootstocks Maxifort, Beaufort

Photo: Dr. Lindsey du Toit (South Africa)

Tomato 2013

- 4-6% disease severity in all treatments
cv. Stupice, rootstocks Beaufort, Maxifort, Colosus,
Supernatural, Dro138TX, Estamino

- Foliar symptoms not typical of Verticillium wilt

- Stem assays inconclusive
Summary

1. Determine disease affecting crop
   - Tomato has natural resistance to Verticillium wilt, grafting may not provide any advantage
   - Eggplant shows potential benefits with grafting
   - Watermelon benefited from grafting

2. Increased vigor and yield
   - ‘Cherokee Purple’ heirloom tomato did not have increased yield with grafting

3. Increased tolerance to environmental stress
   - Eggplant, tomato, and watermelon did not show increased yield with low temperatures

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Research Funding

- WSU Department of Horticulture
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- Dr. George Clough, Oregon State University
University-Industry Collaboration
WSU Grafting Research

- **Eggplant**
  - 2010 & 2011 cv. ??, rootstocks *Epic, Maxifort, Solanum aethiopicum* (*scarlet eggplant or ‘pumpkin on a stick’*)
  - 2013 - cv. Millionaire, rootstocks Java, Meet, Red Scorpion
    - 10 plants per plot; 3-ft in-row spacing

- **Watermelon**
  - 2010 & 2011 cv. *Crisp ‘n Sweet*, rootstocks *Emphasis* (*L. sicerarea; bottle gourd*), *Strong Tosa* (*C. maxima* x *C. moschata*)
  - 2013 – screen 56 rootstocks

- **Tomato**
  - 2010 & 2011 cv. *Cherokee Purple*, rootstocks Maxifort, Beaufort (both *S. lycopersicon* x *S. habrochaites*)
  - 2013 - cv. Stupice, rootstocks Beaufort, Maxifort, Colosus, Supernatural, Dro138TX, Estamino
    - 5 plants per plot; 3-ft in-row spacing
    - Seeded 7 May, grafted 3 June, transplanted 19 June