Managing Soil-Borne Disease in High Tunnels with Vegetable Grafting

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http://vegetables.wsu.edu

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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


Cedarville Farm


Cloud Mountain


WSU Mount Vernon NWREC
- Haygrove Solo


Bow Hill
- Oregon Valley Greenhouse


Terra Verde

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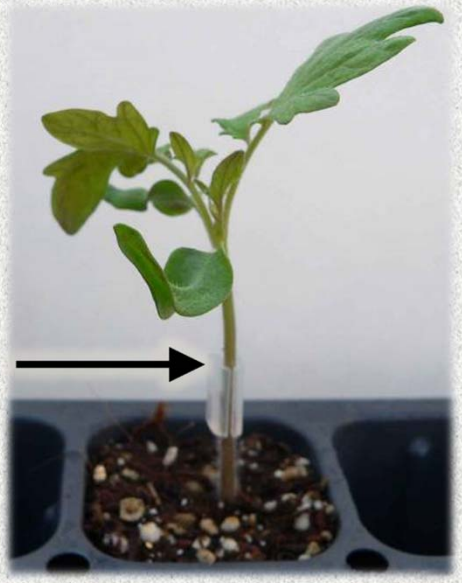
Vegetable Grafting



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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

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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

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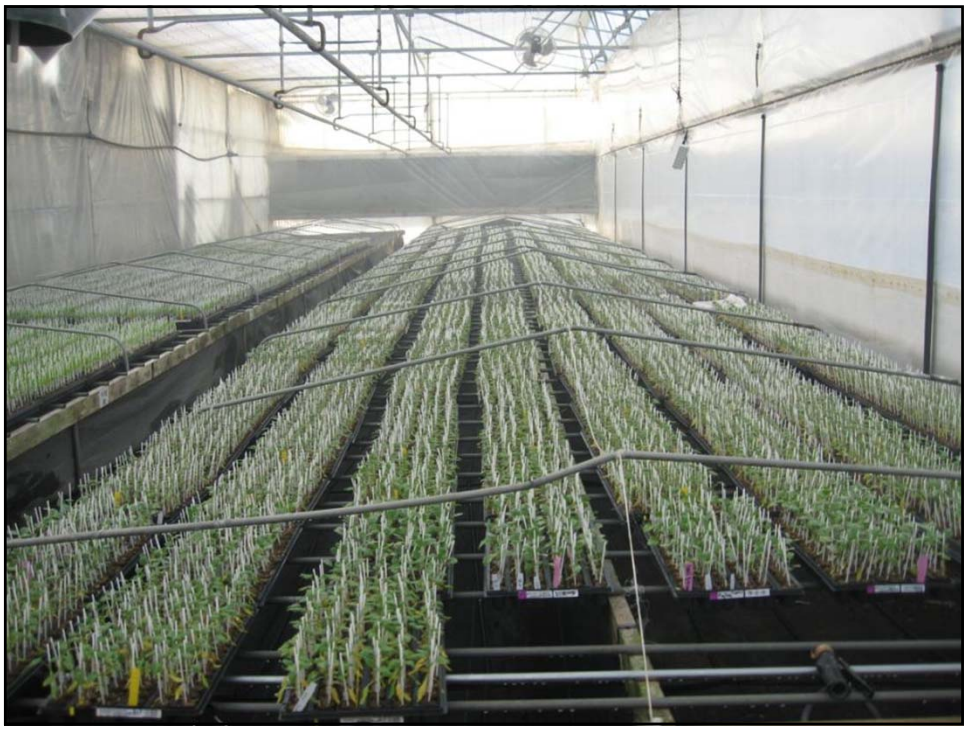
Commercial Vegetable Grafting

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

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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

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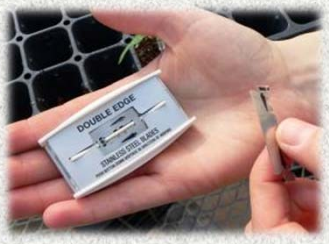
Grafting Equipment

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



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

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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

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Watermelon Grafting

Size for grafting

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One-Cotyledon Grafting

Scion

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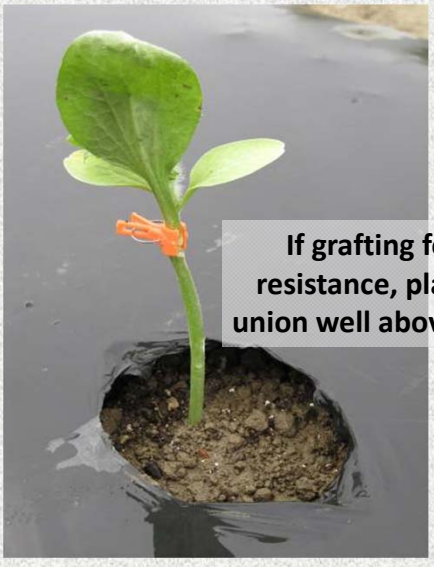
Transplanting to Field



If grafting for disease resistance, plant the graft union well above the soil line

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Managing Rootstock Regrowth

Monitor plants for rootstock growth, remove immediately

Cucurbit rootstock

Watermelon scion

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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

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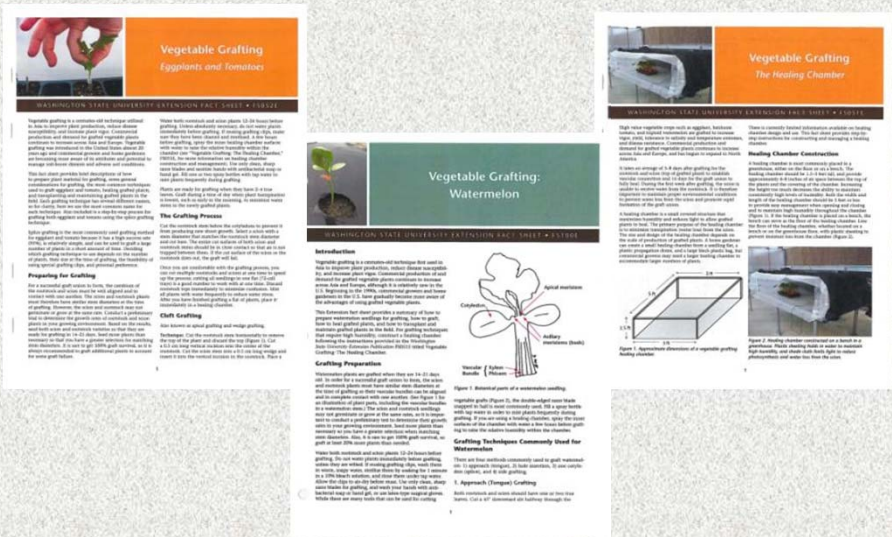
Vegetable Grafting



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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

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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

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Field Trials

WSU Mount Vernon NWREC

Schreiber and Sons Farm
Eltopia, WA

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Verticillium Wilt Symptoms

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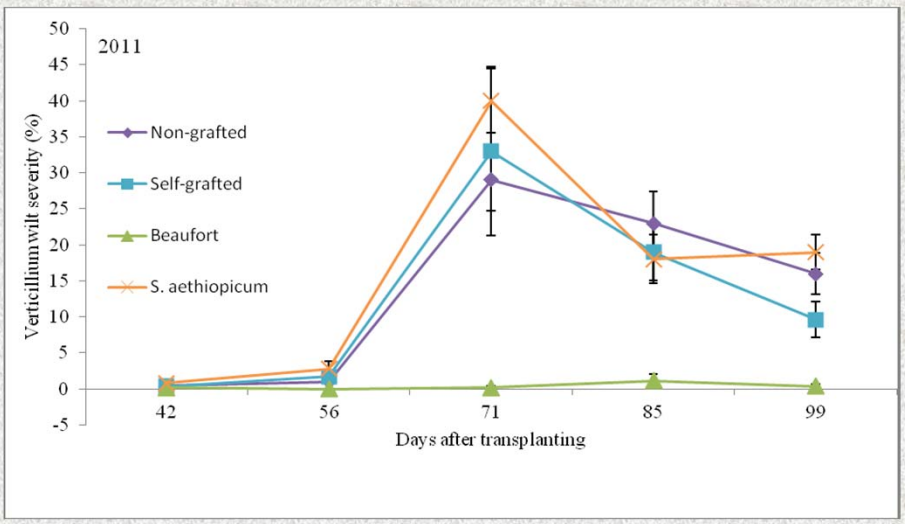
Eggplant 2010 & 2011



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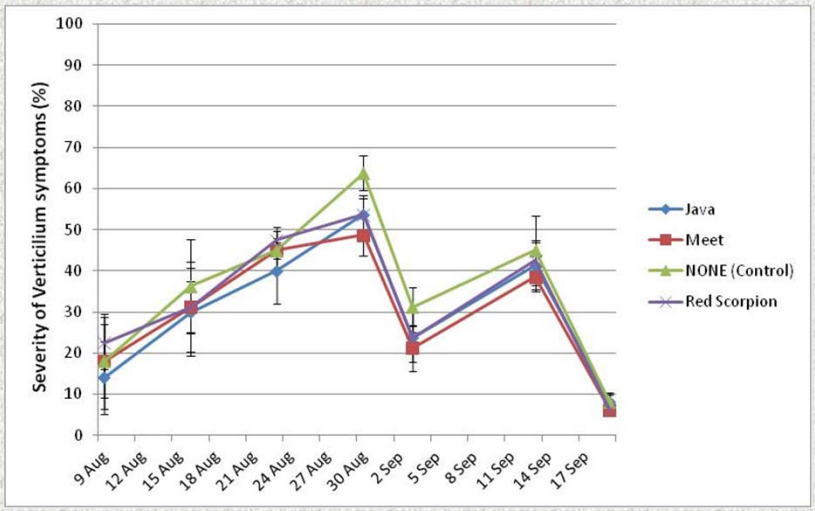
Eggplant 2013



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Eggplant - End of Season

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Watermelon Verticillium Wilt

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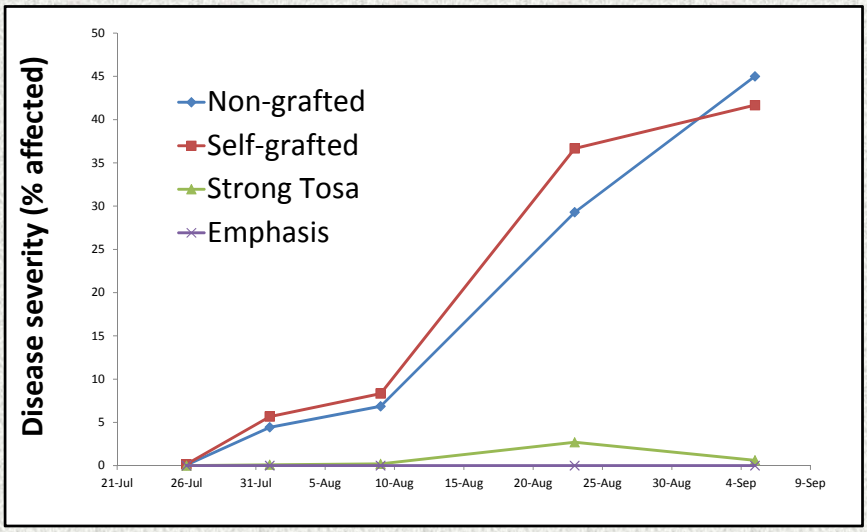
Watermelon 2010 & 2011



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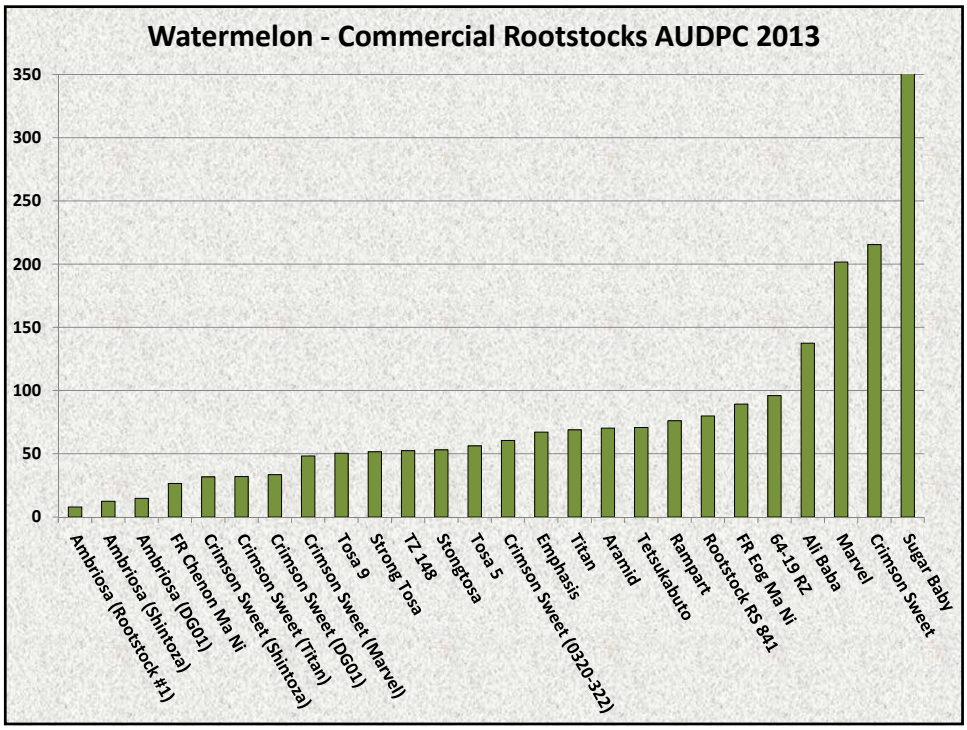
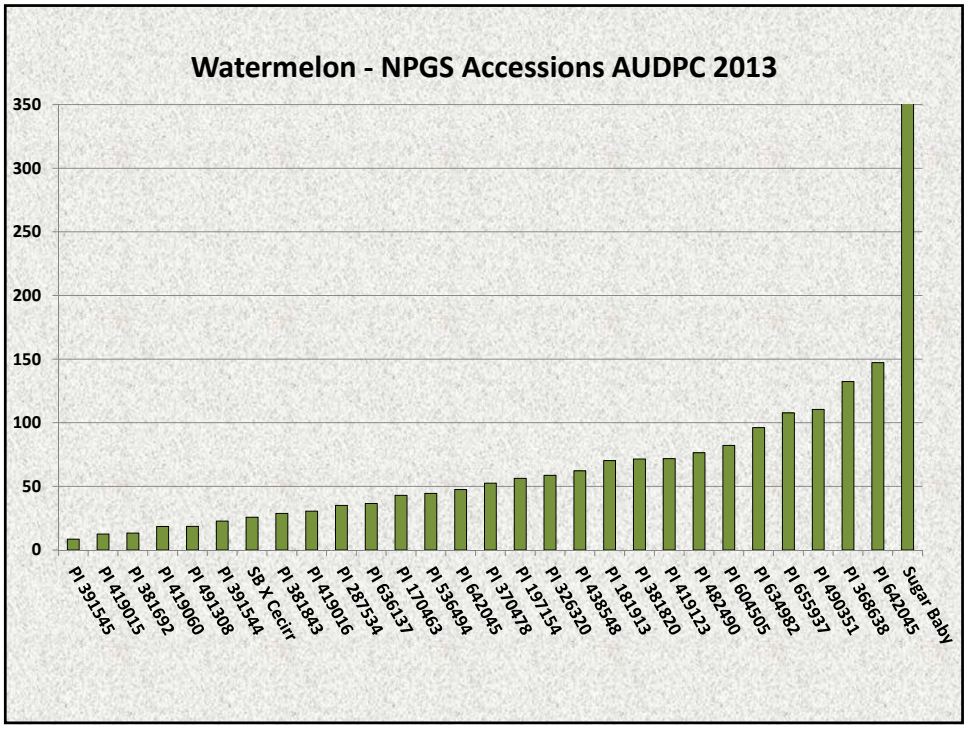
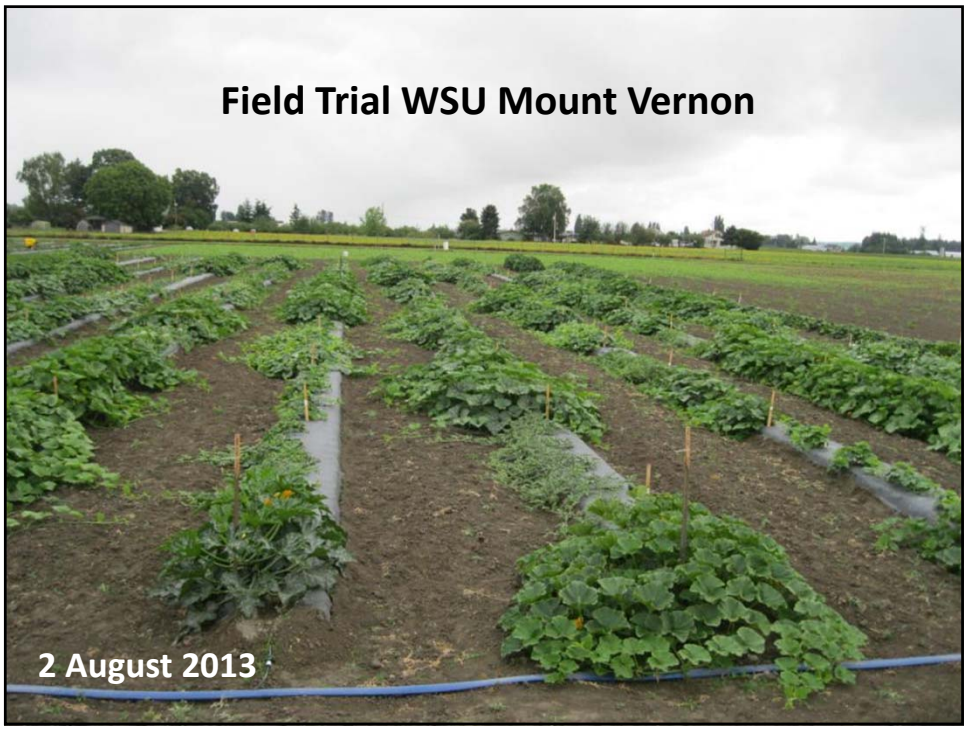
Watermelon Verticillium Wilt

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

Non-grafted 'Crisp'n Sweet' watermelon




Watermelon - NPGS Accessions AUDPC 2013
350
300
250
200
150
100
50
0
PI 391545
PI 419015
PI 381692
PI 419060
PI 491308
PI 391544
SB X Ceciir
PI 381843
PI 419016
PI 287534
PI 636137
PI 170463
PI 536494
PI 642045
PI 370478
PI 197154
PI 326320
PI 438548
PI 181913
PI 381820
PI 419123
PI 482490
PI 604505
PI 634982
PI 655937
PI 490351
PI 368638
PI 642045
Sugar Baby


Field Trial WSU Mount Vernon
2 August 2013

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Tomato 2010 & 2011

No Verticillium detected either year

cv. Cherokee Purple, rootstocks Maxifort, Beaufort

Photo:
Dr. Lindsey du Toit
(South Africa)

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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**

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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
- WSU Center for Sustainable Agriculture and Natural Resources
- Washington State Commission on Pesticide Registration
- Organic Farming Research Foundation
- Pacific Northwest Vegetable Association
- Emerging Research Issues grant from WSU
- Northwest Agriculture Research Foundation
- Dr. George Clough, Oregon State University

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University-Industry Collaboration

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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**