Using High Tunnels and Organic Practices to Grow Grafted Heirloom Tomatoes

Cary Rivard, Suzanne O’Connell, Frank Louws, Mary Peet, & Chris Harlow

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High Tunnels

- Season extension
- Reduced foliar disease
  - Leaf wetness
- Increased fruit quality
  - Water management
- All shapes and sizes
- Intensively managed
- Crop rotation
Fusarium wilt
Early Tomato Production
Grafting Worldwide

81% of Korean and 54% of Japanese vegetable production uses grafted plants

(Lee, 2003)
Project Objectives

• Investigate grafting as a major IPM component of tunnel tomato production.
  – Soilborne disease
  – Nutrient uptake
  – Crop productivity

• Compare system dynamics of tunnel and field production.

• Evaluate rootstock with and without disease pressure.

• On-farm trials
• CEFS Research Trial

Tube Grafting
Tube Grafting

Grafting

for Disease Resistance in Heirloom Tomatoes

Grafting is a simple technique that growers can use to increase soilborne disease resistance in tomatoes without chemical fumigants or pesticides.

Heirloom tomato cultivars lack genetic disease resistance and are particularly susceptible to epidemics in the field. Growers interested in this niche market, however, are not willing to give up the high-quality fruit that they deliver. Grafting can be used to unite the soilborne disease resistance and enhanced vigor of hybrid tomato cultivars with the high fruit quality of heirloom varieties.

**Grafting: An Old Technology with a New Technique**

Grafting vegetables to manage soilborne disease is a simple process. The below-

Grafting has been used in the horticultural industry for woody species, such as apples and grapes, for centuries. The first use of vegetable grafting to reduce soilborne disease occurred in the early 1900s to diminish fusarium wilt on watermelons. More recently, this technique has been used in plant production systems when the genetic trait for disease resistance in a crop is closely linked to a negative quality, such as small fruit size. For example, grafting is often used to reduce bacterial wilt (caused by *Ralstonia solanacearum*) in tomatoes. This disease complex is particularly difficult to manage due to its wide range of
Tube Grafting
Grafting at NC State
- **Bacterial Wilt** \( (R.\ solanacearum) \)
- **Fusarium Wilt** \( (F.\ oxysporum\ f.sp.\ lycopersici) \)
- **Root-knot Nematodes** \( (Meloidogyne\ spp.) \)
- **Verticillium Wilt** \( (V.\ dahliae) \)
- **Southern Stem Blight** \( (Sclerotium\ rolfsii) \)
On-farm trials
NCDA Research Stations
2005
2006
2007
Holtwood, PA
Field Research
## Commercial Rootstock Selection

<table>
<thead>
<tr>
<th>Rootstock</th>
<th>TMV</th>
<th>Root</th>
<th>Fusarium Wilt</th>
<th>Verticillium</th>
<th>Bacterial Wilt</th>
<th>Nematodes</th>
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</thead>
<tbody>
<tr>
<td>Maxifort</td>
<td>HR</td>
<td>HR</td>
<td>HR (HR)</td>
<td>HR</td>
<td>S</td>
<td>MR</td>
</tr>
<tr>
<td>Beaufort</td>
<td>HR</td>
<td>HR</td>
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<td>HR</td>
<td>S</td>
<td>MR</td>
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<tr>
<td>Anchor-T</td>
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<td>S</td>
<td>HR</td>
<td>HR</td>
<td>MR</td>
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<tr>
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<td>S</td>
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<td>S</td>
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<td>S</td>
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</tr>
<tr>
<td>Robusta</td>
<td>HR</td>
<td>HR</td>
<td>S (HR)</td>
<td>HR</td>
<td>S</td>
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</tr>
</tbody>
</table>

**HR** = Highly Resistant, **MR** = Moderately Resistant, **S** = Susceptible

* = De ‘Ruiter Seed Co.  ** = Takii Seed Co.  *** = Dai Honmei
**** = D Palmer Seed Co.  ***** = Rijk Zwaan  ****** = Bruinsma Seed Co.
Bacterial Wilt Incidence (%)

Sampson County - 2007

- Non
- Self
- DP 105
- Asahi

Bacterial Wilt Incidence (%)
Bacterial Wilt

Sampson County - 2007

Based on LSD at P=0.05
Southern Stem Blight Incidence (%)

Alamance County - 2007

- Non
- Self
- Maxifort
- Beaufort
Southern Stem Blight

Alamance County - 2007

Least Significant Difference at P=0.05
Nutrient Analysis

Macro-Nutrient Uptake of Grafted Tomatoes
Orange County - 2007

Based on LSD at P=0.05
2006 SR-SARE R&E Grant

- Compare production dynamics of tunnel vs field production
  - Environment
  - Disease
  - Productivity
  - Economics

- Optimize cultural practices for high tunnels
  - Nutrient inputs
  - Planting date

- Investigate the role of grafting for field and tunnel production
  - Beaufort
  - Maxifort
  - Rootstock / scion combinations
Crop Productivity

Main System Effects: CEFS 2007

Cumulative Total Yield (lbs/plot)

- Tunnel
- Field

25 days
Crop Productivity

Main Effects: CEFS 2007

- **System**
  - Tunnel
  - Field

- **Nutrient**
  - Low
  - Medium
  - High

- **Grafting**
  - Non
  - Beaufort
  - Maxifort

Total Yield (lbs/plot)

- **P=0.01**
- **P=0.001**
- **P<0.001**
Tomato Spotted Wilt Virus

CEFS - 2007

Based on LSD at P=0.05
Plant Vigor

Main Plant Growth Effects: CEFS - 2007

Shoot Biomass (g)

20-Mar: P = 0.0085
3-Apr: P = 0.0085
19-Apr: P = 0.0026
Non
Self
Beaufort
Maxifort
Crop Productivity

CEFS - 2007

Cumulative Total Yield (lbs/plot)

03/20 - Tunnel
04/03 - Tunnel
04/19 - Tunnel

21 days
Main Grafting Effects in 3/19 Tunnel Planting
CEFS - 2007

Cumulative Total Yield (lbs/plot)

- Non
- Beau
- Max

P<0.05
Conclusions

• Grafting provides a site-specific management tool for soilborne disease.
  – Bacterial Wilt (*Ralstonia solanacearum*)
  – Fusarium Wilt (*Fusarium oxysporum* f.sp. *lycopersici*)
  – Root-knot Nematodes (*Meloidogyne* spp.)
  – Verticillium Wilt (*Verticillium dahliae* (race 2))
  – Southern Stem Blight (*Sclerotium rolfsii*)

• Grafting may affect nutrient uptake efficiency.

• ~25 days early season extension with high tunnels.

• Total productivity was higher in the tunnel system.

• Beaufort and Maxifort show higher yields under no soilborne disease pressure.

• Optimal planting date is March 20\textsuperscript{th} for Eastern NC.
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Questions?