Effects of in-Row Spacing on Grafted Watermelon Productivity and Fruit Quality

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Vegetable Grafting

- Organ transplantation;
- Creates a physical hybrid containing desired traits;
- Makes faster and more effective use of genetics in production;
- Solves farmer’s practical questions.
Vegetable Grafting requires 2 varieties; may use more

**Scion: ‘recipient’**
- supplies shoot
- fruit marketable
- but roots flawed

**Rootstock: ‘donor’**
- supplies roots
- fruit not marketable but roots better

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vegetable grafting
combine and secure

several ways possible

A scion

B rootstock
Grafted plants are production tools.
China: Grafting started in 500s. Japan and Korea: Farmers began using grafting as a tool for combating diseases and enhancing growth in 1920s – 1930s.

From 1950s – 1980s, development of breeding technology gave plant disease resistance. Grafting started in Europe.

During 1990s, grafting started in Canada and Netherlands for hydroponic greenhouse.

During 2000s, grafting started in US and Mexico for hydroponic greenhouse.

During 2010s, vegetable grafting are used in various production systems across US and Mexico. More federal- and state-funded programs bring institutional collaborations.

From: Chieri Kubota, OSU
other academic teams that have worked or now work on vegetable grafting
2011-2015: how to produce high quality grafted transplants

2016-2020: how to take the best use of grafted plants in different production systems
Grafted plants can be more:
(1) resistant to biotic, abiotic stresses,
(2) vigorous in root system,
(3) resource-efficient (e.g., water and fertilizer),
(4) productive (yield potential), but
(5) expensive (seeds, grafting, field management).

than nongrafted counterparts.
High cost is the no. 1 obstacle from widespread adoption of vegetable grafting.

Lowering cost while maintaining the merits is key: on growers' end, reducing plant population is what they can do.
2019 Field Trial Setup

- **In-row spacing**: 3 feet (93 cm), 4 feet (123 cm), and 6 feet (183 cm).
- **Scion**: Triploids ‘7187’ and ‘Fascination’.
- **Pollenizer**: ‘Wild Card Plus’.
- **Study design**: split-split plot design.
- **Pollenizer placement**: xxxpxxxxpxxxpx (3-footer), xxxpxxxxpx (4-footer), xxxpxxxp (6-footer); x=triploid plants; p=pollenizer.
- **Reduced population**: 3-footer: full population, 4-footer: 25% reduction; 6-footer: 50% reduction.
Field Management and Data Collection

- **Field location**: Turlock, California.
- **Transplanting**: Hand transplanted on April 24, 2019.
- **Plot length**: 30 feet (9.3 m), containing 10, 7, and 5 plants for each spacing.
- **Harvest**: Total of five: Jul. 24, Aug. 7 and 23, Sep. 11, and Oct. 2.
- **Data Collection**: yield, fruit number, Brix, hollow heart rating, flesh firmness, and fruit size.
Grafted watermelon seedlings in the greenhouse (Photo credit: Ben Hinson, Tri-Hishtil).
Grafted and non-grafted watermelon plants were transplanted at the spacing of 3 feet, 4 feet, and 6 feet (left to right). The corresponding plant population is 2074, 1555 (25% reduction), and 1037 (50% reduction) per acre, respectively (photos were taken on May 24, 2019).
# Results – Fruit Quality

Table 1. Comparisons of the main effects on fruit quality.

<table>
<thead>
<tr>
<th></th>
<th>Brix</th>
<th>Length (in.)</th>
<th>Width (in.)</th>
<th>Fruit penetration (psi)</th>
<th>Hollow heart</th>
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</thead>
<tbody>
<tr>
<td>3 feet</td>
<td>12.0</td>
<td>11.8</td>
<td>10.1</td>
<td>3.9</td>
<td>ns</td>
</tr>
<tr>
<td>4 feet</td>
<td>12.1</td>
<td>12.2</td>
<td>10.3</td>
<td>4.1</td>
<td>ns</td>
</tr>
<tr>
<td>6 feet</td>
<td>12.1</td>
<td>12.3</td>
<td>10.0</td>
<td>3.9</td>
<td>ns</td>
</tr>
<tr>
<td>7187</td>
<td>12.1</td>
<td>11.9</td>
<td>10.0</td>
<td>4.1</td>
<td>0.3*</td>
</tr>
<tr>
<td>Fascination</td>
<td>12.0</td>
<td>12.3*</td>
<td>10.2</td>
<td>3.9</td>
<td>0.1</td>
</tr>
<tr>
<td>Flexifort</td>
<td>12.0</td>
<td>12.3*</td>
<td>10.1</td>
<td>4.1*</td>
<td>0</td>
</tr>
<tr>
<td>RS841</td>
<td>12.1</td>
<td>12.2</td>
<td>10.2</td>
<td>3.9*</td>
<td>0.2</td>
</tr>
<tr>
<td>UG29A</td>
<td>12.2</td>
<td>12.0</td>
<td>10.1</td>
<td>4.0*</td>
<td>0.3</td>
</tr>
<tr>
<td>XSQ9901</td>
<td>11.8</td>
<td>12.3*</td>
<td>10.1</td>
<td>4.3*</td>
<td>0</td>
</tr>
<tr>
<td>Nongrafted</td>
<td>11.9</td>
<td>11.7</td>
<td>10.2</td>
<td>3.5</td>
<td>0.5*</td>
</tr>
</tbody>
</table>
## Results – Average Fruit Weight

Table 2. Comparisons of the main effects on average fruit weight (lbs.).

<table>
<thead>
<tr>
<th></th>
<th>1&lt;sup&gt;st&lt;/sup&gt; harvest</th>
<th>2&lt;sup&gt;nd&lt;/sup&gt;/3&lt;sup&gt;rd&lt;/sup&gt; harvest</th>
<th>4&lt;sup&gt;th&lt;/sup&gt; harvest</th>
<th>5&lt;sup&gt;th&lt;/sup&gt; harvest</th>
</tr>
</thead>
<tbody>
<tr>
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<td>20.7</td>
<td>16.1</td>
<td>14.0</td>
<td>10.8</td>
</tr>
<tr>
<td>4 feet</td>
<td>21.3</td>
<td>18.9</td>
<td>15.9</td>
<td>10.9</td>
</tr>
<tr>
<td>6 feet</td>
<td>21.8</td>
<td>19.5</td>
<td>16.4</td>
<td>11.0</td>
</tr>
<tr>
<td>7187</td>
<td>20.0</td>
<td>18.3</td>
<td>16.6</td>
<td>11.3</td>
</tr>
<tr>
<td>Fascination</td>
<td>22.6</td>
<td>18.4</td>
<td>14.3</td>
<td>10.6</td>
</tr>
<tr>
<td>Flexifort</td>
<td>21.2</td>
<td>19.6</td>
<td><strong>15.4</strong></td>
<td>10.7</td>
</tr>
<tr>
<td>RS841</td>
<td>22.2</td>
<td><strong>16.8</strong></td>
<td>15.2</td>
<td><strong>11.2</strong></td>
</tr>
<tr>
<td>UG29A</td>
<td>20.6</td>
<td>17.4</td>
<td>12.4</td>
<td>10.9</td>
</tr>
<tr>
<td>XSQ9901</td>
<td>21.5</td>
<td>17.8</td>
<td>16.3</td>
<td>10.5</td>
</tr>
<tr>
<td>Nongrafted</td>
<td>20.9</td>
<td>19.2</td>
<td><strong>17.9</strong></td>
<td>11.3</td>
</tr>
</tbody>
</table>
Figure 1. Fruit Accumulative Yield Per Plot (lbs.)

- **In-row Spacing**: 3 feet, 4 feet, 6 feet
- **Rootstock**: Flexifort, RS841, UG29A, XSQ9901, Nongrafted

Legend:
- 5th harvest
- 4th harvest
- 2nd/3rd harvest
- 1st harvest

Fruit weight (lbs.)

- 0
- 200
- 400
- 600
- 800
- 1000
- 1200
Results – Fruit Number

Figure 2. Total No. of Fruit Per Plot
Results – Single Plant Productivity

Figure 3. Productivity Per Plant (lbs.)

- **3 feet**
- **4 feet**
- **6 feet**

Fruit weight (lbs.)

- **Flexifort**
- **RS841**
- **UG29A**
- **XSQ9901**
- **Nongrafted**

In-row Spacing

Rootstock

- 5th harvest
- 4th harvest
- 2nd/3rd harvest
- 1st harvest

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# Results – Yield of Each Combination

Table 3. Fruit yield (lbs./plot) from the first harvest for each grafted combination.

<table>
<thead>
<tr>
<th></th>
<th>3 feet-7187</th>
<th>4 feet-7187</th>
<th>6 feet-7187</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexifort</td>
<td>685.6</td>
<td>561.1</td>
<td>583.7</td>
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<td>RS841</td>
<td>689.9</td>
<td>631.6</td>
<td>595.0</td>
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<tr>
<td>UG29A</td>
<td>601.4</td>
<td><strong>673.4</strong></td>
<td>489.4</td>
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<tr>
<td>XSQ9901</td>
<td>621.7</td>
<td><strong>705.1</strong></td>
<td><strong>638.8</strong></td>
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<tr>
<td>Nongrafted</td>
<td>672.8</td>
<td>618.7</td>
<td>625.4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>3 feet-Fascination</th>
<th>4 feet-Fascination</th>
<th>6 feet-Fascination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexifort</td>
<td>640.2</td>
<td>655.1</td>
<td>622.1</td>
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<td>653.3</td>
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<td><strong>673.1</strong></td>
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<td>UG29A</td>
<td>570.9</td>
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<td>567.6</td>
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<td>650.8</td>
<td><strong>723.3</strong></td>
<td>655.7</td>
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<tr>
<td>Nongrafted</td>
<td>632.6</td>
<td>696.6</td>
<td>574.9</td>
</tr>
</tbody>
</table>
Project Summary

From this trial...

- Fruit quality is more affected by grafting than productivity.
- Rootstocks affect yield and quality differently even when grafting onto the same scion.
- Not all commercial cultivars are suitable for grafting (scion-rootstock incompatibility).
- Choosing the right combination is difficult. Evaluations of rootstock vigor and scion-rootstock performance are needed.
Incompatibility affects fruit quality, such as more hollow-heart fruit.

Not all commercial varieties are suitable for grafting, such as '7187'.

Same rootstock has different performance when grafting with different scions ('Fascination' vs. '7187').
Acknowledgements

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Seed supplier: ENZA ZADEN, Seminis, Sakata, Unigen Seeds

Grower collaborator: Dan Avila & Sons

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THANK YOU!