High Tunnel Melon Varieties

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Mary S. Rice Grant

Outline of Presentation

• Background

• Materials and Methods

• Results

• Conclusion
Background

- Indiana is a very important player in the domestic melon market
- Total acreage planted in Indiana peaked in 1997:
  - 3,600 acres
  - Total production was 455,000 cwt with an average income of $16.00 per cwt
  - Total farm value of production was $7,280,000 ($2,022 per acre)
- Yield has increased since 1997 from 130 cwt per acre to 230 cwt per acre in 2014
- The Indiana melon growers have lost a significant share of the melon market since the 2011 and 2012 food borne illness outbreak
# Quick Facts about Indiana Cantaloupe

<table>
<thead>
<tr>
<th>Year</th>
<th>Acres Planted</th>
<th>Yield (cwt per acre)</th>
<th>Value of Production</th>
<th>Value of Production per Acre</th>
<th>Production (cwt)</th>
<th>Value per cwt</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997</td>
<td>3,600</td>
<td>130</td>
<td>$7,280,000</td>
<td>$2,022</td>
<td>455,000</td>
<td>$16.00</td>
</tr>
<tr>
<td>2011</td>
<td>2,700</td>
<td>220</td>
<td>$12,698,000</td>
<td>$4,703</td>
<td>572,000</td>
<td>$22.20</td>
</tr>
<tr>
<td>2012</td>
<td>2,500</td>
<td>220</td>
<td>$10,487,000</td>
<td>$4,195</td>
<td>462,000</td>
<td>$22.70</td>
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<tr>
<td>2013</td>
<td>2,100</td>
<td>230</td>
<td>$11,500,000</td>
<td>$5,476</td>
<td>460,000</td>
<td>$25.00</td>
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<tr>
<td>2014</td>
<td>1,900</td>
<td>220</td>
<td>$5,980,000</td>
<td>$3,147</td>
<td>396,000</td>
<td>$15.10</td>
</tr>
<tr>
<td>2015</td>
<td>1,800</td>
<td>160</td>
<td>$7,616,000</td>
<td>$4,231</td>
<td>272,000</td>
<td>$28.00</td>
</tr>
<tr>
<td>2016</td>
<td>1,800</td>
<td>185</td>
<td>$7,245,000</td>
<td>$4,255</td>
<td>315,000</td>
<td>$23.00</td>
</tr>
</tbody>
</table>

Average price per melon: $0.70 - $1.10

- Mainly planted in southwest Indiana
- Transplant Production: March/April
- Planting Season: April – June
- Harvest Season: June – Sept.
- Plant Population (2.5 ft. x 6 ft.): 2,904 plants per acre
- U.S. ranking in 2016: 4th in terms of production
Goals and Objective

- Develop solutions to reverse the decrease in acreage, market share and associated risk of food borne illness
- Long term goal is to increase the planted acreage, farm productivity and profit margins for Indiana melon growers
- In the short term we can address the demand for high quality smaller fruit (e.g. personalized melons), which would entail the continuous evaluation of a market driven selection of melon types that are currently not being grown in Indiana
- Additionally, new production technologies that would increase yield and enhance product quality will be tested
- Objective of this study was (1) to evaluate the productivity and quality of a selection of specialty Cantaloupe and Charentais melon varieties in the field, (2) to determine production economics, (3) to evaluate the concentration and significance of pathogenic organisms found on produce, and (4) to develop a production management practices guide

Materials and Methods
Material and Methods

<table>
<thead>
<tr>
<th>Location</th>
<th>Technique</th>
<th>Tunnel size (ft²)</th>
<th>Reps.</th>
<th>Plants per rep.</th>
<th>Sow Date</th>
<th>Plant date</th>
<th>In-row Spacing (ft)</th>
<th>Between-row Spacing (ft)</th>
<th>Sq. ft. per plant</th>
<th>Plants/Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>SWPAC</td>
<td>High Tunnel Soil</td>
<td>2,880</td>
<td>6</td>
<td>5</td>
<td>3/27/2017</td>
<td>4/18/2017</td>
<td>1.5</td>
<td>4</td>
<td>6</td>
<td>7,260</td>
</tr>
<tr>
<td>Meigs Farm</td>
<td>High Tunnel Hydroponics</td>
<td>1,152</td>
<td>4</td>
<td>2</td>
<td>4/10/2017</td>
<td>5/1/2017</td>
<td>1.5</td>
<td>4</td>
<td>6</td>
<td>7,260</td>
</tr>
<tr>
<td>Meigs Farm</td>
<td>Open Field Soil</td>
<td>N/A</td>
<td>5</td>
<td>10</td>
<td>5/23/2017</td>
<td>6/12/2017</td>
<td>1.5</td>
<td>7.7</td>
<td>19.2</td>
<td>2,273</td>
</tr>
</tbody>
</table>

- Specialty melons were produced in a high tunnel using hydroponic (soilless) and conventional techniques.
- SWPAC, Vincennes, IN – raised beds were made and covered with black plastic mulch, drip tape with 8 inch emitter spacing.
- Meigs Farm, Lafayette, IN – Coconut coir was used as substrate, slabs 3 feet long, irrigated using 2 GPH P.C. emitter (Netafim).
- Meigs Farm, Lafayette, IN – open field, soil grown, plastic mulch and drip irrigation.

Locations

- Meigs Farm (Hydroponics): 24 X 48 ft.
- SWPAC (Soil): 30 X 96 ft.
- Meigs Farm (soil): 6/14/2017
Material and Methods

- Pesticides were applied to control cucumber beetles and powdery mildew
- Melons were harvested as they mature (every 1 to 3 days)
- At harvest fruit count and weight per plot was recorded. A sub-sample of three melons per plot were used to measure width and length of the fruit
- Additionally, internal fruit quality measurements—sap was sampled to determine Brix (%SS), pH and firmness
- SWPAC, high tunnel, soil:
  - First harvest date: 7/1/2017 (74 DAT)
  - Last harvest date: 8/8/2017 (112 DAT)
- Meigs Farm, high tunnel, hydroponics:
  - First harvest date: 7/10/2017 (70 DAT)
  - Last harvest date: 8/3/2017 (94 DAT)
- Meigs Farm, open field, soil:
  - First harvest date: 8/7/2017 (56 DAT)
  - Last harvest date: 8/28/2017 (77 DAT)

Specialty Cantaloupe and Charentais Varieties Tested

<table>
<thead>
<tr>
<th>#</th>
<th>Variety Name</th>
<th>Type</th>
<th>Days to Maturity</th>
<th>Shape</th>
<th>Fruit size (kg)</th>
<th>Flesh color</th>
<th>Disease Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lilliput Cantaloupe</td>
<td>80</td>
<td>Round</td>
<td>0.5-0.9</td>
<td>Orange</td>
<td>F2, PM</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Inspire Cantaloupe</td>
<td>65</td>
<td>Semi round</td>
<td>0.5-0.9</td>
<td>Bright orange</td>
<td>F3, PM</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Sugar Cube Cantaloupe</td>
<td>80</td>
<td>Round</td>
<td>0.9</td>
<td>Deep orange</td>
<td>PM, FW, ZYMV, PRSV, WMV</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>French Orange</td>
<td>75</td>
<td>Round to oval</td>
<td>1.1</td>
<td>Deep orange</td>
<td>F3, PM</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Tasty Bites Ananas x Charentais</td>
<td>80</td>
<td>Round to oval</td>
<td>0.8-1.1</td>
<td>Light orange</td>
<td>AB, F3, PM</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Escorial French Charentais</td>
<td>72</td>
<td>Round to oval</td>
<td>0.9</td>
<td>Dark orange</td>
<td>F2, PM</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Savor French Charentais</td>
<td>78</td>
<td>Round to oval</td>
<td>0.9</td>
<td>Dark orange</td>
<td>F3, PM</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Artemis French Charentais</td>
<td>78</td>
<td>Round</td>
<td>0.9-1.1</td>
<td>Deep orange</td>
<td>F: 0, 2, PM:1, 2, 5</td>
<td></td>
</tr>
</tbody>
</table>

Electrostatic Sprayer Sponsored by: Mary S. Rice Grant
Materials and Methods, **Plant Husbandry**

- All plants were trellised vertically
  - Meigs Farm - 8 feet high, string and clips
  - SWPAC – 6.6 feet high, trellis support netting
- All lateral shoots were removed by hand from the bottom up to 18 inches
- All tendrils were removed
- Laterals that developed from other nodes were left until it could be confirmed that fruit set has occurred
- Laterals were then removed in order to have fruit develop on laterals growing from every second node
- Fruit development is limited to one fruit per lateral
- Lateral shoot was terminated two leaves from the developing fruit
- Bumblebees (from Koppert Biological Systems) were used for pollination

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Water Analysis and Nutrient Solution Composition, Meigs Farm

<table>
<thead>
<tr>
<th></th>
<th>pH</th>
<th>EC (mS-cm⁻¹)</th>
<th>Na⁺ ppm</th>
<th>NH₄⁺ ppm</th>
<th>K⁺ ppm</th>
<th>Ca²⁺ ppm</th>
<th>Mg²⁺ ppm</th>
<th>NO₃⁻ ppm</th>
<th>PO₄³⁻ ppm</th>
<th>SO₄²⁻ ppm</th>
<th>Cl⁻ ppm</th>
<th>HCO₃⁻ ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual Well water</td>
<td>8.1</td>
<td>0.6</td>
<td>18</td>
<td>0</td>
<td>1</td>
<td>79</td>
<td>33</td>
<td>0.05</td>
<td>0.08</td>
<td>6</td>
<td>9</td>
<td>378</td>
</tr>
<tr>
<td>Calculated Week 1-5</td>
<td>6.0-6.5</td>
<td>2.14</td>
<td>18</td>
<td>7</td>
<td>217</td>
<td>195</td>
<td>64</td>
<td>143</td>
<td>48</td>
<td>131</td>
<td>9</td>
<td>120</td>
</tr>
<tr>
<td>Calculated Week 6-20</td>
<td>6.0-6.5</td>
<td>2.37</td>
<td>18</td>
<td>7</td>
<td>271</td>
<td>200</td>
<td>72</td>
<td>160</td>
<td>60</td>
<td>162</td>
<td>9</td>
<td>120</td>
</tr>
<tr>
<td>Actual Week 1-5</td>
<td>6.5</td>
<td>2.28</td>
<td>20</td>
<td>10.3</td>
<td>232</td>
<td>235</td>
<td>74</td>
<td>177</td>
<td>44</td>
<td>132</td>
<td>26</td>
<td>116</td>
</tr>
</tbody>
</table>

Fertility Program, Meigs Farm

- Fertilizer Sources:
  - Peters Professional 5-11-26
  - Jack’s Professional 15.5-0-0
  - ... 1.08 % NH₄⁺-N
  - ... 14.42 NO₃⁻-N
  - ... 18 % Ca

- pH was adjusted through acid injection
  - Sulfuric acid 96% (66 BE)
Soil Analysis, SWPAC

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Lab #</th>
<th>Organic Matter</th>
<th>Bray-1 Equiv.</th>
<th>K</th>
<th>Mg</th>
<th>Ca</th>
<th>Na</th>
<th>Soil pH</th>
<th>Buffer pH</th>
<th>CEC</th>
<th>% K</th>
<th>% Mg</th>
<th>% Ca</th>
<th>% H</th>
<th>% Na</th>
</tr>
</thead>
<tbody>
<tr>
<td>SWPAC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HT3</td>
<td>69687</td>
<td>0.7</td>
<td>58</td>
<td>163</td>
<td>95</td>
<td>500</td>
<td>35</td>
<td>5.9</td>
<td>6.9</td>
<td>5.1</td>
<td>8.3</td>
<td>15.6</td>
<td>49.4</td>
<td>23.7</td>
<td>3.0</td>
</tr>
</tbody>
</table>

\[ \text{P}_2\text{O}_5 \quad \text{K}_2\text{O} \]

lb/acre 267 391

<table>
<thead>
<tr>
<th>Meigs Field</th>
<th>11334 11335</th>
<th>3.9</th>
<th>56</th>
<th>173</th>
<th>365</th>
<th>2200</th>
<th>-</th>
<th>6.5</th>
<th>6.9</th>
<th>16.3</th>
<th>2.7</th>
<th>18.7</th>
<th>67.7</th>
<th>11.0</th>
<th>-</th>
</tr>
</thead>
</table>

\[ \text{P}_2\text{O}_5 \quad \text{K}_2\text{O} \]

lb/acre 258 415.2

Fertility Program

Meigs Farm, High Tunnel, Hydroponics (soilless)

- Complete nutrient solution, applied through irrigation system with every irrigation cycle (7-8 times per day)

SWPAC, High Tunnel, Soil, Fertigated

- Pre-plant fertilizers were applied according to soil test results
  - Urea (46-0-0) at 30 lb/acre nitrogen (N)
  - Diammonium phosphate (18-20.1-0) at 70 lb/acre P
  - Zinc sulfate at 1 lb/acre zinc (Zn)
  - 34 lb/acre gypsum and 300 lb/acre pelletized lime
- Plants were fertigated every day, starting one month after transplanting
  - Potassium nitrate (13.7-0-38.5; Krista™ K, Yara) at a rate of 0.5 lb/acre N per day until one week before the final harvest
  - Fertigation was applied three times a day. Irrigation amount was adjusted according to weather conditions
- **Total application**: 130 N, 70 P₂O₅, and 112 K₂O lb/acre

Meigs, Open Field

- **Total application**: 130 N, 150 P₂O₅, and 200 K₂O lb/acre (9-22-31), applied pre-plant
Results and Discussion
Plant Disease Challenges

- Variety performance at Meigs Farm (high tunnel) was impacted by disease and insect pressure
- The main diseases were bacterial wilt (transferred by cucumber beetles) and powdery mildew
- Bacterial wilt affected about 47% of all the plants in this study
  - French Orange had plant casualties of up to 88% of the original population
  - Sugar Cubes and Tasty Bites (13%), Savor, Artemis and Inspire (26%)
  - Least affected by bacterial wilt was Lilliput and Escorial (no casualty)
  - Did not affect the SWPAC trial
- Powdery mildew affected most varieties accept Lilliput and Sugar Cubes
  - Savor was the most affected by powdery mildew
  - PM was effectively controlled and therefore a low incidence of powdery mildew was observed on all varieties
- SWPAC (high tunnel), virtually no bacterial wilt and almost no powdery mildew. Very low spider mite pressure
### Fruit Weight and Yield

<table>
<thead>
<tr>
<th>Variety</th>
<th>Days to Maturity</th>
<th># Fruit/plant</th>
<th>Fruit Size (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SC</td>
<td>Meigs Open Field</td>
<td>Meigs HT Hydro</td>
</tr>
<tr>
<td>Lilliput</td>
<td>80</td>
<td>79</td>
<td>95</td>
</tr>
<tr>
<td>Inspire</td>
<td>65</td>
<td>76</td>
<td>91</td>
</tr>
<tr>
<td>Sugar Cubes</td>
<td>80</td>
<td>76</td>
<td>92</td>
</tr>
<tr>
<td>French Orange</td>
<td>75</td>
<td>79</td>
<td>94</td>
</tr>
<tr>
<td>Tasty Bites</td>
<td>80</td>
<td>76</td>
<td>94</td>
</tr>
<tr>
<td>Escorial</td>
<td>72</td>
<td>76</td>
<td>91</td>
</tr>
<tr>
<td>Savor</td>
<td>78</td>
<td>85</td>
<td>91</td>
</tr>
<tr>
<td>Artemis</td>
<td>78</td>
<td>76</td>
<td>91</td>
</tr>
</tbody>
</table>

Ideal: 0.9 to 1.8 kg

---

### Fruit Weight and Yield

<table>
<thead>
<tr>
<th>Variety</th>
<th>Yield/plant (kg)</th>
<th># Fruit/Acre</th>
<th>Yield (kg/Acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Meigs Open Field</td>
<td>Meigs HT Hydro</td>
<td>SWPAC HT Soil</td>
</tr>
<tr>
<td>Lilliput</td>
<td>5.3</td>
<td>4.7</td>
<td>5.3</td>
</tr>
<tr>
<td>Inspire</td>
<td>7.1</td>
<td>5.9</td>
<td>5.7</td>
</tr>
<tr>
<td>Sugar Cubes</td>
<td>6.8</td>
<td>4.8</td>
<td>3.7</td>
</tr>
<tr>
<td>French Orange</td>
<td>4.7</td>
<td>3.1</td>
<td>4.1</td>
</tr>
<tr>
<td>Tasty Bites</td>
<td>7.1</td>
<td>4.5</td>
<td>6.7</td>
</tr>
<tr>
<td>Escorial</td>
<td>5.6</td>
<td>5.4</td>
<td>5.1</td>
</tr>
<tr>
<td>Savor</td>
<td>1.9</td>
<td>4.5</td>
<td>3.3</td>
</tr>
<tr>
<td>Artemis</td>
<td>5.4</td>
<td>6.2</td>
<td>4.8</td>
</tr>
</tbody>
</table>

SWPAC 2017
Field Trial
Standard Varieties

Athena 7,792 fruit/acre 17,517 kg/acre
Aphrodite 7,889 fruit/acre 24,028 kg/acre
## Fruit Characteristics, External

**Cultivar Name**

1. Lilliput
2. Inspire
3. Sugar Cubes
4. French Orange
5. Tasty Bites
6. Escorial
7. Savor
8. Artemis

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## Fruit Characteristics, Internal

- **Lilliput**
- **Inspire**
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**Fruit Characteristics, Internal**

3. Sugar Cubes

4. French Orange

5. Tasty Bites

6. Escorial
### Internal Fruit Quality at Harvest: Brix, pH, and Firmness

<table>
<thead>
<tr>
<th>Variety</th>
<th>Brix (%SS)</th>
<th>Sap pH</th>
<th>Firmness</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Meigs Open Field</td>
<td>Meigs HT Hydro</td>
<td>SWPAC HT Soil</td>
</tr>
<tr>
<td>Lilliput</td>
<td>13.3</td>
<td>7.9</td>
<td>7.4</td>
</tr>
<tr>
<td>Inspire</td>
<td>10.6</td>
<td>7.2</td>
<td>6.7</td>
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<tr>
<td>Sugar Cubes</td>
<td>13.3</td>
<td>8.8</td>
<td>9.6</td>
</tr>
<tr>
<td>French Orange</td>
<td>13.4</td>
<td>10.6</td>
<td>7.3</td>
</tr>
<tr>
<td>Tasty Bites</td>
<td>12.4</td>
<td>8.0</td>
<td>7.6</td>
</tr>
<tr>
<td>Escorial</td>
<td>14.1</td>
<td>8.5</td>
<td>7.9</td>
</tr>
<tr>
<td>Savor</td>
<td>12.6</td>
<td>8.5</td>
<td>7.6</td>
</tr>
<tr>
<td>Artemis</td>
<td>13.9</td>
<td>8.8</td>
<td>9.4</td>
</tr>
</tbody>
</table>

Class 1: >11%  /  Class 2: 9%  
Ideal range: 6.13-6.58
## Fruit Quality at Harvest: Fruit Length and Width

<table>
<thead>
<tr>
<th>Variety</th>
<th>Seed Cavity</th>
<th>External</th>
<th>External</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Meigs</td>
<td>Meigs Open Field</td>
<td>Meigs HT Hydroponics</td>
</tr>
<tr>
<td></td>
<td>Length (mm)</td>
<td>Width (mm)</td>
<td>Length (mm)</td>
</tr>
<tr>
<td>Lilliput</td>
<td>74</td>
<td>57</td>
<td>125</td>
</tr>
<tr>
<td>Inspire</td>
<td>98</td>
<td>60</td>
<td>148</td>
</tr>
<tr>
<td>Sugar Cubes</td>
<td>78</td>
<td>52</td>
<td>128</td>
</tr>
<tr>
<td>French Orange</td>
<td>83</td>
<td>57</td>
<td>129</td>
</tr>
<tr>
<td>Tasty Bites</td>
<td>92</td>
<td>60</td>
<td>147</td>
</tr>
<tr>
<td>Escorial</td>
<td>89</td>
<td>63</td>
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<tr>
<td>Savor</td>
<td>83</td>
<td>61</td>
<td>130</td>
</tr>
<tr>
<td>Artemis</td>
<td>88</td>
<td>59</td>
<td>135</td>
</tr>
</tbody>
</table>
Conclusions

- French Orange is very susceptible to bacterial wilt (Meigs open field and high tunnel trials)
- Savor is very susceptible to powdery mildew
- DTH was longer for high tunnel grown crops, due to pruning vs. no pruning in field trial
- Harvest period was longer in open field trial, 38 days vs. 21 and 24 days
- All varieties met the fruit size criteria set out at the onset of the study. However, Inspire and Escorial did produce significantly larger fruit in the open field trial
- Yields from high tunnel trials were much higher than open field, 3.2 times higher plant density
- Soilless (hydroponic) and soil grown high tunnel production offer similar production results. Quality was higher in soilless culture
- Yields in most cases are higher than current commercial varieties planted
- Harvest protocols need to be better defined

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Conclusions

- Brix was consistently higher in open field produced melons
- Support hanging fruit with netted sack?
- Soil grown high tunnel melons produced softer fruit with lower brix values
- Fruit of French Orange, Escorial, Savor and Artemis tend to crack at the blossom end. However, the worst effected variety was Savor (soft and thin-skinned variety)
- Adjusting production practices might help to minimize fruit cracking
- Varieties with none to very little defects and production issues include Lilliput and Sugar Cubes.
- From initial results, Lilliput and Sugar Cubes seem to have the most potential; plus Escorial and Artemis if fruit cracking can be managed
- Economic considerations:
  - Trellising requires a lot more labor; netting less than single string and clips
  - Additional inputs and infrastructure needed when high tunnel grown
  - Consumer
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THANK YOU

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