Sweet Cherries: High Tunnels Change Just About Everything

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MSU High Tunnel Cherry Project

Tree Goals:
- Fill orchard space and begin fruiting rapidly
- Manage and harvest trees mostly from the ground

Fruiting Goals:
- Premium quality - size, sugar, appearance
- Reduced cracking, fruit rot, bird damage

Research Sites:
- SWMREC (Benton Harbor): Four 24 ft x 200 ft tunnels
- CHES (Clarksville): Three 28 ft x 159 ft tunnels

- 6’ at CHES in tunnel leg row
- 8’ at SWMREC in tree row
- 12’ at CHES in tractor alley

Tree row weed barrier, weed barrier, tractor alley

Two stations:
- Manage and harvest trees mostly from the ground

permanent and mobile

Fruiting Goals:
- Air temperature
- Relative humidity
- Wind speed and gust
- Leaf wetness
- Solar radiation
- Soil temperature

Research Sites:
- SWMREC (Benton Harbor): Four 24 ft x 200 ft tunnels
- CHES (Clarksville): Three 28 ft x 159 ft tunnels

- Solar radiation
- Soil temperature
- Water level
- Wind speed and gust

Table 1. 2006 sweet cherry lateral shoot formation, with and without high tunnel production systems, SWMREC (est. 2005)

<table>
<thead>
<tr>
<th>Variety</th>
<th>Covered (tunnel)</th>
<th>Covered (no tunnel)</th>
<th>Open (tunnel)</th>
<th>Open (no tunnel)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rainier/Gi5</td>
<td>36</td>
<td>22.6</td>
<td>21.6</td>
<td>24.6</td>
</tr>
<tr>
<td>Skeena/Gi5</td>
<td>36</td>
<td>22.6</td>
<td>25.6</td>
<td>22.6</td>
</tr>
<tr>
<td>Glacier/Gi6</td>
<td>36</td>
<td>23.7</td>
<td>24.6</td>
<td>24.6</td>
</tr>
<tr>
<td>Average</td>
<td>24.1</td>
<td>23.3</td>
<td>23.2</td>
<td>24.6</td>
</tr>
<tr>
<td>NY Elite/Gi6</td>
<td>21</td>
<td>18.5</td>
<td>18.5</td>
<td>19.7</td>
</tr>
<tr>
<td>Glacier/Gi6</td>
<td>36</td>
<td>13.3</td>
<td>13.3</td>
<td>9.0</td>
</tr>
</tbody>
</table>

Test in NY Elite & Glacier 21.1 20.6

Table 2. 2006 ‘Rainier’ sweet cherry yield and fruit size, with and without high tunnel production systems, CHES (est. 2000)

<table>
<thead>
<tr>
<th>Variety</th>
<th>Covered (tunnel) (kg/tree)</th>
<th>Covered (no tunnel) (kg/tree)</th>
<th>Open (tunnel) (kg/tree)</th>
<th>Open (no tunnel) (kg/tree)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rainier/Gi5</td>
<td>13.7</td>
<td>25.1</td>
<td>10.0</td>
<td>21.8</td>
</tr>
<tr>
<td>‘Rainier’/Gisela 5</td>
<td>20.1</td>
<td>44.4</td>
<td>22.0</td>
<td>48.0</td>
</tr>
</tbody>
</table>

Table 3. 2006 ‘Rainier’ sweet cherry fruit size distribution and crop value with and without high tunnel production systems, CHES (est. 2000)

<table>
<thead>
<tr>
<th>Variety</th>
<th>Covered (tunnel) (g)</th>
<th>Covered (no tunnel) (g)</th>
<th>Open (tunnel) (g)</th>
<th>Open (no tunnel) (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lapins/Gi5</td>
<td>12.5</td>
<td>9.3</td>
<td>12.5</td>
<td>9.3</td>
</tr>
<tr>
<td>Rainier/Gi5</td>
<td>8.3</td>
<td>6.3</td>
<td>8.3</td>
<td>6.3</td>
</tr>
</tbody>
</table>

Crop value per acre appears to justify the higher establishment costs for tunnel production systems.

Thus far, high tunnels have provided noticeable reductions of:
- Spring frost damage during bloom (2006)
- Reduced fruit cracking and postharvest diseases (2005)
- Red leaf development on ‘Rainier’ (2005-06; not a good effect)

Moreover, additional advantages have been observed with respect to integrated pest management issues (e.g., Fig. 2) and reduced pesticide inputs, as high tunnel production also reduced:
- Cherry leaf spot and defoliation (2006)
- Japanese beetle damage and defoliation (2006)
- Bacterial canker (2005; preliminary data)
- Bird damage to fruit and deer damage to trees

There have been noticeable, though not yet economically important, increases of:

In 2006, no pesticides were used in the CHES tunnels; there was little to no apparent movement of plum curculio or cherry fruit fly into the tunnels from surrounding infested plots, which were sprayed conventionally.

In 2006, brown rot infections were significant in both the tunnel and no-tunnel plots. Although levels were similar at harvest, it appeared to develop earlier under the tunnels, possibly due to higher humidity and temperatures.

Much research remains regarding high tunnel production of sweet cherries - climatic (especially temperature, humidity, and light) analyses; optimization of yields, fruit quality traits, and high density tree architectures; whether IPM strategies can approach organic certification, etc. However, the dramatic results of these preliminary studies have revealed a significant set of potential advantages under Great Lakes growing conditions for growers wishing to target dwarf cherry production for high value premium fresh markets.

Financial, in-kind, and/or technical support from Project GREEEN, Haygrove Inc., International Fruit Tree Association, Summit Sales, Growers Inc., Michigan Agricultural Experiment Station, SWMREC, and CHES is gratefully acknowledged.
MSU High Tunnel Cherry Production - An Update
Gregory Lang, Tara Valentino, and Bill Shane, Michigan State University

Locations
SWMREC (Benton Harbor): Four 24 x 200 ft tunnels
CHES (Clarksville): Three 28 x 159 ft tunnels
Each site included adjacent comparative plots without tunnels

Objectives
- Optimize the climate-tree interface: air and soil temperature, light, water relations, relative humidity, and wind
- Optimize tunnel-constrained tree growth and architecture, filling orchard space rapidly and efficiently
- Produce high yields of large, premium quality fruit
- Reduce fruit defects due to cracking, rots, bird damage, etc.
- Reduce pesticide use and associated application costs
- Manage and harvest trees from the ground, without ladders

SWMREC Tunnels
- Dark Red Cultivars: Skeena/Gi®5, NY Elite/Gi®5, Glacier/Gi®6, Guards/Pollinators: Benton, Blackgold, Blushing Gold, Cristalina, Lapins, Regina, Sandra Rose, Tieton, Tettnan, Ulster, as well as 20 advanced selections from Cornell & Washington State University, plus Danube and Jubileum sweet/tart cherries

Effects on the Cherry Production Environment
- Soils warmed earlier in the spring under tunnels or in the standard orchard if black polypropylene wind barrier fabric was installed.
- Growing degree accumulation was 10% higher under the tunnels than outside, both during fruit development as well as the entire growing season (graph at left).
- Photosynthetically-active radiation was reduced about 25% under the tunnels (graph at right).
- The Luminance plastic also reduces UV (potential effects on both plants and insects) and infra-red (heat-bearing) light.
- Wind speed was generally reduced by 5 to 10 mph under the tunnels.

CHES Tunnels
Trees planted in 2000, tunnels erected in 2005
- Dark Red Cultivars: Lapins/Gi®5 and Gi®6, Sweetheart/Gi®6

Effects on Vegetative Growth (SWMREC)
- In 2006, terminal leader growth under the tunnels was increased by 24%; trunk girth was reduced by ~18%, probably due to reduced exposure to wind.
- In 2007, trunk girth of trees under the tunnels was increased by ~35%, probably due to better tree health (less damage from the April freeze and May leaf spot and bacterial canker infections) and reduced environmental stress.
- Leaf size was increased under the tunnels by 20 to 25%.
- In 2006, neither lateral shoot number nor average shoot length were influenced strongly by tunnels, with results varying by cultivar.
- In 2007, lateral shoot length was clearly greater under the tunnels.
- The reduced wind exposure has not only improved trunk orientation, but also appears to promote more horizontal growth (a light effect?).
- The use of white reflective mulch (Extenday) increased tree growth by 7% during the 2008 season.

Effects on Cropping and Fruit Quality (CHES)
- In 2006, yields of Rainier/Gisela®5 and Rainier/Gisela®6 trees under the tunnels were half of those outside the tunnels, presumably due to reduced pollination by honeybees.
- However, fruit size under the tunnels was 3% to 10% larger under the tunnels (97% 9.5-Row [28 mm] and larger), making the actual net crop value (fruit value - harvest cost) highest for the Rainier/Gisela®5 crop in the tunnel.
- In 2006, fruit blush was reduced under the tunnels due to reduced UV light transmission.
- In 2007, bumblebee hives placed in the center tunnel (see inset in photo below) supplemented the standard honeybee hives placed outside the tunnels. Side-venting of the tunnels was increased to allow more angled sunlight for the white plastic mulch to reflect.
- In 2007, tunnel-grown fruit in 2007 were still 5% to 17% larger than fruit grown outside the tunnel.
- In 2008, the incidence of brown rot was high for all trees (tunnel and standard) grown without fungicides. In 2007, with greater tunnel venting and a switch from under-tree micro-sprinklers to drip irrigation to reduce relative humidity under the tunnels, there was less brown rot on fruit from tunnel-grown trees.
- Black cherry aphids and spider mites were present at higher levels on tunnel-grown trees and will require an integrated pest management strategy for adequate control.

Effects on Tree Health, Insect and Disease Pests
- In both 2006 and 2007, no pesticides were applied to the research trees at CHES.
- In both years, cherry leaf spot infections began in May, causing significant defoliation in the standard trees by late July in 2006 and mid-June in 2007, but none in the tunnels.
- In both years, Japanese beetle feeding led to 50% to 100% defoliation of new shoots on standard trees by August, but feeding was negligible on trees under the tunnels.
- In fall and winter 2006-07, shoot cold hardness tended to be better in the tunnel-grown trees, probably due to their better leaf health and higher carbohydrate reserves from 2006.
- During the April 2007 freeze, which occurred when the tunnels had yet to be covered, more damage to flowers, leaf spots, shoot buds, and even trunk cambium (see inset in photo below) occurred on the standard trees compared to the tunnel-grown trees.
- In 2006, the incidence of brown rot was high for all trees (tunnel and standard) grown without fungicides. In 2007, with greater tunnel venting and a switch from under-tree micro-sprinklers to drip irrigation to reduce relative humidity under the tunnels, there was less brown rot on fruit from tunnel-grown trees.
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