Ten Years of Studies on Systems to Modify the Sweet Cherry Production Environment: Retractable Roofs, High Tunnels, and Rain-Shelters

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Lynne Sage, Tammy Wilkinson
Michigan State University
Two Types of Cherry Fruit Cracking

**Type 1: Rain on Fruit Skin**
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**Type 2: Excessive Water in the Soil**
Fruit side cracking (due to rain or irrigation water taken up by the roots and pumped into the fruit *(especially when leaves have low evapotranspiration)*).

Can occur even with protective covers; must manage soil moisture and drainage!
Protected Tree Fruit Production = Localized Climate Change

Pole and Cable Tent Structures:
- least expensive, movable vs. fixed, venting

Three- vs. Four-Season High Tunnels:
- multi-bay, snow loads, single layer plastic, heat

Greenhouse-like, Automated Structures:
- most expensive, most manipulation options
Fixed or Hand-pulled Pole and Cable Covers
Vented Covers (VOEN) – Fixed protection from rain and hail; passive venting of heat in summer
13 ft Pole-Cable Tent Covers: TSA (6 ft spacing, 558 trees/acre) Conical Fruiting Wall + Tractor Sprayer + Berm (3 ft x 1 ft) + Drain Tile
Multi-Bay High Tunnels
Multi-Bay High Tunnels with doors and bird nets
26 ft Tunnel: TSA (6 ft spacing, 558 trees/acre) Conical Fruiting Wall + Tractor Sprayer + Berm (3 ft x 1 ft) + Drain Tile + Netted Plastic
Programmable Retractable Roof
Covered Sweet Cherries
Roof Panels Open and Close in Response to Rain, Wind, and High and Low Temperature Set-Points to Optimize Growing Conditions (Cravo X-frame)
Retractable Flat-Roof with drainage slits; retractable benefits, lower cost, less control of Type 2 cracking
8 Ft Flat Roof Retractable Covers: UFO (6 ft spacing, 907 trees/acre) or SSA (3 ft spacing, 1815 trees/acre) Vertical Fruiting Walls + Tractor Sprayer
MSU Hort Farm (HTRC, 2010)
Nine multibays 8.0 x 62 m (26 x 200 ft)
   Organic cherry and raspberry production systems

Clarksville (CHES, 2005)
Three multibay 8.6 x 49 m (28 x 160 ft) tunnels
   (Haygrove) initially cherries, now planted to apricots, plums, nectarines
2012 Cherries – Cravo retractable X-frame roof (7 rows), VOEN cover (5 rows)
2013 Cherries – Cravo retractable flat roof structure

Southwest (SWMREC, 2005)
Eight multibays 7.4 x 62 m (24 x 200 ft)
   cherries, raspberries, strawberries, blackberries
Cover First or Plant First? Impact of Covers on Growth

Earlier leaf area and fruiting structure development = higher early fruit yields
### 2007 ‘Rainier’ Sweet Cherry Yield and Fruit Size at MSU-CHES, with Bumblebee Pollinators

<table>
<thead>
<tr>
<th></th>
<th>‘Rainier’ /Gisela 5</th>
<th></th>
<th>‘Rainier’ /Gisela 6</th>
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<tbody>
<tr>
<td></td>
<td>Covered (tunnel)</td>
<td>Open (no tunnel)</td>
<td>Covered (tunnel)</td>
<td>Open (no tunnel)</td>
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<tr>
<td><strong>Tree Yield</strong> (kg/tree)</td>
<td>21.4</td>
<td>20.4</td>
<td>22.6</td>
<td>22.0</td>
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<tr>
<td><strong>Orchard Yield</strong> (ton/ha)</td>
<td>22.9</td>
<td>21.8</td>
<td>24.2</td>
<td>23.6</td>
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<tr>
<td><strong>Fruit Weight</strong> 100 fruit mean (g)</td>
<td>10.4</td>
<td>9.9</td>
<td>11.2</td>
<td>9.6</td>
</tr>
</tbody>
</table>

1Tree density is 1083 trees/ha (446 trees/acre)
2014 Covering Systems: Yield and Fruit Size

- **Retractable Roof**
  - Yield (t/ha): 6.3
  - Fruit size (g/fruit): 11.2

- **Vented Plastic**
  - Yield (t/ha): 2.5
  - Fruit size (g/fruit): 10.6

- **Uncovered Control**
  - Yield (t/ha): 1.1
  - Fruit size (g/fruit): 9.8
MSU Tunnel Research: 80,000 BTU Propane Heaters; for every +1°C, need ~13 heaters/ha
Cravo Heating: for every +1°C, need ~4.5 heaters/ha
## 2009 SWMREC ‘Rainier’ Harvest, GDH Effects

<table>
<thead>
<tr>
<th>Date</th>
<th>Plot (cover date)</th>
<th>Diam</th>
<th>Wt (g)</th>
<th>Brix</th>
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<tbody>
<tr>
<td>6/22</td>
<td>Tunnel 4 (13 Mar)</td>
<td>34</td>
<td>15.5</td>
<td>18.8</td>
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<tr>
<td></td>
<td>Tunnel 3 (20 Mar)</td>
<td>32</td>
<td>13.2</td>
<td>17.4</td>
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<tr>
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<td>Tunnel 2 (27 Mar)</td>
<td>31</td>
<td>11.8</td>
<td>17.7</td>
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<tr>
<td></td>
<td>Tunnel 1 (8 Apr)</td>
<td>28</td>
<td>9.1</td>
<td>15.8</td>
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<tr>
<td></td>
<td>No Tunnel</td>
<td>25</td>
<td>7.0</td>
<td>14.3</td>
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</table>
Solid-Set Canopy Spray Systems

On-Hoop Orientation

Over-Row Orientation
Bloom delay of 7-10 days (2013); longer is feasible
Tunnel W Canopy

Tunnel M Canopy

Tunnel Spray Systems
## Covering Systems: Protective Attributes

<table>
<thead>
<tr>
<th>Protection from:</th>
<th>Pole and Cable</th>
<th>High Tunnel</th>
<th>Programmable Retraction</th>
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<tbody>
<tr>
<td>Fixed, Non-Vented</td>
<td>Retractable</td>
<td>Fixed, Net-Vented</td>
<td>Rooftop Non-Vented</td>
</tr>
</tbody>
</table>

### Type 1 fruit cracking
- X

### Type 2 fruit cracking*
- -

### Spring frost
- ~

### Hail, wind
- +

### Pseudomonas
- ~

### Blumeriella
- +

<table>
<thead>
<tr>
<th>Protection from:</th>
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<td>Blumeriella</td>
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<tr>
<td></td>
<td>Pole and Cable</td>
<td>High Tunnel</td>
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<td>Retractable</td>
<td>Fixed, Net-Vented</td>
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<td>Other effects:</td>
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<tr>
<td>Early bloom &amp; ripening</td>
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<tr>
<td>Sequenced ripening</td>
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<td>Advanced foliation</td>
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<tr>
<td>Full light</td>
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<tr>
<td>Fruit blush formation</td>
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<tr>
<td>Excessive heat</td>
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<tr>
<td>Cost</td>
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<td>$</td>
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For additional information, see:

Greg Lang’s MSU Website:  www.hrt.msu.edu/greg-lang
The MSU Cherry Website:  www.cherries.msu.edu

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