Opportunities to improve sweet cherry production efficiency

Matthew Whiting

WASHINGTON STATE UNIVERSITY

What we have…….

• Aged genetics
• Lengthy production cycles
• Inefficient/static production
• Crops that are vital to health & well-being
• New opportunities for research & outreach & collaboration
• Increasing cost & decreasing supply of labor
• Inadequate education and outreach
Output vs. Input:
Production systems

Innovations in cherry production

- Genetic
- Orchard systems
- Automation/mechanization
  - Mechanical pruning
  - Mechanical harvest
- Precision management
- Plant growth regulators
Future orchard systems

Simplified Pruning of the UFO System:

Pruning rules:
1. Remove all lateral wood (leave short stubs)
2. Renew vigorous uprights (leave renewal sites)
PAR interception of vertical and angled fruiting walls

Vertical UFO

Y-trellised UFO

Mobile measurement system

- 1: AccuPAR LP-80
- 2: Li-COR quantum sensor
- 3: I-O interface control box
- 4: Deere E-Gator
- 5: TRD-S encoder

- Diurnal trend was nearly symmetric around solar noon
- Yield potential on angled canopies is greater than planar canopies

Mechanical pruning

- Simplified planar systems – simplify pruning
- Investigated potential for mechanical pruning in UFO since 2010
Mechanical pruning
- Collard system
- 7 (vertical) or 4 (horizontal) circular saw blades
- 6-th leaf UFO

CONCLUSIONS

Hand pruning
2 min 40 s per tree (1800 trees/ha = 80 hr/ha)

Full mechanical pruning:
- 12.5-times faster (6.5 hr/ha)
- Removed ca. 60% less wood than hand pruning

Mechanical + hand pruning:
- 25% faster than hand pruning
- Same amount of wood removed as hand pruning

Good potential to reduce pruning time/costs using mechanical systems.
Objective

Determine best management practices for pruning sweet cherry and apple mechanically, by understanding equipment and orchard requirements.

Mechanical pruning

- Gillison’s GVF Center Mount Topper and Hedger
- Side shift ca. 1.2 m on either side of the tractor
- Height adjustment of 1 m to 6.5 m
- 360° rotation of cutting head
Experiment outline

**Sweet cherry**

- Mechanical hedging and topping vs/+ hand pruning
- Pre/postharvest topping

**Apple**

- Mechanical pruning vs. hand pruning

Sweet cherry trials:

<table>
<thead>
<tr>
<th>Trial block details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Variety</strong></td>
</tr>
<tr>
<td><strong>Rootstock</strong></td>
</tr>
<tr>
<td><strong>Training system</strong></td>
</tr>
<tr>
<td><strong>Tree age</strong></td>
</tr>
<tr>
<td><strong>Tree spacing</strong></td>
</tr>
</tbody>
</table>
Trial design:

Mechanical pruning vs. Hand pruning

3 treatments x 5 reps

- 20 trees/rep
- Completely randomized design
- Post-harvest hedging and topping

YEAR 1
1. Hand pruning
2. Mechanical pruning (1)
3. Mechanical pruning (2)

YEAR 2
1. Hand pruning
2. Mechanical pruning
3. Mechanical pruning + Hand pruning

Data collection

- Time to prune
- Performance of the machine
- Weight wood pruned
- Wood damage
- Economic evaluation
Preliminary results (2014)

Hand pruning removed 2 x wood removed than mechanical pruning
Hand pruning 10 kg/tree
Mechanical pruning 5 kg/tree
“Dirty cuts”

Results - Time

Mechanical pruning 23 x faster than hand pruning (hedging and topping)
Hand pruning 374 sec/tree  →  6 min/tree
Mechanical pruning 16 sec/tree  →  0.3 min/tree
Tractor speed: 1.9 km/h
Topping

Hedging
Example

- Sweet cherry orchard trained to UFO training system
- Spacing: 2 m x 3.1 m
- 8 h work/day
- Mechanical pruning:
  - 6 h/ha
  - 1.3 ha/day
- Hand pruning:
  - 135 h/ha
  - 0.06 ha/day

Mechanical pollination

For yield security and resilience to:
- Colony collapse disorder, variable environmental conditions, poor bloom overlap, insufficient pollenizers/pollinators all threaten ability to set a crop

8.2 t/ha
Proposed solution:

• Collect pollen
• Suspend pollen
• Apply pollen via sprayer

• Challenges:
  – Stigma is a small target!
  – Pollen loses viability in liquid

Electrostatic sprayer
Mechanical pollination

‘Tieton’/ ‘Gisela 5’: 8 years old trained to UFO

Mechanical pollination
Mechanical pollination

- Proof of concept study
- Supplemental pollination
- Sprayed pollen once at 50% bloom
- Fruit set improved 15%
- Increased pollen deposition

Mechanical pollination

- Proof of concept study
- Replacement pollination
- Sprayed pollen through bee exclusion netting
  - Two applications (50% and 90%)
- Yield similar to open-pollinated trees
Mechanical pollination
Mechanical shaking to transfer pollen
Self-fertile cultivars

<table>
<thead>
<tr>
<th>Fruit set (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>90%</td>
</tr>
<tr>
<td>80%</td>
</tr>
<tr>
<td>70%</td>
</tr>
<tr>
<td>60%</td>
</tr>
<tr>
<td>50%</td>
</tr>
<tr>
<td>40%</td>
</tr>
<tr>
<td>30%</td>
</tr>
<tr>
<td>20%</td>
</tr>
<tr>
<td>10%</td>
</tr>
<tr>
<td>0%</td>
</tr>
</tbody>
</table>

Treated | Control
a       | b

Mechanical harvest

- Harvest costs are >50% of all
- Labor cost increasing
- Labor availability decreasing
Mechanical harvest

- Taking short- and long-term approach using total systems approach
  - Mechanical assist (shake-and-catch)
  - Fully mechanical harvest

In domestic and export markets, stem-free cherries are accepted/preferred
New packaging + marketing by Chelan Fresh

Plant growth regulators

- Post-bloom thinning
- AVG for improving fruit set
Post-bloom thinning response:
Summary of 2012 trials

- Ethephon is an effective post-bloom thinner
- Efficacy is rate dependent
- Early applications more effective
- Quality improvements not assoc. with thinning

‘Lapins’

Fruit quality – weight (g) vs. fruit per foot

- Continuing research on moderate Ethephon rates on quality
Increasing fruit set
‘Kordia’ in Tasmania

Collaboration with Dugald Close, Sally Bound; UTas

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Fruit set (%)</th>
<th>Fruit wt (g)</th>
<th>Cracked fruit (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>9.7 a</td>
<td>14.5 b</td>
<td>25.1 b</td>
</tr>
<tr>
<td>AVG 500 g/ha</td>
<td>15.3 b</td>
<td>12.9 a</td>
<td>14.0 a</td>
</tr>
<tr>
<td>(ca. ¾ pouch/ac)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rate of AVG</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>Time of application</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
</tr>
</tbody>
</table>

Rate and timing studies

• Rates:
  – 0, 0.5, 1.0, 1.5 pouches/acre
  – 0, 166, 333, 500 g/ac

• Timings:
  – Popcorn, 10% FB, 50% FB, ca. FB
‘Regina’ in Zillah

Fruit set - % available flowers

AVG Improves ‘Regina’ Fruit Set

Data from Todd Einhorn, OSU

- Surfactant → 0.1% v:v
- Rate → 1 pouch per ac
- Timing between 10 to 80% of full bloom

12/3/2014
AVG Improves ‘Regina’ Fruit Set
Data from Todd Einhorn, OSU

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Yield per limb (lbs)</th>
<th>Fruit per limb (no.)</th>
<th>Avg. fruit weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>1.6 b</td>
<td>48 b</td>
<td>11.8</td>
</tr>
<tr>
<td>Retain @ 30 % FB</td>
<td>3.1 a</td>
<td>81 a</td>
<td>12.0</td>
</tr>
<tr>
<td>Retain @ 65 % FB</td>
<td>3.0 a</td>
<td>85 a</td>
<td>11.3</td>
</tr>
<tr>
<td>Retain @ 30 &amp; 65 % FB</td>
<td>3.0 a</td>
<td>92 a</td>
<td>12.0</td>
</tr>
</tbody>
</table>

2011 Limb Trials

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Yield/projected (lbs/tree)</th>
<th>Yield/projected (tons/a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>51.9 b</td>
<td>6.3</td>
</tr>
<tr>
<td>Retain (1 pouch/a)</td>
<td>69.2 a</td>
<td>8.4</td>
</tr>
</tbody>
</table>

P>F 0.022
4 reps (RCBD), n=19

• Product cost ~ $300/ac

Recommendations:

• ReTain® applied at 10% to full bloom
  • 333 g per acre
  • Single application
  • Particularly during warm weather
Pruning severity levels:
- **Light pruning**: thinning cuts and few heading cuts.
- **Medium pruning**: balanced thinning cuts and few heading cuts.
- **Heavy pruning**: many thinning cuts and heading cuts.

**Experiment**

Samples: 45 trees, 15 blocks with 5 trees of each, 3 blocks for each pruning level.

Data collection:
- PAR interception of pre- and post-pruning.
- Length and diameters of both ends of all branches in each tree pre-pruning.
- Length and diameters of both ends of all prunings from each tree.
- Total weight of all prunings from each tree.
**Relative reduction of light interception =** 
\[
\frac{\text{light interception (pre-pruning)} - \text{light interception (post-pruning)}}{\text{light interception (pre-pruning)}} \times 100\%
\]

**Relative reduction of VCA =** 
\[
\frac{\text{VCA (pre-pruning)} - \text{VCA (post-pruning)}}{\text{VCA (pre-pruning)}} \times 100\%
\]

**Conclusion**

- Adoption of innovation has been slow in cherry industry
- Market pressures will continue to force innovation
- Research at WSU at leading edge
Questions?

FB: WSUStoneFruitPhysiology