Developing and Optimizing Sweet Cherry Training Systems for Efficiency and High Quality Fruit – Part 1

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Cherry Training Systems

Continuously evolving strategies to grow the best fruit, with high yields, most efficiently

Fruit tree growers have changed cherry trees from a naturally tall tree in the forest, to a moderated-sized pruned tree in the orchard, to a highly-structured fruiting wall that is easy to harvest and may allow partial mechanization.

Sweet Cherry Trees in Nature
- A forest tree, tall with top vigor
- Slow to begin fruiting, 5-7 years
- The Cherry Revolution began in the 1990s with hybrid rootstocks to induce early fruiting and control tree size
Fruit tall growers have changed cherry trees from a naturally tall tree in the forest, to a moderated-sized pruned tree in the orchard, to a highly-structured fruiting wall that is easy to harvest and may allow partial mechanization.
Simplified canopy architectures and mechanized thinning
Advantages and Drawbacks of High Density Sweet Cherry Systems

- Early bearing
- High yields
- Harvest efficiency and ease
- Tree efficiency (light and spray distribution)
- Easy to protect with covers

- Fruit quality?
- Early return on investment and breakeven cost?

- High establishment cost
- High level of inputs (training labor)
- High level of knowledge
- Must protect from frost since trees are smaller
- Short lifespan?

Slide by Musacchi and Lang
Narrow “Fruiting Wall” Canopies for Space Efficiency under Protective Structures

MSU High Tunnel Cherries for Early Ripening and Rain Protection
Cherry Systems Fundamentals: Growth and the Basic Fruiting Units

2-Yr-old growth
Fruit density increases terminally

Last year’s growth
A few nonspur fruit

New growth

Fruiting spurs
Non-fruiting spurs
Larger leaves

Understanding this basic set of leaf populations and fruiting sites is a fundamental key to all training systems.

Ayala and Lang, 2004
$^{13}\text{CO}_2$ Research

Marlene Ayala
Managing the Sugar Supply to Fruit

<table>
<thead>
<tr>
<th>Year</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
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<tbody>
<tr>
<td>Leaf population</td>
<td>Fruiting spurs</td>
<td>Non-fruiting spurs</td>
<td>Current season shoot</td>
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<tr>
<td></td>
<td>CO</td>
<td>CO</td>
<td>CO</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>2</td>
<td>13</td>
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</table>
Leaf Area and Location

Carbon Sources and Distribution to Fruit

- Fruiting spur leaves: 55%
- Non-fruiting spur leaves: 29%
- Shoot leaves: 16%

Beginning of Stage III (44 days after full bloom)

Fruit: 25% final size
Shoot: 16 leaves

Large leaf size, close to the fruiting clusters, is critical to achieve maximum fruit size, firmness, and sweetness

Ayala and Lang, 2004
Crop Load Effects on $^{13}\text{C}$ Movement to Fruit

Balanced crop loads improve uniformity of quality fruit
Basic Growth & Fruiting Units

Year 3:
Fruit populations: 1 spur (e.g., 75 total), 1 non-spur (e.g., 10 total)
Leaf populations: 2 spur (e.g., 120 total), 1 shoot (e.g., 10 x 2X)
Leaf-to-Fruit Ratio: 1.65

Year 4:
Fruit populations: 2 spur (e.g., 150 total), 1 non-spur (e.g., 10)
Leaf populations: 3 spur (e.g., 180 total), 1 shoot (e.g., 10 x 2X)
Leaf-to-Fruit Ratio: 1.25
Anticipation of the future unbalanced cropping sites can help in pre-emptive management to better balance leaf-to-fruit ratios and improve performance.

A dormant heading cut to remove: 15 to 30% of last year’s shoot will remove 25 to 40% of the future spur density.
Basic Growth & Fruiting Units

Heading cuts stimulate new shoot leaf populations and non-spur fruit populations, while reducing future spur fruit populations.

Year 3:
- **Fruit** populations: 1 spur (e.g., 40 total), 2 non-spur (e.g., 20 total)
- **Leaf** populations: 3 spur (e.g., 166 total), 2 shoot (e.g., 20 x 2X)
- Leaf-to-Fruit Ratio: 2.75
Strategies to Optimize Precision Cropping: The Highly-Structured Tree

De-construct the tree canopy into a simplified fruiting unit to manage leaf-to-fruit ratios, then repeat many times.
High Performance Orchards:
Precisely-Structured Trees with
Simplified Fruiting Units

Lang 2001
2010 NC140 Sweet Cherry Training Systems Trial Sites
(13 Planted, 9 Active in 2012)
Fruiting Wall Cherries

- A narrow canopy improves light penetration & distribution, producing fruit with higher sugar, color, firmness, and uniformity
- Improved spray coverage with reduced volume and drift
## Harvest Labor and Productivity

<table>
<thead>
<tr>
<th>Orchard Type</th>
<th>Picking Efficiency(^1) (min/Tree)</th>
<th>Trees per Acre</th>
<th>Pickers Hours per Acre</th>
<th>Pickers Required per Season(^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional</td>
<td>52.80</td>
<td>136</td>
<td>119.68</td>
<td>124.69</td>
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<tr>
<td>Pedestrian</td>
<td>21.93</td>
<td>272</td>
<td>99.42</td>
<td>103.58</td>
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<tr>
<td>Mechanical</td>
<td>0.30</td>
<td>390</td>
<td>1.93</td>
<td>2.03</td>
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\(^1\)Based on Assumed Yields

\(^2\)Based on an 8-hr day for hand harvest and 16-hr day for machine; 33.34 acres to harvest in 4 days
California NC140
Cherry Systems Trial

Photo courtesy of Joe Grant
All have **minimal permanent wood** (solid green line) and simplified strategies for **fruit wood renewal**
Rootstock Effect on Tree Vigor

Very dwarfing  Semi-vigorous

Gisela 3  Gisela 5  Gisela 6

TCSA (cm²), End of Year 2 (2011)
System x Rootstock Effect on Tree Vigor (TCSA), Fall 2012

Root Competition
There is no single best system. Growers will be successful who understand the fundamental training rationale and fruiting units for each system, and how to adapt their system management for their specific needs: their orchard site, their variety characteristics, their markets, and their labor situation.
Precise Fruiting Unit Formation

Year 1 - 10 to 15 lateral or upright shoots (future fruiting units)

Year 2 – 20 to 35 total future fruiting units

The greater the number of new shoots created in Years 1 and 2, the greater the diffusion of vigor.

This diffusion, and removal of any overly vigorous or weak shoots, results in more balanced and uniform fruiting units.
TSA Spacing: 5 x 11 ft

Heading of lateral shoots to balance crop load with leaf area.

Fruiting sites: both spur and non-spur
Establishing the TSA Orchard: Nursery Trees

TSA

Can use whip nursery trees; feathered nursery trees best if available
Shoot Promotion

The goal in forming shoots in Years 1-2 should be to establish fruiting units for Years 2-4:

- **Heading** (not desirable)
- **Promalin** (sensitive to climate)
- **Bud selection**
- **Bud notching/scoring** (susceptible to bacterial canker)
MSU-Clarksville TSA System Cherries
Heading cuts stimulate new shoot leaf populations and non-spur fruit populations, while reducing future spur fruit populations.
Lillrose and Lang, 2011 (preliminary data, not analyzed for publication)