Optimizing Cherry Production: Physiology-Based Management

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2011 Sweet Cherry Acreage

Sweet Cherry Acreage¹

#1: WA 34,000 acres

#2: CA 29,000 acres

#3: OR 12,500 acres

#4: MI 6,500 acres

¹USDA, 2009-2011
Rain Covers in Chile
Rain Covers in Norway
High Tunnels in Norway
Rain Covers in Switzerland
Semi-Mechanical Rain Covers in Netherlands

Crank-down covers

Hand-pull covers
Vented Covers (VOEN) in Germany, Italy, Switzerland
- Protection from rain and hail; passive venting of heat in summer
Haygrove Tunnels in the United Kingdom

- Protection from rain, hail, and wind; heat retention in spring
High Tunnels in the United States
- Protect from rain, hail, wind, frost; reduce some diseases, and promote earlier ripening; improve tree training & early yields
Chinese structures range from bamboo tunnels to 28 ft high steel greenhouses.
Greenhouse Cherries in Spain
- Promote early harvest for high value, off-season markets

“World’s Most Expensive Cherries” $35 to $150 per kg
Roof Panels Open and Close in Response to Rain, Wind, and High and Low Temperature Set-Points to Optimize Growing Conditions
MSU Tunnel Research: Propane Heaters to add ~3°C when outside temperatures were -8 to -3°C; overhead spray system
Small root systems need higher frequency irrigation and available nutrients.
# Cherry Growth & Cropping Timeline, Part 1

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<td>Southern Latitude:</td>
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## Stage of Development:
- **Flower Bud Induction**
- **Flower Organ Differentiation**
- **Autumn Leaf Fall**

## Physiological Processes:
- **Photosynthesis**
- **Soil Nitrogen Uptake**
- **Carbon and Nitrogen Mobilization to Reserve Tissues**

## Important Effects:
- **New Shoot Growth and Shoot Leaf Size**
- **Building of Storage Reserves for Spring Growth; Cold Acclimation**
Cherry Growth & Cropping Timeline, Part 2

**Stage of Development:**
- Final Bud Differentiation
- Bloom
- Fruit Cells
- Harvest

**Physiological Processes:**
- Mobilization of C and N Reserves To Growing Points
- Fruit Set
- Fruit Cell #
- Spur Leaf Size
- Soil N Uptake
- Photosynthesis
- Fruit Size, Firmness, and Sweetness

**Important Effects:**

**Northern Latitude:**
- Dec/Jan/Feb (Jun/Jul/Aug)
- Mar (Sept)
- Apr (Oct)
- May (Nov)
- Jun (Dec)
- Jul (Jan)

**Southern Latitude:**
- Jun (Dec)
- Jul (Jan)
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
Marlene Ayala

$^{13}\text{CO}_2$ Research
### Managing the Sugar Supply to Fruit

<table>
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<th>Year</th>
<th>2001</th>
<th>2002</th>
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<tr>
<td>Leaf population</td>
<td>Fruiting spurs</td>
<td>Non-fruiting spurs</td>
<td>Current season shoot</td>
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![Diagram showing the flow of \(^{13}\text{CO}_2\) through different plant parts over the years 2001, 2002, and 2003.]
Large leaf size, close to the fruiting clusters, is critical to achieve maximum fruit size, firmness, and sweetness.
Crop Load Effects on $^{13}$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
Basic Growth & Fruiting Units

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.
Heading cuts stimulate new shoot leaf populations and non-spur fruit populations, while reducing future spur fruit populations.
Basic Growth & Fruiting Units

Heading cuts stimulate new shoot leaf populations and non-spur fruit populations, while reducing future spur fruit populations.
Basic Growth & Fruiting Units

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

Heading cuts stimulate new shoot leaf populations and non-spur fruit populations, while reducing future spur fruit populations.
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
Simplified canopy architectures and mechanized thinning

Photo Courtesy of Mark and Ines Hanrahan
Narrow “Fruiting Wall” Canopies for Space Efficiency under Protective Structures

*MSU High Tunnel Cherries for Early Ripening and Rain Protection*
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
2010 Sweet Cherry Training Systems Trial

KGB

TSA

SSA

UFO

Kym Green Bush

Tall Spindle Axe

Super Slender Axe

Upright Fruiting Offshoots

All have **minimal permanent wood** and simplified strategies for fruit wood renewal
Precise Shoot (Fruiting Unit)

Formation in Years 1-3

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.
Bud Selection

Promalin (BA + GA₄+7)
Notching / Scoring

Pegs for Crotch Angles
TSA Trees (semi-traditional)

Heading of lateral shoots to increase the number of fruiting units and balance crop load with leaf area.
MSU-Clarksville TSA System Cherries
Super Slender Axe (SSA)

Stefano Musacchi
University of Bologna
System x Rootstock Effect on Tree Vigor (TCSA), Fall 2012

TCSA (cm²)

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Root Competition
Annual Short-Pruning of every fruiting unit regenerates new shoot leaf populations and non-spur fruit populations, and maintains a balanced crop load (favorable leaf-to-fruit ratio)
SSA Cropping on basal buds of year-old shoots

Photo by Stefano Musacchi
Lower fruiting units are slightly longer.
New Shoots from Latent Vegetative Buds
Cultivar Suitability for SSA

SSA cropping success is highly dependent on:

1) Lateral shoot formation in the first two years;

2) Precocious basal flower bud formation (not too much, not too little)

Therefore, each cultivar must be tested for adaptability to this system and grafted to precocious rootstocks.
KGB Establishment

Year 1

1) Head at planting to 45 cm

2) After ~45 cm new growth, head the 4-5 strongest shoots back to about 10 cm (by mid-June)

Goal: 8-12 uniform uprights at Year 1

Year 2 - head all shoots back to ~10 cm (target is ~15 to 25 upright fruiting units)
Two cuts in Year 2 will eliminate fruiting potential in Year 3
Year 3 – Thin / renew fruiting units to final target number
Year 3: Basal Fruiting

Basic Fruiting Units (Renew 20% per year)

Year 4: Spur Fruiting

KGB System
**UFO Sweet Cherry**

The permanent wood is a lateral cordon; fruiting units are upright shoots, similar to KGB.

*Photo courtesy of Mark & Ines Hanrahan*
Moderate caliper nursery trees are easier to bend and maintain after bending.
Target is 10-15 Uniform Upright Shoots;
Renewal of Strong Shoots is Critical
UFO Spacing: 1.5 x 3.0 m

Fruiting is primarily on spurs like the KGB
SSCD High Tunnel Spray System

Optimal SSCD spray coverage - a mix of emitter types (sprinkler + fogger) and canopy orientations?
Fruiting Wall + SSCD Spray System: Best Optimized with 8 m Tunnels

Tree spacing = 1.5 x 2.5 x 2.5 m (height) = 2500 trees/ha; Canopy fruiting volume:
1.5 m (between) x 1.7 m (spread) x 2.0 m (height) x 3 rows = 1.25 m³/m² tunnel area
MSU Tree Fruit Research

Training video clips at:
www.giselacherry.com

www.cherries.msu.edu