Optimizing Cherry Production: Physiology-Based Management

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IFTA INTERNATIONAL FRUIT TREE ASSOCIATION

NC-140

MICHIGAN STATE UNIVERSITY AgBioResearch

2011 Sweet Cherry Acreage

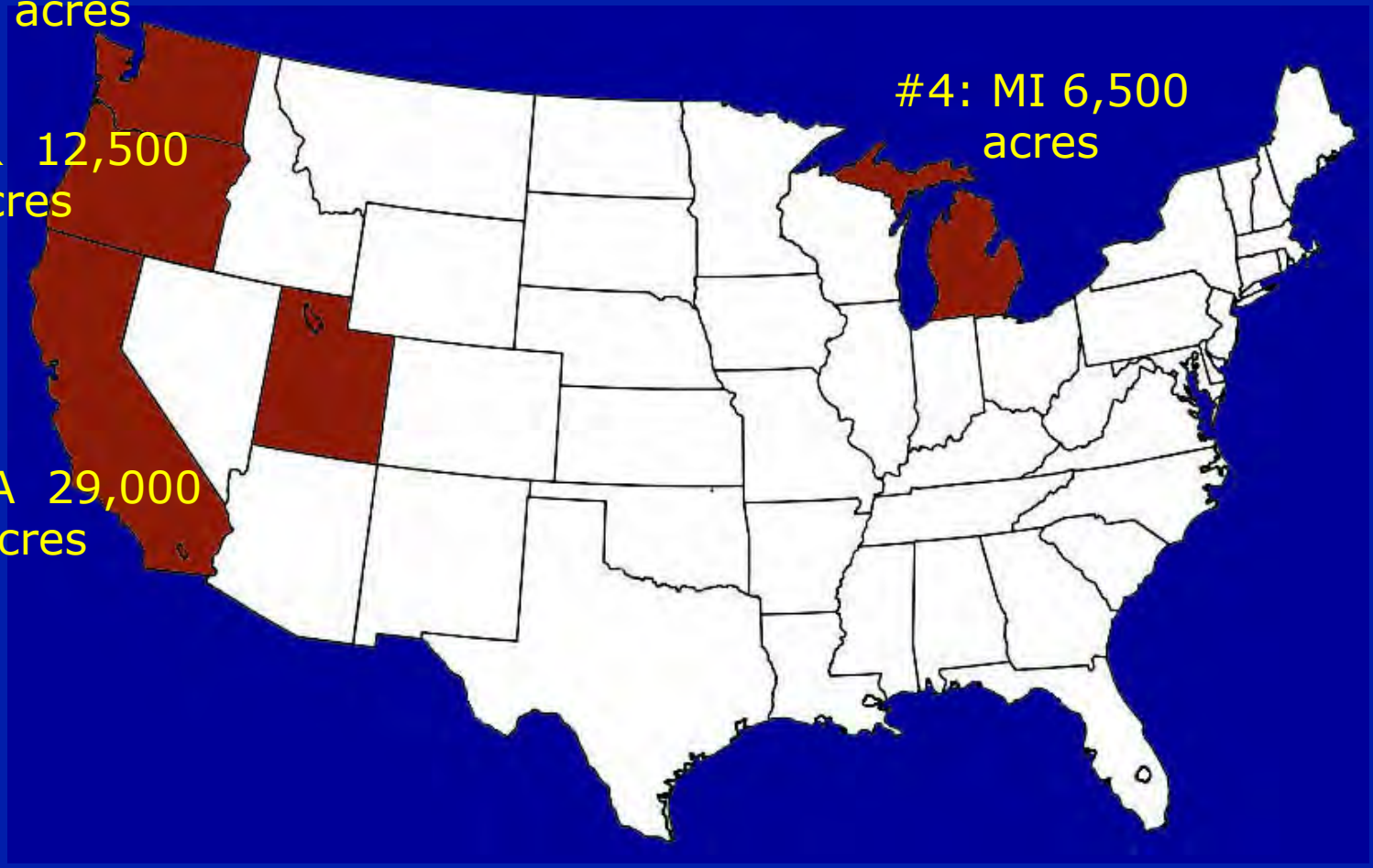
Sweet Cherry Acreage[1]

#1: WA 34,000 acres

#3: OR 12,500 acres

#2: CA 29,000 acres

#4: MI 6,500 acres



[1]USDA, 2009-2011

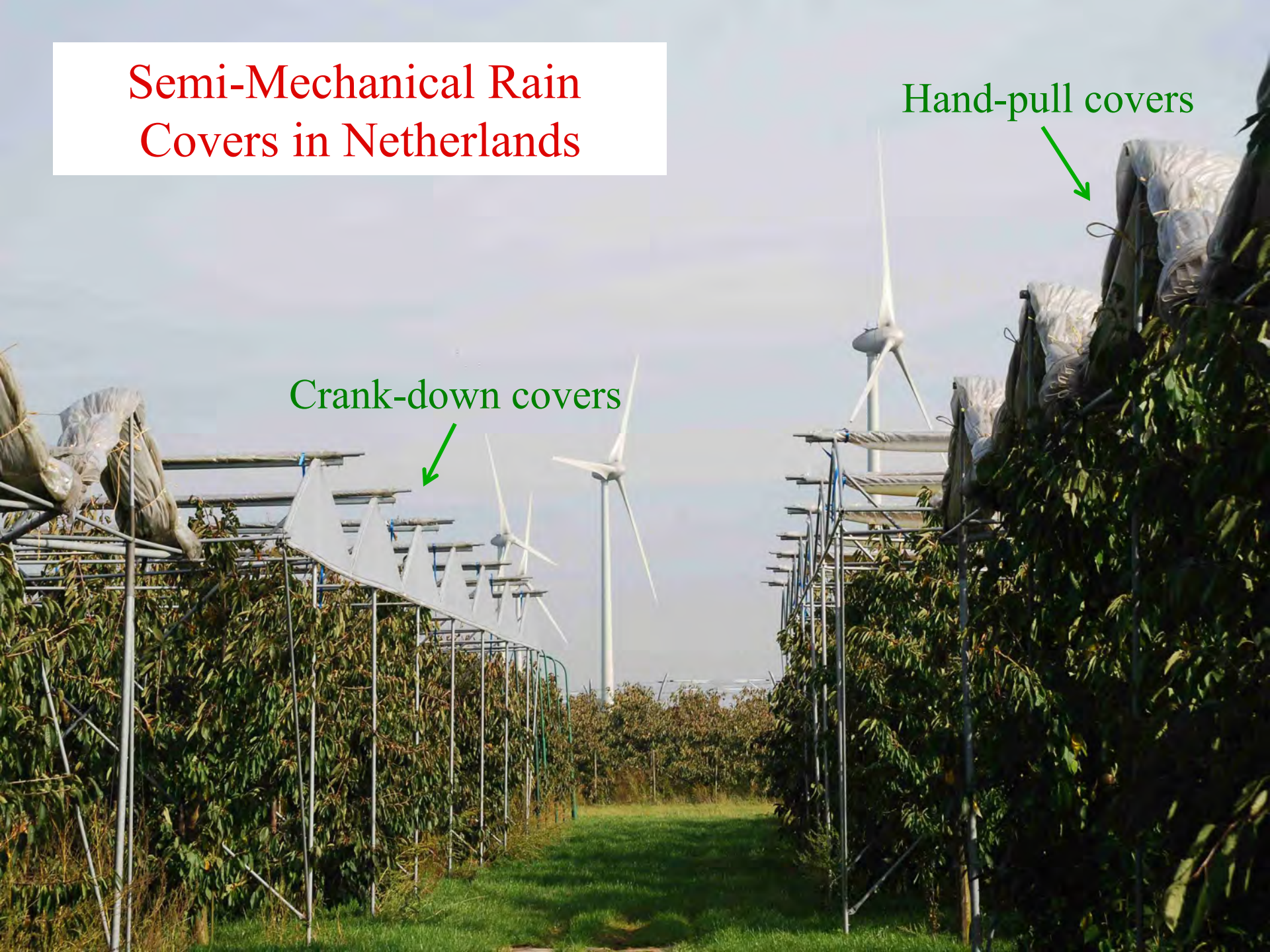
Rain Covers in Chile


Rain Covers in Norway

High Tunnels in Norway


Rain Covers in Switzerland

Semi-Mechanical Rain Covers in Netherlands



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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High Tunnels in the United States
- Protect from rain, hail, wind, frost; reduce some diseases, and promote earlier ripening; improve tree training & early yields

Half-Tunnels in China

Chinese structures range from bamboo tunnels to 28 ft high steel greenhouses

Greenhouse Cherries in Spain

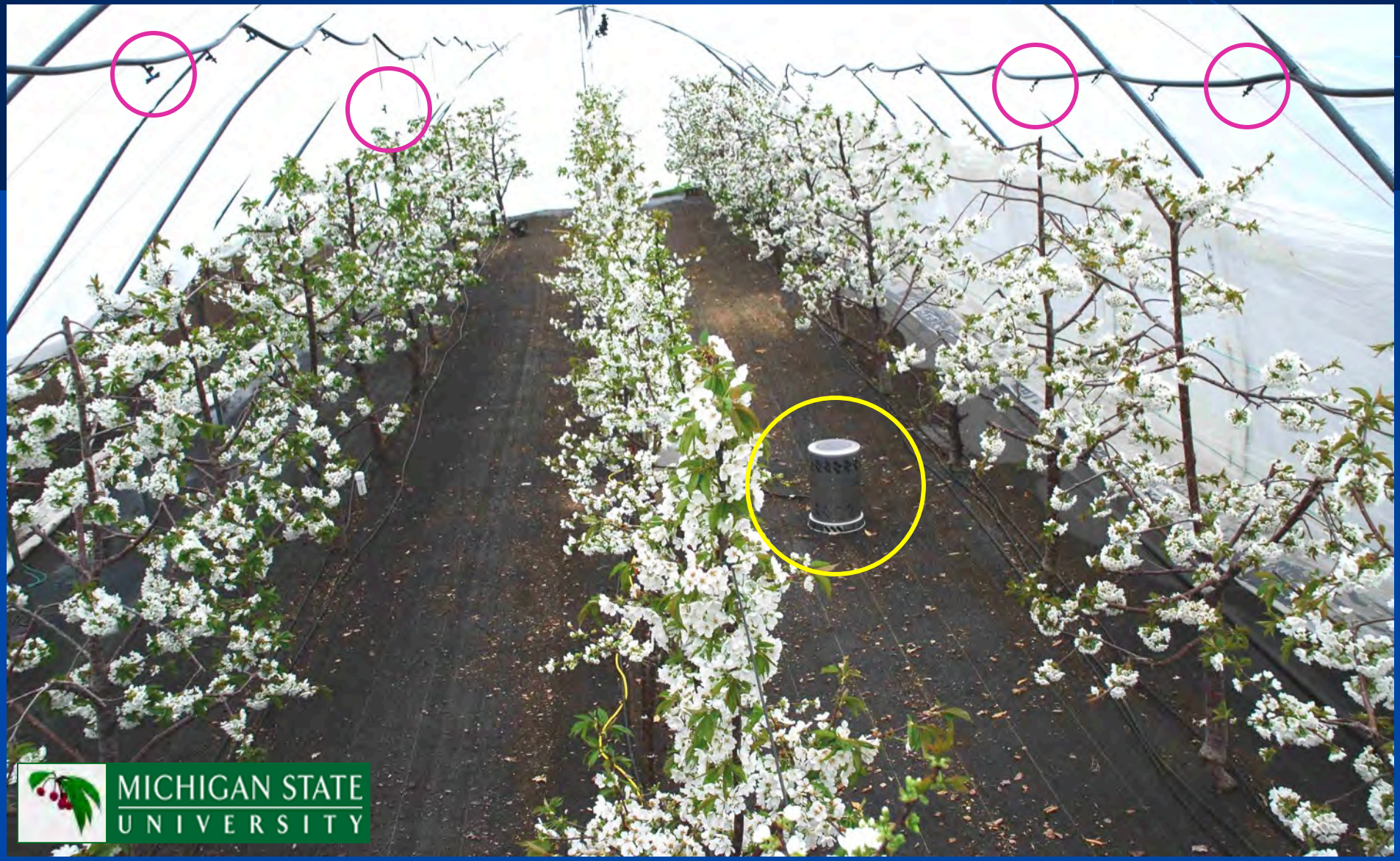
- Promote early harvest for high value, off-season markets

"World's Most Expensive Cherries" $35 to $150 per kg

Computer-Programmable Retractable Roof (Cravo)

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



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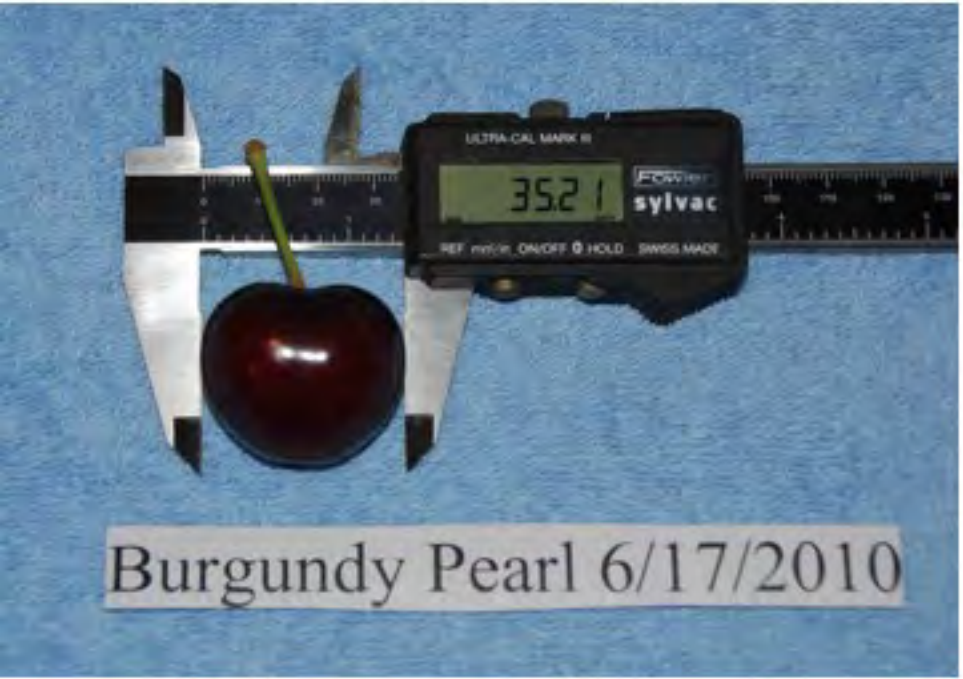
Ebony Pearl 6/11/2010

Benton 6/14/2010



Burgundy Pearl 6/17/2010

Rainier 6/14/2010

Small root systems need higher frequency irrigation and available nutrients

Cherry *Growth & Cropping* Timeline, Part 1

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

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

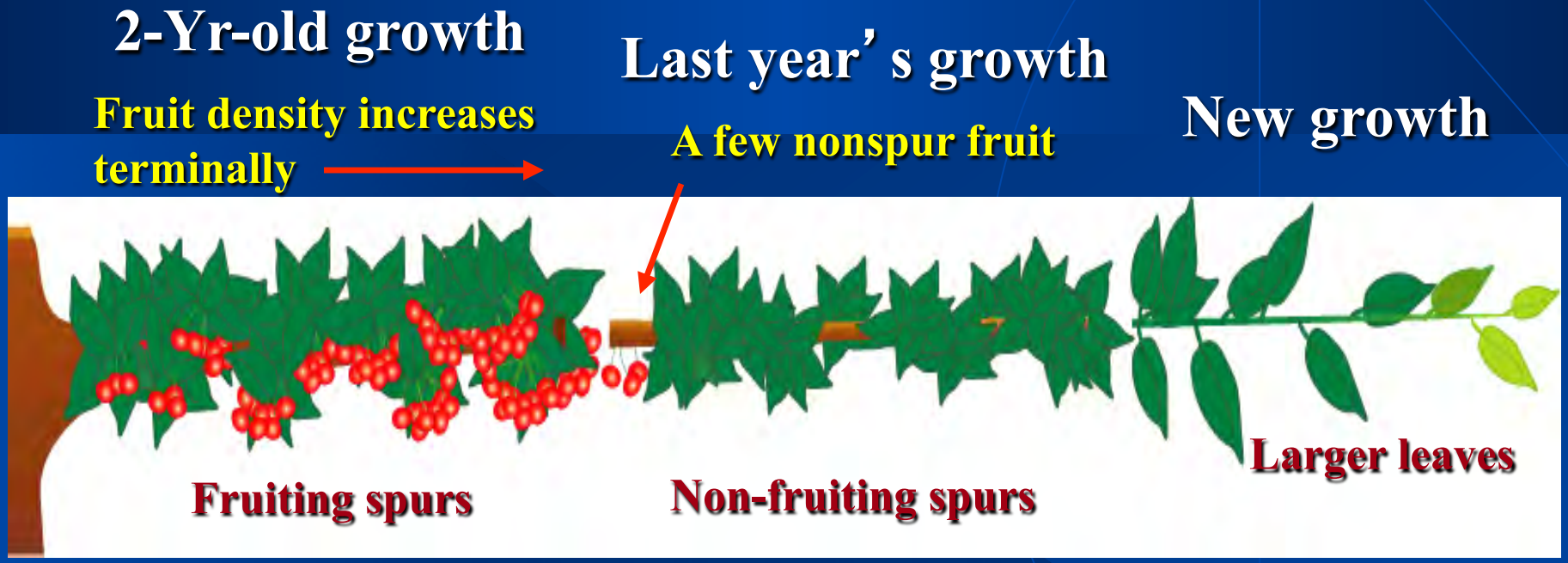
Important Effects: New Shoot Growth and Shoot Leaf Size

Building of Storage Reserves for Spring Growth; Cold Acclimation

Cherry *Growth & Cropping* Timeline, Part 2

Northern Latitude: *Southern Latitude:*	Dec/Jan/Feb *(Jun/Jul/Aug)*	Mar *(Sept)*	Apr *(Oct)*	May *(Nov)*	Jun *(Dec)*	Jul *(Jan)*
Stage of Development:	Final Bud Differentiation	Bloom	Fruit Cells: Dividing, Elongating			Harvest
Physiological Processes:	Mobilization of C and N Reserves To Growing Points		Photosynthesis; Soil N Uptake			
Important Effects:		Fruit Set; Fruit Cell #; Spur Leaf Size			Fruit Size, Firmness, and Sweetness	

Cherry Systems Fundamentals: Growth and the Basic Fruiting Units



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

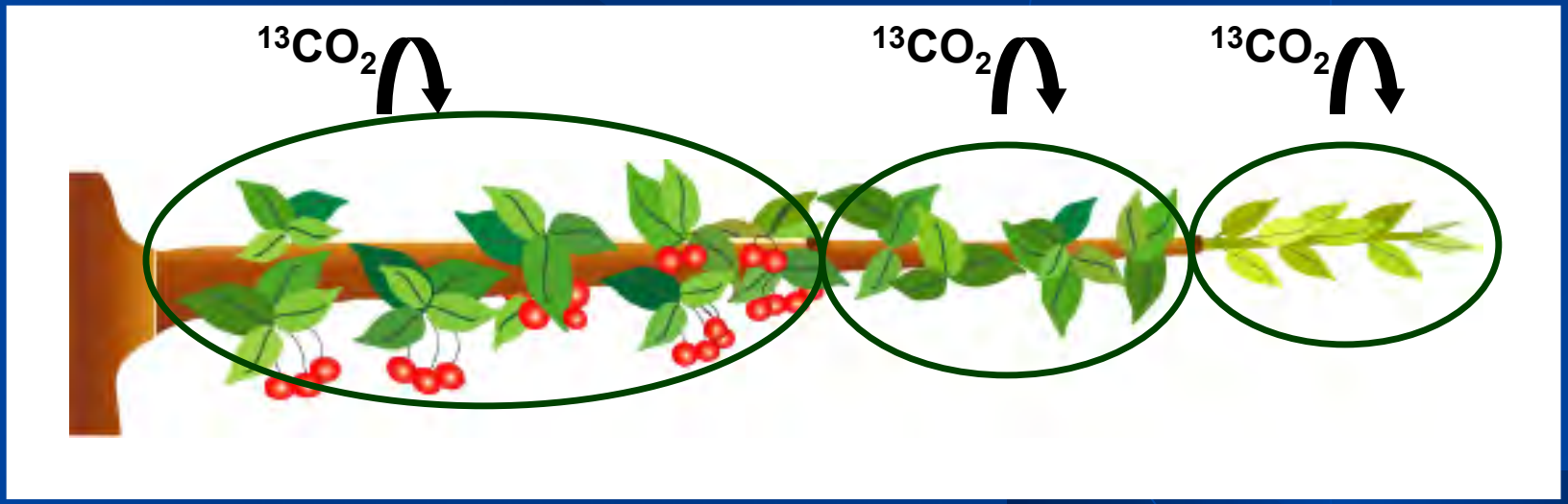
Ayala and Lang, 2004

$^{13}CO_2$ Research

Marlene Ayala

Managing the Sugar Supply to Fruit

Year	2001	2002	2003
Leaf population	Fruiting spurs	Non-fruiting spurs	Current season shoot



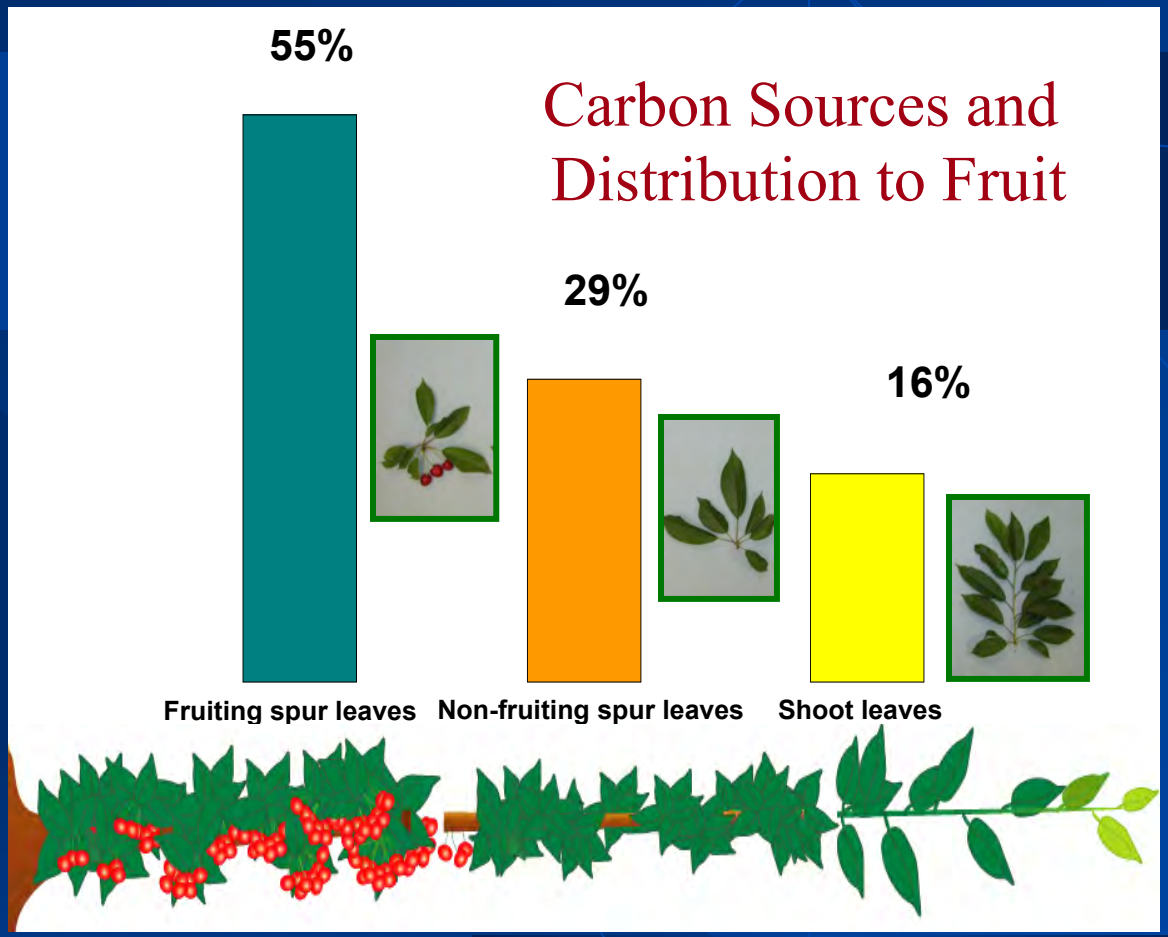
Leaf Area and Location

Beginning of Stage III (44 days after full bloom)

Fruit : 25% final size

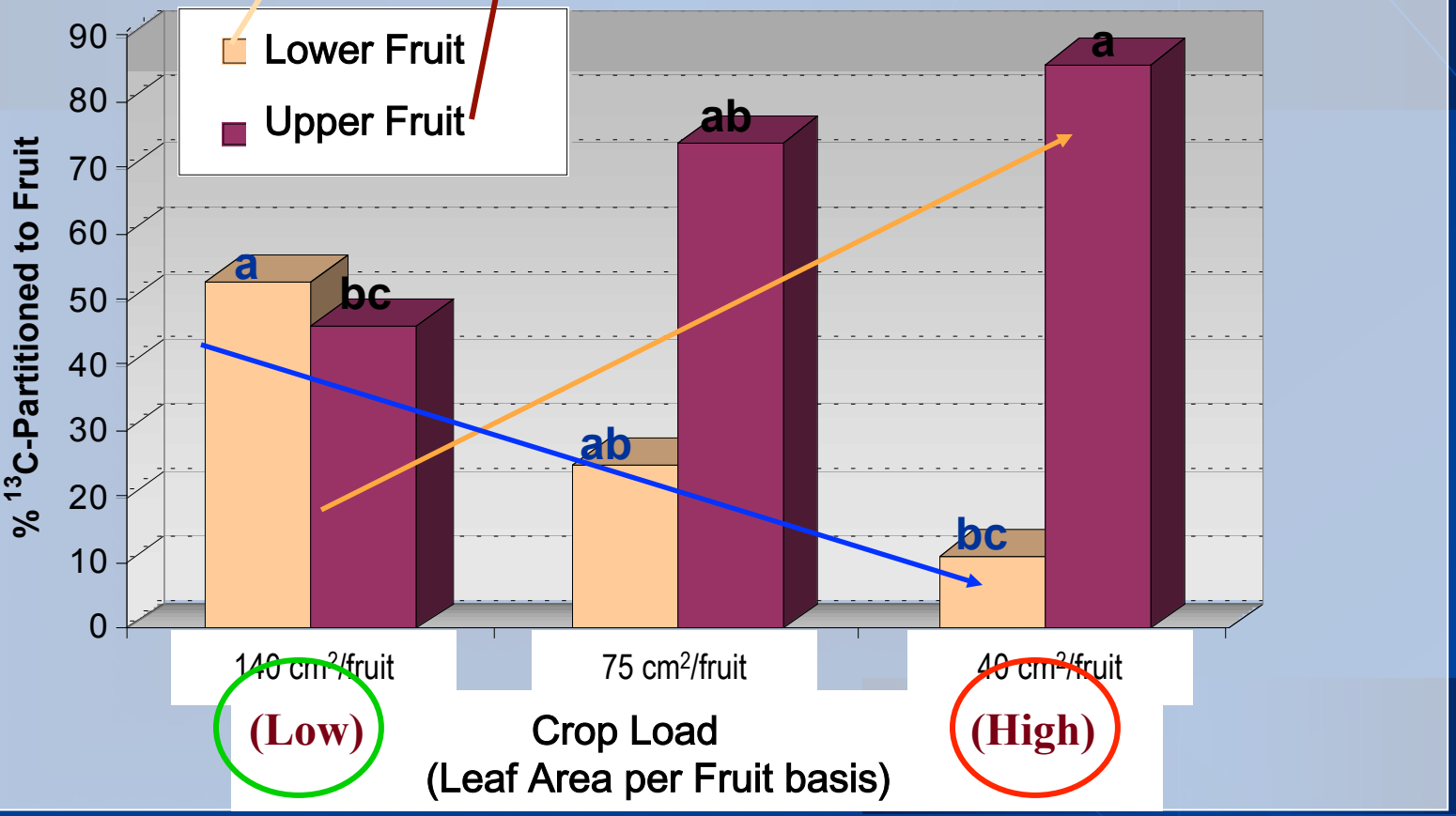
Shoot: 16 leaves

Ayala and Lang, 2004



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

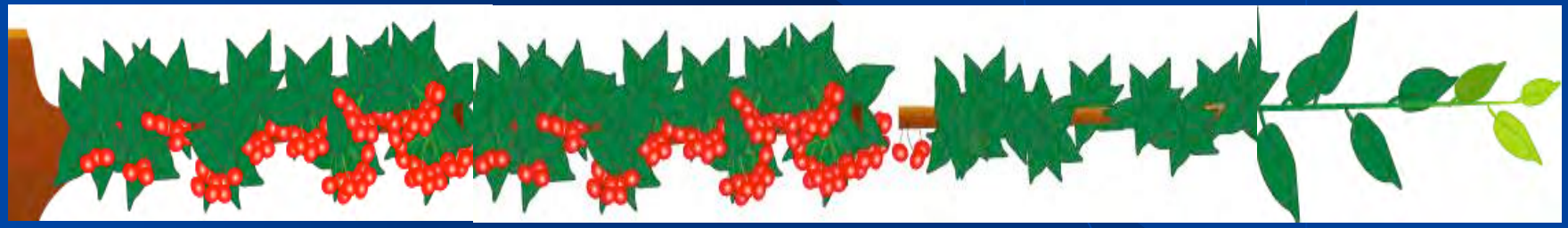
Basic Growth & Fruiting Units

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



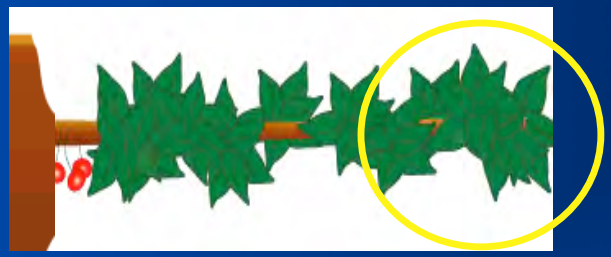
Year 4:

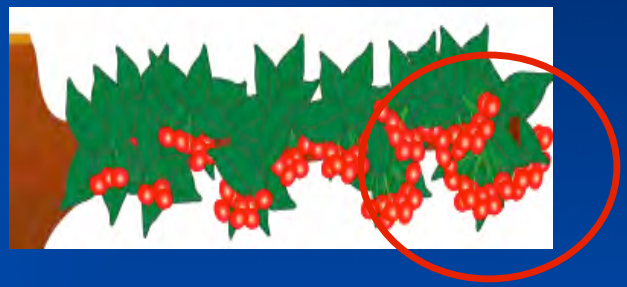
Fruit populations: 2 spur (e.g., 150 total), 1 non-spur (e.g., 10)

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

Basic Growth & Fruiting Units

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

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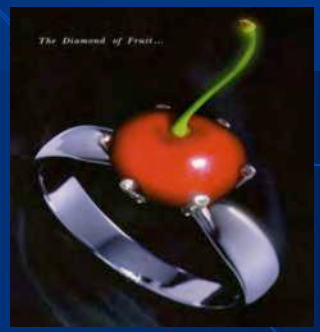
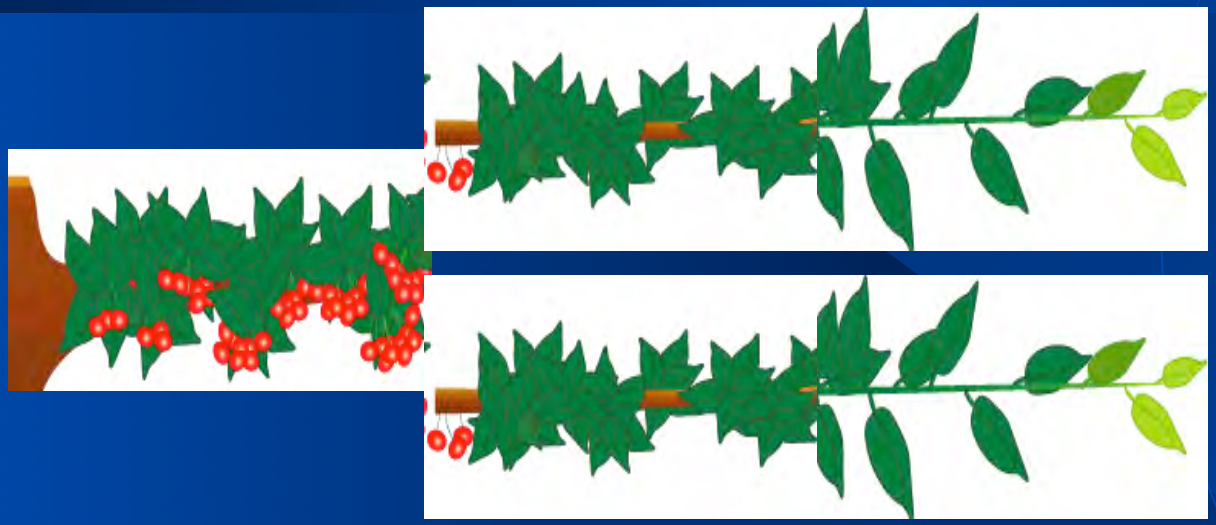
Basic Growth & Fruiting Units





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

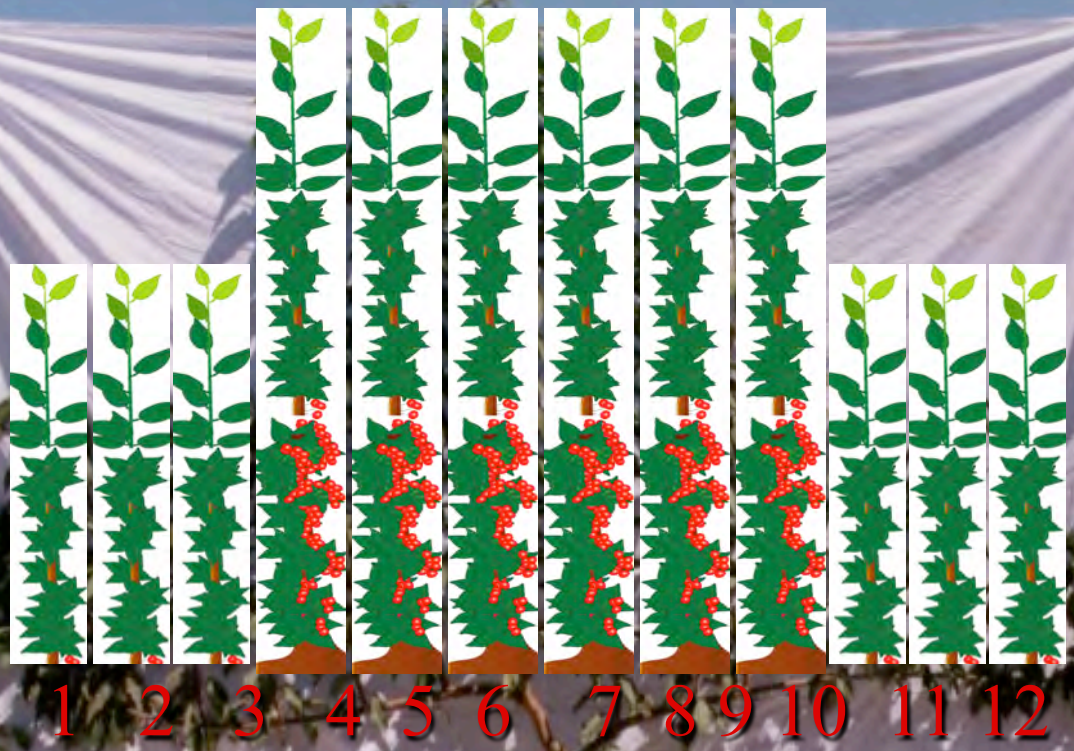
Fruiting Wall Cherries

- 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

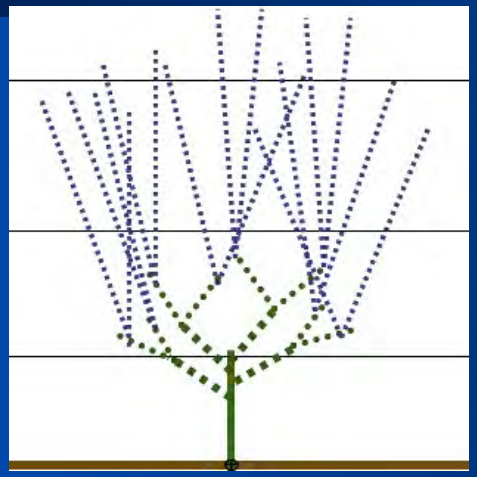


Lang, 20

De-construct the tree canopy into a simplified fruiting unit to manage leaf-to-fruit ratios, then repeat many times

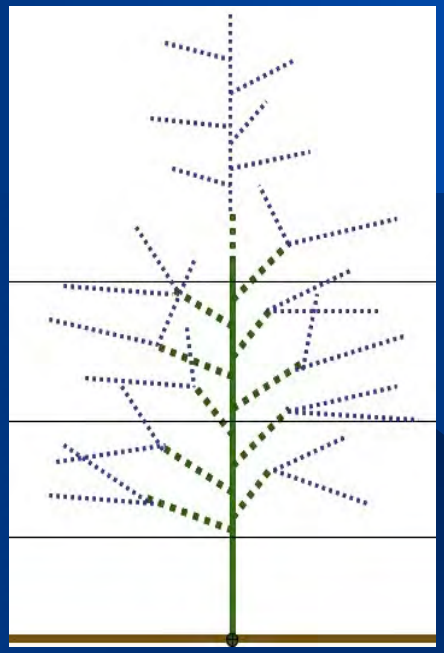
2010 Sweet Cherry Training Systems Trial

KGB



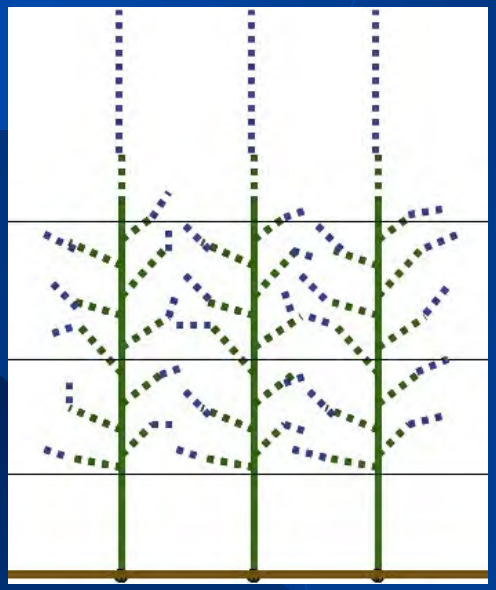
Kym Green Bush

TSA



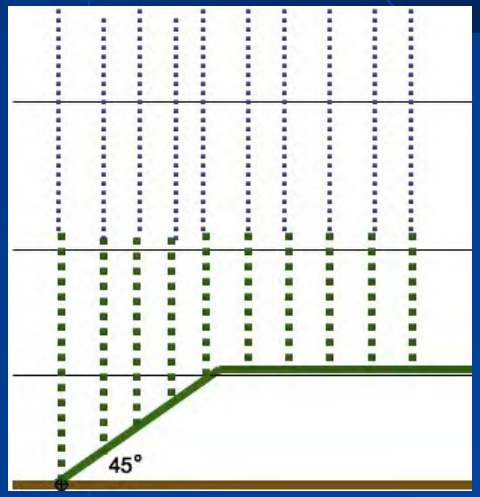
Tall Spindle Axe

SSA



Super Slender Axe

UFO



Upright Fruiting Offshoots

All have minimal permanent wood and simplified strategies for fruit wood renewal

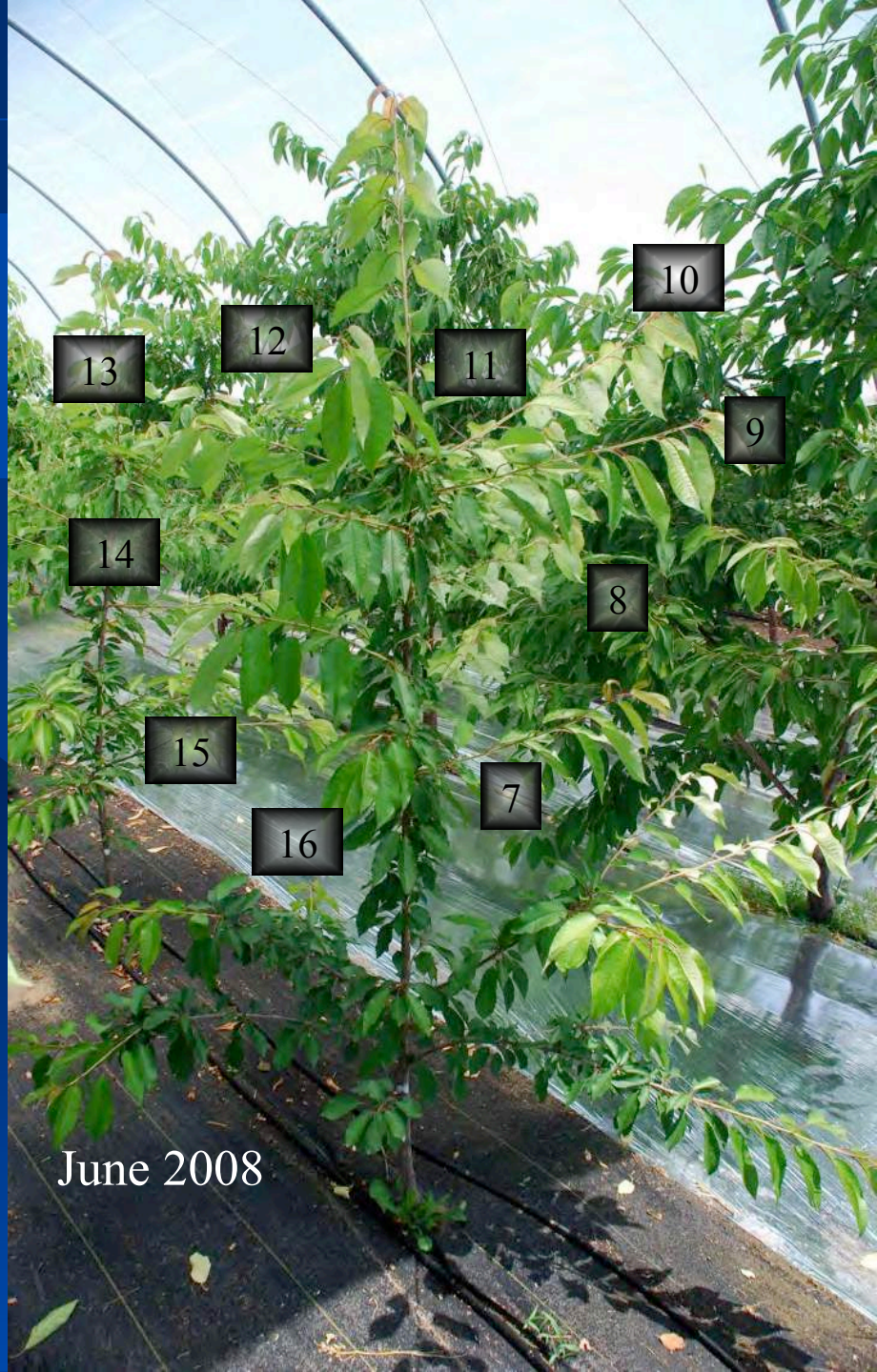
Precise Shoot (Fruiting Unit) Formation in Years 1-3

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

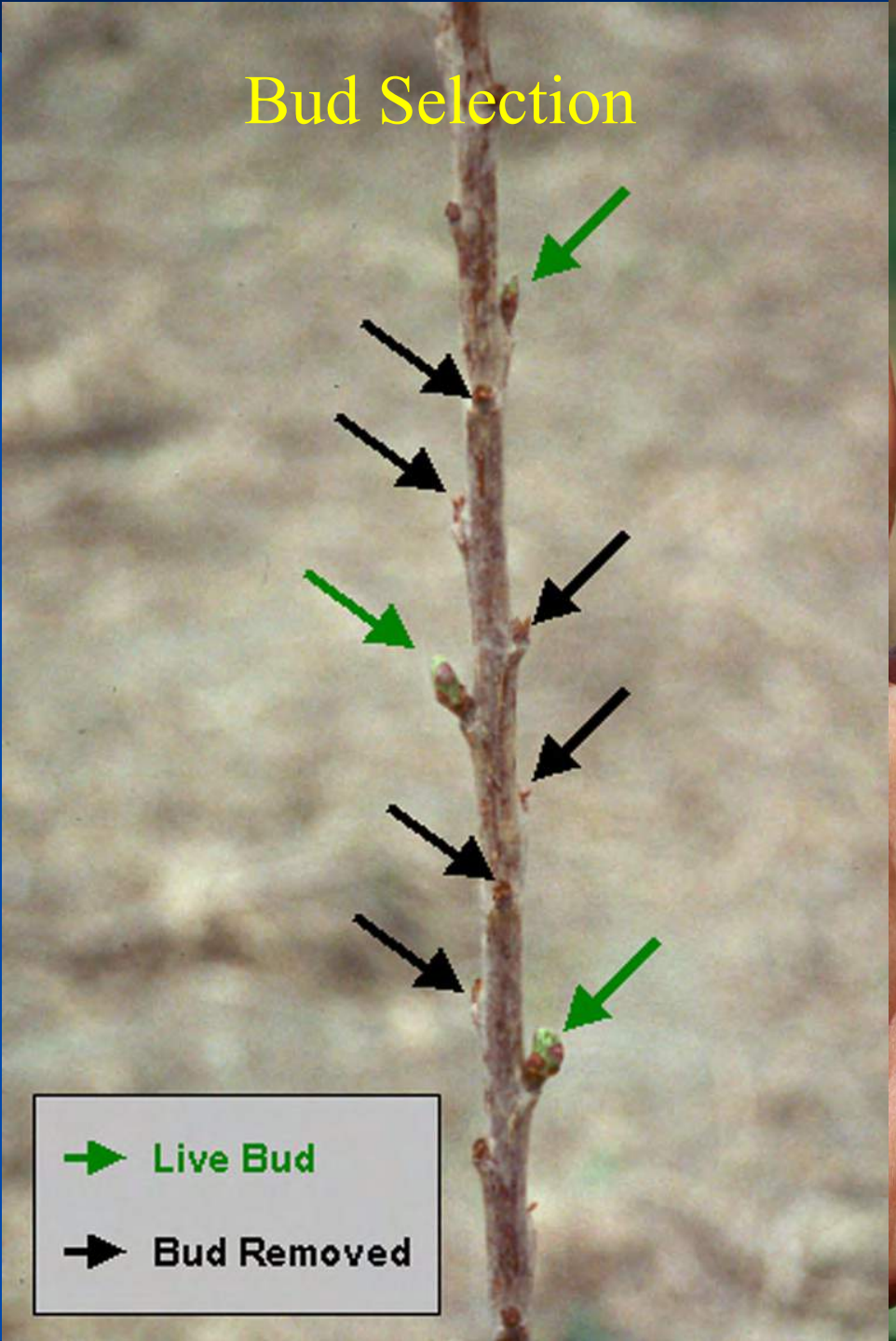
Year 2 – 20 to 35 total future fruiting units

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.



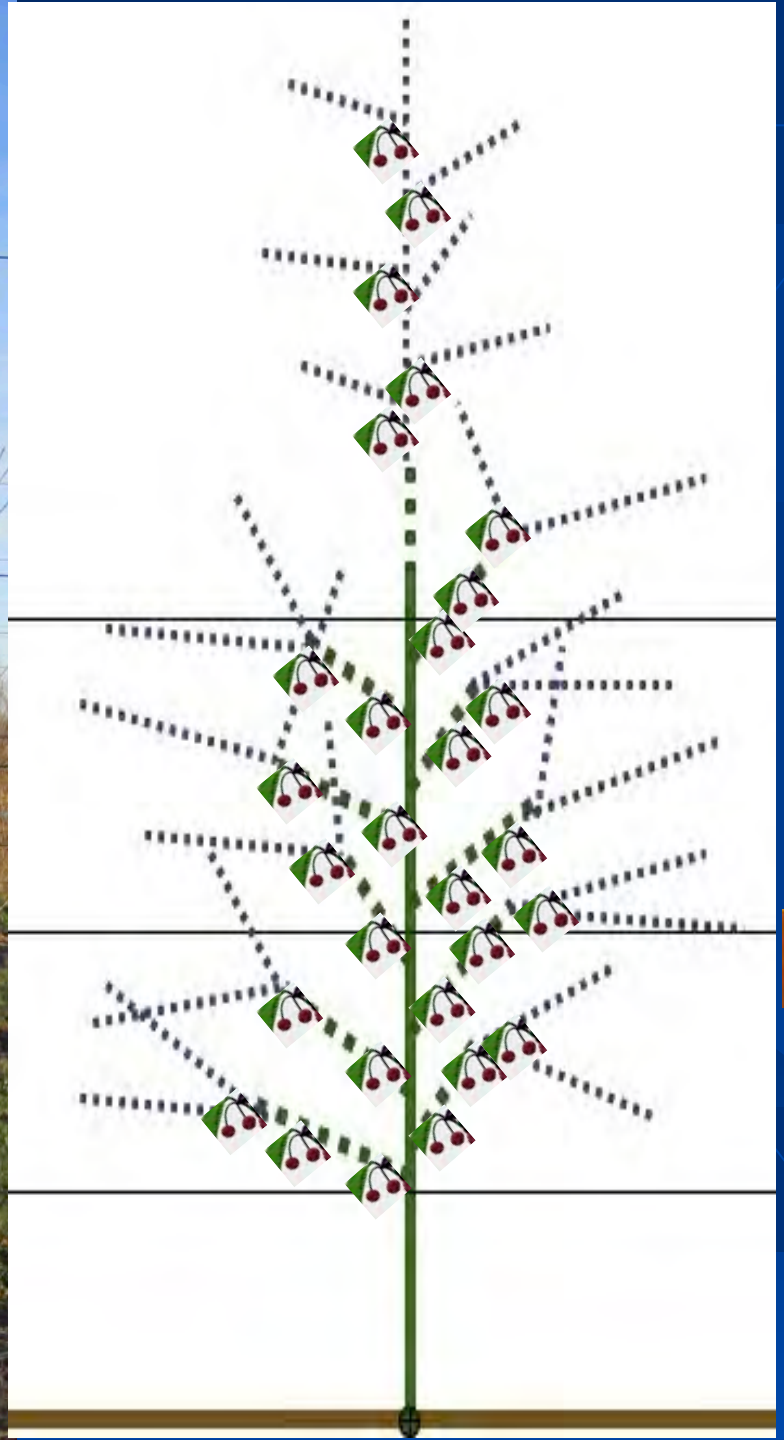
Bud Selection



Promalin
(BA+GA4+7)


Notching /
Scoring
Photo by Stefano Musacchi


24.05.2007 11:39
Pegs for Crotch Angles

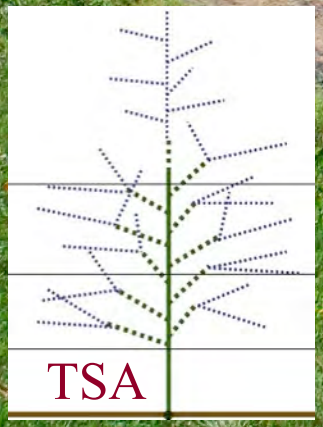


TSA Trees (semi-traditional)

Heading of lateral shoots to increase the number of fruiting units

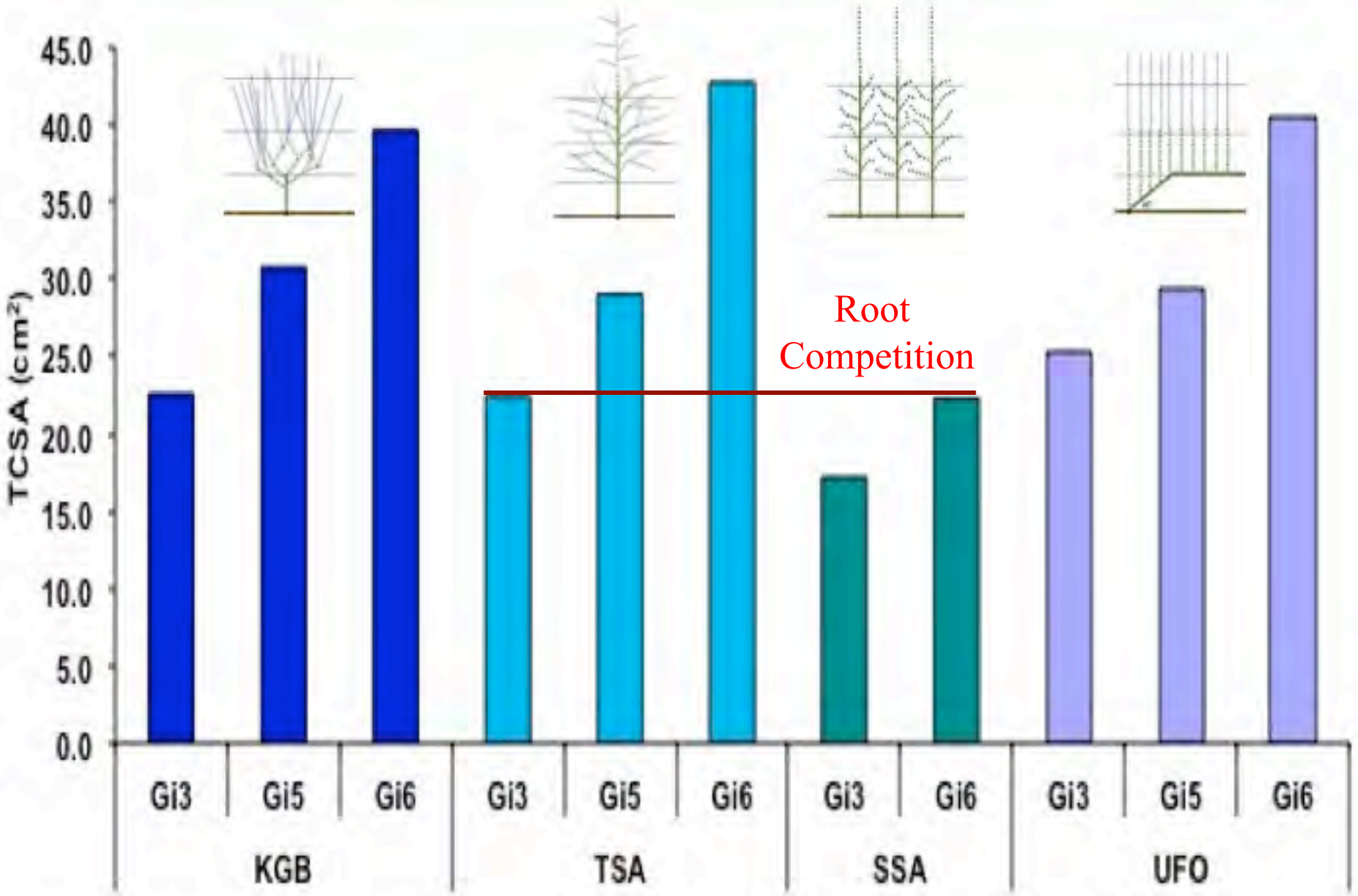
and balance crop load with leaf area.

MSU-Clarksville TSA System Cherries

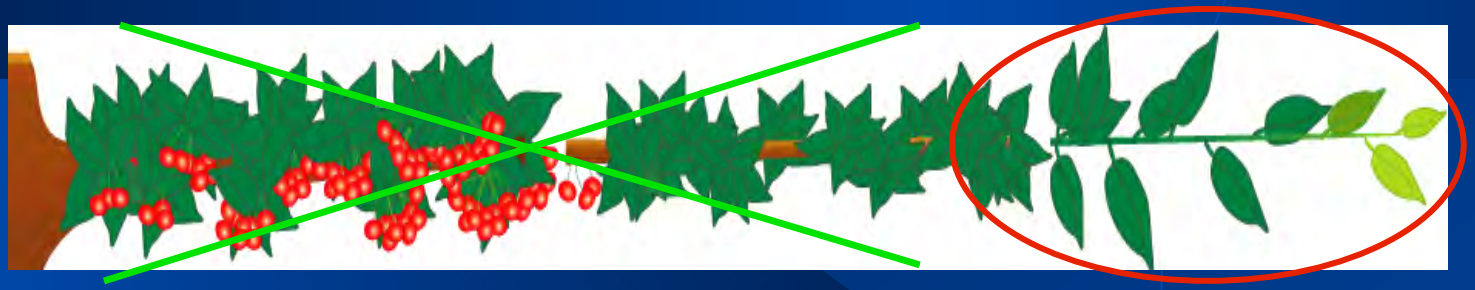


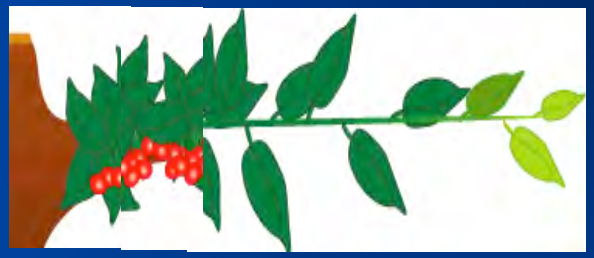
Stefano Musacchi
University of Bologna

System x Rootstock Effect on Tree Vigor (TCSA), Fall 2012



SSA Fruiting Unit Development





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)

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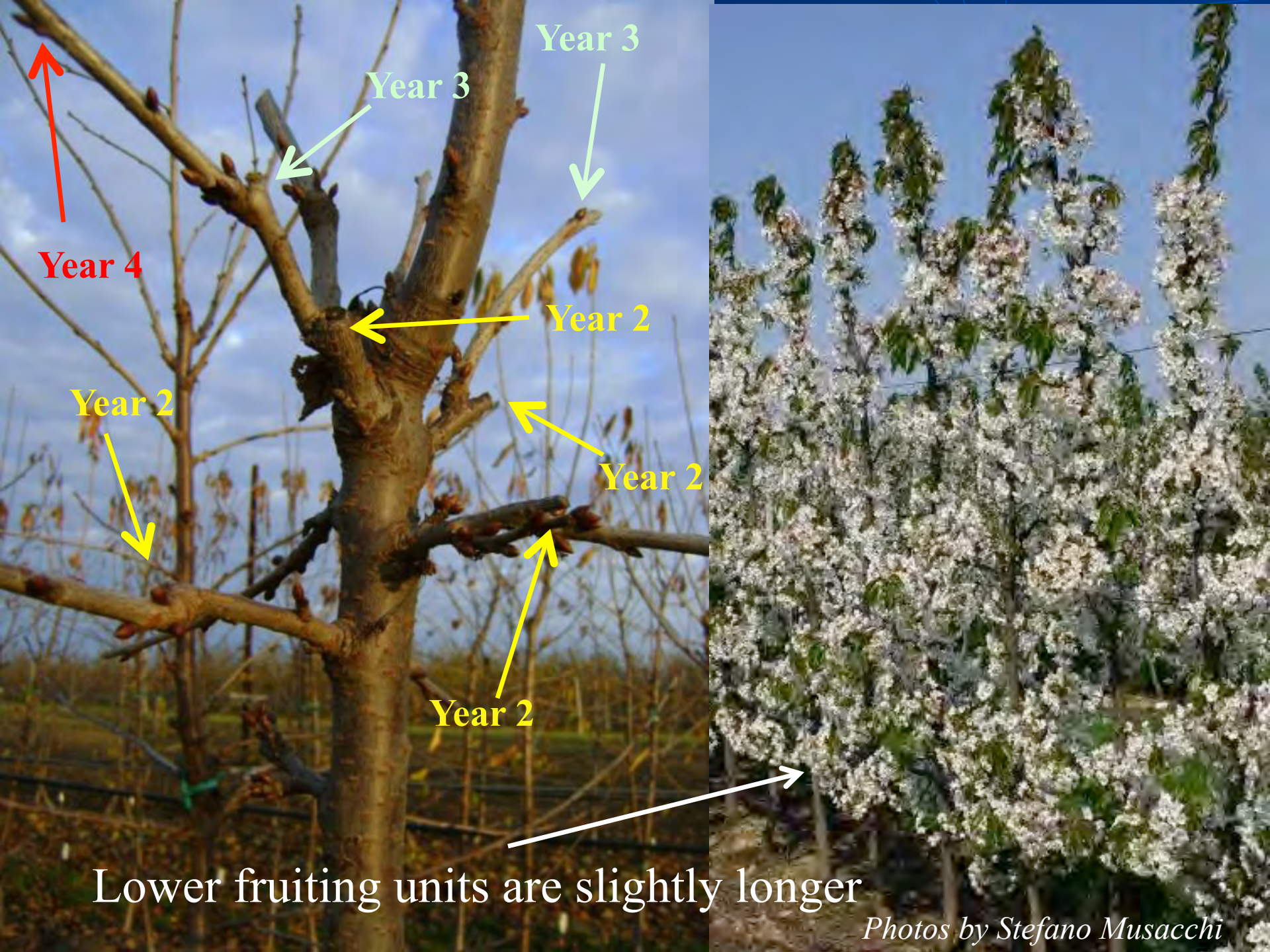
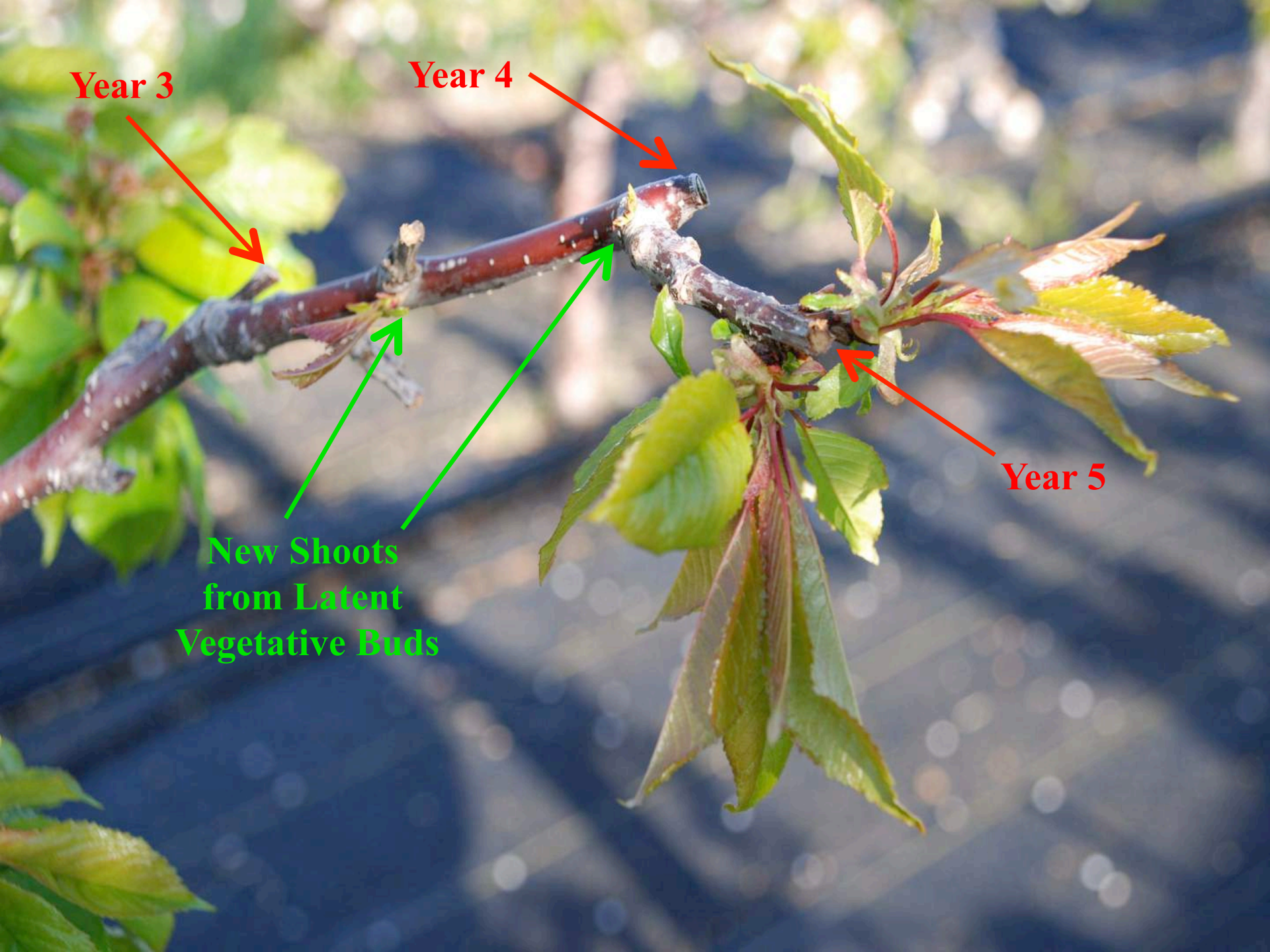
SSA Pruning

Vegetative buds

Basal floral buds

SSA Cropping on basal buds of year-old shoots


Year 3
Year 3
Year 4
Year 2
Year 2
Year 2
Year 2
Lower fruiting units are slightly longer
Photos by Stefano Musacchi


Year 3
Year 4
Year 5
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

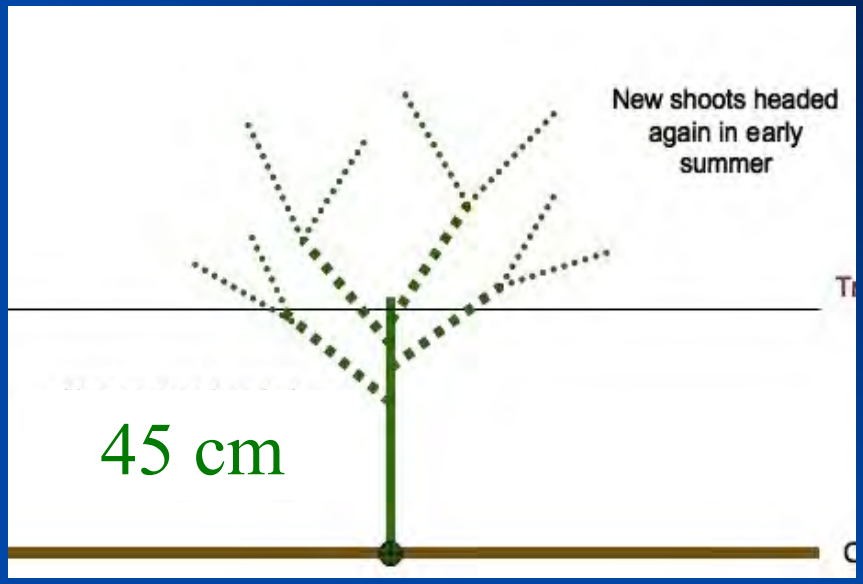
KGB Establishment

Year 1

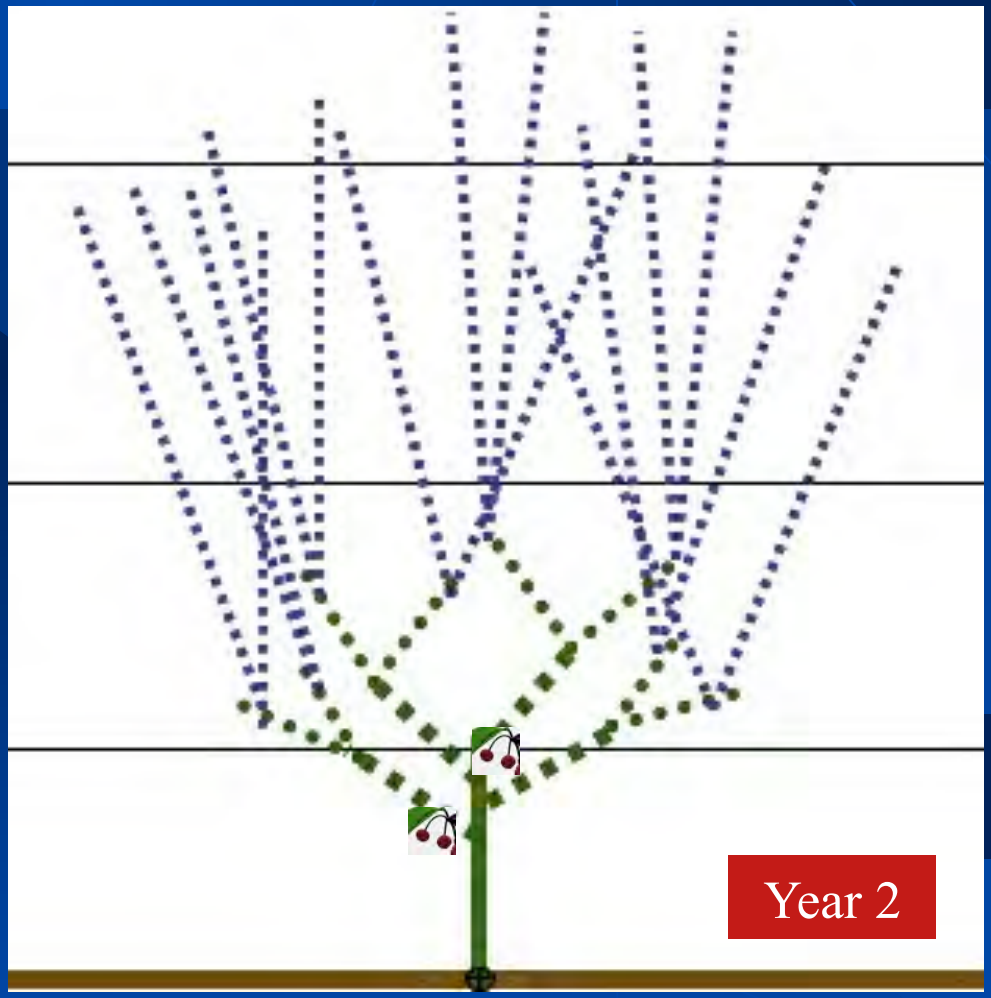
1) Head at planting to 45 cm

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

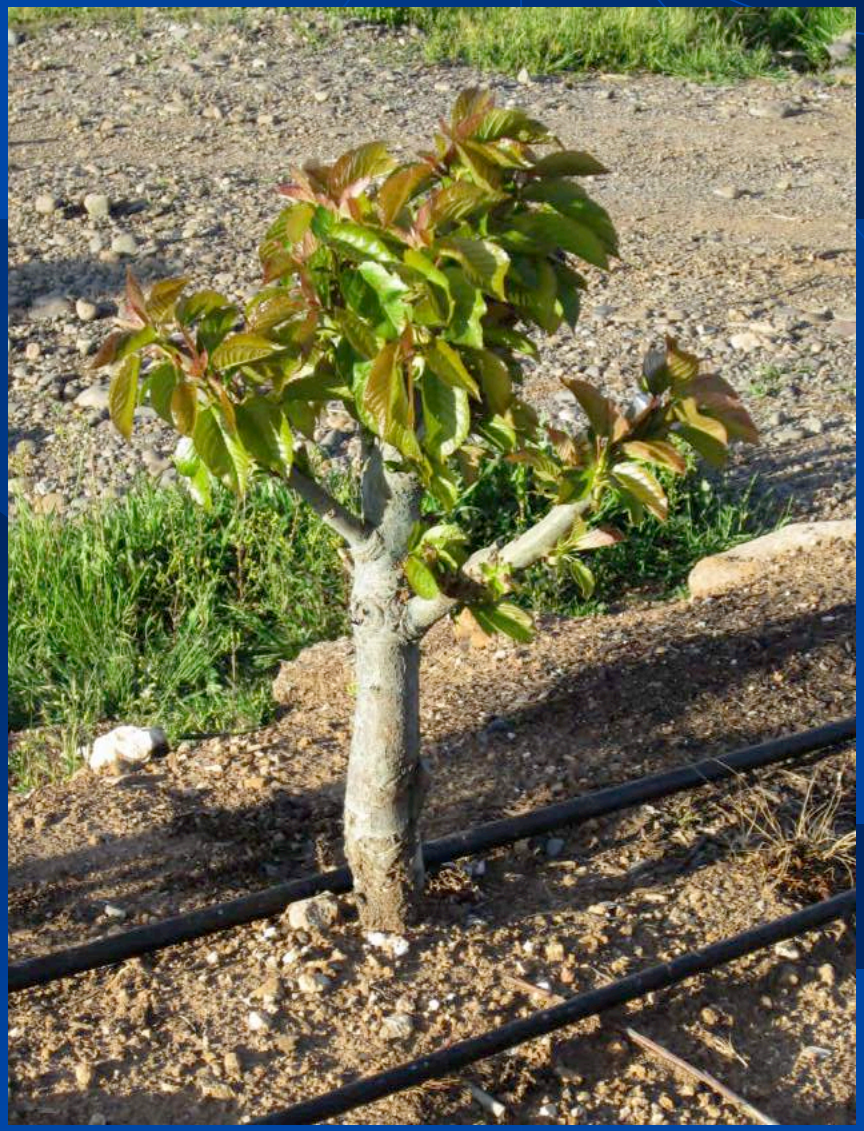
Goal: 8-12 uniform uprights at Year 1



Year 2 - head all shoots back to ~10 cm (target is ~15 to 25 upright fruiting units)

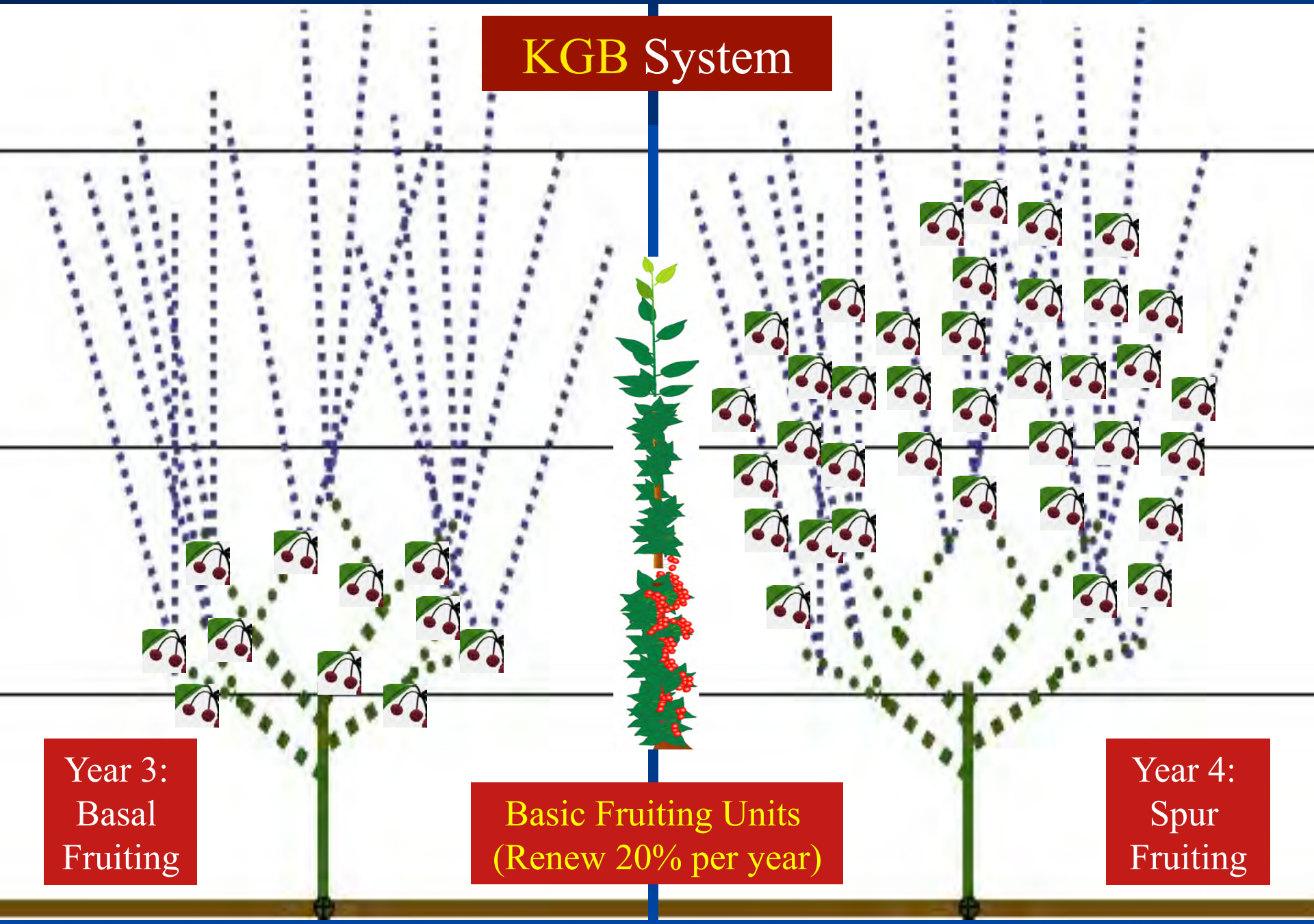


Two cuts in Year 2 will eliminate fruiting potential in Year 3



Year 3 – Thin / renew fruiting units to final target number

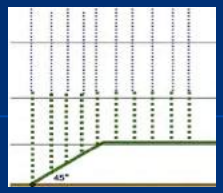
KGB System



Year 3: Basal Fruiting

Basic Fruiting Units (Renew 20% per year)

Year 4: Spur Fruiting



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UFO Sweet Cherry

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


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

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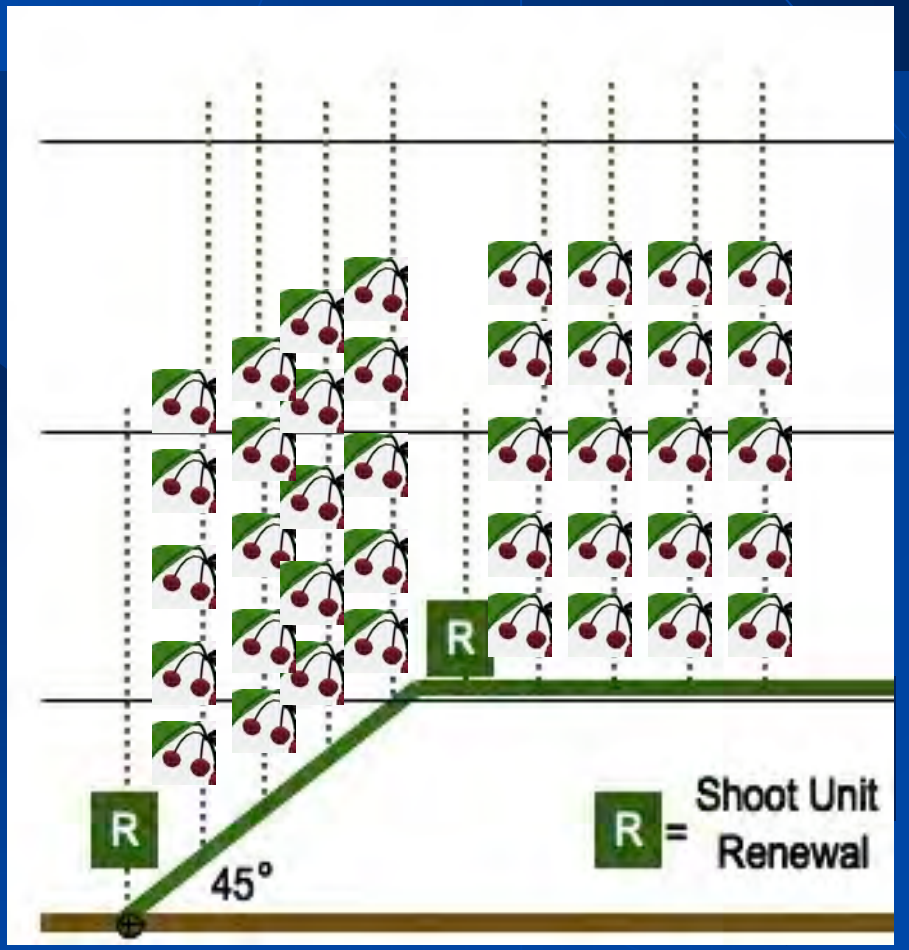
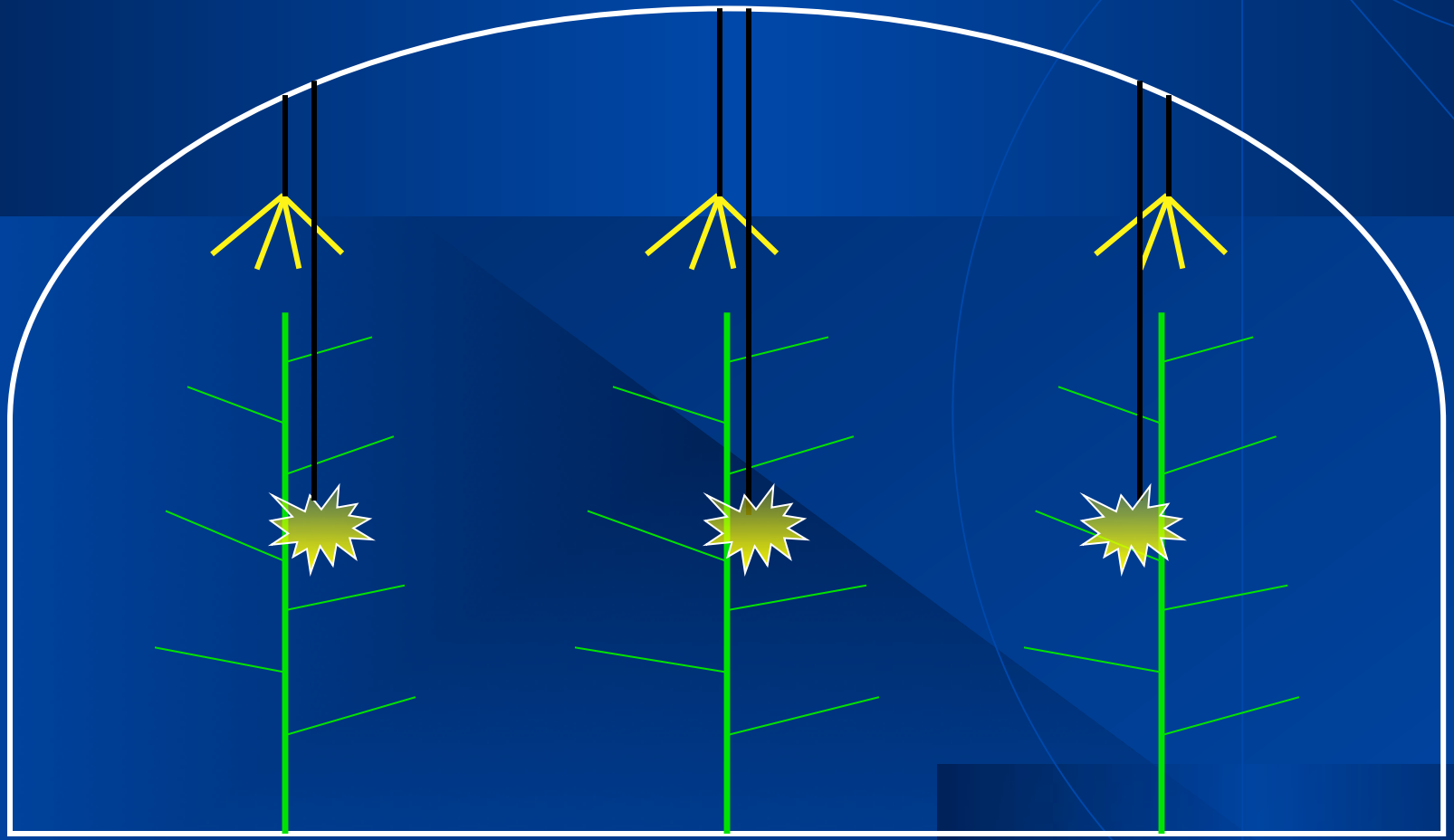
UFO Spacing: 1.5 x 3.0 m

Fruiting is primarily on spurs like the KGB

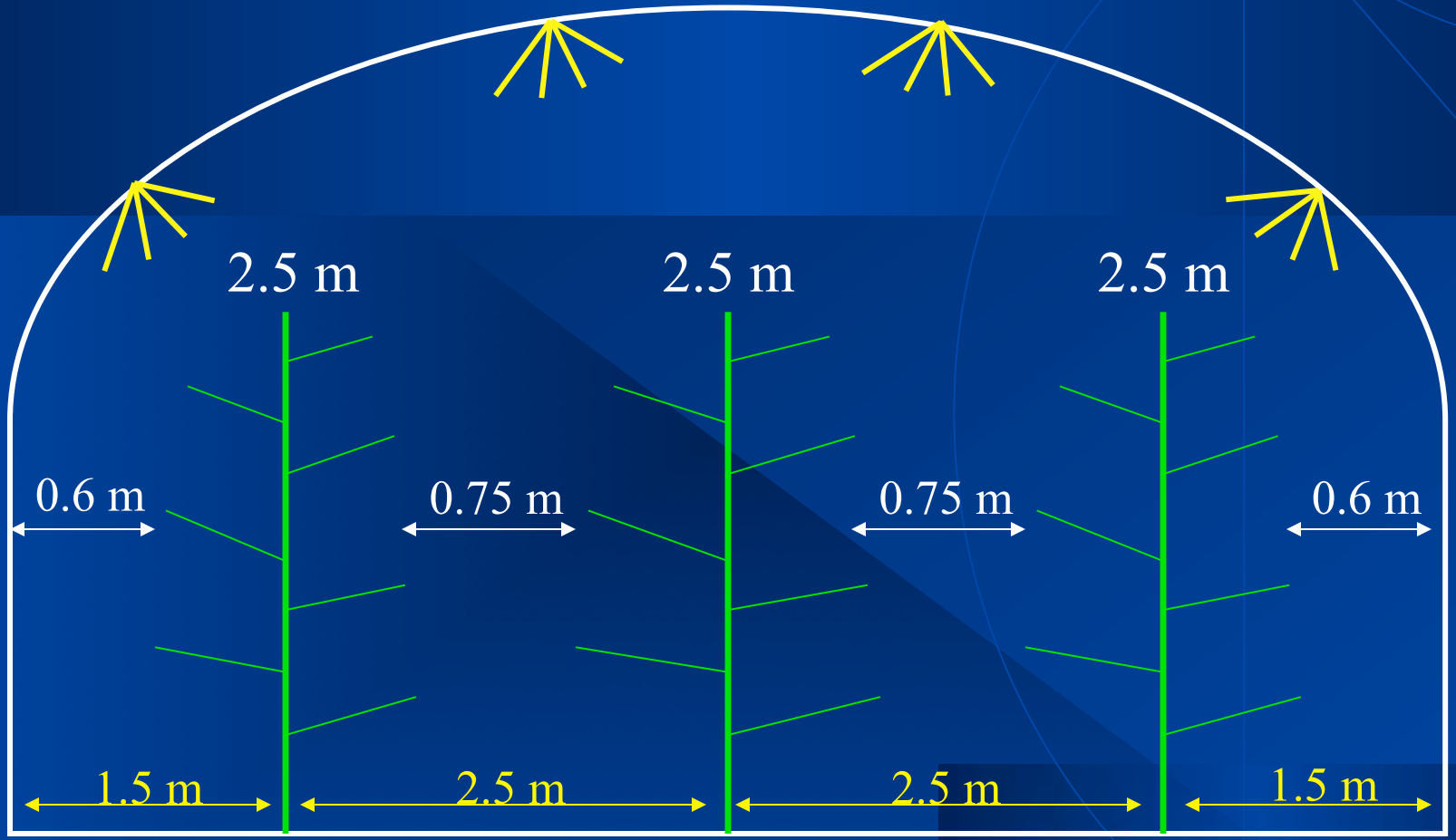


SSCD High Tunnel Spray System



Optimal SSCD spray coverage - a mix of emitter types (sprinkler + fogger) and canopy orientations?

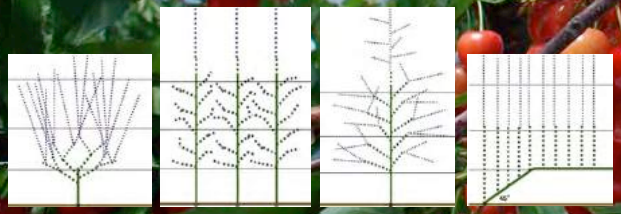
Fruiting Wall + SSCD Spray System: *Best* Optimized with 8 m Tunnels



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 m^3/m^2 tunnel area

MSU Tree Fruit Research



Training video clips at:
www.giselacherry.com

www.cherries.msu.edu