
Optimizing Cherry Production:
Varieties, Rootstocks, and
Physiology-Based Management
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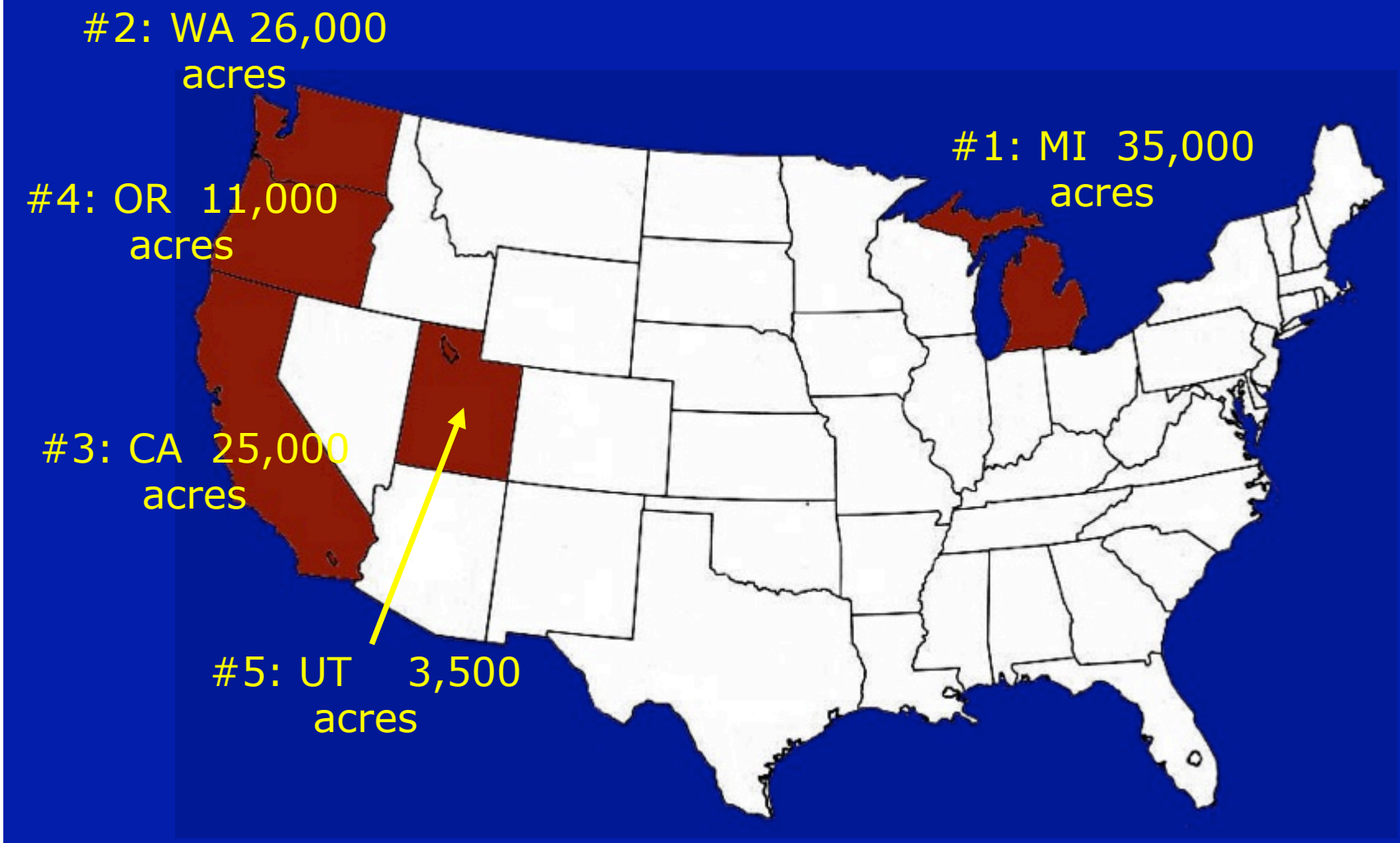
INTERNATIONAL FRUIT TREE ASSOCIATION
NC-140
MICHIGAN STATE UNIVERSITY
AgBioResearch

# U.S. Cherry Production 2001

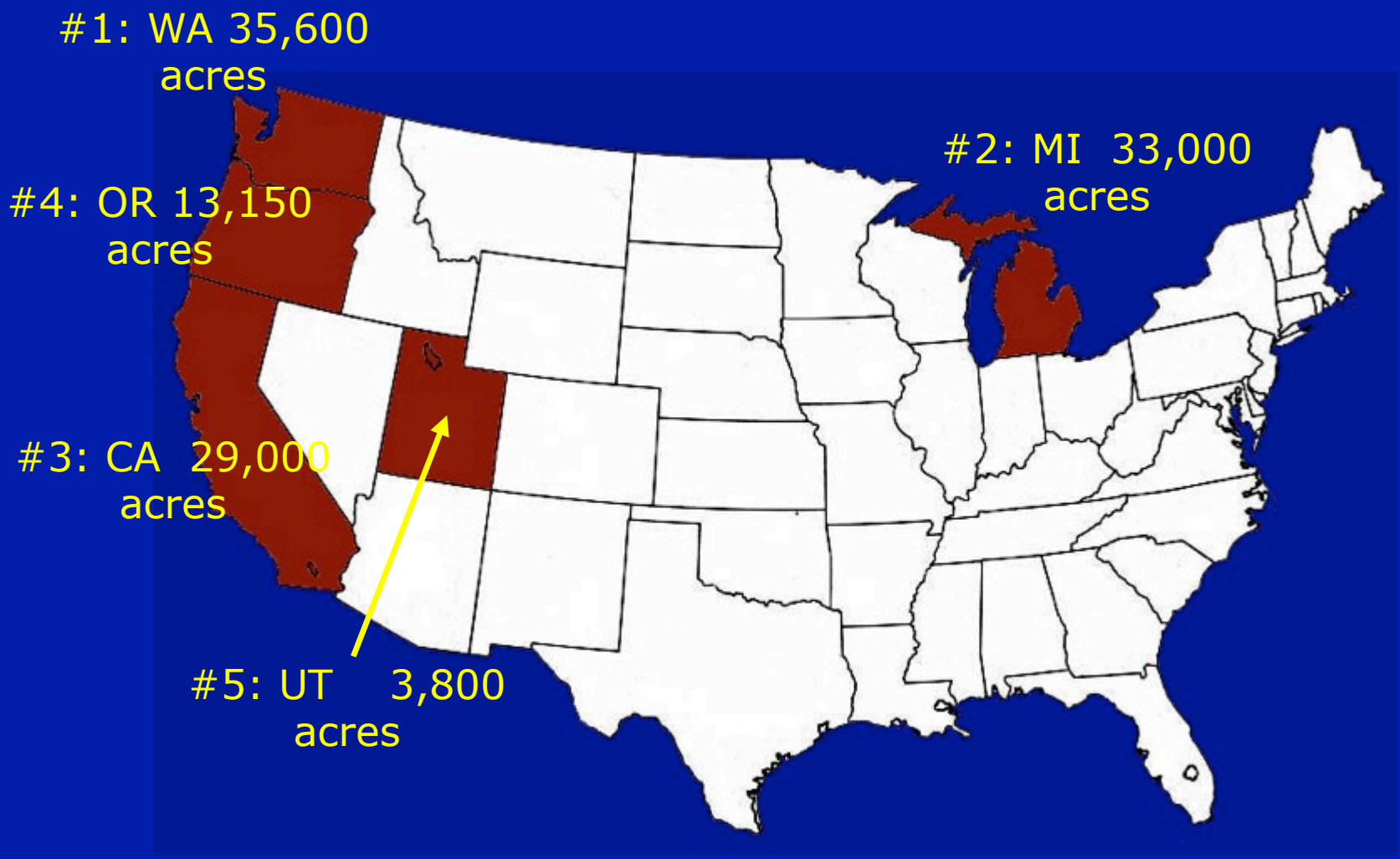
## Total Cherry Acreage[1]




[1]USDA, 1999-2001

# U.S. Cherry Production 2011

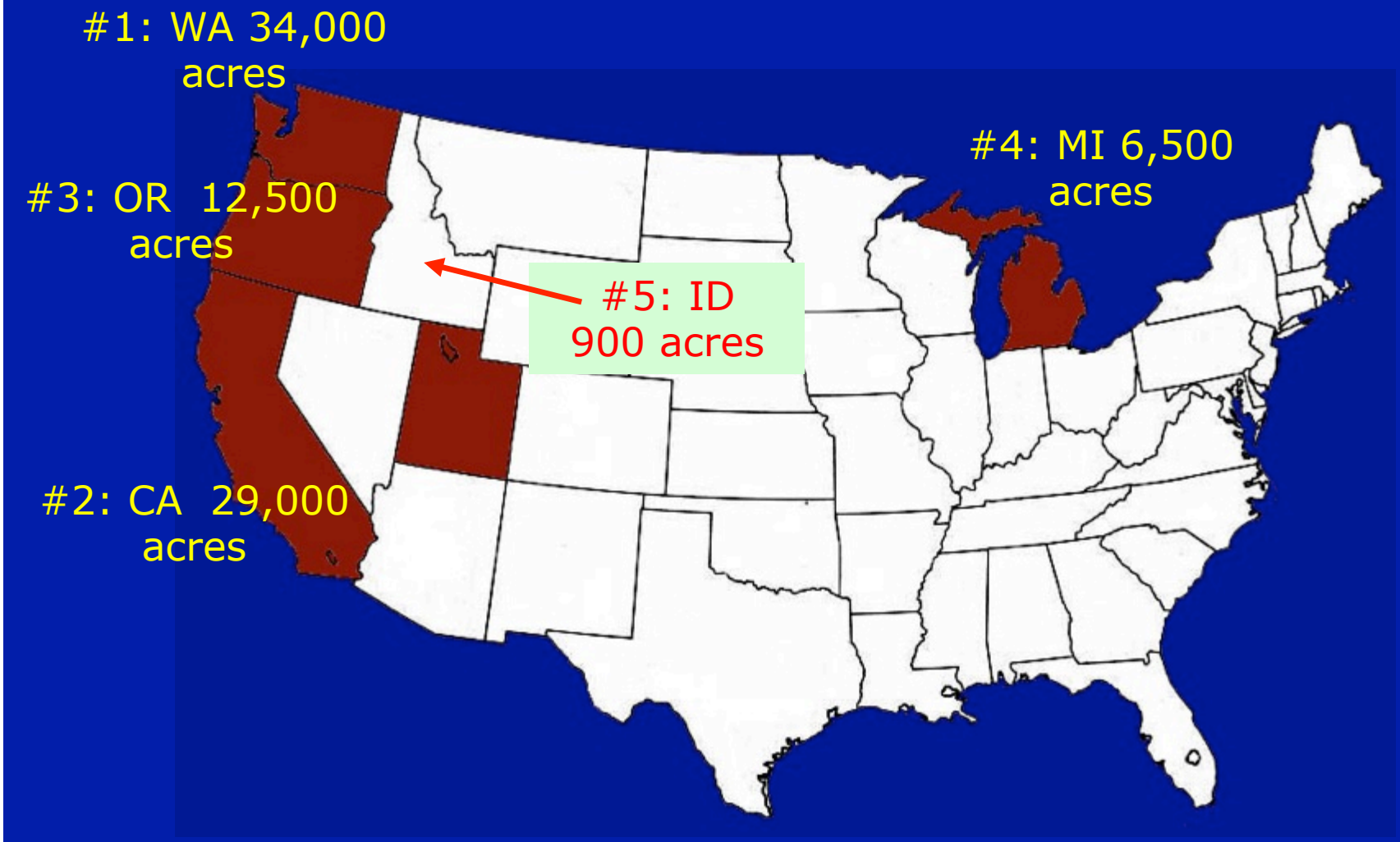
## Total Cherry Acreage[1]




[1]USDA, 2009-2011

# 2011 Sweet Cherry Acreage

## Sweet Cherry Acreage[1]




[1]USDA, 2009-2011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Globally Competitive Production through Advanced Germplasm, Technologies, and Physiology-Based Production Knowledge
A R C T I C O C E A N
N
Alaska (USA)
Canada
Hudson Bay
Beaufort Bay
Arctic Circle
United States of America
NORTH PACIFIC OCEAN
NORTH ATLANTIC OCEAN
Bermuda (U.K.)
Tropic of Cancer
Hawaii Islands (U.S.)
Kiribati
Equator
Galapagos (Ecuador)
Tropic of Capricorn
Easter I. (Chile)
Tonga
French Polynesia
Mexico
Bahamas
Haiti
Cuba
Dominican Rep.
Belize
Guatemala
Honduras
El Salvador
Nicaragua
Costa Rica
Venezuela
Guyana
Suriname
French Guiana
Colombia
Ecuador
Peru
Brazil
Bolivia
Paraguay
Chile
Uruguay
Argentina
Falkland Islands (U.K.)
South Georgia (U.K.)
South Sandwich (U.K.)
SOUTH PACIFIC OCEAN
SOUTH ATLANTIC OCEAN
Iceland
Faroe Islands
Finland
Sweden
Norway
Russia
Estonia
Latvia
Lithuania
Belarus
United Kingdom
Denmark
Ireland
Poland
Germany
Ukraine
France
Romania
Georgia
Azerbaijan
Bulgaria
Italy
Spain
Portugal
Greece
Turkey
Armenia
Morocco
Tunisia
Algeria
Libya
Egypt
Iran
Iraq
Jordan
Qatar
Saudi Arabia
UAE
Oman
Yemen
Western Sahara
Canary Islands
Mauritania
Mali
Niger
Chad
Sudan
Eritrea
Djibouti
Senegal
Gambia
Burkina Faso
Nigeria
Sierra Leone
Liberia
Ivory Coast
Cape Verde
Central African Rep.
South Sudan
Ethiopia
Somalia
Uganda
Kenya
Dem. Rep. Congo
Rwanda
Burundi
Tanzania
Gabon
São Tomé and Príncipe
Ascension (U.K.)
Angola
Zambia
Zimbabwe
Namibia
Botswana
Mozambique
Madagascar
Mauritius
Reunion
Swaziland
Lesotho
South Africa
St Helena (U.K.)
Trinidade (Brazil)
Kazakhstan
Mongolia
Uzbekistan
Kyrgyzstan
Turkmenistan
Tajikistan
China
North Korea
South Korea
Japan
Afghanistan
Pakistan
Nepal
Bhutan
India
Bangladesh
Sri Lanka
Myanmar
Laos
Thailand
Vietnam
Taiwan
Philippines
Brunei
Malaysia
Singapore
Indonesia
Papua New Guinea
Timor-Leste
Australia
Cocos Islands
Christmas Islands
Coral Sea
Solomon Islands
Tuvalu
Fiji
New Caledonia (France)
Tasman Sea
New Zealand
Sea of Okhotsk
Kara Sea
Svalbard (Norway)
Marshall Islands
PACIFIC OCEAN
INDIAN OCEAN
Maldives
Seychelles
Comoros
Mayotte
S O U T H E R N O C E A N
A N T A R C T I C A
Antarctic Circle
1. Netherlands
2. Belgium
3. Luxembourg
4. Switzerland
5. Slovenia
6. Croatia
7. Bosnia and Herzegovina
8. Czech Republic
9. Slovakia
10. Austria
11. Hungary
12. Serbia
13. Moldova
14. Macedonia
15. Albania
16. Cyprus
17. Lebanon
18. Guinea-Bissau
19. Guinee
20. Ghana
21. Togo
22. Benin
23. Cameroon
24. Equatorial Guinea
25. Rwanda
26. Cambodia
27. Panama
28. Malawi
1260Km 0 1260 2520 3780 5040Km
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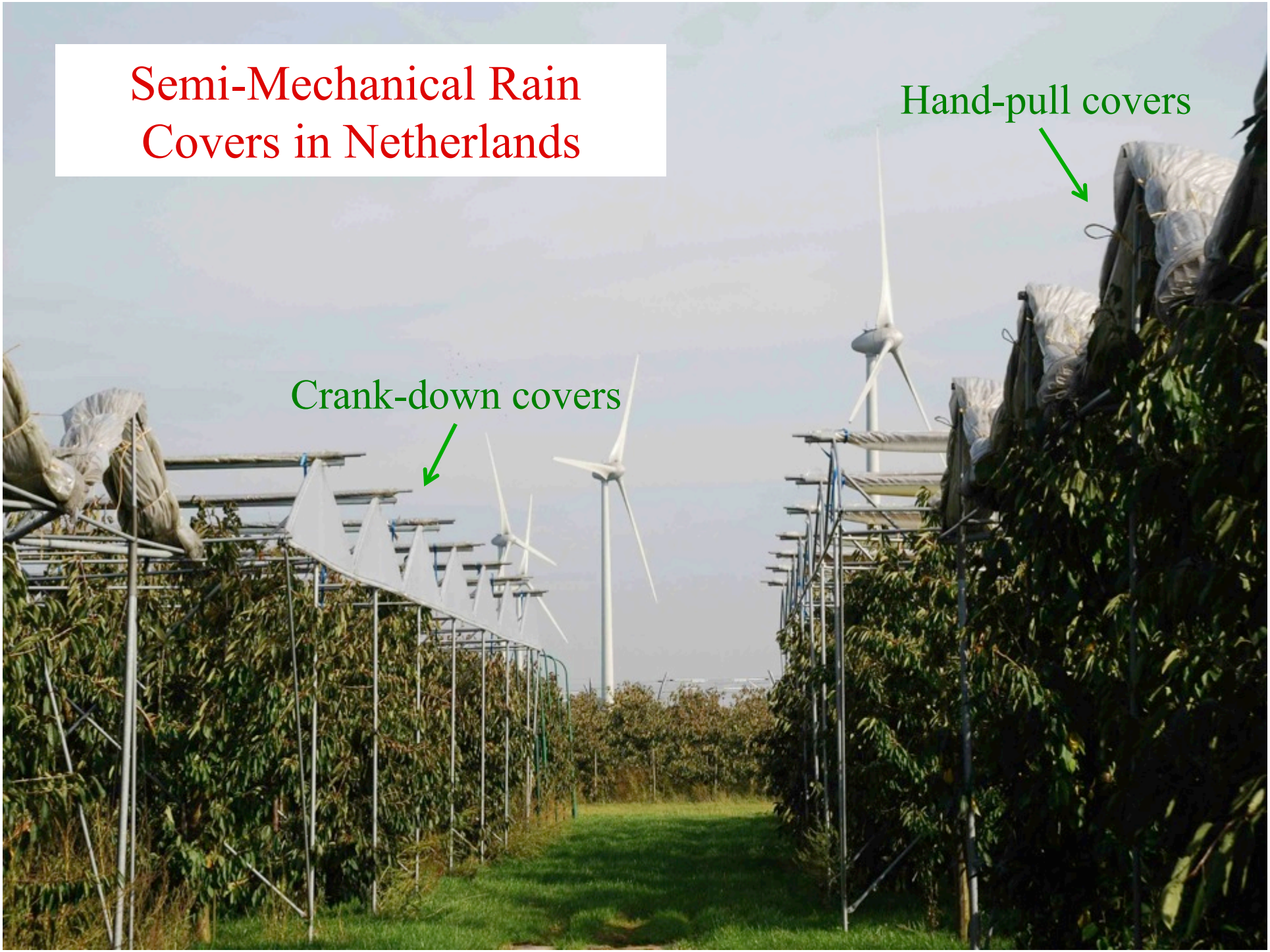
(Updated on 15th November, 2012)

# Rain Covers in Chile


Rain Covers in Norway


Rain Covers in Switzerland


Semi-Mechanical Rain Covers in Netherlands
Hand-pull covers
Crank-down covers

# Vented Covers (VOEN) in Germany, Italy, Switzerland

- Protection from rain and hail; passive venting of heat in summer

# High Tunnels (Haygrove) in the United Kingdom

- Protection from rain, hail, and wind; greater 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

# Half-Tunnels in China

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

# High Tunnels in Norway

# Greenhouse Cherries in Spain

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

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


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UNIVERSITY
Computer-Programmable Retractable Roof (Cravo)


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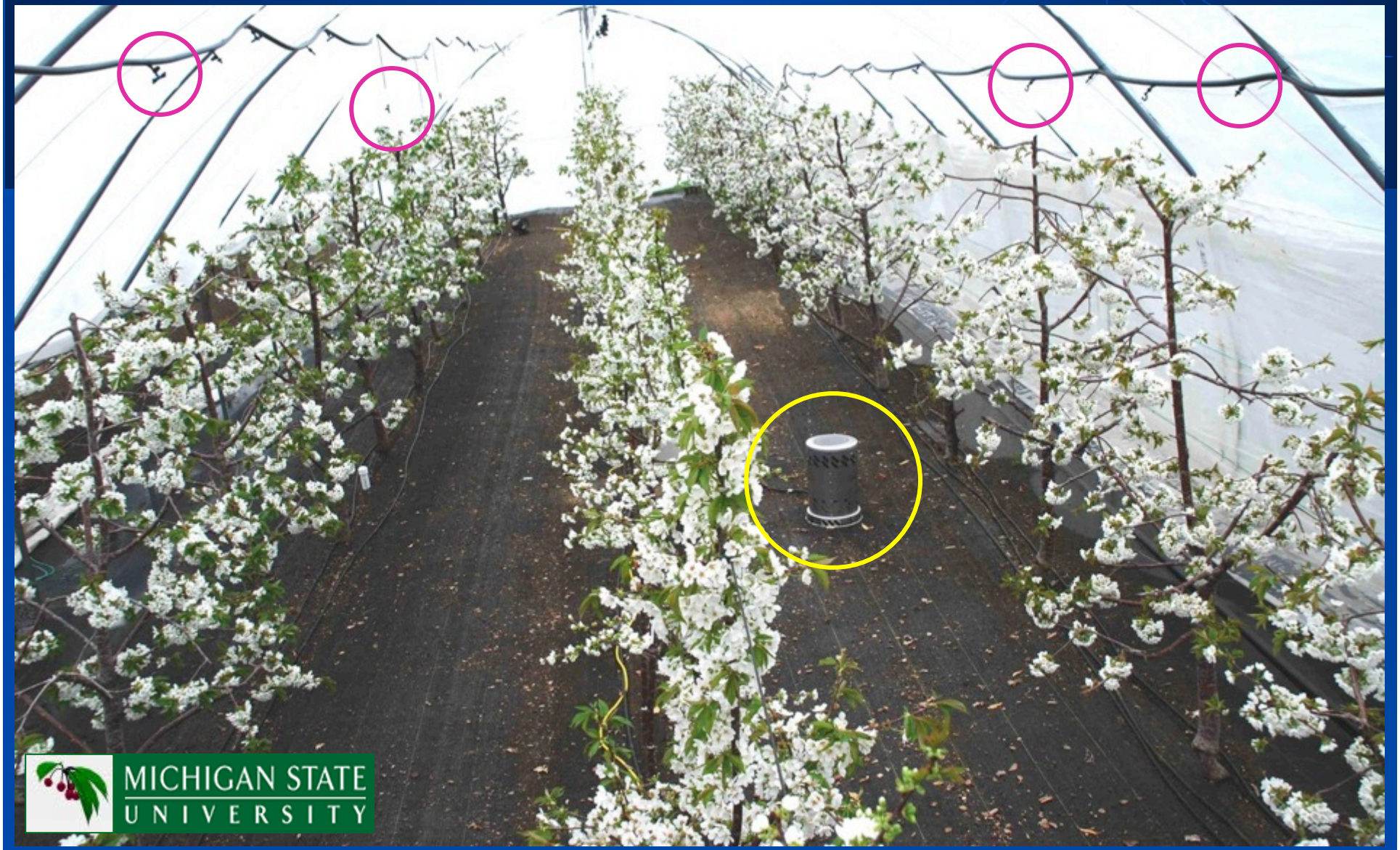
UNIVERSITY
Roof Panels Open and Close in Response to Rain, Wind, and High and Low Temperature Set-Points to Optimize Growing Conditions

# 2011 Research: 80,000 BTU Propane Heaters, every 100 ft, added ~6°F when outside temperatures were 17 to 27°F



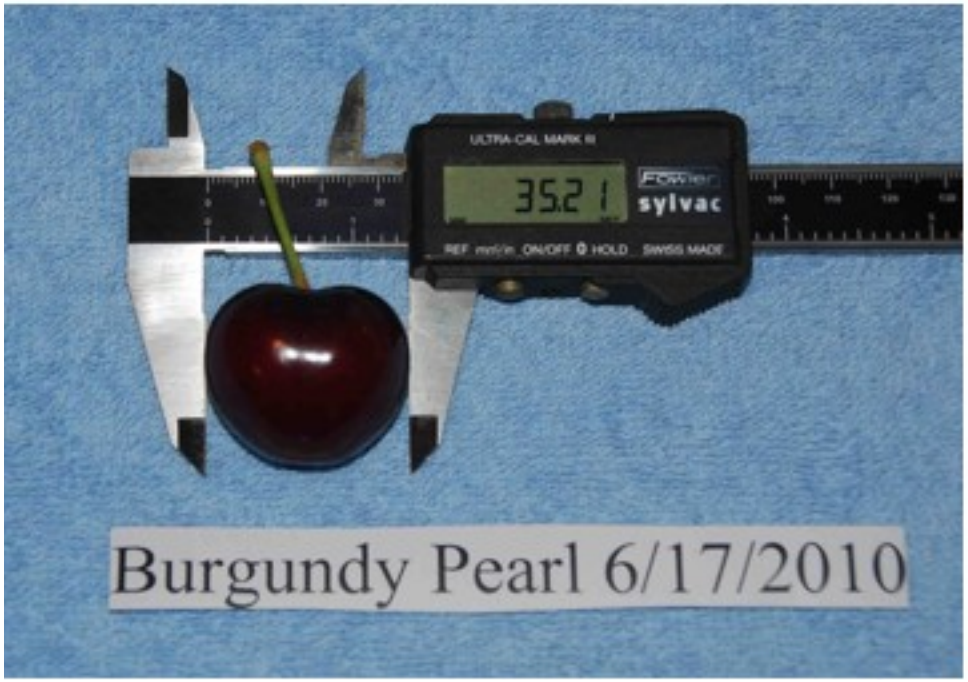
# 2010 Harvest Dates
# MSU-SWMREC Tunnels

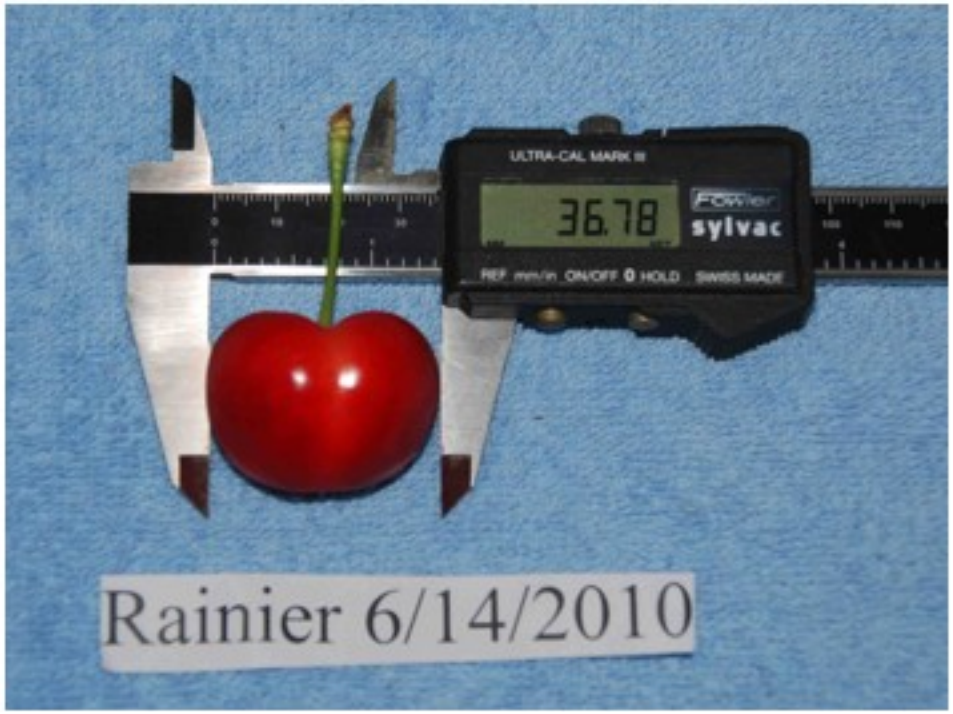

NY 1913
NY 1038
NY 8306
White Gold
WSU X5
WSU X11
WSU X6
WSU X7
WSU X8
NY 7855
WSU X9
Summit
Lapins
Black Pearl
Rainier
NY 8315
Black Gold
Burgundy Pearl
NY 9295
NY 7091
Glacier
Ebony Pearl
WSU X2
NY 213
Kristin
Regina
Tieton
Blushing Gold
Sonnet
Benton
WSU X3
NY 252
WSU X1
Attika
Selah
Cristalina
Ulster
NY 299
WSU X12
Skeena
Sandra Rose
WSU X10
WSU X4
Early Robin
NY 7690
NY 9165

6/7 6/11 6/14 6/17 6/21 6/24 6/28

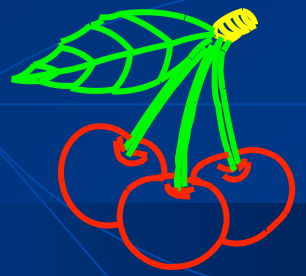

ULTRA-CAL MARK III
32.60
sylvac
REF mm/in ON/OFF 0 HOLD SWISS MADE
Ebony Pearl 6/11/2010


ULTRA-CAL MARK III
36.39
sylvac
REF mm/in ON/OFF 0 HOLD SWISS MADE
Benton 6/14/2010


ULTRA-CAL MARK III
35.21
sylvac
REF mm/in ON/OFF 0 HOLD SWISS MADE
Burgundy Pearl 6/17/2010


ULTRA-CAL MARK III
36.78
sylvac
REF mm/in ON/OFF 0 HOLD SWISS MADE
Rainier 6/14/2010

# Chelan



- Parents: Stella x Beaulieu
- Early ripening, 10-12 days before Bing
- Precocious, moderately upright, highly productive tree (rootstocks, stress)
- Less rain cracking than Bing
- Graft incompatible w/ mahaleb, sensitive to stress, limb-bending?

# Santina

- Parents: Stella x Summit
- Self-fertile
- Firm, large size
- Blooms mid-season, ripens 8 days before Bing
- Moderately tolerant to rain cracking

# Cornell Stone Fruit

An IPM Variety

# BlackPearl® NY 8139

BlackPearl is the best cherry it's season, ripening 10 days before Bing, with Chelan. (-10) It has exceptional flavor and is extremely firm and crunchy. The fruit is medium size with 20% sugar. BlackPearl has amazing storage qualities and keeps better than almost any other cherry. It is hardy and canker resistant with low cracking. Early season bloom,
S4 unknown.

# Cornell Stone Fruit

An IPM Variety

# RadiancePearl™ NY 7679

RadiancePearl™ is a Rainier type cherry that ripens 7 to 10 days ahead of Bing (-7-10) and has exceptional flavor and quality. The fruit averages 11g with 20% sugar and has exceptional flavor and low rain cracking. It has a vigorous, hardy and productive tree. RadiancePearl™ has an early mid-season bloom, S1 Unknown. It is perfect for fresh market and u-pick operations.

# Tieton

- Firm, very large fruit (11-13 g, 28-32 mm), excellent stems, early season premium
- Blooms mid-season, ripens 6-8 days before `Bing', incompatible with `Chelan', `Burlat'
- Very vigorous, upright growth, light to moderate cropping, well-suited to dwarfing rootstocks (i.e., Gisela 5)

# Cornell Stone Fruit

An IPM Variety

# BurgundyPearl™ NY 38L


A large, high quality, very firm, crack resistant cherry with a tough, grower friendly tree. BurgundyPearl ripens 3 to 5 days before Bing. (-3) It has large, firm, crunchy, 12g fruit with 20.5% sugar. The tree is vigorous, productive, and canker resistant . BurgundyPearl has superior quality, storability and excellent crack resistance, averaging 4% cracking with 1” of rain in 2008. Early midseason bloom,S3S4

# Cornell Stone Fruit

An IPM Variety

# EbonyPearl™ NY 32


EbonyPearl is a large, very high quality cherry that ripens 3 days ahead of Bing. (-3) It has excellent crack resistance, averaging 4% cracking with 1" of rain in 2008. The tree is hardy, vigorous and canker resistant . Very large fruit averages 9.5 row, 11.6g with exceptional flavor and quality and has long, firmly attached stems. EbonyPearl has a early mid -season bloom. S1S4.

# Benton (Columbia)

- Parents: Stella x Beaulieu
- Self-fertile
- Firm, large fruit size
- High sugar, excellent flavor

- Blooms late, ripens with Bing
- Excellent cropping, moderately spreading growth habit
- Less susceptible to rain cracking


# Sandra Rose

- Parents: (Star x Van) x Sunburst
- Medium firm, large fruit size
- Self-fertile
- Blooms mid-season, ripens 3 days after Bing
- Tolerant to rain cracking
- Precocious, spreading growth habit

# Kordia (Attika)

- From Czechoslovakia
- Very firm, large, heart-shaped fruit, excellent flavor
- Blooms late, ripens 10 days after Bing, not self-fertile
- Vigorous and productive tree
- Less susceptible to rain cracking; more to frost
- Compatible with Van, Stella, Hedelfingen, Sam, Lambert

# Skeena

- Parents: (Bing x Stella) x (Van x Stella)
- Very firm, large fruit size
- Self-fertile
- Blooms mid-season, ripens 15 days after Bing
- Very susceptible to rain cracking (not “tolerant”)
- Precocious, spreading growth habit

# Rootstock Traits

*Vigor* – high, semi-vigorous, dwarfing, or very dwarfing

*Precocity* – early flowering, high productivity

*Adaptation to Soil Conditions* – silty loam, sandy (well-drained, quick to dry, warm) or heavy clay (wet, prone to Phytophthora, cold in spring)

*Adaptation to Climatic Conditions* – temperate/moderate; hot, sunny, and/or windy with high daily water demand; cool and cloudy with less photosynthesis

# *Precocity and the Basic Cherry Fruiting Units*

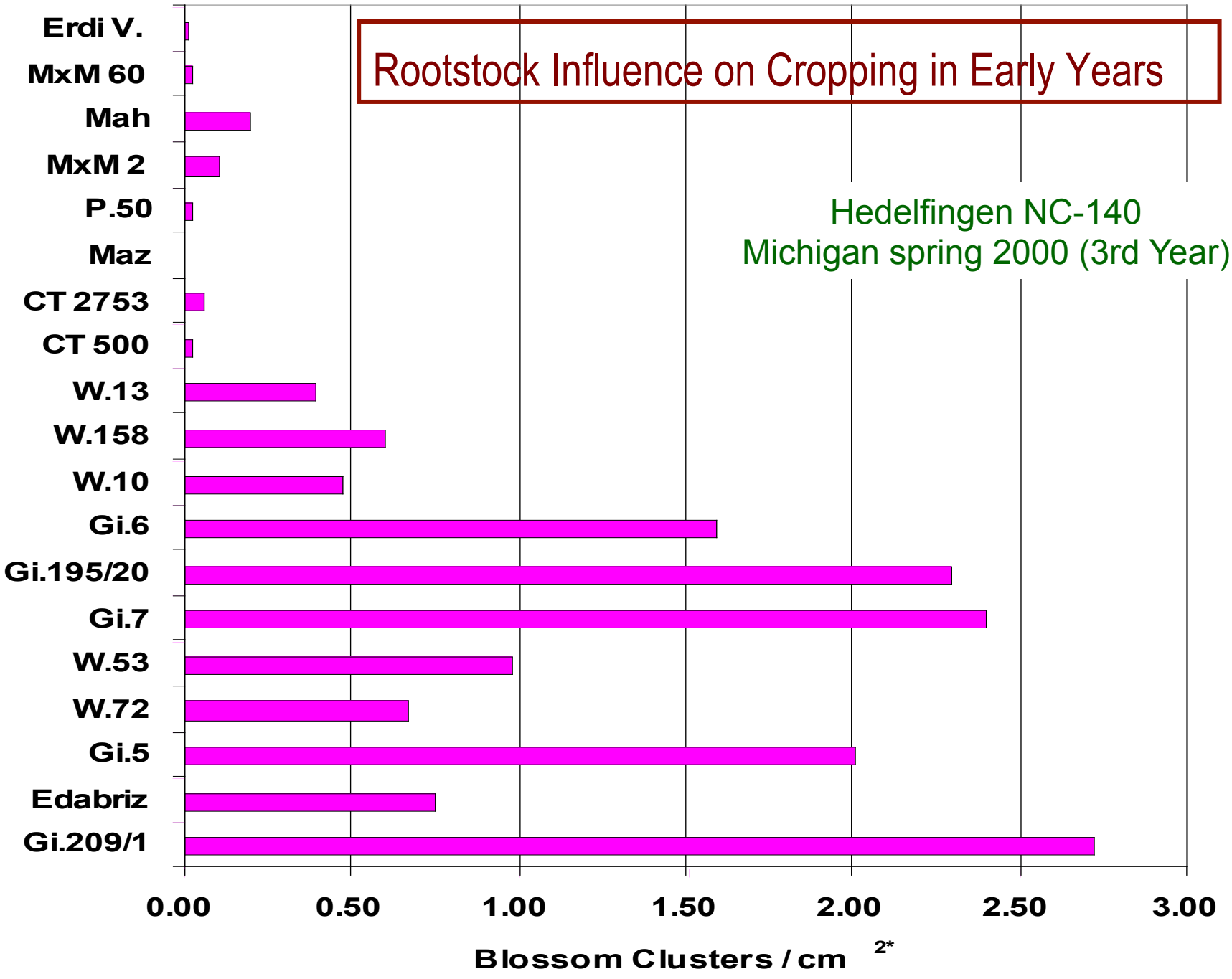
**2-Yr-old growth**

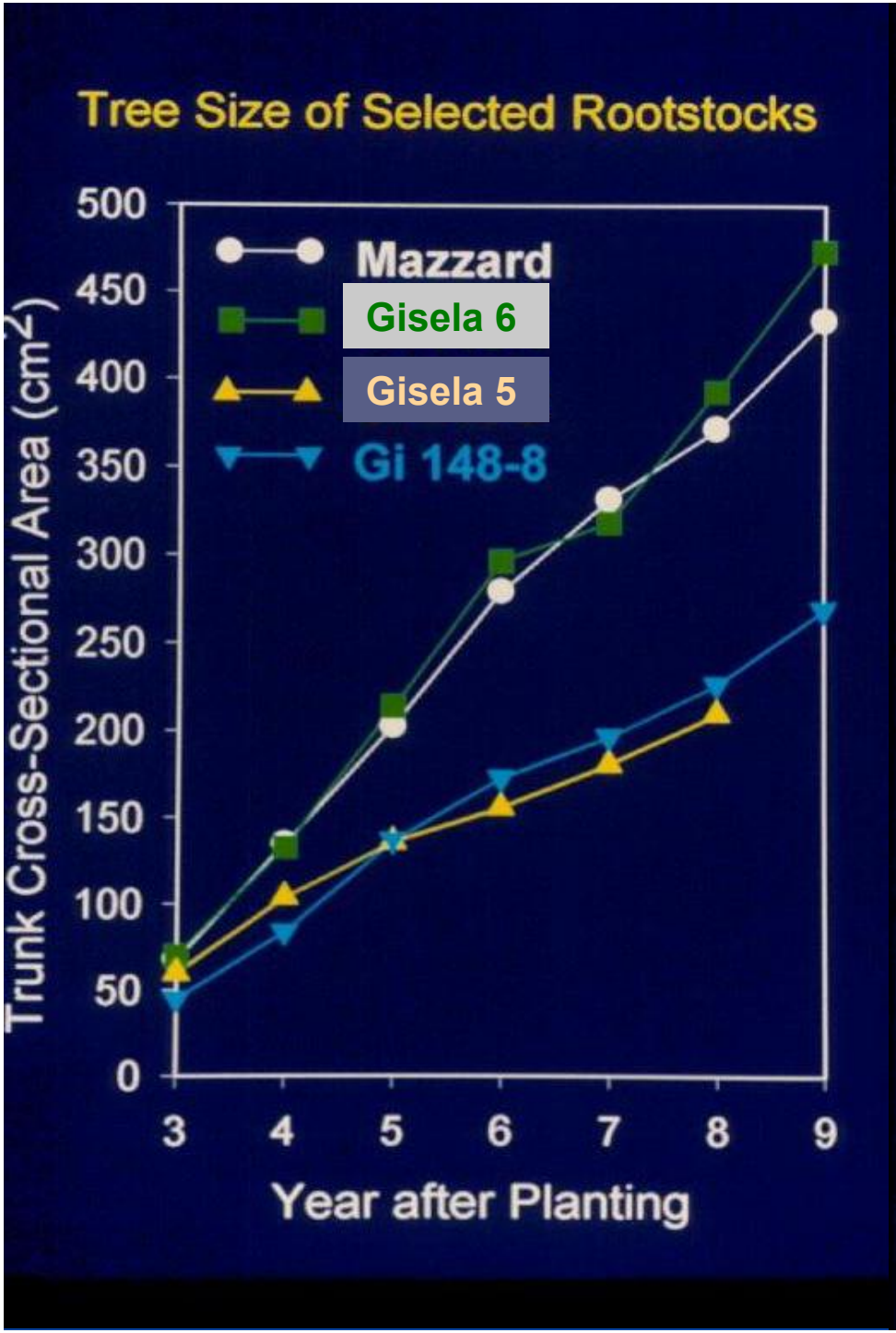
**Last year's growth**

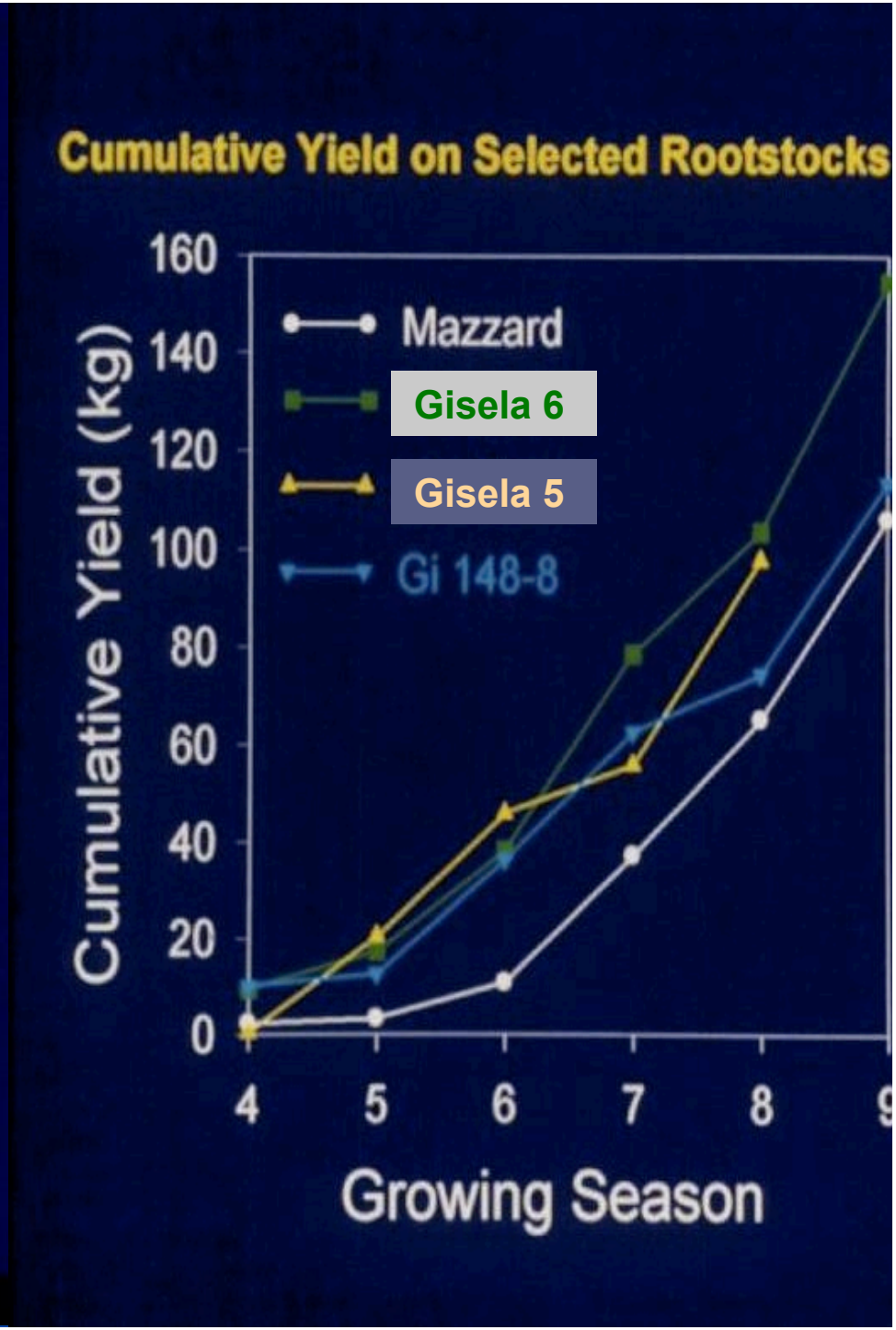
**New growth**


*Ayala and Lang, 2004*

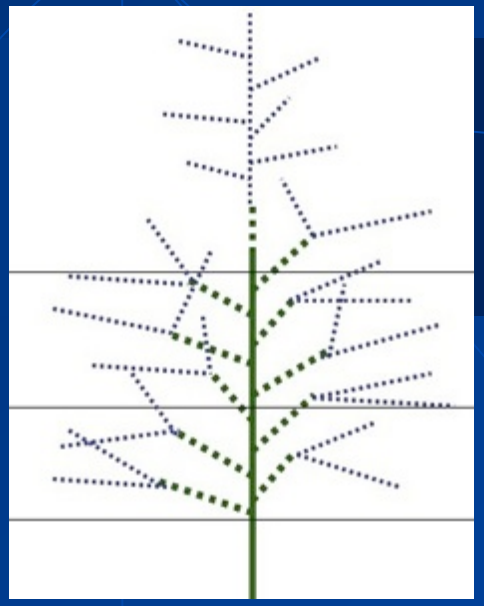
***The first fruit to appear on trees on precocious rootstocks are spur fruit on the leader (trunk) and nonspur fruit on the first lateral shoots (branches)***


Rootstock Influence on Cropping in Early Years
Hedelfingen NC-140
Michigan spring 2000 (3rd Year)
Erdi V.
MxM 60
Mah
MxM 2
P.50
Maz
CT 2753
CT 500
W.13
W.158
W.10
Gi.6
Gi.195/20
Gi.7
W.53
W.72
Gi.5
Edabriz
Gi.209/1
0.00
0.50
1.00
1.50
2.00
2.50
3.00
Blossom Clusters / cm 2*


Tree Size of Selected Rootstocks
Trunk Cross-Sectional Area (cm2)
500
450
400
350
300
250
200
150
100
50
0
3
4
5
6
7
8
9
Year after Planting
Mazzard
Gisela 6
Gisela 5
Gi 148-8


Cumulative Yield on Selected Rootstocks
Cumulative Yield (kg)
160
140
120
100
80
60
40
20
0
4
5
6
7
8
Growing Season
Mazzard
Gisela 6
Gisela 5
Gi 148-8

# High Vigor, Low Precocity Rootstocks



Mazzard (*Prunus avium*)
- seedling
- F12/1, Charger, others

Mahaleb (*Prunus mahaleb*)
- seedling
- SL64, SL405
- CT500, CT 2753, Korponay, others

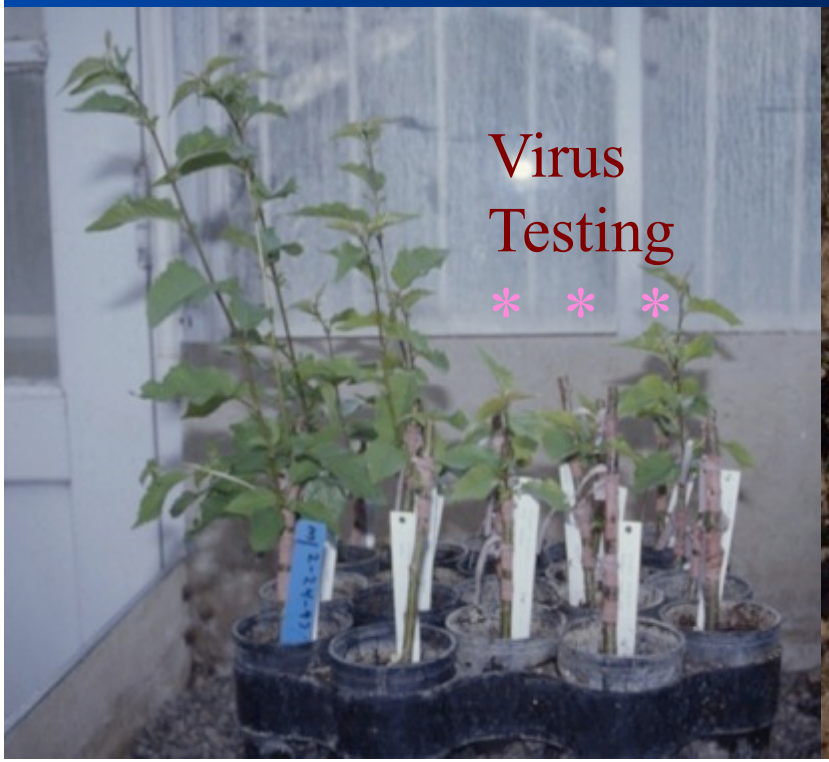
MxM series (Mazzard x Mahaleb)
- 2, 14 (MaxMa 14), 39, 60

- Colt: Mazzard x *P. pseudocerasus*

# NC-140 Rootstock Research

- The NC-140 Rootstock Research Project is ~30 scientists across N. America (US, Canada, Mexico)

- NC-140 Project evaluates rootstock performance in many climates and soils, characterizing productivity, disease susceptibility, etc.




# Gisela Hybrid Rootstock Series, Giessen, Germany


1987/1998 NC140 Trial

- Gisela 1 (172-9)*
- Gisela 3 (209-1)
- Gisela 4 (473-10)*
- Gisela 5 (148-2)
- Gisela 6 (148-1)
- Gisela 7 (148-8)*
- Gisela 8 (148-9)*
- Gisela 10 (173-9)*
- Gisela 11 (195-1)*
- Gisela 12 (195-2)

*Werner Gruppe*
Justus Liebig University
- *Hanna Schmidt*
- *Sabina Franken-Bembenek*

Sweet or sour cherry x
*P. canescens or P. fruticosa*

318-17, 154-4*, 154-7*
169-15, 196-4, 148-20
195-20*

# Other Somewhat Dwarfing Hybrids

Gembloux (Belgium):

- Inmil (GM 9)*: *incisa* x *serrulata*
- Damil (GM 61-1): *Prunus dawykensis*
- Camil (GM 79)*: *Prunus canescens*

Krymsk 5*, 6*, others (Russia)

PiKu 1, 3, 4, others – sweet cherry x *canescens*, *tomentosa*, *kurilensis*, *pseudocerasus*, *incisa* (Germany)

P-HL A, B, C (sweet cherry x sour cherry) (Czech)

# Rootstocks Based on Sour Cherry

- Stockton Morello
- CAB6P, others (Bologna, Italy)
- Tabel Edabriz (France)
- Weiroot 10*, 13*, 53*, 72, 154*, 158 (Germany)
- Michigan State University series (some are sour cherry x *canescens*): still experimental

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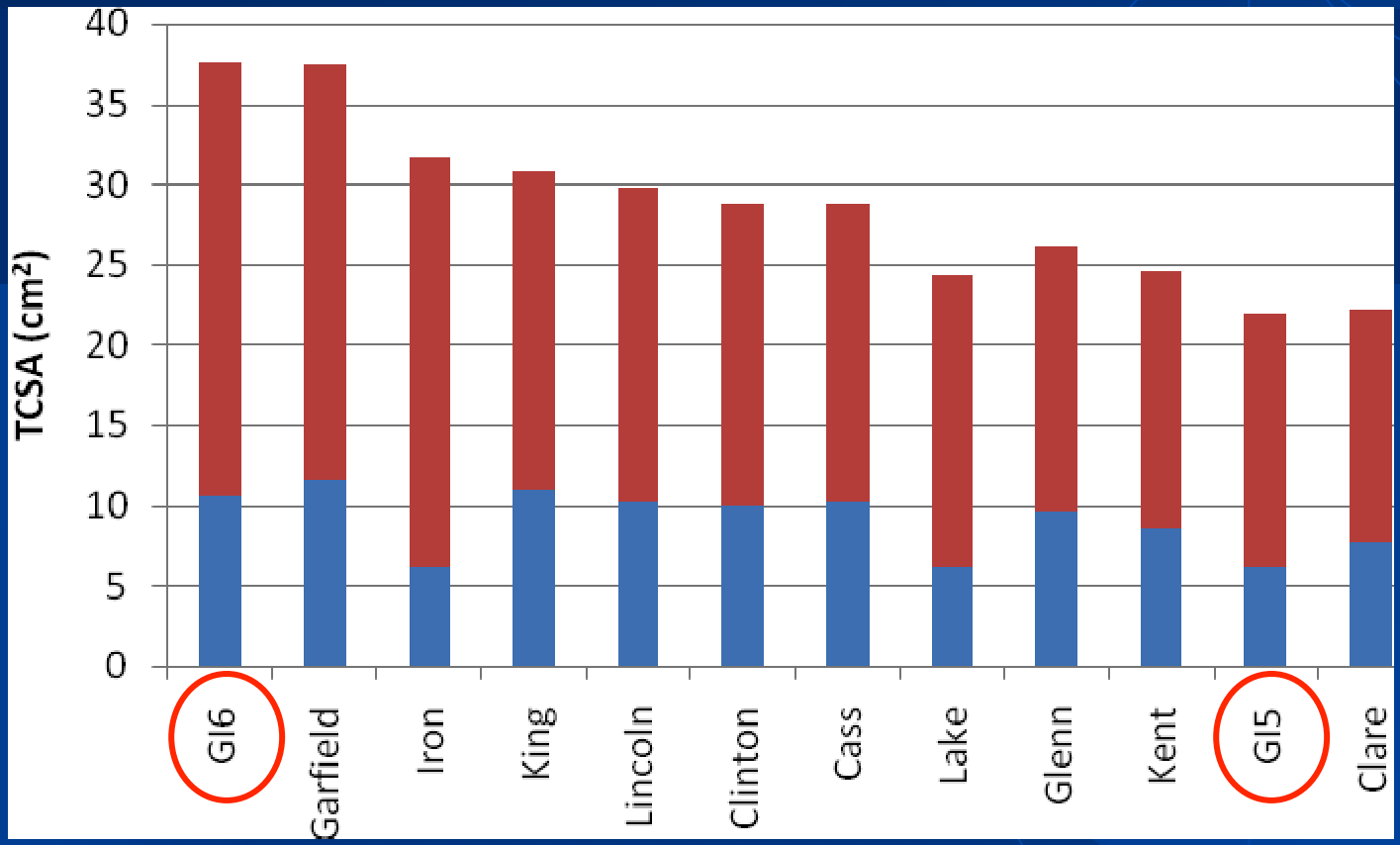
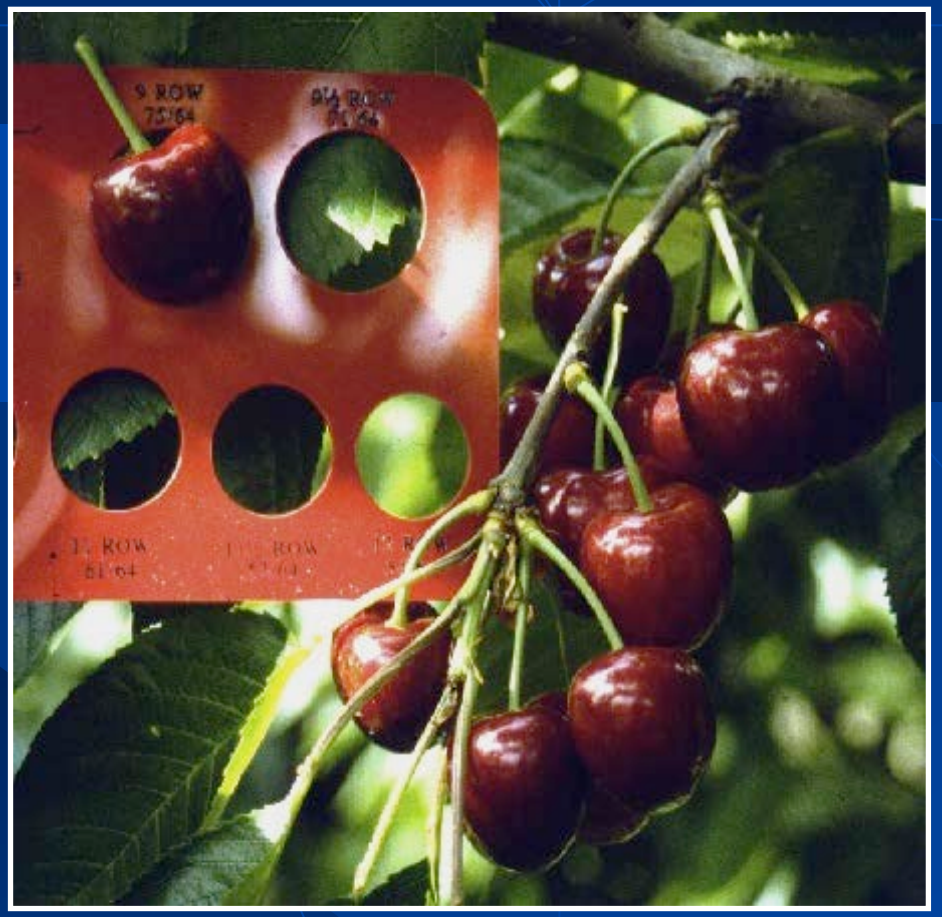
# MSU Cherry Rootstocks - Vigor




~13 years research on sour cherry-based candidates (Began with ~96 genotypes, screened for virus sensitivity, propagation, graft compatibility); currently 9 genotypes, most sucker profusely. Key traits: precocity, range in size from Gi5 to somewhat smaller than Gi6, lower flower numbers

Iezzoni, Whiting

# Management for Success with New Rootstocks



Match light-bearing, vigorous cultivars like Tieton and Regina to dwarfing productive rootstocks like Gi 5 or 12

Match highly-productive cultivars like Sweetheart to more vigorous rootstocks like Colt

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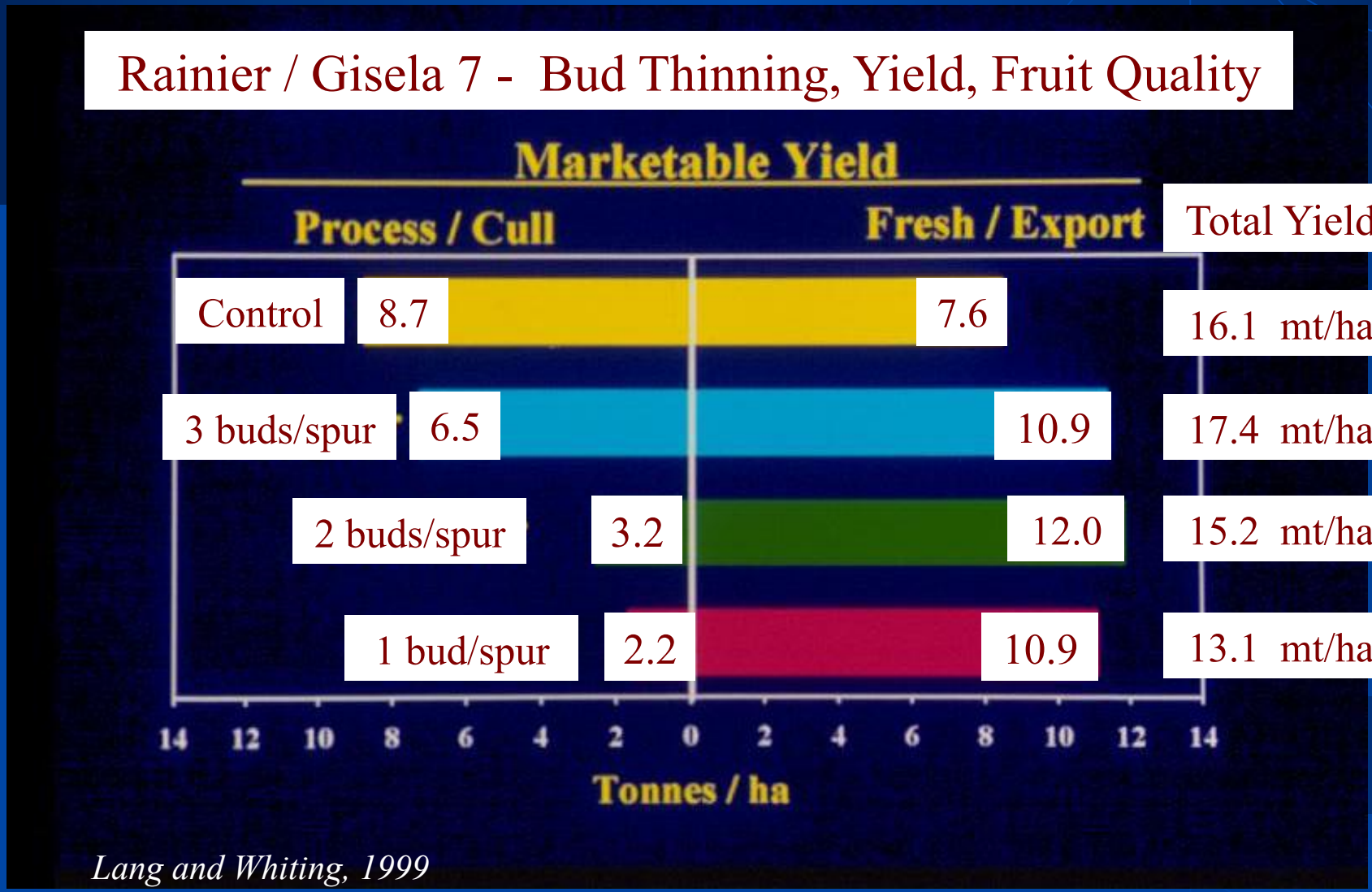
# Do Dwarfing Rootstocks Yield Small Fruit?




*Lang and Whiting, 1999*


Fertilization:
Focus on Producing
Fruit, not Trees

# Nitrogen Fertilization Strategies: Demands and Sources

WHEN is Nitrogen most needed during the cherry tree's development cycle?

*e.g., bloom, leaf expansion, fruit set, fruit growth, shoot elongation, root growth, flower bud formation, cold acclimation?*

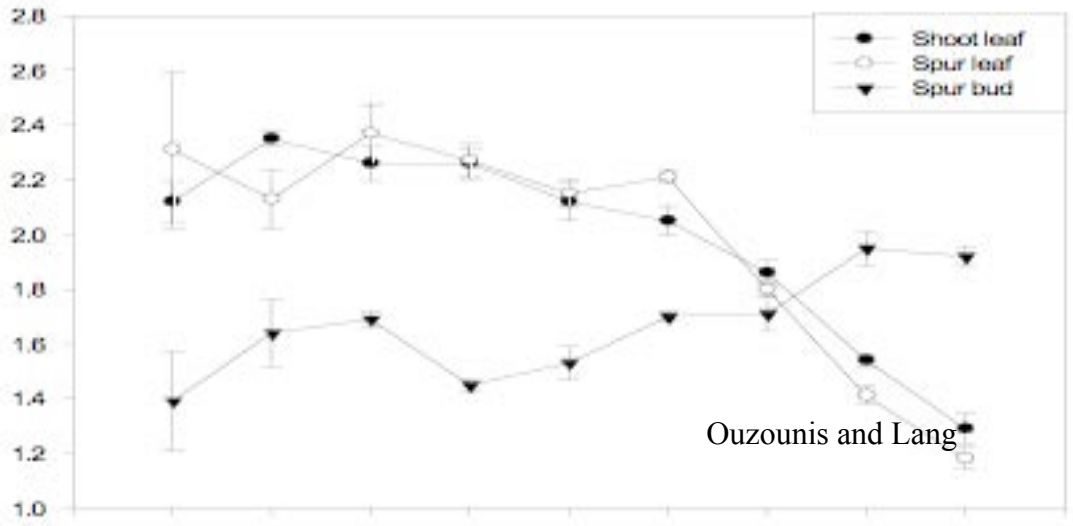
WHERE does the Nitrogen needed for these plant demands come from - soil uptake vs. tissue storage?

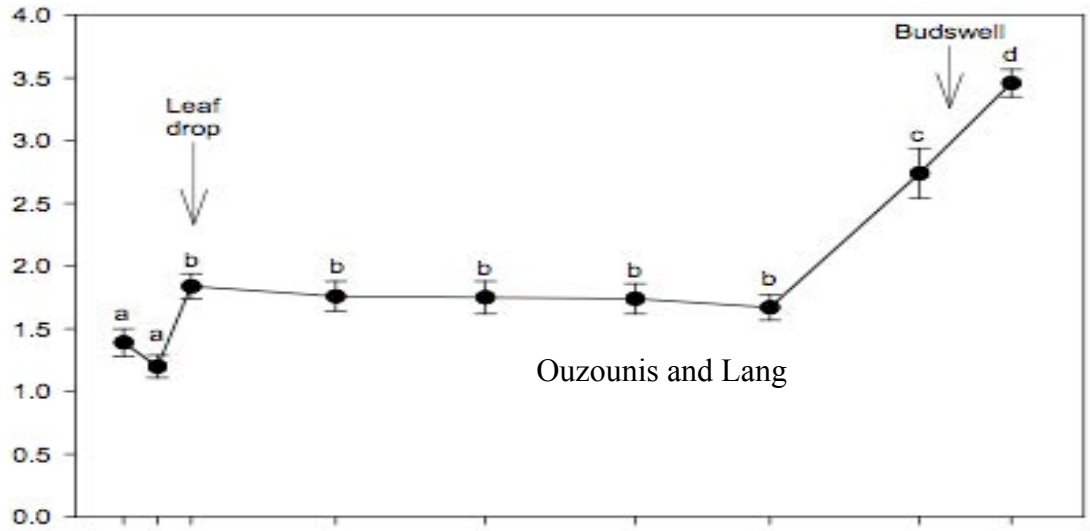
WHAT application forms are best to optimize N use efficiency for fruiting?

## Fall to Leaf Drop (Michigan)

Leaf N declined 50% during the month before leaf drop; fruiting spur N concomitantly increased ~50%; premature defoliation decreased spur N

Small trees on Gisela 5 rootstock



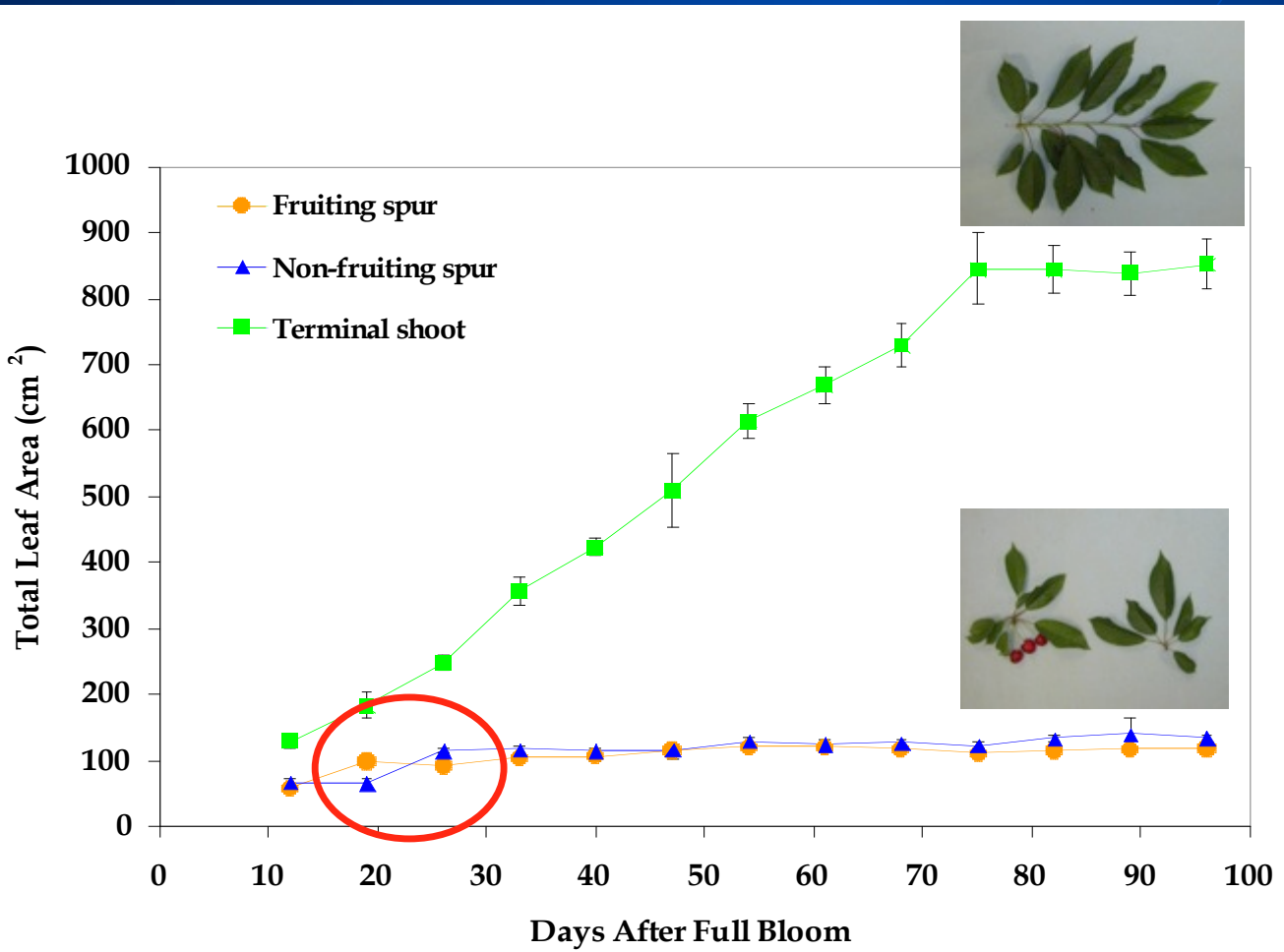




## Dormancy (Michigan)

Fruiting spur N levels did not change during dormancy in winter, then increased rapidly (80%) during budswell with remobilization from other tissues

Small trees on Gisela 5 rootstock

# Timing of Spur and Shoot Leaf Area Formation




N moves into the plant from the soil solution:

until new leaves form and evapo-transpirational demand begins, very little N is taken up from spring fertilizer applications

Ayala, 2004

# 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

**Physiological Processes:** ← Photosynthesis →

← Soil Nitrogen Uptake →

**Important Effects:** Fruiting

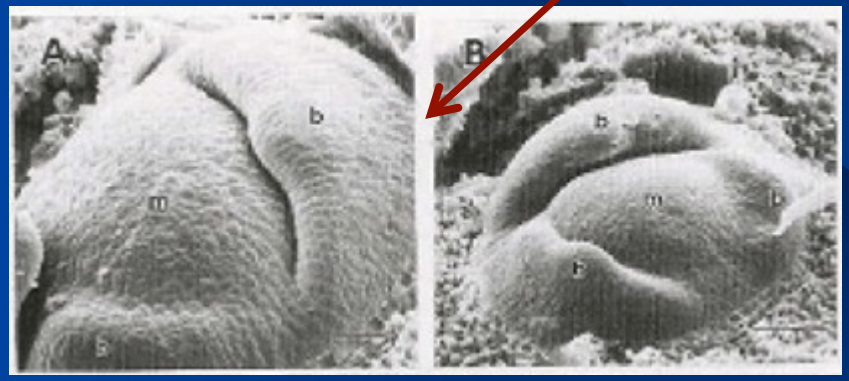
New Shoot Growth

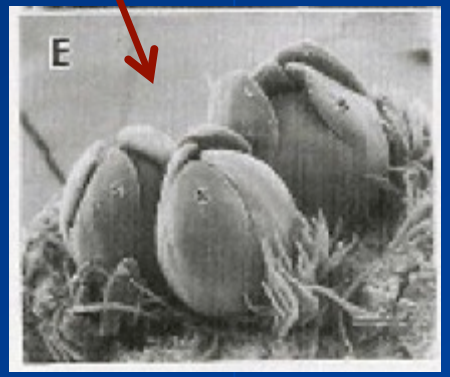
# Cherry *Growth & Cropping* Timeline, Part 1

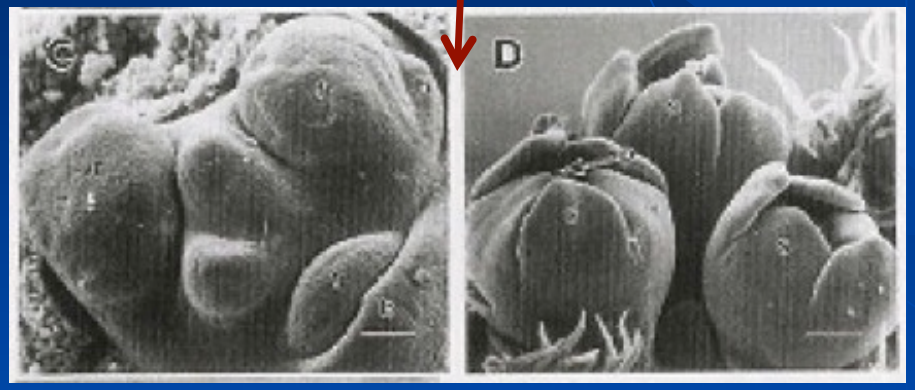
| Northern Latitude: / *Southern Latitude:* | May *(Nov)* | Jun *(Dec)* | Jul *(Jan)* | Aug *(Feb)* | Sept *(Mar)* | Oct *(Apr)* | Nov *(May)* |
|---|---|---|---|---|---|---|---|

**Stage of Development:**

**Flower Organ Differentiation**



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| 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:** Fruiting; New Shoot Growth

**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

# MSU Tree Fruit Research

Training video clips at:
*www.giselacherry.com*

www.cherries.msu.edu