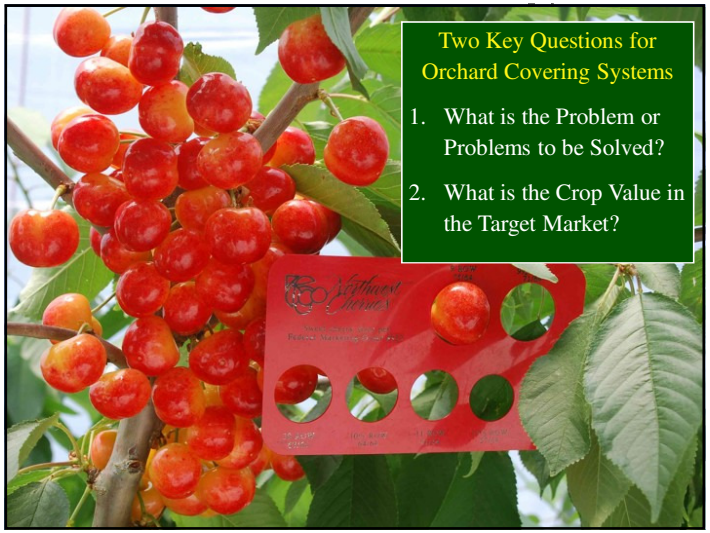
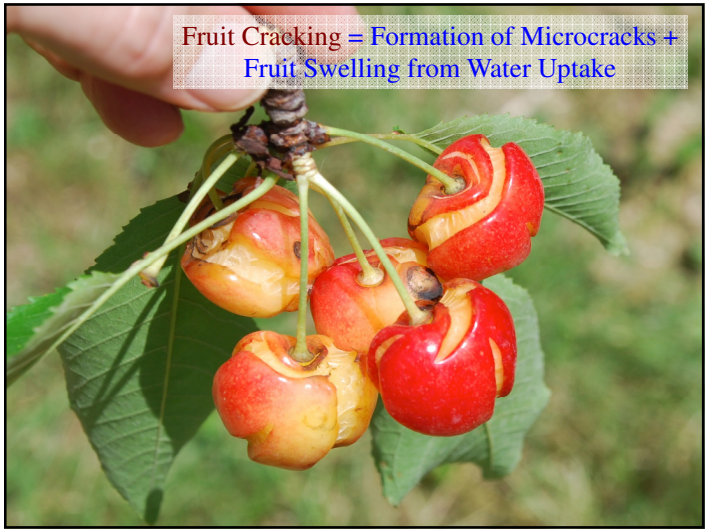
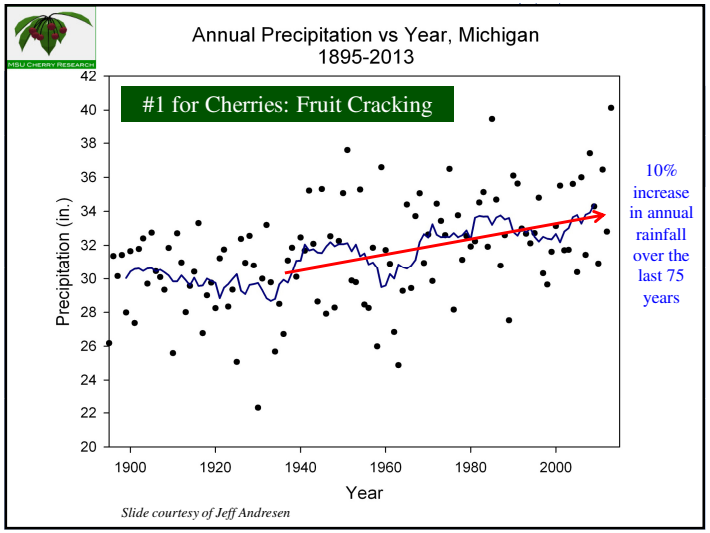

FRUTICULTURA PROTEGIDA:
Uso de Cubiertas en Frutales y Vides Como
Alternativa Frente a la Variabilidad Climática
Cerezos Bajo Cubierta Plàstico: 10 Años
Experiencia en el Estado de Michigan, USA
INIA
subsole
Gregory Lang
Michigan State University
MSU CHERRY RESEARCH


High Tunnel Nectarines and Apricots


Two Key Questions for
Orchard Covering Systems
1. What is the Problem or Problems to be Solved?
2. What is the Crop Value in the Target Market?


Fruit Cracking = Formation of Microcracks +
Fruit Swelling from Water Uptake




## Two Types of Cherry Fruit Cracking

***Type 1: Rain on Fruit Skin***

Cracking at the tip (stylar end) or bowl (stem end) due to long fruit contact with rainwater.

Eliminated with protective covers (reduced with some water-resistant fruit coatings)

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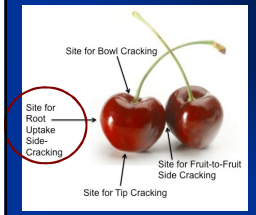



***Type 2: Excessive Water in the Soil***

Fruit *side* cracking (due to rain or irrigation water taken up by the roots and pumped into the fruit (*especially when leaves have low evapotranspiration*).

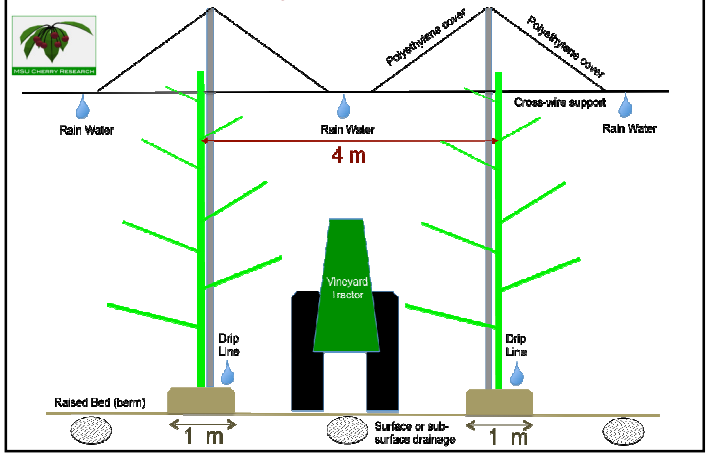
Can occur even with protective covers; must manage soil moisture and drainage!

## 2008 'Rainier' Sweet Cherry Yield, Fruit Size, and 'Rainier' & 'Lapins' Fruit Cracking at MSU-CRC

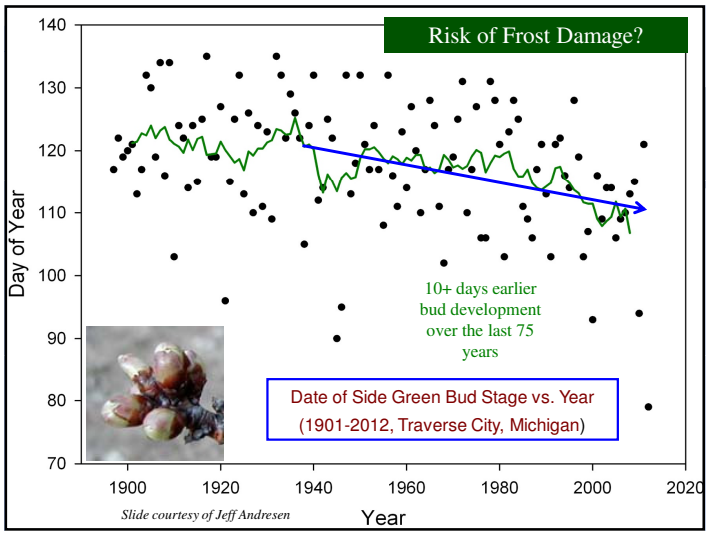
| | 'Rainier'/Gisela 5 | | 'Rainier'/Gisela 6 | |
|---|---|---|---|---|
| | **Covered (tunnel)** | Open (no tunnel) | **Covered (tunnel)** | Open (no tunnel) |
| *Tree Yield* (kg/tree) | 19.2 | 14.8 | 32.5 | 13.1 |
| *Orchard Yield* (ton/ha) | 20.5 | 15.9 | 34.7 | 14.0 |
| Rainier *fruit cracking* (%) | 60 | 89 | | |
| Lapins *fruit cracking* (%) | 32 | 91 | | |

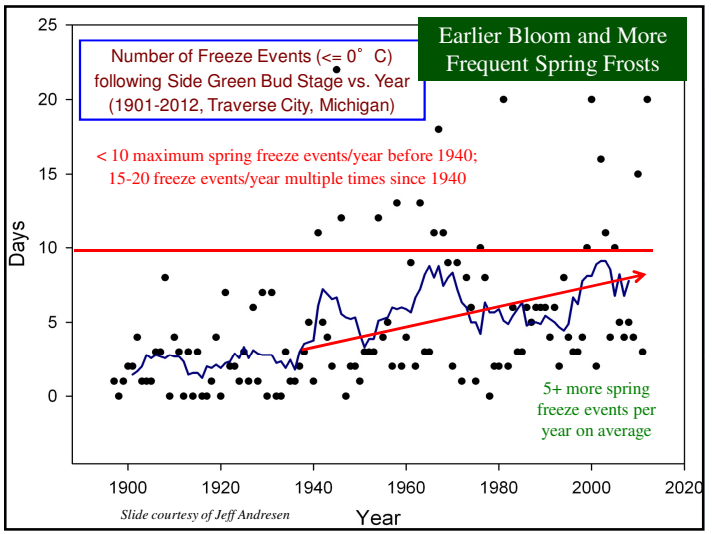
In fact, in 2009, fruit cracking in high tunnels occurred due to *too much irrigation water*

Designing Orchards for Tree Canopy *and* Rootzone Water Management:
Covers to keep the fruit and tree canopy dry
Raised beds and drainage tiles to reduce excessive rootzone water

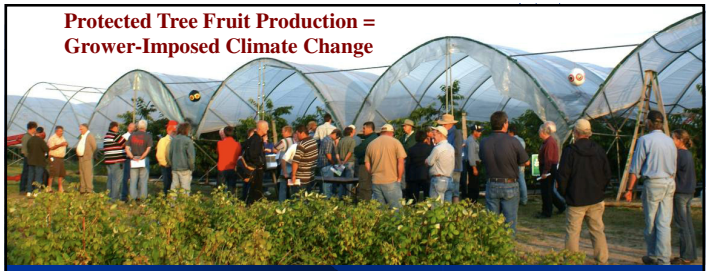






**Protected Tree Fruit Production = Grower-Imposed Climate Change**



Pole and Cable Tent Structures:

Three-Season High Tunnels:

Greenhouse-like, Automated Structures:

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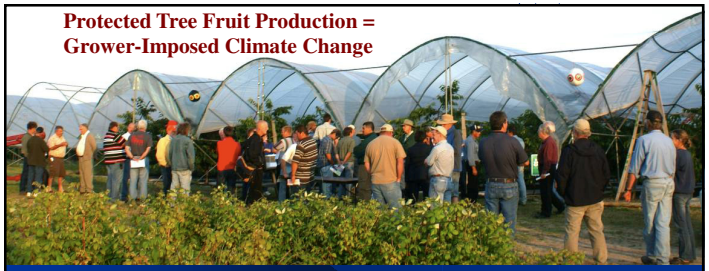
**Protected Tree Fruit Production = Grower-Imposed Climate Change**



Pole and Cable Tent Structures:

- least expensive
- movable vs. fixed plastic
- solid vs. self-venting plastic (Voen)
- very minor frost protection (cold air barrier, trap soil heat)
- some potential heat management issues

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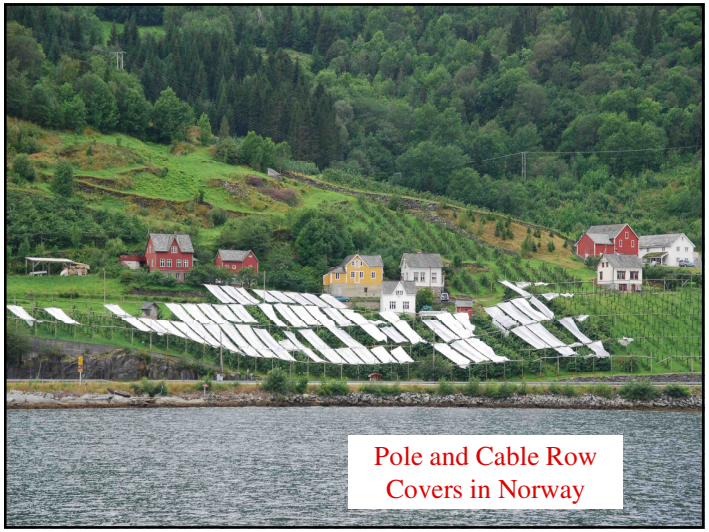
Pole-and-Cable Covers in Chile



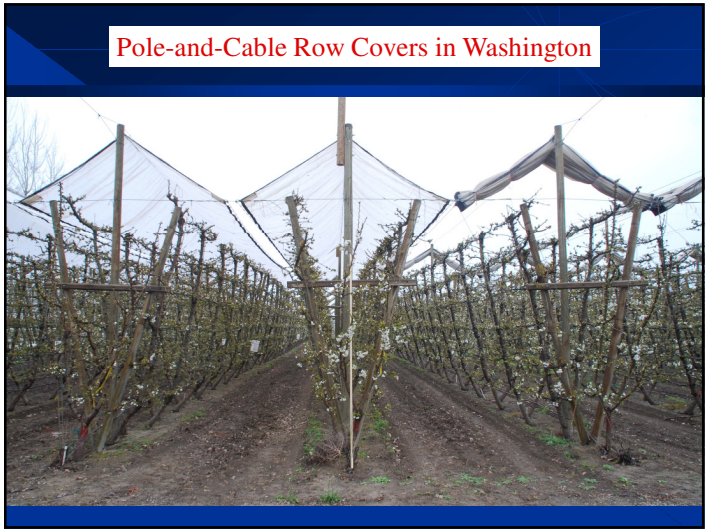
Pole and Cable Row Covers in Norway

Vented (VOEN) Pole-and-Cable Covers

- Protection from rain and hail; best passive venting of heat

Voen Cover "Hibernation" in Winter (Michigan)

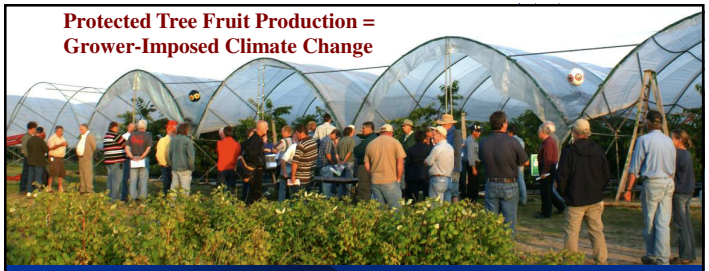
Pole-and-Cable Mini-Covers in New Zealand



Pole-and-Cable Row Covers in Washington

Europe – Rain-protective Row Covers with Net Side Panels for Insect Control (*Spotted Wing Drosophila*)

**Protected Tree Fruit Production = Grower-Imposed Climate Change**



Three-Season High Tunnels:

- multi-bay, minimal steel
- cannot withstand snow loads
- single layer plastic
- slightly more frost protection
- more challenging heat management

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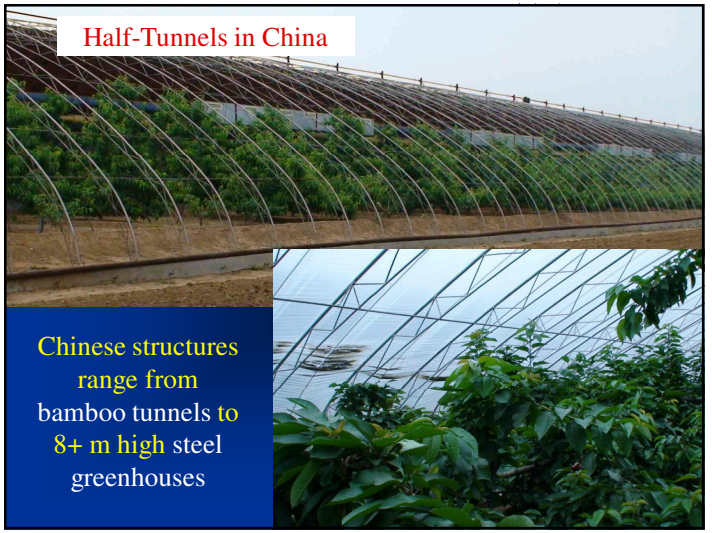
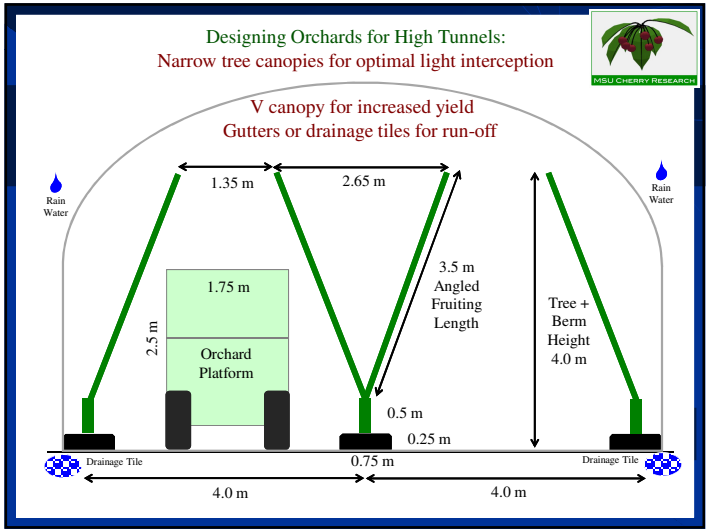
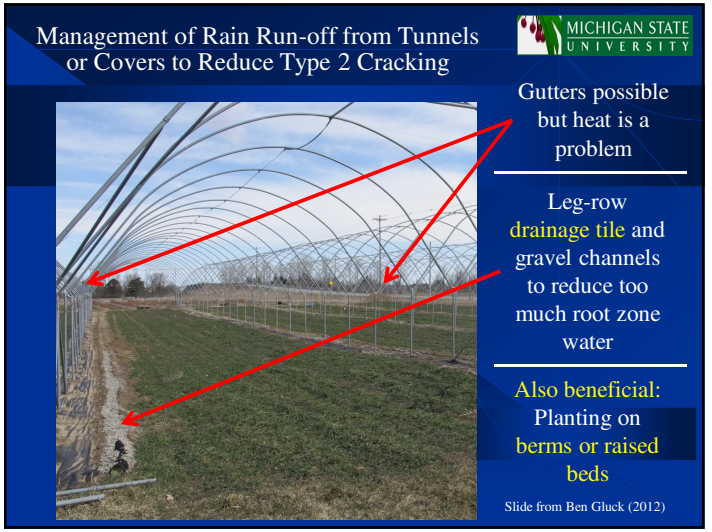
High Tunnels (Haygrove) in the UK, US, Norway

Multi-Bay High Tunnels with doors and bird nets


Mini-Tunnel Covers in Switzerland


Half-Tunnels in China
Chinese structures range from bamboo tunnels to 8+ m high steel greenhouses


Designing Orchards for High Tunnels:
Narrow tree canopies for optimal light interception
MSU Cherry Research
V canopy for increased yield
Gutters or drainage tiles for run-off
Rain Water
Rain Water
1.35 m
2.65 m
3.5 m Angled Fruiting Length
1.75 m
2.5 m
Orchard Platform
Tree + Berm Height 4.0 m
0.5 m
0.25 m
Drainage Tile
0.75 m
Drainage Tile
4.0 m
4.0 m


Management of Rain Run-off from Tunnels or Covers to Reduce Type 2 Cracking
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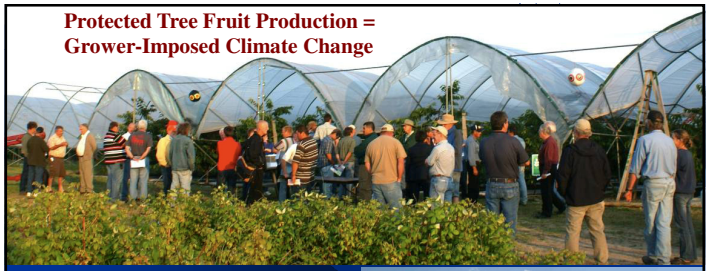
Gutters possible but heat is a problem
Leg-row drainage tile and gravel channels to reduce too much root zone water
Also beneficial: Planting on berms or raised beds
Slide from Ben Gluck (2012)

**Protected Tree Fruit Production = Grower-Imposed Climate Change**



Greenhouse-like Structures:
- programmable, automated
- most manipulation options
- best frost control w/added heat
- best early ripening potential
- very expensive

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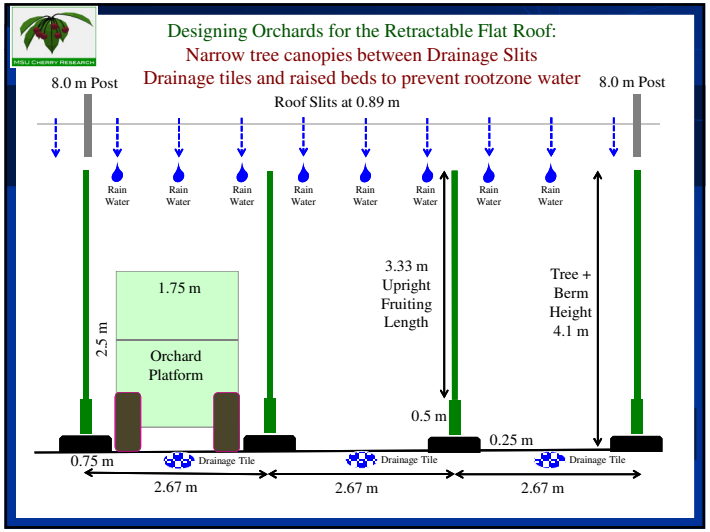
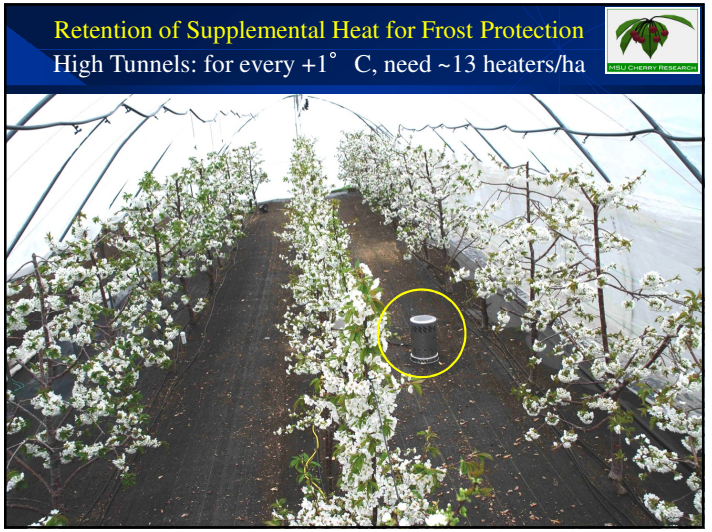
Propane tanks
for heaters


Retractable Flat Roof Covers – Less Expensive, But No Gutters
T - slits


Designing Orchards for the Retractable Flat Roof:
Narrow tree canopies between Drainage Slits
Drainage tiles and raised beds to prevent rootzone water
8.0 m Post
Roof Slits at 0.89 m
8.0 m Post
Rain Water
1.75 m
2.5 m
Orchard Platform
3.33 m Upright Fruiting Length
Tree + Berm Height 4.1 m
0.5 m
0.25 m
0.75 m
Drainage Tile
2.67 m
2.67 m
2.67 m


Retention of Supplemental Heat for Frost Protection
High Tunnels: for every +1° C, need ~13 heaters/ha

## Retention of Supplemental Heat for Frost Protection

Retractable Roof: for every +1° C, need ~5 heaters/ha


Covers Improve Canopy Water Relations, Leading to Increased Fruit Size

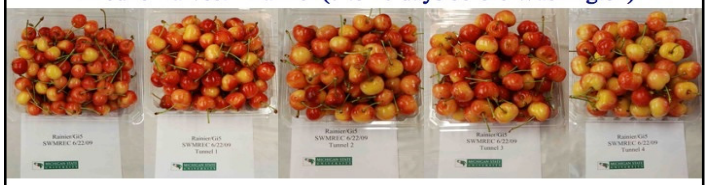




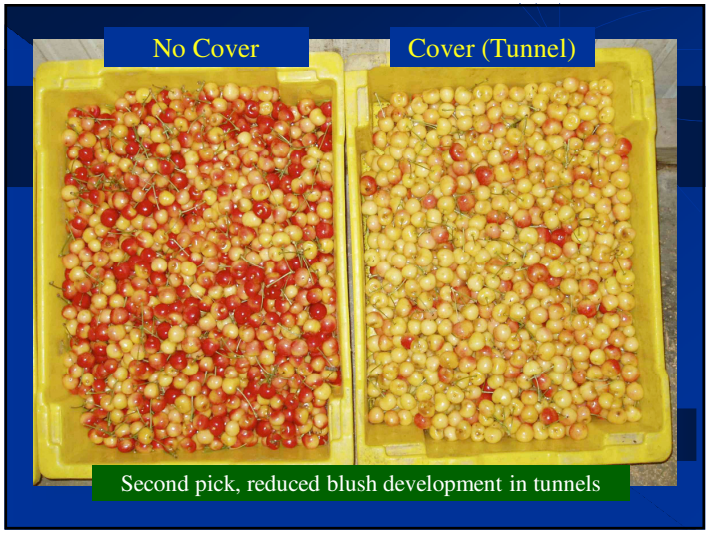

## Using Covers (Tunnels) for Sequential Ripening

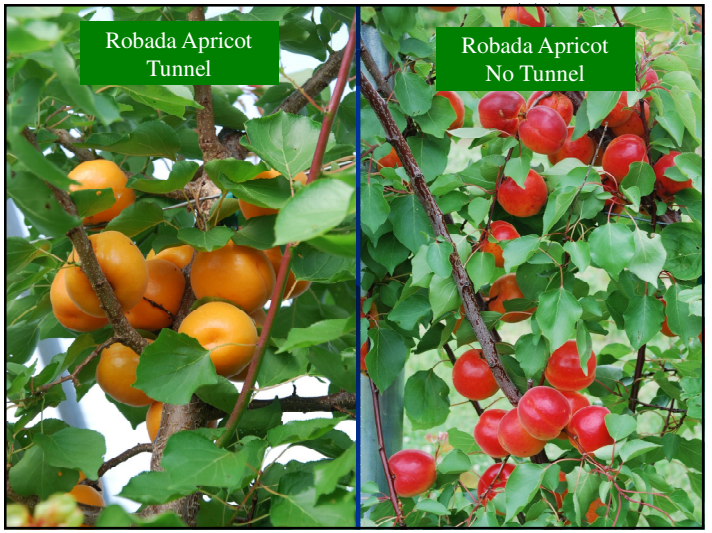
| Tunnel | Date of Covering* | Date of Enclosure* | Fruit Diam. (mm) | Fruit Wt (g) | SSC (° Brix) |
|---|---|---|---|---|---|
| None | - | - | 25 (0.2) | 7.2 (0.2) | 14.6 (0.4) |
| 1 | 8 April | 8 April | 28 (0.3) | 9.1 (0.2) | 15.8 (0.2) |
| 2 | 27 March | 2 April | 31 (0.3) | 11.8 (0.3) | 17.7 (0.3) |
| 3 | 20 March | 24 March | 32 (0.2) | 13.4 (0.2) | 17.3 (0.4) |
| 4 | 13 March | 17 March | 34 (0.1) | 15.5 (0.1) | 18.8 (0.2) |

22 June Harvest - Rainier (7 to 10 days before Washington)



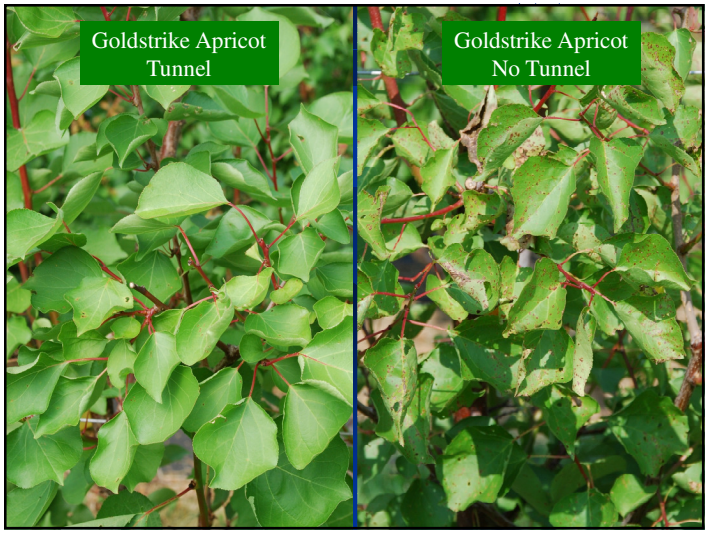
No T T1 T2 T3 T4

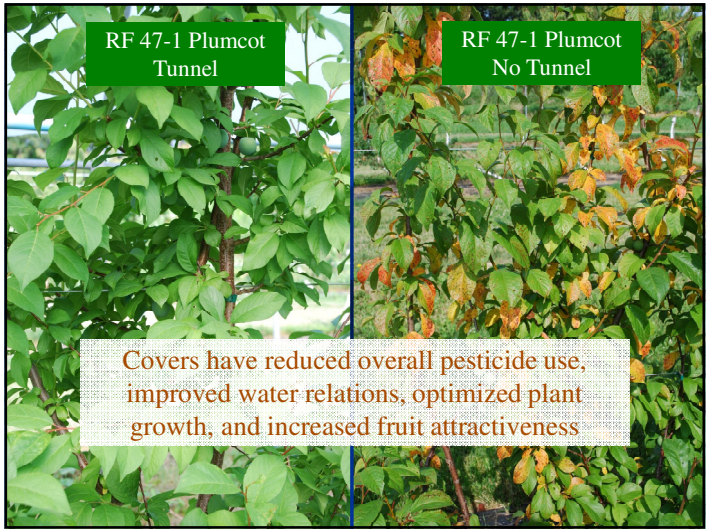

No Cover
Cover (Tunnel)
Second pick, reduced blush development in tunnels


Robada Apricot
Tunnel
Robada Apricot
No Tunnel


Nectarines Under Tunnel
Nectarines Outside Tunnel


Leaf Spot
Cherry Diseases
Under Covers
Canker
Mildew
Brown Rot


## Covering Systems: Protective Attributes

| | Pole and Cable | | | High Tunnel | | Programmable Retraction | |
|---|---|---|---|---|---|---|---|
| | Fixed, Non-Vented | Retract-able | Fixed, Net-Vented | Roof Non-Vented | Roof Net-Vented | Flat Roof w/Drainage Slits | Peaked Roof with Gutters |
| *Protection from:* | | | | | | | |
| **Type 1 fruit cracking** | X | X | X | X | X | X | X |
| **Type 2 fruit cracking*** | - | - | - | - | - | - | X |
| **Spring frost** | ~ | ~ | - | + | - | ++ | ++ |
| **Hail, wind** | + | -/+ | + | ++ | ++ | ++ | ++ |
| ***Pseudo-monas*** | ~ | - | + | ++ | + | ++ | ++ |
| ***Blumeriella*** | + | - | + | +++ | +++ | +++ | +++ |

## Covering Systems: Other Attributes

| | Pole and Cable | | | High Tunnel | | Programmable Retraction | |
|---|---|---|---|---|---|---|---|
| | Fixed, Non-Vented | Retract-able | Fixed, Net-Vented | Roof Non-Vented | Roof Net-Vented | Flat Roof w/Drainage Slits | Peaked Roof with Gutters |
| *Other effects:* | | | | | | | |
| Early bloom & ripening | - | - | - | + | - | ++ | ++ |
| Sequenced ripening | - | - | - | ++ | - | - | - |
| Advanced foliation | - | - | - | ++ | + | ++ | ++ |
| Full light | - | + | - | - | - | + | + |
| Fruit blush formation | - | + | - | - | ~ | + | + |
| Excessive heat | ~ | - | - | + | - | - | - |
| *Cost* | $ | $ | $$ | $$ | $$+ | $$$+ | $$$$$+ |

1$ = US$40,000 / ha

## MSU Tree Fruit Research

Support also from: IFTA, USDA-Small Farms, Haygrove Tunnels, Cravo, Voen, MSU AgBioResearch,

www.hrt.msu.edu/greg-lang