Sweet Cherries: High Tunnels Change Just About Everything

Gregory Lang, Bill Shane, Phil Schwallier, Rufus Isaacs, MSU

MSU Tree Fruit Research

MSU High Tunnel Cherry Project

Tree Goals:

- Fill orchard space and begin fruiting rapidly
- Manage and harvest trees mostly from the ground

Fruiting Goals:

- Premium quality - size, sugar, appearance
- Reduced cracking, fruit rots, bird damage

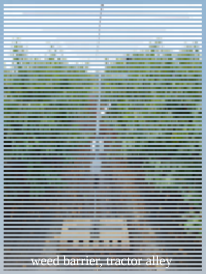
Research Sites:

- SWMREC (Benton Harbor): Four 24 ft x 200 ft tunnels
- CHES (Clarksville): Three 28 ft x 159 ft tunnels
- Adjacent comparative plots without tunnels

Cherry Tunnel Climatic Monitoring

Two stations: permanent and mobile

- air temperature
- relative humidity
- wind speed and gust
- leaf wetness
- solar radiation
- soil temperature



SWMREC Varieties & Tree Development

Red: Skeena/Gi5, NY Elite/Gi5, Glacier/Gi6

Blush: Rainier/Gi5, Early Robin/Gi12

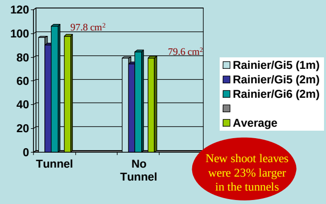
Guards/Pollinizers: Benton (sf), BlackGold (sf), BlushingGold, Cristalina, Lapins (sf), Regina, Sandra Rose (sf), Summit, Tieton, Ulster;

20 advanced selections from Cornell & WSU, plus the sweet/tarts Danube and Jubileum

Table 1. 2006 sweet cherry lateral shoot formation, with and without high tunnel production systems, SWMREC (est. 2005)

Variety	n=	Tunnel	No Tunnel
		2006 Lateral Shoots (#)	
Early Robin / Gi12	36	26.8	22.6
Rainier / Gi5	36	23.7	22.0
Skeena / Gi5	36	24.1	29.6
Average		24.9	24.7
NY Elite / Gi5	21	18.5	19.7
Glacier / Gi6	10	12.3	9.0
Ave w/NY Elite & Glacier		21.1	20.6

Fig. 1. 2006 sweet cherry shoot leaf size, with and without high tunnel production systems, at MSU-CHES



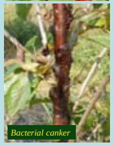
Tunnel Production of Sweet Cherries Can Affect Tree Growth and Leaf Area; Fruit Set, Yield, and Quality; and Incidence of Fruit Cracking, Insect Pests, and Diseases

High tunnel production systems resulted in larger leaves, smaller diameter trunks, and variety-specific effects on lateral shoot formation (Table 1 and Fig. 1). Fruit set at CHES was excellent in 2006; high tunnels reduced fruit set and yield (Table 2), presumably due to reduced honeybee activity. However, average fruit size and market size distributions (Table 3) were outstanding, achieving levels not only uncommon for the Great Lakes but on par with sweet cherry production anywhere in the world. Crop values per acre appear to justify the higher establishment costs for tunnel production systems.

Thus far, high tunnels have provided noticeable reductions of:

- spring frost damage during bloom (2006)
- rain-induced fruit cracking and postharvest diseases (2005)
- red blush development on 'Rainier' (2005-06; not a good effect!)

Moreover, additional advantages have been observed with respect to integrated pest management issues (e.g., Fig. 2) and reduced pesticide inputs, as high tunnel production also reduced:



- cherry leaf spot damage and defoliation (2006)
- Japanese beetle damage and defoliation (2006)
- bacterial canker (2006; preliminary data)
- bird damage to fruit and deer damage to trees

There have been noticeable, though not yet economically important, increases of:

- powdery mildew (2005), aphids & spider mites (2006)

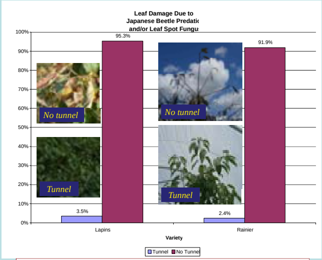


Fig. 2. Sweet cherry new shoot leaf damage due to Japanese beetle and cherry leaf spot, recorded 9 Aug 2006 at MSU-CHES

In 2006, no pesticides were used in the CHES tunnels; there was little to no apparent movement of plum curculio or cherry fruit fly into the tunnels from surrounding infested plots, which were sprayed conventionally.

In 2006, brown rot infections were significant in both the tunnel and no-tunnel plots. Although levels were similar at harvest, it appeared to develop earlier under the tunnels, probably due to higher humidity and temperatures.

Much research remains regarding high tunnel production of sweet cherries - climatic (especially temperature, humidity, and light) analyses; optimization of yields, fruit quality traits, and high density tree architectures; whether IPM strategies can approach organic certification, etc. However, the dramatic results of these preliminary studies have revealed a significant set of potential advantages under Great Lakes growing conditions for growers wishing to target dwarf cherry production for high value premium fresh markets.

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CHES Varieties and Cropping

Red: Lapins/Gi5 and Gi6, Sweetheart/Gi5

Blush: Rainier/Gi5 and Gi6

Planted in 2000, tunnels erected in 2005

Table 2. 2006 'Rainier' sweet cherry yield and fruit size, with and without high tunnel production systems, CHES (est. 2000)

	'Rainier'/Gisela 5		'Rainier'/Gisela 6	
	Covered (tunnel)	Open (no tunnel)	Covered (tunnel)	Open (no tunnel)
Tree Yield				
(kg/tree)	13.7	25.1	10.0	21.8
(lb/tree)	30.1	55.2	22.0	48.0
[1]Orchard Yield				
(mt/ha)	12.2	22.4	8.9	19.4
(ton/acre)	5.4	9.9	4.0	8.6
Fruit Weight				
100 fruit mean (g)	12.5	8.3	12.5	9.3

[1]Tree density is 890 trees/ha (360 trees/acre)

Table 3. 2006 'Rainier' sweet cherry fruit size distribution and crop value with and without high tunnel production systems, CHES (est. 2000)

	'Rainier'/Gisela 5		'Rainier'/Gisela 6	
	Tunnel	No Tunnel	Tunnel	No Tunnel
Fruit Size Distribution (%)				
9-Row & larger	73	3	81	9
9.5 to 10-Row	24	39	17	62
10.5 to 11-Row	3	38	2	25
11.5-Row & smaller	1	20	0	4
[2]Gross Crop Value ($)				
($/acre)	24,500	24,750	18,650	27,250
[3]Net Crop Value (Gross value – Harvest cost)				
($/acre)	19,100	14,850	14,650	18,650

[2]Crop values based on: Export/specialty premium (9-row & larger) $2.50/lb, Domestic premium (9.5 to 10-Row) $1.75/lb, Domestic value (10.5 to 11-Row) $1.00/lb, Processing (11.5-Row & smaller) $0.50/lb

[3]Labor cost to hand-pick based on $0.50/lb

2007 Pollination Options to Improve Fruit Set

- Honeybee hives placed in the tunnel
- A bumblebee hive placed in each (?) tunnel
- Hornfaced bee straws placed in each tunnel

MSU High Tunnel Cherry Production - An Update

Gregory Lang, Tara Valentino, and Bill Shane, Michigan State University

MSU Tree Fruit Research

Visit our website: www.hrt.msu.edu/faculty/langg.htm

Locations

SWMREC (Benton Harbor): Four 24 x 200 ft tunnels

CHES (Clarksville): Three 28 x 159 ft tunnels

Each site included adjacent comparative plots without tunnels

Objectives

- Optimize the climate-tree interface: air and soil temperature, light, water relations, relative humidity, and wind
- Optimize tunnel-constrained tree growth and architecture, fill orchard space rapidly and efficiently
- Produce high yields of large, premium quality fruit
- Reduce fruit defects due to cracking, rots, bird damage, etc.
- Reduce pesticide use and associated application costs
- Manage and harvest trees from the ground, without ladders

SWMREC Tunnels

Trees planted in 2005, tunnels erected in 2005.

Dark Red Cultivars: Skeena/Gi®5, NY Elite/Gi®5, Glacier/Gi®6

Blush Cultivars: Rainier/Gi®5, Early Robin/Gi®12

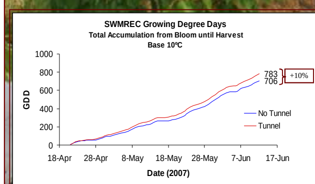
Guards/Pollinators: Benton, Blackgold, Blushing Gold, Cristalina, Lapins, Regina, Sandra Rose, Summit, Tieton, Ulster, as well as 20 advanced selections from Cornell & Washington State University, plus Danube and Jubileum sweet/tart cherries

CHES Tunnels

Trees planted in 2000, tunnels erected in 2005

Dark Red Cultivars: Lapins/Gi®5 and Gi®6, Sweetheart/Gi®6

Blush Cultivars: Rainier/Gi®5 and Gi®6



Effects on the Cherry Production Environment

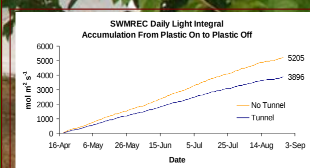
- Soils warmed earlier in the spring under tunnels or in the standard orchard if black polypropylene weed barrier fabric was installed.

- Growing degree accumulation was 10% higher under the tunnels than outside, both during fruit development as well as the entire growing season (graph at left).

-Photosynthetically-active radiation was reduced about 25% under the tunnels (graph at right).

- The Luminance plastic also reduces UV (potential effects on both plants and insects) and infra-red (heat-bearing) light.

- Wind speed was generally reduced by 5 to 10 mph under the tunnels.



Effects on Vegetative Growth (SWMREC)

- In 2006, terminal leader growth under the tunnels was increased by 24%; trunk girth was reduced by ~18%, probably due to reduced exposure to wind.

- In 2007, trunk girth of trees under the tunnels was increased by ~35%, probably due to better tree health (less damage from the April freeze and May leaf spot and bacterial canker infections) and reduced environmental stress.

- Leaf size was increased under the tunnels by 20 to 25%.

- In 2006, neither lateral shoot number nor average shoot length were influenced strongly by tunnels, with results varying by cultivar.

- In 2007, lateral shoot length was clearly greater under the tunnels.

- The reduced wind exposure has not only improved trunk orientation, but also appears to promote more horizontal growth (a light effect?).

-The use of white reflective mulch (Extenday) increased tree growth by 34% under the tunnels and by 24% outside the tunnels, compared to control plots without the white reflective mulch.

Effects on Cropping and Fruit Quality (CHES)

- There was negligible rain-induced fruit cracking in either 2006 or 2007.

- In 2006, yields of Rainier/Gisela®5 and Rainier/Gisela®6 trees under the tunnels were half of those outside the tunnels, presumably due to reduced pollination by honeybees.

- However, fruit sizes were 34% to 50% larger under the tunnels (97% 9.5-Row [28 mm] and larger), making the actual net crop value (fruit value - harvest cost) highest for the Rainier/Gi®5 crop in the tunnel).

- In 2006, fruit blush was reduced under the tunnels due to reduced UV light transmission.

- In 2007, bumblebee hives placed in the center tunnel (see inset in photo below) supplemented the standard honeybee hives placed outside the tunnels. Side-venting of the tunnels was increased to allow more angled sunlight for the white plastic mulch to reflect.

- In 2007, yields were not different between the trees grown under or outside the tunnels, and were equal to the highest yields (about 9 ton/acre) from 2006. The increased yields under the tunnels correspondingly reduced fruit size compared by 10% to 17% to 2006, but tunnel-grown fruit in 2007 were still 5% to 17% larger than fruit grown outside the tunnel.

- Blush development was significantly improved by the better light management (see photo below).

Effects on Tree Health, Insect and Disease Pests

- In both 2006 and 2007, no pesticides were applied to the research trees at CHES.

- In both years, cherry leaf spot infections began in May, causing significant defoliation in the standard trees by late July in 2006 and mid-June in 2007, but none in the tunnels.

- In both years, Japanese beetle feeding led to 50% to 100% defoliation of new shoots on standard trees by August, but feeding was negligible on trees under the tunnels.

- In fall and winter 2006-07, shoot cold hardiness tended to be better in the tunnel-grown trees, probably due to their better leaf health and higher carbohydrate reserves from 2006.

- During the April 2007 freeze, which occurred when the tunnels had yet to be covered, more damage to flowers, leaf spurs, shoot buds, and even trunk cambium (see inset in photo below) occurred on the standard trees compared to the tunnel-grown trees.

- In 2006, the incidence of brown rot was high for all trees (tunnel and standard) grown without fungicides. In 2007, with greater tunnel venting and a switch from under-tree micro-sprinklers to drip irrigation to reduce relative humidity under the tunnels, there was less brown rot on fruit from tunnel-grown trees.

- Black cherry aphids and spider mites were present at higher levels on tunnel-grown trees and will require an integrated pest management strategy for adequate control.