



## *Getting Started With High Tunnels*

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# www.hightunnels.org



HighTunnels.org

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## MARKETING & ECONOMICS:

Return on Investment | Economic Impacts | Wholesale Production

### Events and Happenings

- **Tomato Nutrition in High Tunnels Webinar:**  
03/15/2015, .
- [View All Events and Happenings](#)

Do you know of any conferences or seminars featuring

### Featured:

→ [Moving the Needle, Accomplishments of the National Strawberry Sustainability Initiative 2013-2014](#)

→ [Cool Season Vegetables](#)

### Join the [hightunnels] listserv:

The [hightunnels] listserv comprises over 850 members, most of which are growers using high

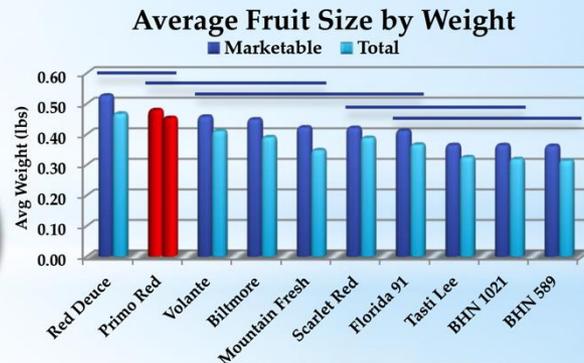
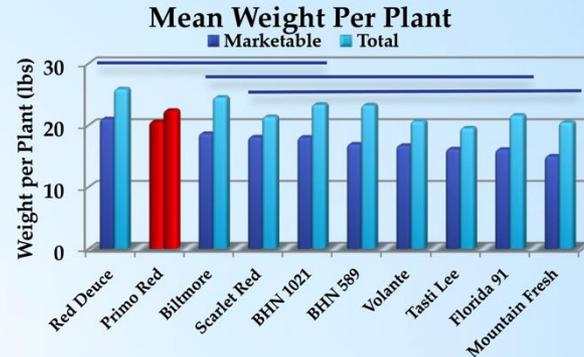
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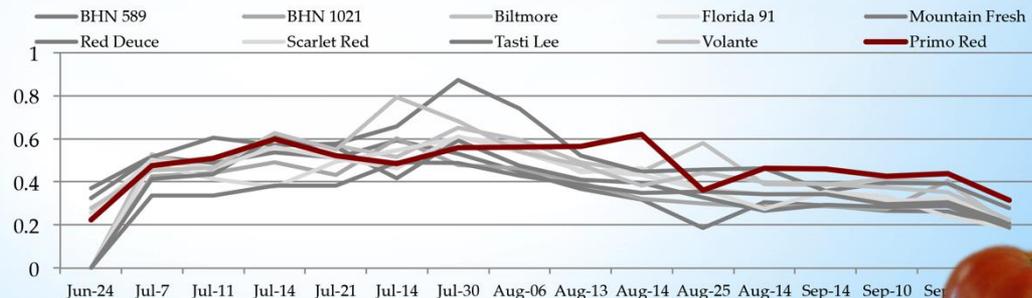
tunnels. The listserv is a great place to learn what growers are doing with high tunnels, what crops and

# High Tunnel Resources

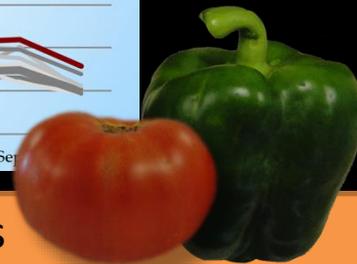
## PRIMO RED



### Average Fruit Size by Weight: Harvest Date



**DAYS: 65**  
**FRUIT SIZE: 8.5oz.**  
**PLANT TYPE/HEIGHT:**  
**Compact**  
**VIGOR: 3 out of 5**





**Microclimate Modification**

# High Tunnels



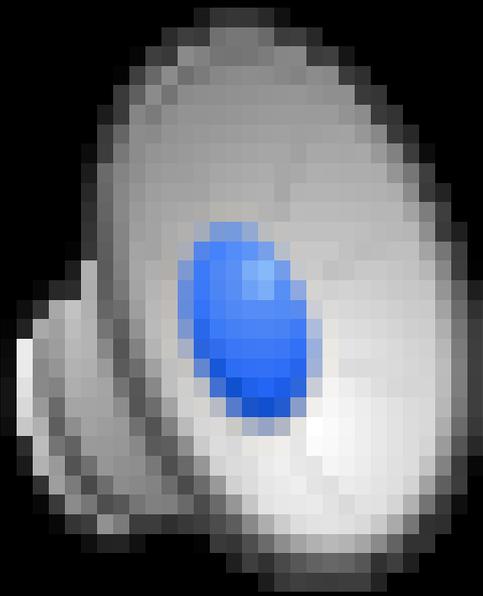
- All shapes and sizes
  - Three or four seasons
- Climate Control
  - Season Extension
  - Use of low tunnels, etc.
  - Protection
- Reduced Foliar Disease
- Access to new market windows
- Production stability

Photo courtesy: S. O'Connell (NCSU)



**Incredible growth of warm and cool season crops**







# Why High Tunnels?

## Environmental Protection



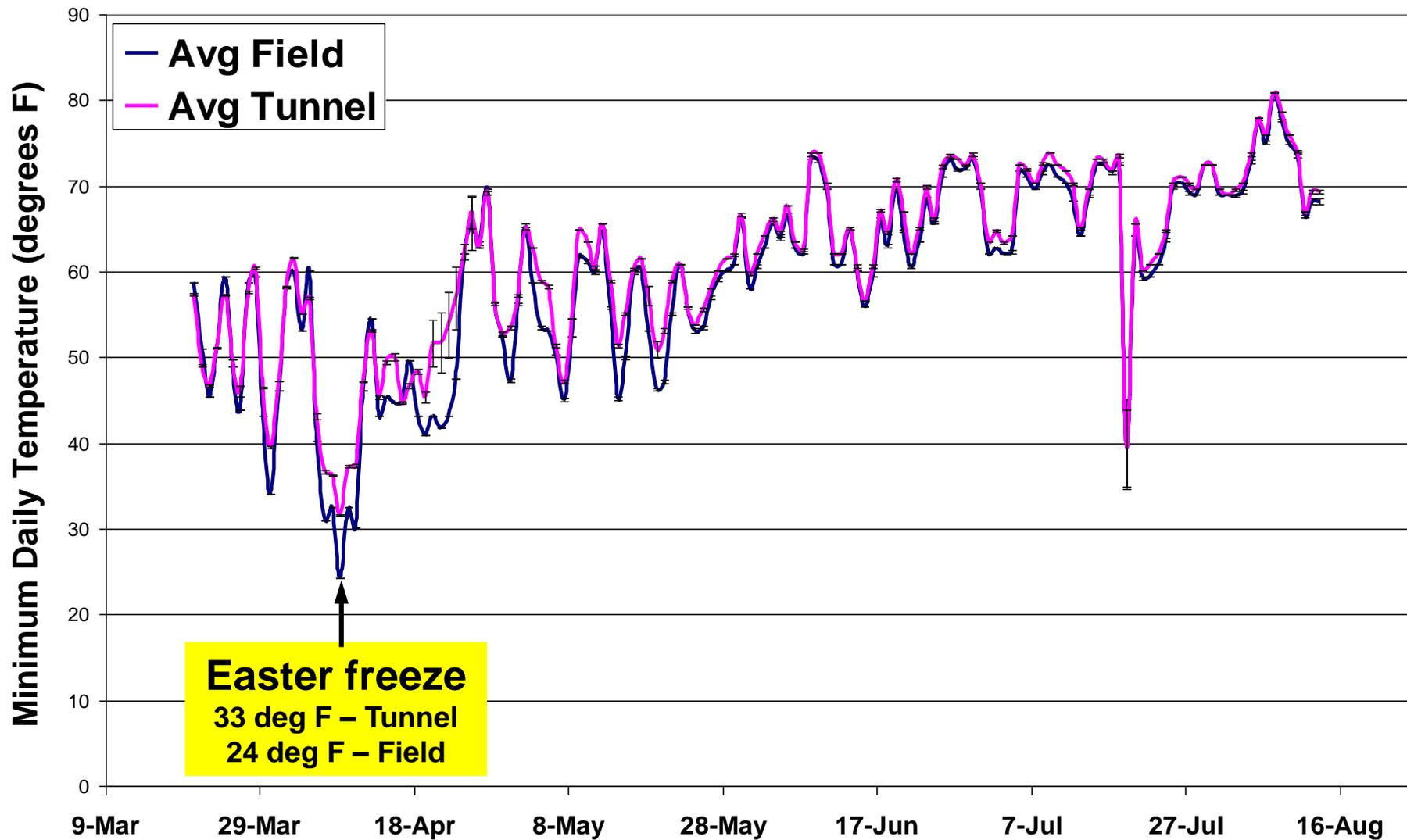
- Early/late frosts
- WIND
- Thermal Stress
- Storms
- Heat ??

# Frost Protection

Protecting crops from early/late frosts



# Minimum Temperature - CEFS 2007



# Overnight Lows (°F)

Outside: 39

No Cover: 49

Cover Only: 56

Cover and hoops: 53



# Wind Protection



# Storm Protection



Hail damage on lettuce



Perfect  
Mango

Midnight  
Blue

# Protection from Heat

## High Tunnels *CAN* be cooler than the field

- Ventilation
- Plastic type
  - UV/IR blocking
- Shade cloth
  - 30% is recommended
  - Timing
  - Structural ??





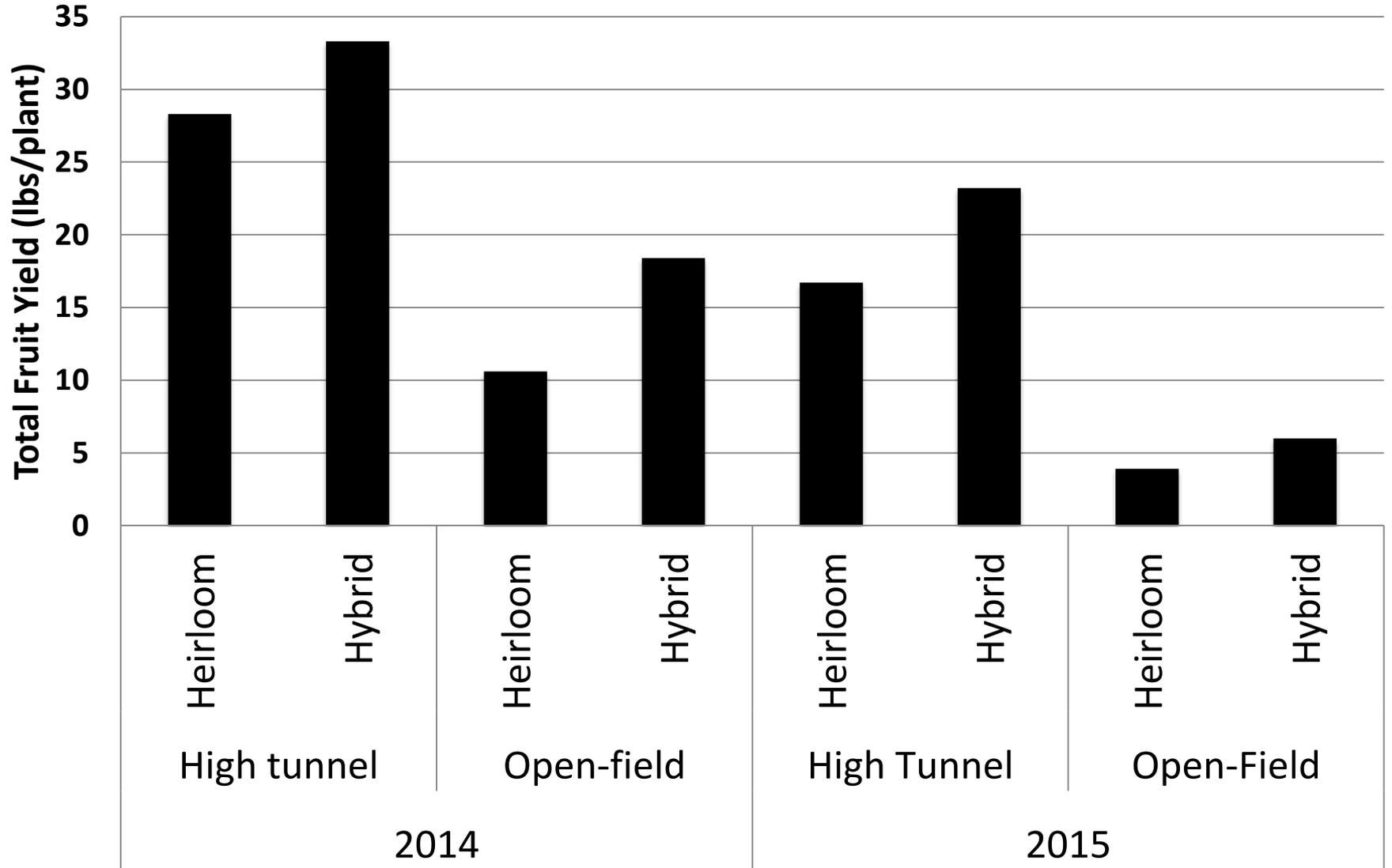
# Protection from Heat

## High Tunnels = Early Planting Date

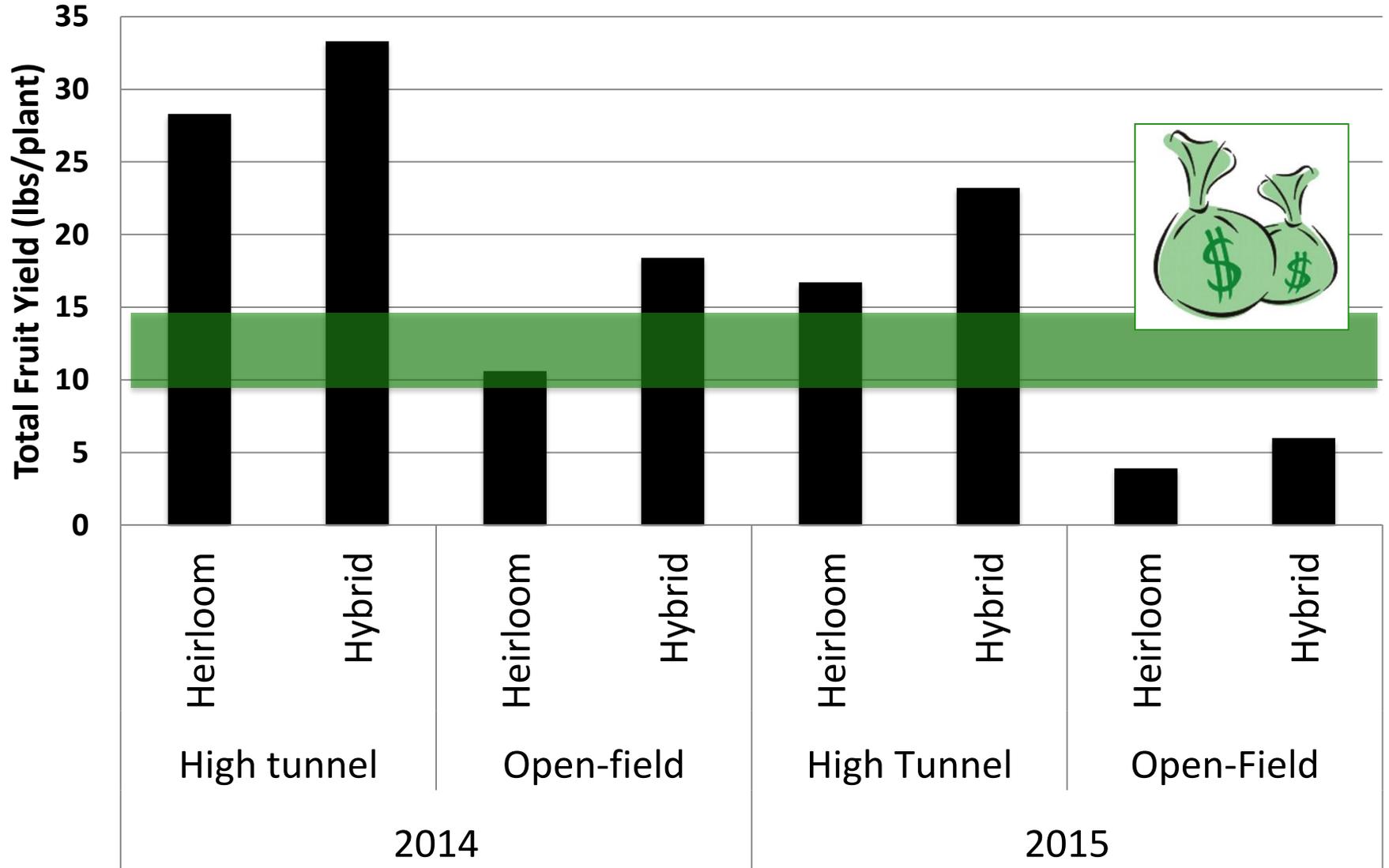
- Fruit set before heat
- Plant is established
  - Root system
  - Foliage – fruit shading
- Planting Preference
  - Scheduling
  - Varieties
  - Transplant quality



# 2014-15 AFRI Food Security Project



# 2014-15 AFRI Food Security Project



# Protection from Heat

## Shade Cloth

- New area of research
- Few recommendations
- White vs. Black vs. Metal
  - Depends on the goal
- Disadvantages:
  - Crop growth
  - Cost





# Fruit Quality



VS



# Poly Covering

## Plastic Types



- Clear vs. UV/IR blocking
- Single vs. double layer
- Light Diffusion
  - Luminance brand
- “Woven” plastics
- Colored plastics ??
  - No data yet

# Management

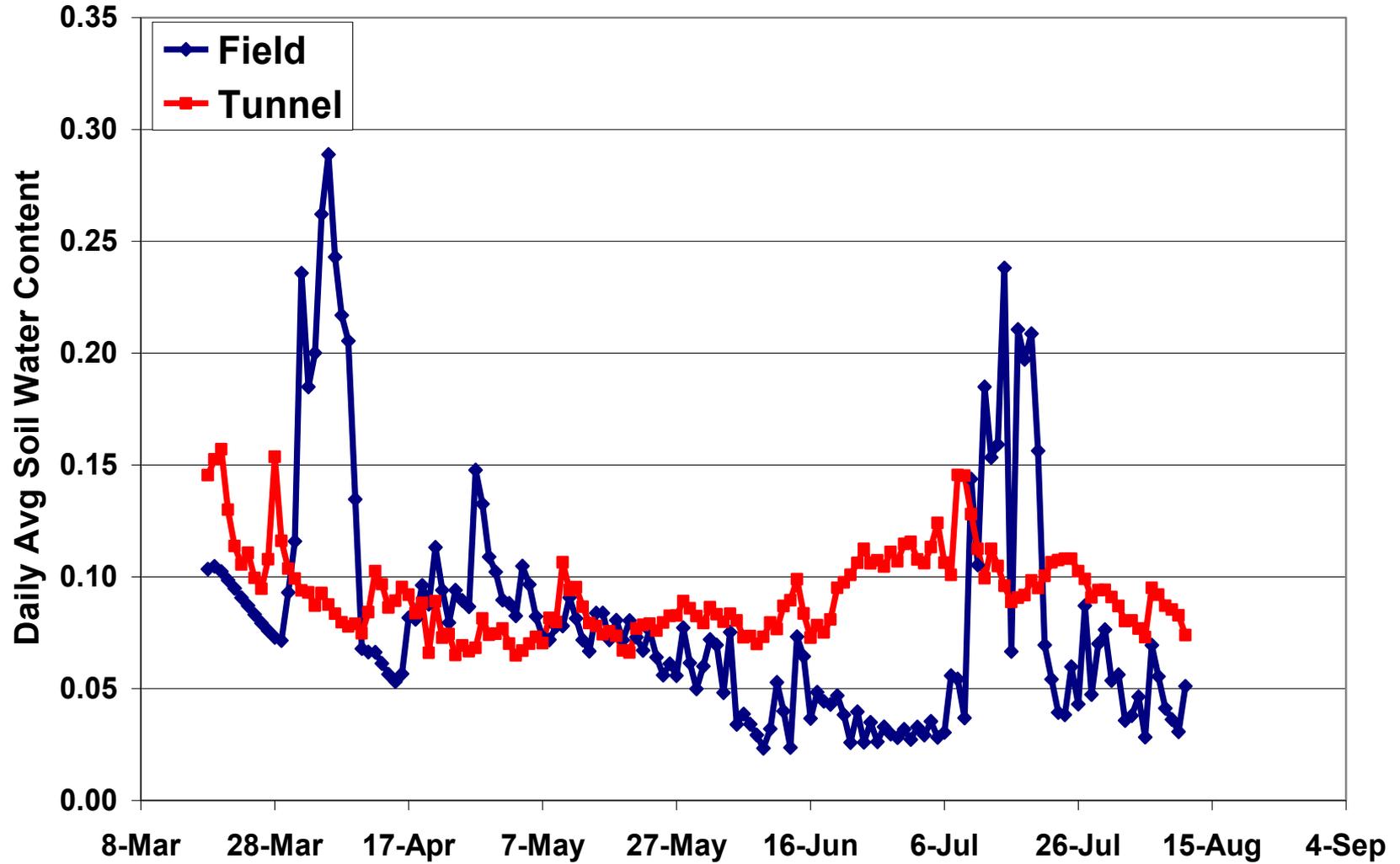
## Managing the High Tunnel

- Maintain good soil quality
- Irrigation
  - No rain in the tunnels
  - Overhead irrigation ?
  - Fertilizer injector when possible
- Nutrient management
  - Similar to field
  - Be careful of soil salt build-up
  - Always use compost wisely

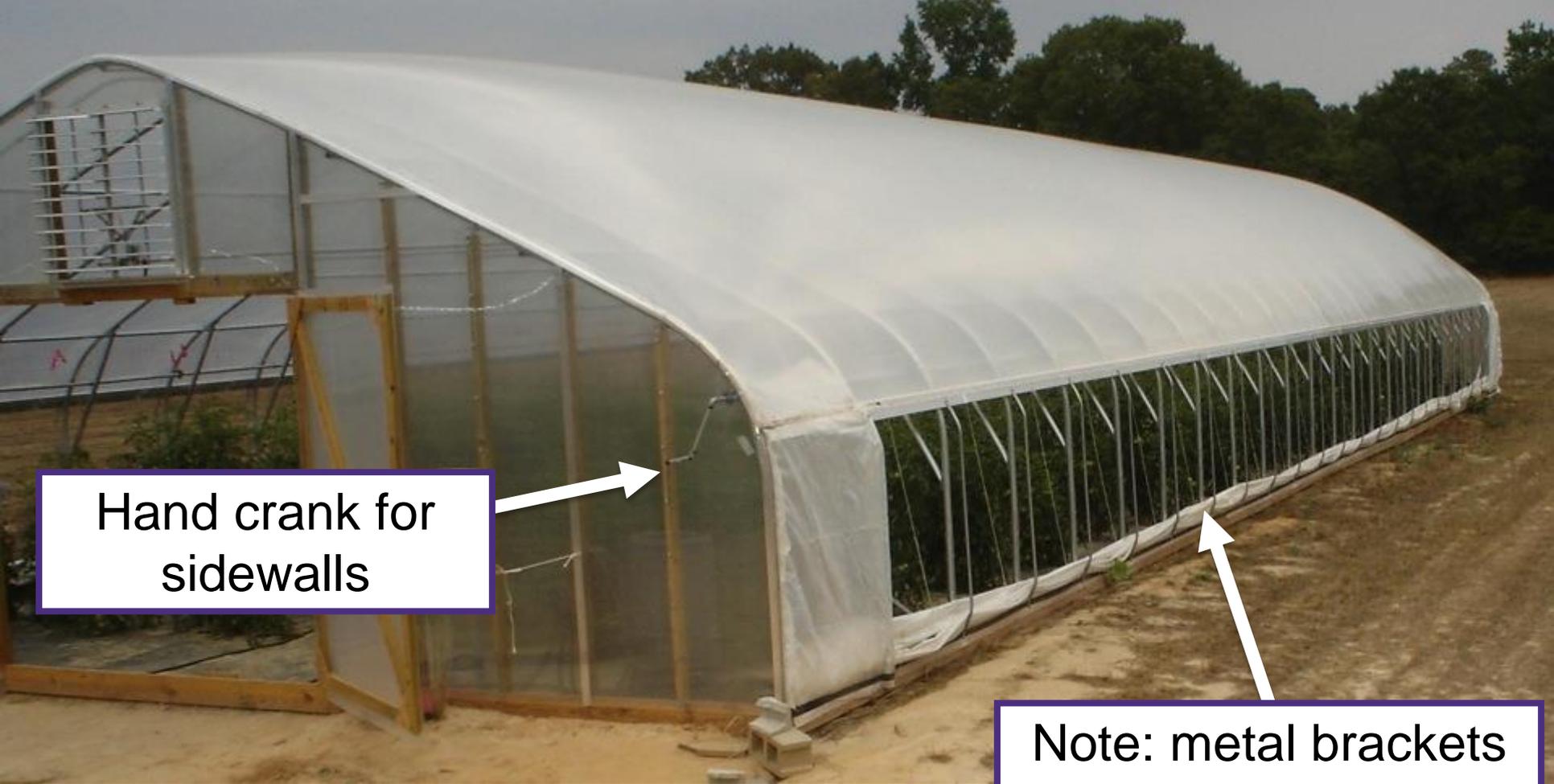




# Soil Moisture - CEFS 2008



Daily average soil moisture fluxuations



Hand crank for  
sidewalls

Note: metal brackets  
to hold sidewall

- **Manage/Ventilate sidewalls**
  - Summer Crops – close when nights are  $<55^{\circ}\text{F}$
  - Winter Crops – Varies with crop/climate
  - Automated sidewall curtains

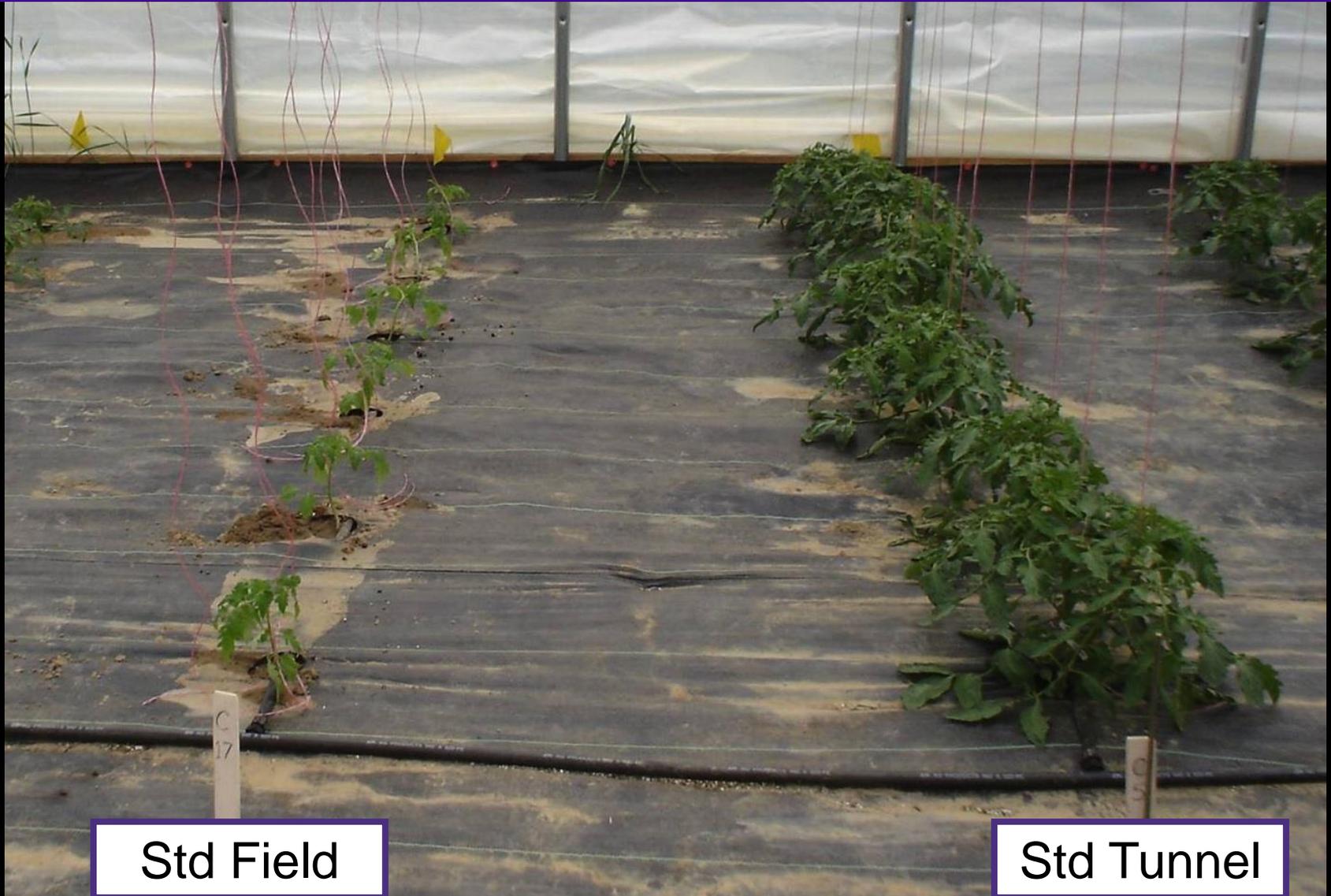
# Ventilation

## Need to Protect, but Allow Ventilation

- Sidewall height
- Obstructions (6x Rule)
- Orientation of tunnel



# Planting Date



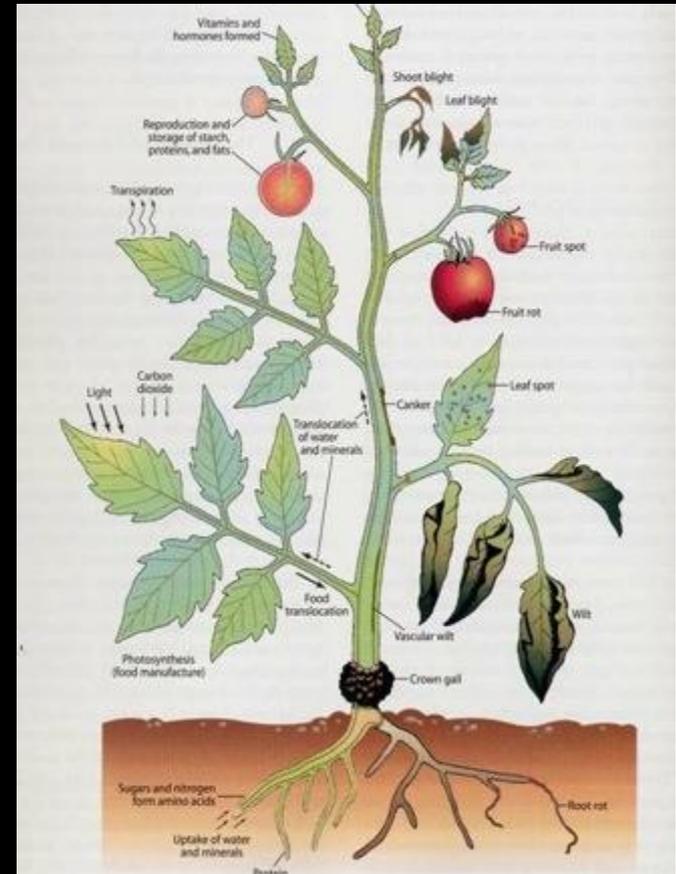
Std Field

Std Tunnel

# Management

## Disease Management in High Tunnels

- Reduced foliar disease
  - Leaf wetness
- Foliar diseases in tunnels
  - Powdery mildews
  - Botrytis
  - Viruses
- Reduced crop rotation
  - Soilborne pathogens
  - Moveable tunnels



From: G.N. Agrios. 2005. Plant Pathology. 5th edition. Elsevier AP.

# Management

**Soil almost never freezes under  
row cover in tunnels**



**Outside**



**Inside**





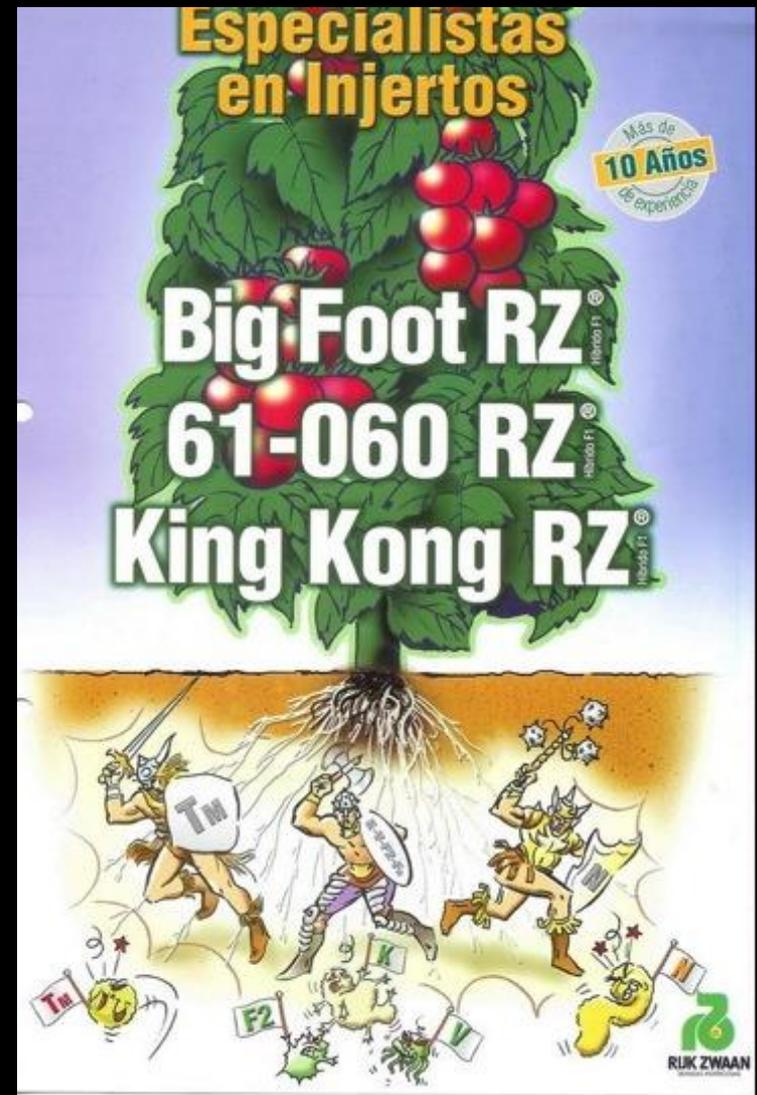
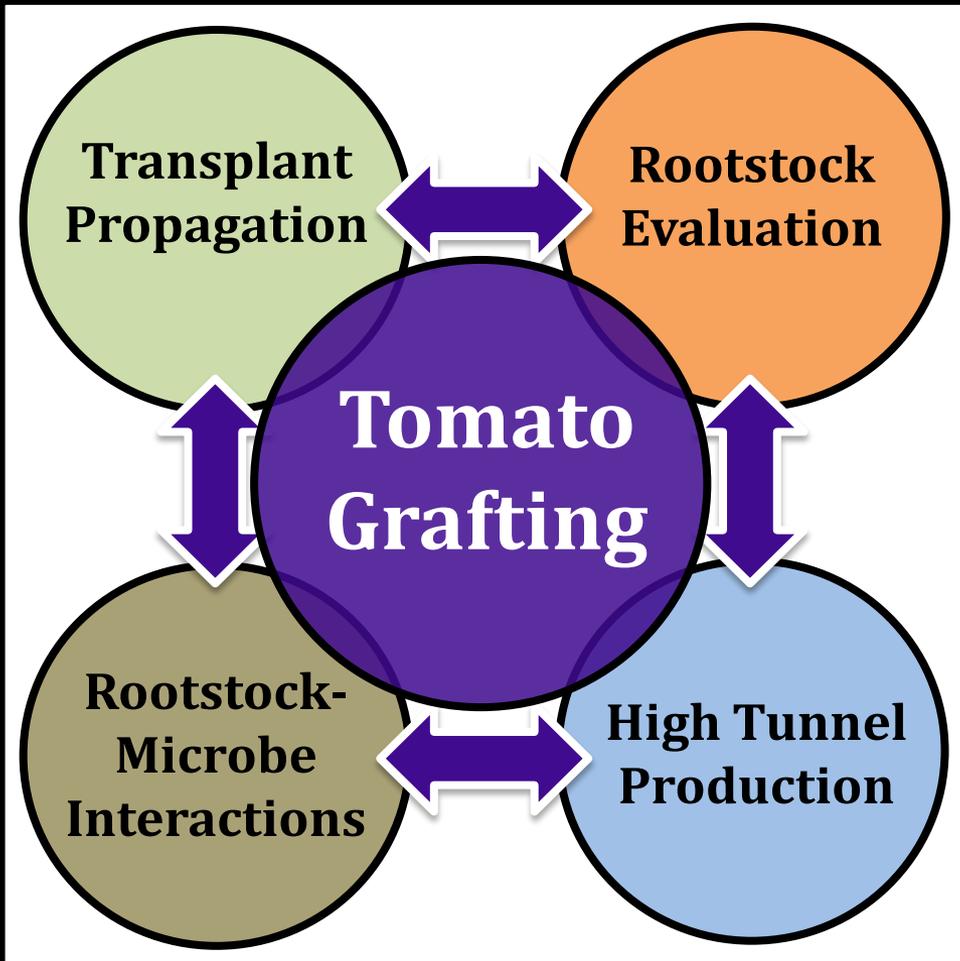
**Verticillium wilt - Tomato**





**Early Tomato Production**

# Diversifying with Rootstocks



# Integrated Pest Management

**OMRI-approved Fung. & Pest.**

**Biological control**

**Sanitation**

**Cultural control**

**Environmental control**

**Genetic resistance**

**Crop Selection**

**Growing system**

**Site Selection**

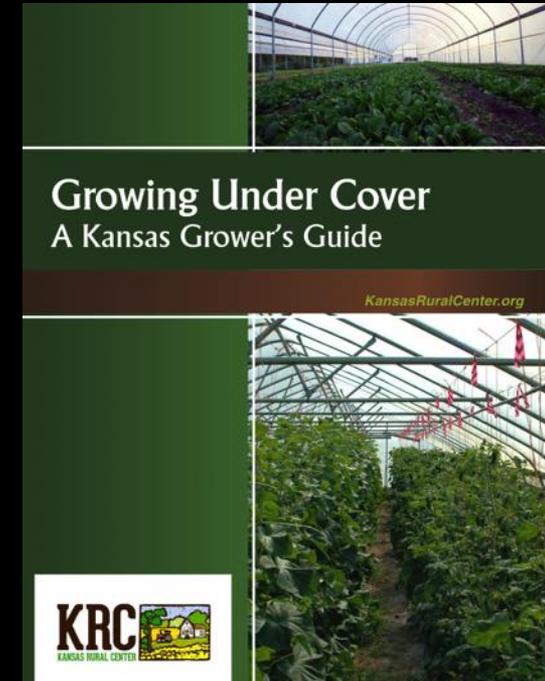
**Knowledge/Experience**



# Crop Rotation in HTs

## The Challenge: Generating Per SqFt Revenue

Crop Type	Production Window	Sale Price	Gross Revenue/ft <sup>2</sup>	HT Crop
Tomato	Apr – Oct	\$2.50/lb	\$3.66	1
Lettuce	Sept – May	\$2.00/head	\$1.30	2
Spinach	Sept – May	45.50/lb	\$1.09	3
Cucumber	Apr – Aug	\$1.50/lb	\$1.62	4
Bell Pepper	Apr – Oct	\$1.50/lb	\$2.30	5
Salad Mix	Sept – May	\$8.00/lb	\$2.40	6
Beets	Sept – May	\$2.00/lb	\$1.92	



- \$0.44/ft<sup>2</sup>/year fixed costs for structure (KRC, 2017)
- \$0.49/ft<sup>2</sup>/year fixed costs for structure (NCSU, 2013)
  - 2 years of tomato production (\$2.60/lb) paid for structure  
*(Sydorovych et. al., 2013)*



Crop Rotation at Peregrine Farm (Graham, NC)



Mobile High Tunnels

# Scouting For Pests

- Weekly (at least)
- Economic thresholds
  - UCD IPM Guide
- Beneficials



# OMRI-Approved Pesticides

## Caterpillars and Worms

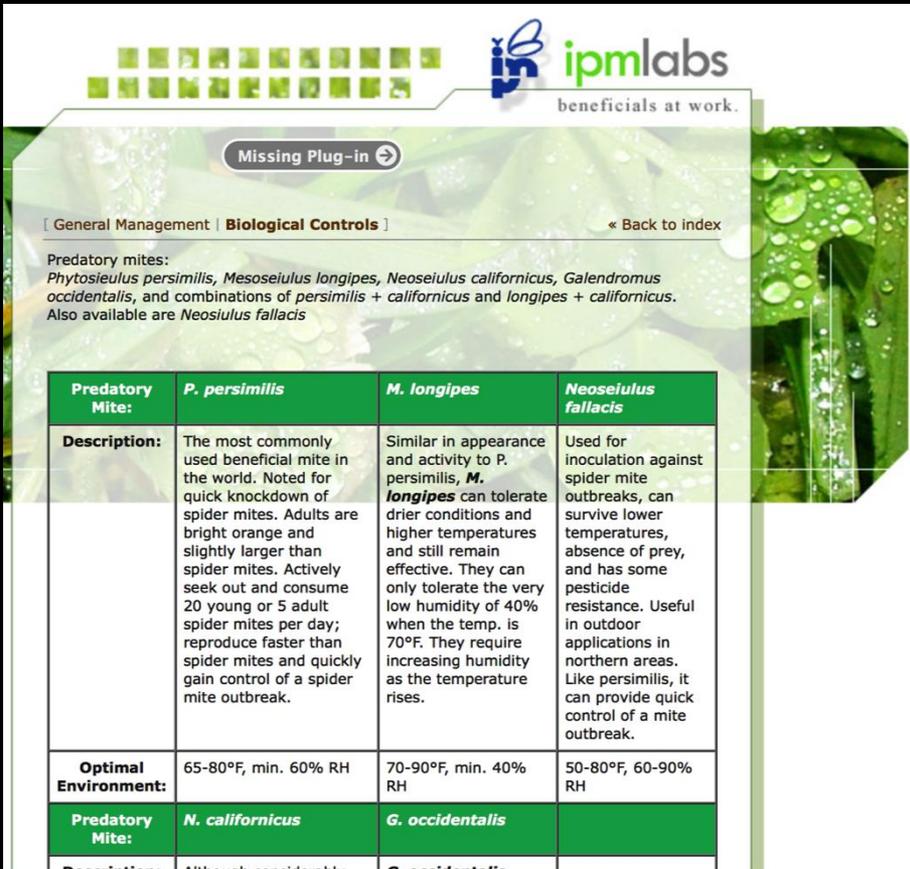
- Particularly sensitive
  - Ingest and contact
- Bt toxin
  - Dipel vs. Xentari
- Spinosad (Entrust)
- Azadirachtin
- Pyrethrins (Pyganic)





# Biological Control

## Using Beneficial Insects



ipmlabs  
beneficials at work.

Missing Plug-in

[ General Management | **Biological Controls** ] « Back to index

Predatory mites:  
*Phytoseiulus persimilis*, *Mesoseiulus longipes*, *Neoseiulus californicus*, *Galendromus occidentalis*, and combinations of *persimilis* + *californicus* and *longipes* + *californicus*.  
Also available are *Neoseiulus fallacis*

Predatory Mite:	<i>P. persimilis</i>	<i>M. longipes</i>	<i>Neoseiulus fallacis</i>
<b>Description:</b>	The most commonly used beneficial mite in the world. Noted for quick knockdown of spider mites. Adults are bright orange and slightly larger than spider mites. Actively seek out and consume 20 young or 5 adult spider mites per day; reproduce faster than spider mites and quickly gain control of a spider mite outbreak.	Similar in appearance and activity to <i>P. persimilis</i> , <i>M. longipes</i> can tolerate drier conditions and higher temperatures and still remain effective. They can only tolerate the very low humidity of 40% when the temp. is 70°F. They require increasing humidity as the temperature rises.	Used for inoculation against spider mite outbreaks, can survive lower temperatures, absence of prey, and has some pesticide resistance. Useful in outdoor applications in northern areas. Like <i>persimilis</i> , it can provide quick control of a mite outbreak.
<b>Optimal Environment:</b>	65-80°F, min. 60% RH	70-90°F, min. 40% RH	50-80°F, 60-90% RH
<b>Predatory Mite:</b>	<i>N. californicus</i>	<i>G. occidentalis</i>	

IPM Laboratories (New York)

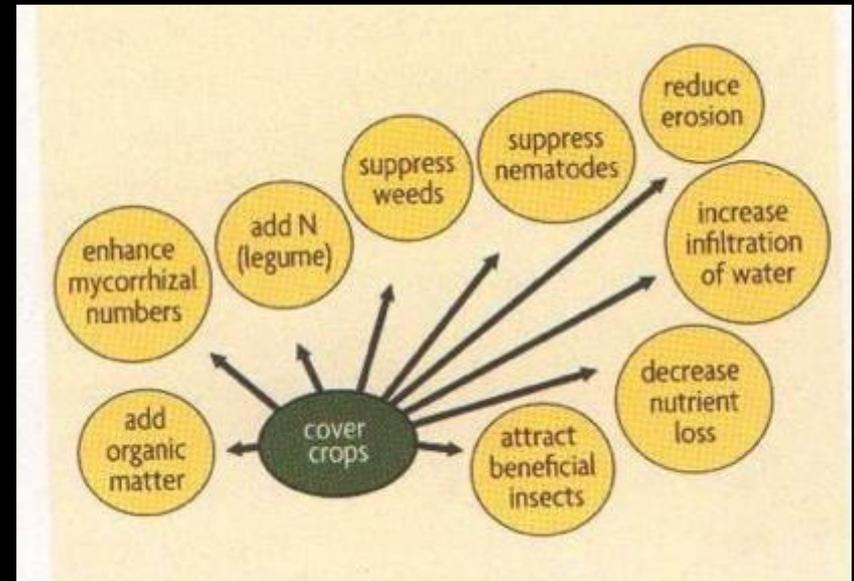
- A few companies
- Greenhouse industry
- Numerous species
  - Predators, parasites, and parasitoids
- Applying pesticides
- Handling
  - Keep cool and act fast
  - Pesticide sprays



# Management

## Cover Crops

- Also known as “green manures”, cover crops are extremely important for soil health
  - Organic matter
  - Soil microbial health
- Suppress Weeds
- Add / Recover nitrogen
  - Highly-leachable  $\text{NO}_3$
  - Legume cover crops fix N
- Can be used as mulch
  - No-till or strip-tillage
- Can reduce excess nutrients (P)
- Reduce soil erosion







**Beneficial habitat planted around the tunnel**

# What About Cover Crops?

- OREI Regional Grant
  - UMN, UKY
  - Ashlee Skinner (MS)
- Comparing benefits of CC vs. spinach
  - Economic vs soil-building
- Identifying crops for HT production
  - “Short windows”
  - Summer, fall, over-winter





# Putting the Pieces Together

## A few scenarios for planning your high tunnel

Yr 1	Greens	Grafted Tomatoes	Cover	
Yr 2	Cover	Cucurbits/Melons	Cover	Greens
Yr 3	Greens	Strawberries	Greens	
Yr 4	Greens	Peppers	Cover	
Yr 5	Cover	Brassicas	Cover	Greens
Yr 6	Greens	Sweetpotato Slips	Cover	Greens
	January			December



# Putting the Pieces Together

Think About Revenue in the Long Term

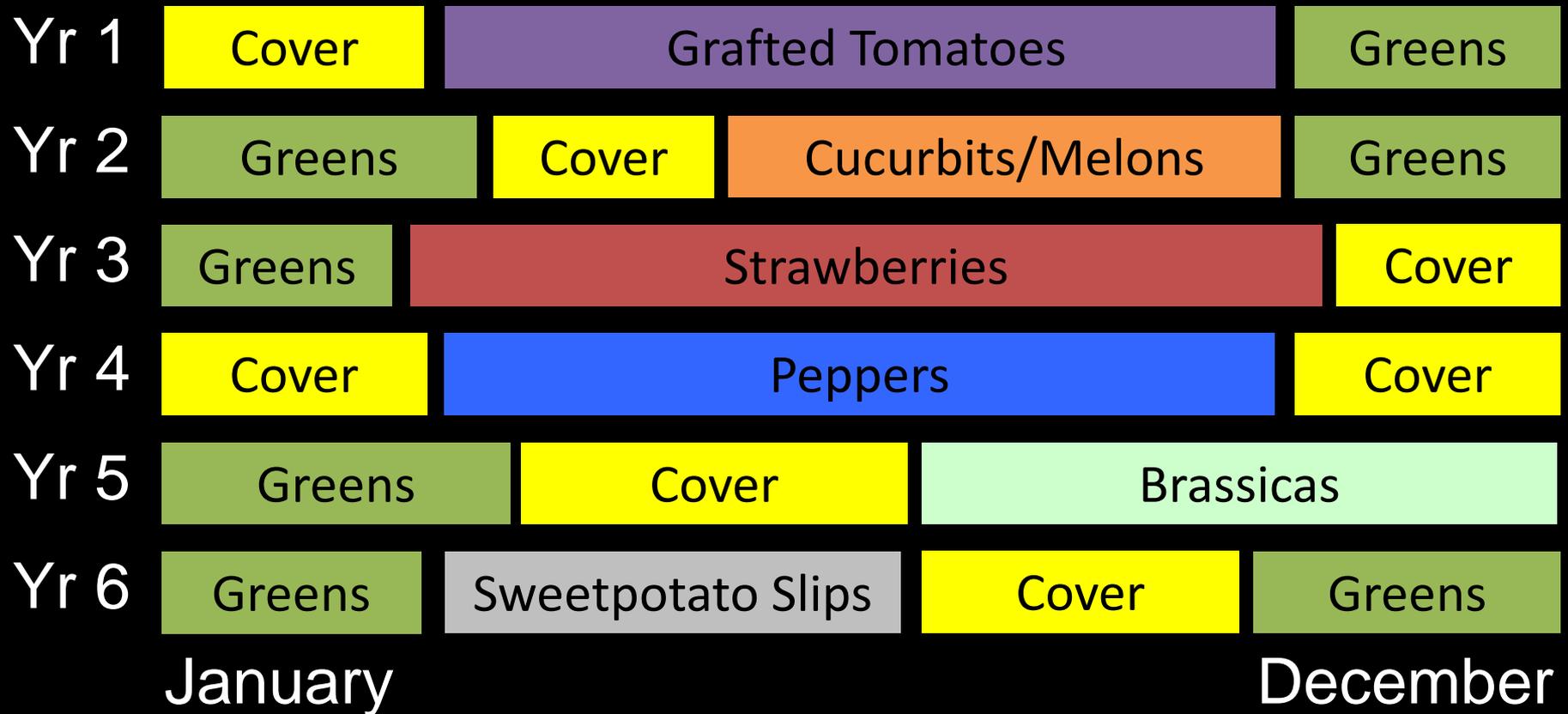
Yr 1	\$1.09	\$3.66	Cover
Yr 2	Cover	\$1.20	Cover
Yr 3	\$1.09	\$1.76+	\$1.92
Yr 4	\$1.30	\$2.17	Cover
Yr 5	Cover	\$1.25	Cover
Yr 6	\$0.55	\$4.30	Cover

January December

**Average Annual GROSS Rev = \$4.09 per ft<sup>2</sup>**  
**Overhead (structure) Costs = 11%**

# Putting the Pieces Together

Think About the Timing – Pest Cycles, Labor, etc.



# Summary

## Using High Tunnels for Vegetable Production

- MAXIMIZE the benefit of the tunnel
- Manage soil moisture and humidity in the tunnel
- Variety selection -> Market niche
- Be generous on fertility
  - Potassium (K) is mega-important (tomatoes)
  - Tissue analysis is worth the time
- Watch for worms and be proactive at managing pests.
- SANITATION, SANITATION, SANITATION

# QUESTIONS??

