

HIGH TUNNEL PRODUCTION AND MANAGEMENT

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What is a high tunnel?

- Frame structure with plastic covering
- Unheated
 - Portable heaters are sometimes used
- Passive Ventilation
 - Roll up sides, end walls, vents
- Single layer of plastic vs double layer
- Multiple styles and sizes
- Other terms: hoop houses, low tunnels, cold frames



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High Tunnels





http://www.nrcs.usda.gov/wps/portal/nrcs/detail/nm/programs/financial/equip/?cid=nrcs144p2_068639



Benefits to high tunnel production

- Season Extension
 - Early spring, late fall, and winter production
- Lower input cost as compared to greenhouses
- Clean fruit/plants
- Protected from elements
- Reduced disease pressure
- Controlled growing environment

Drawbacks to high tunnel production

- Pollinator Exclusion
- Temperature Extremes
- Summer Heat
- Humidity
- Soil Health
- Maintenance Inputs

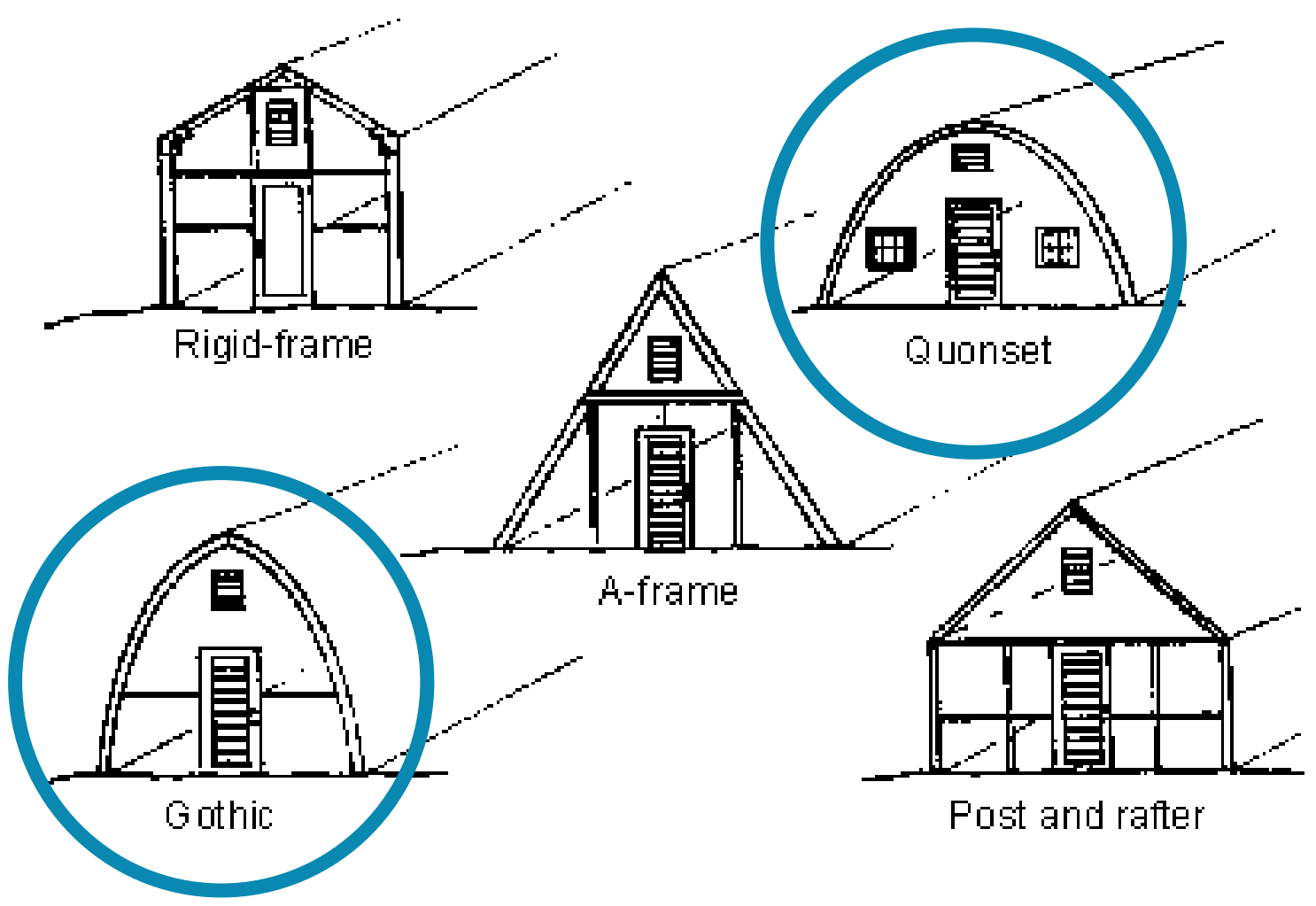


Timothy Coolong, University of Kentucky

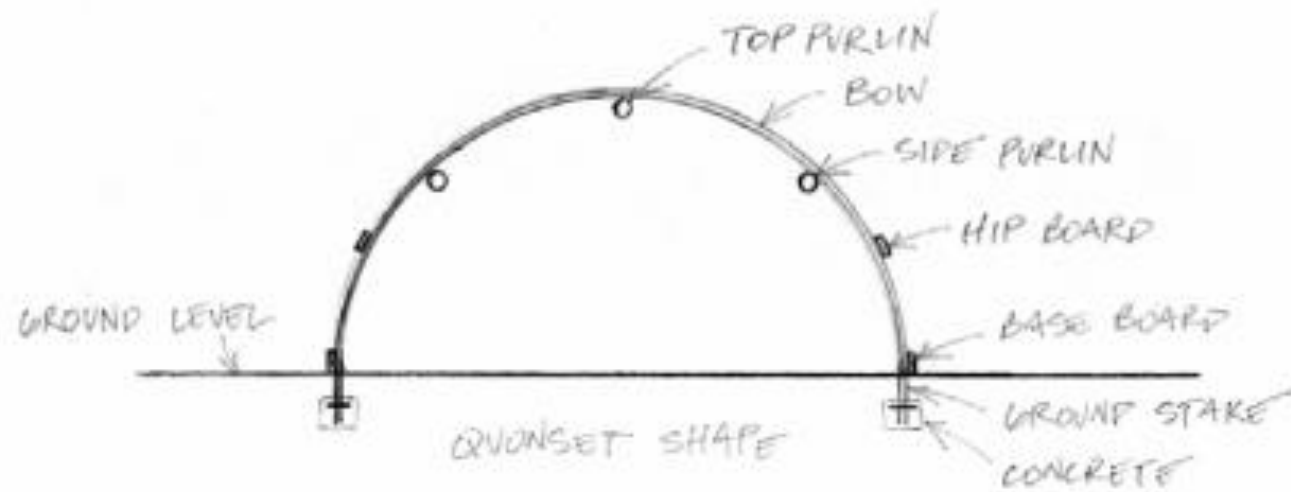
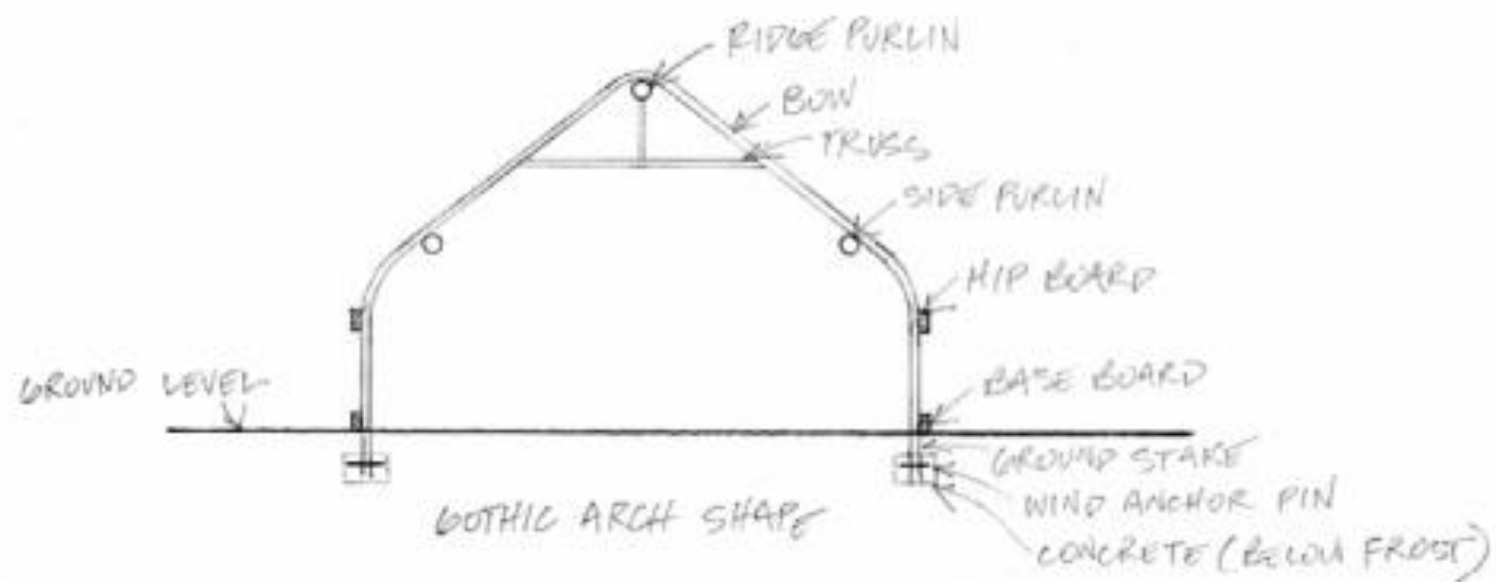
CONSTRUCTION & ORIENTATION

Functionality

- Treated wood, un-treated wood, metal bottom bracing
- How deep are the side posts buried?
- Side wall height: 5ft or greater side wall height is best
- V vs W bracing
- Solid end walls vs soft end walls
- Doors
- Vents
- Shade cloth



<https://ag.purdue.edu/extension/smallfarms/Pages/High-Tunnels.aspx>



6 ft. Arch Spacing



Standard High tunnel (6' sidewall height)

30'x48'	\$3,107
30'x60'	\$3,683
30'x72'	\$4,195
30'x96'	\$5,381
30'x120'	\$6,408



Peak Height-14 ft Height to cross-brace-11 ft

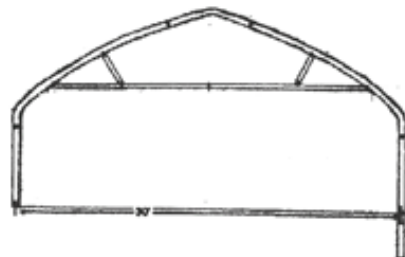
5ft. Arch Spacing



30'x50'	\$3,554
30'x60'	\$4,070
30'x70'	\$4,577
30'x95'	\$5,981
30'x120'	\$7,218

V-Truss High tunnel (6' sidewall height)

30'x48'	\$3,345
30'x60'	\$3,997
30'x72'	\$4,575
30'x96'	\$5,928
30'x120'	\$7,071

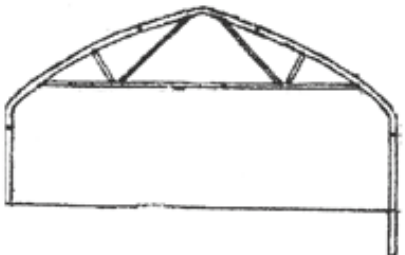


Peak Height-14 ft Height to truss-8.5 ft

30'x50'	\$3,828
30'x60'	\$4,384
30'x70'	\$5,051
30'x95'	\$6,608
30'x120'	\$8,000

W-Truss High tunnel (6' sidewall height)

30'x48'	\$3,500
30'x60'	\$4,195
30'x72'	\$4,852
30'x96'	\$6,255
30'x120'	\$7,577



Peak height-14 ft Height to truss-8.5 ft

30'x50'	\$4,027
30'x60'	\$4,700
30'x70'	\$5,332
30'x95'	\$6,999
30'x120'	\$8,497

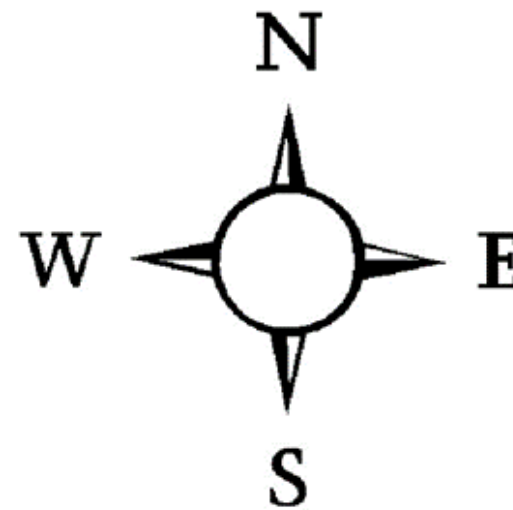
2-3/8" diameter side-poles (13 gauge steel) are set in ground 32 inches

Zimmermans High Tunnels

http://www.zimmermanshightunnels.com/main/page_pricing_high_tunnel_pricing.html

Orientation and Geography

- We are south of 40° Latitude so orient the ridgeline of your tunnel North to South
- Shading
- Wind
- High vs Low Land
- Access to water



MICROCLIMATE CONSIDERATIONS

Microclimate

- Microclimate is a culmination of weather data specific to an area
- You have a specific microclimate on your farm that may be different from County data
- Your high tunnel will have it's own microclimate as well
- This is important because:
 - Plant have specific growing requirements that directly correlate with microclimate factors
 - Frost dates are really important
 - Growing Degree Day (GDD) accumulation
 - Optimal growing conditions

USDA Plant Hardiness Zone Map

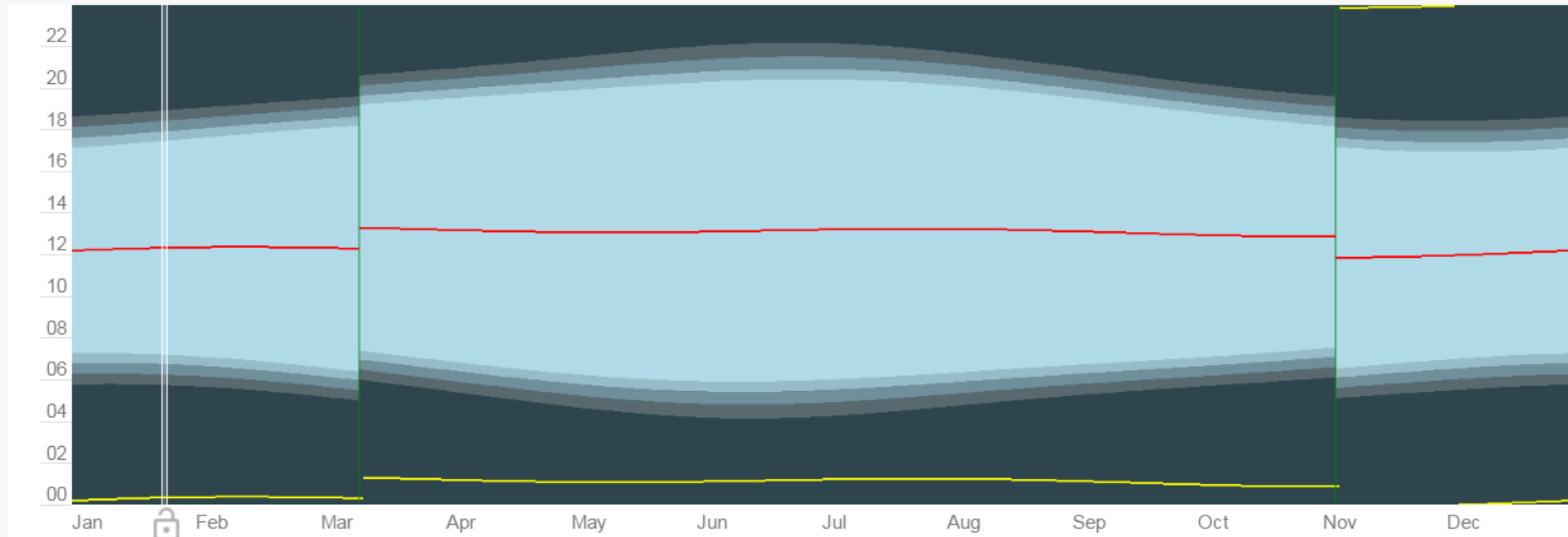
North Carolina



Yearly Sun Graph for Jacksonville

Rise/Set Times

Day/Night Length



Exceed 10 hours daylight around January 10

Drop under 10 hours daylight around December 1

Get To Know Your Tunnel

- Every high tunnel is going to be a little bit different
 - How big is your tunnel?
 - How many layers of plastic?
 - Are you using row covers?
 - How do you irrigate?
- Every area/farm has a unique climate
 - What is your USDA Hardiness Zone?
 - Is wind an issue?
 - How much sun/shade does your tunnel receive and when?
- These factors (+ your management practices) create your high tunnel microclimate!



High/Low thermometers range from \$10 to hundreds of dollars. This digital one cost \$25. It provides relative humidity as well!



Soil temperature probes are helpful since many plants root systems are sensitive to cold soils. This is a very basic one, great and only \$9.

HIGH TUNNEL MANAGEMENT

Key management practices

- Variety Selection
- Early/Late Season Production
- Row Covers
- Shade Cloth
- Pruning
- Crop Rotation
- Cover Crops
- Irrigation
- Trellising
- Temperature Management



Variety selection

Cool Season

- Spring
 - Bolt resistant varieties
- Summer
 - Heat loving varieties
- Fall
 - Cold loving varieties
- Winter
 - Day neutral OR extend the harvest with cold loving varieties

Warm Season

- Spring
 - Indeterminate tomatoes
 - Early producers
- Summer
 - Usually carrying through spring plantings
- Fall
 - Determinate tomatoes
 - High disease resistance varieties

What about transplants?

- This is a particular challenge for high tunnel production
 - Not readily available for season extension plantings
 - Specific varieties are not available
- Grow you own
 - Need a growing environment like a green house or grow room
 - Time and materials
- Buy
 - Order from transplant suppliers
 - Banner Greenhouses in Nebo NC
 - Sprout in Barnwell, SC

<https://www.carolinafarmstewards.org/successful-transplant-production/>

Types of Season Extension

- Early Season Production (Spring)
 - Centered around frost protection and increased Growing Degree Days (GDD)
 - Shorter harvest period for cool season crops and longer harvest period for warm season crops
- Late Season Production (Fall)
 - More difficult to determine planting dates
 - Longer harvest period for cool season crops and shorter harvest period for warm season crops
- Out of Season Production
 - Mainly seen in greenhouses

How can season extension diversify your farming operations?

- Earlier and later harvest of crops you already grow
- Adding a new crop
- Year round harvests for the market

- Have you ever heard anyone say “High tunnels are my crop insurance”?
 - Crop protection
 - Controlled growing environments

Medium Weight Row Cover

- Thick fabric
- High light penetration (70%)
- Good frost protection
- Overwintering

- Avoid soggy row covers by mulching aisle ways



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Shade Cloth

- Used on:
 - Green houses
 - High tunnels
 - Low tunnels
- Inhibits light penetration
- Lessens greenhouse effect in tunnels
- Different weights available



<http://www.johnnyseeds.com/p-8450-knitted-shade-cloth-50-shade-10-x-100.aspx>

Pruning and culling

- Increases ventilation
- Reduces disease
 - Reduces spread of disease
- Reduces pest pressure
- Easier harvesting
- Healthier plants!



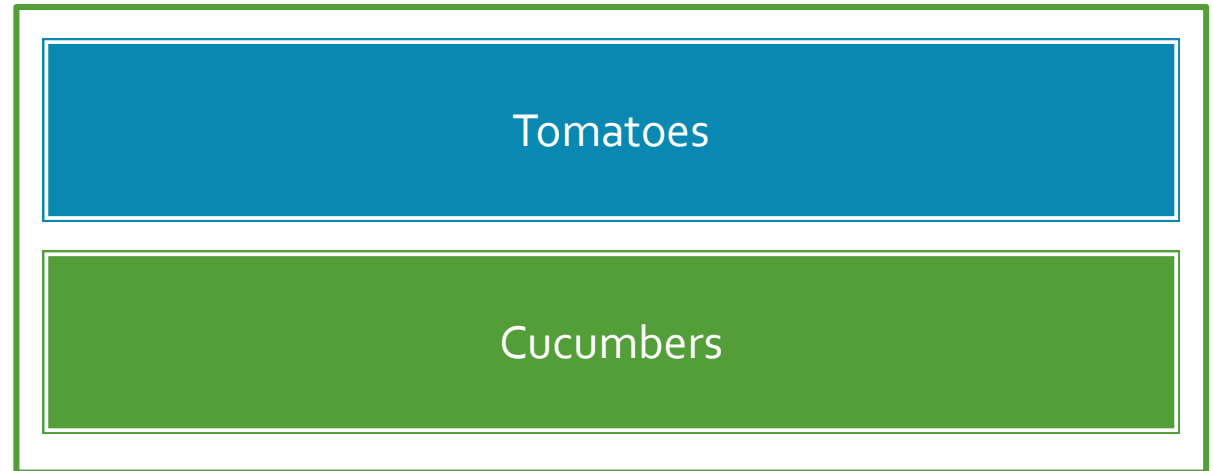
Pruning Guidelines

- Depends on species, variety, and trellising method
- Sucker to one or two leaders
 - A leader is a main stem. Suckers are typically found where leaves extend from main stems. Prune off the suckers, leaving the main stem(s) intact.
- Prune bottom leaves
- Prune out damaged foliage and fruit
- Prune out disease and infestation areas
- Always prune close to the main stem
- Remember to disinfect, especially if you detect any abnormalities in plants!!

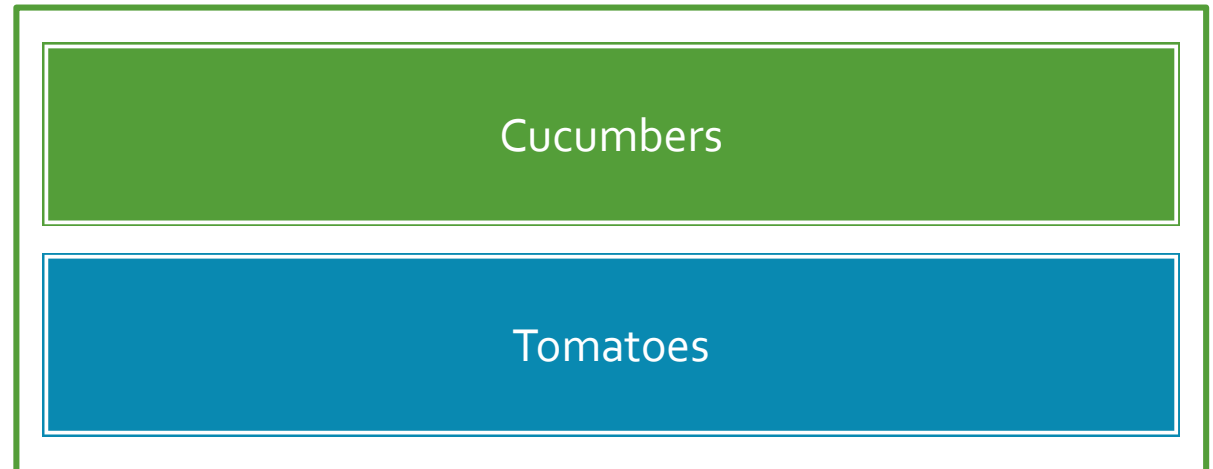
Crop Rotation

- Why?
 - Soil health
 - Disease
- Monoculture
 - Whole tunnel rotation
 - Tomato and lettuce
- Section or row crop rotation
 - Integrate as possible
- Example: Rotating Nightshades and Cucurbits

Year One



Year Two



Cover Crops

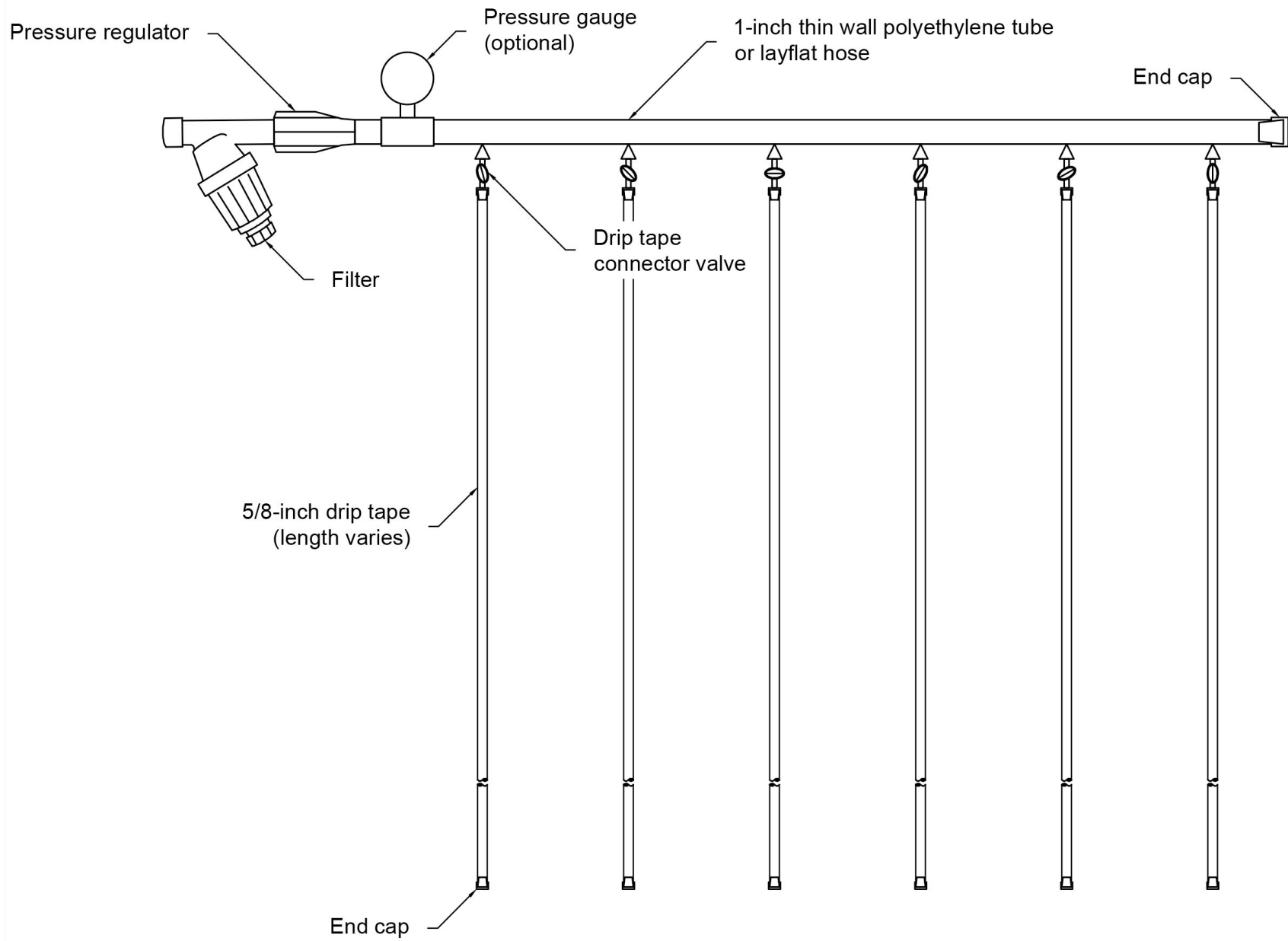
- Why?
 - Soil health
 - Beneficial's
 - Crop rotation
- Entire tunnel cover cropping
 - Done during fallow production time (summer)
- Section or row cover cropping
 - Permanent beds



Irrigation

- Basics
 - Drip is best
 - Plants can be placed at each emitter
 - Needs: pressure reducer, filter, fittings, injection system
- Over head is necessary for cover crops. Install above the maximum height of the cover crop and irrigate as needed.
- Higher pressure is needed to run these

CFSA High Tunnel Irrigation Guide coming in December 2016





Trellising

- Proper trellising makes management easy
- Less Inputs
- Choices
 - Roller hook/line trellising
 - Florida weave
 - Cages
 - Single stakes
 - Mesh wire/fence





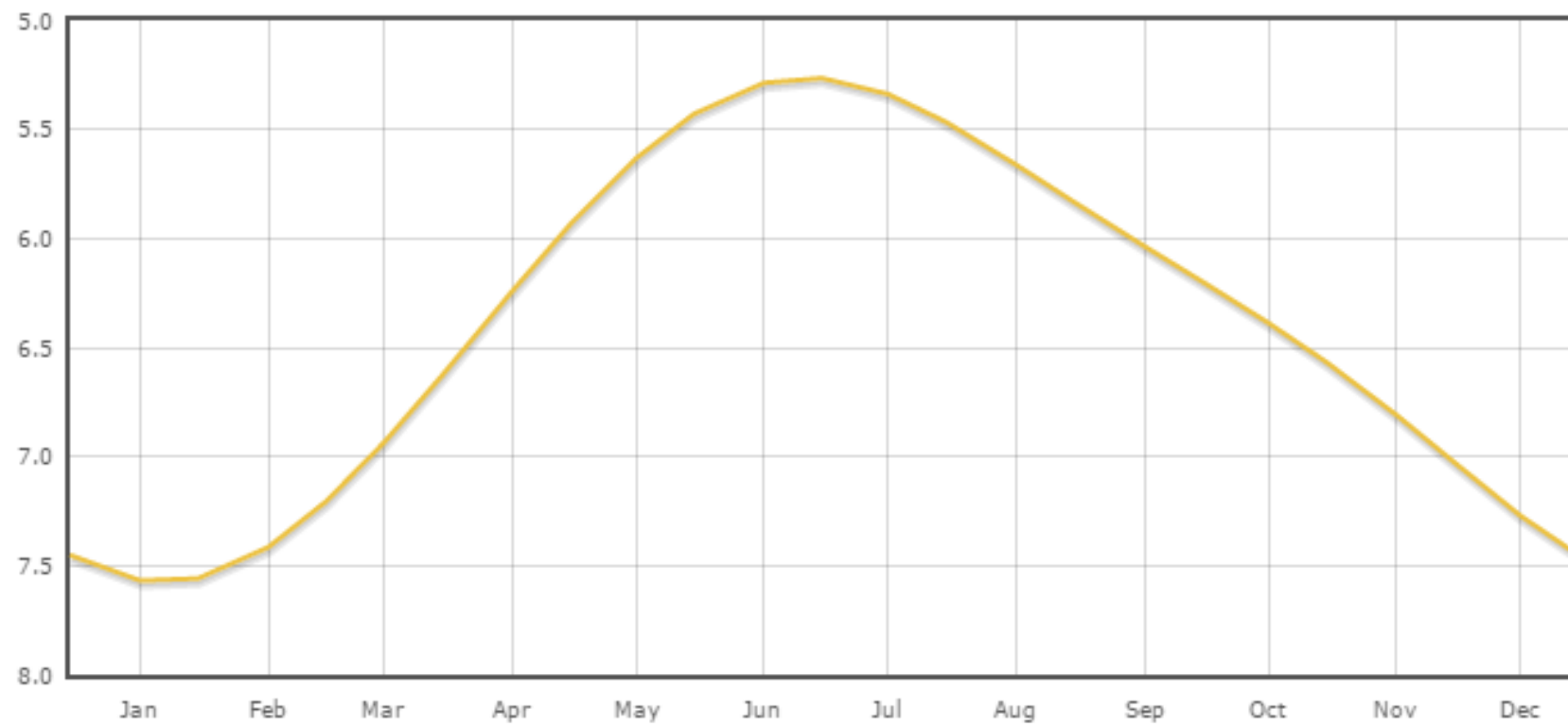
Ventilation tips

- Opening and close sides at appropriate times can be critical to plant health and quality of produce
- Ventilation practices will depend on the crop. Warm season vs Cool season
 - Warm season: base temperature of 50°F
 - Cool season: base temperature of 40°F
- Cold damage
 - Warm season: anything at or below freezing
 - Cool season: typically at or below 25°F but it varies
- Humidity! Vent the tunnel to decrease humidity and leaf wetness

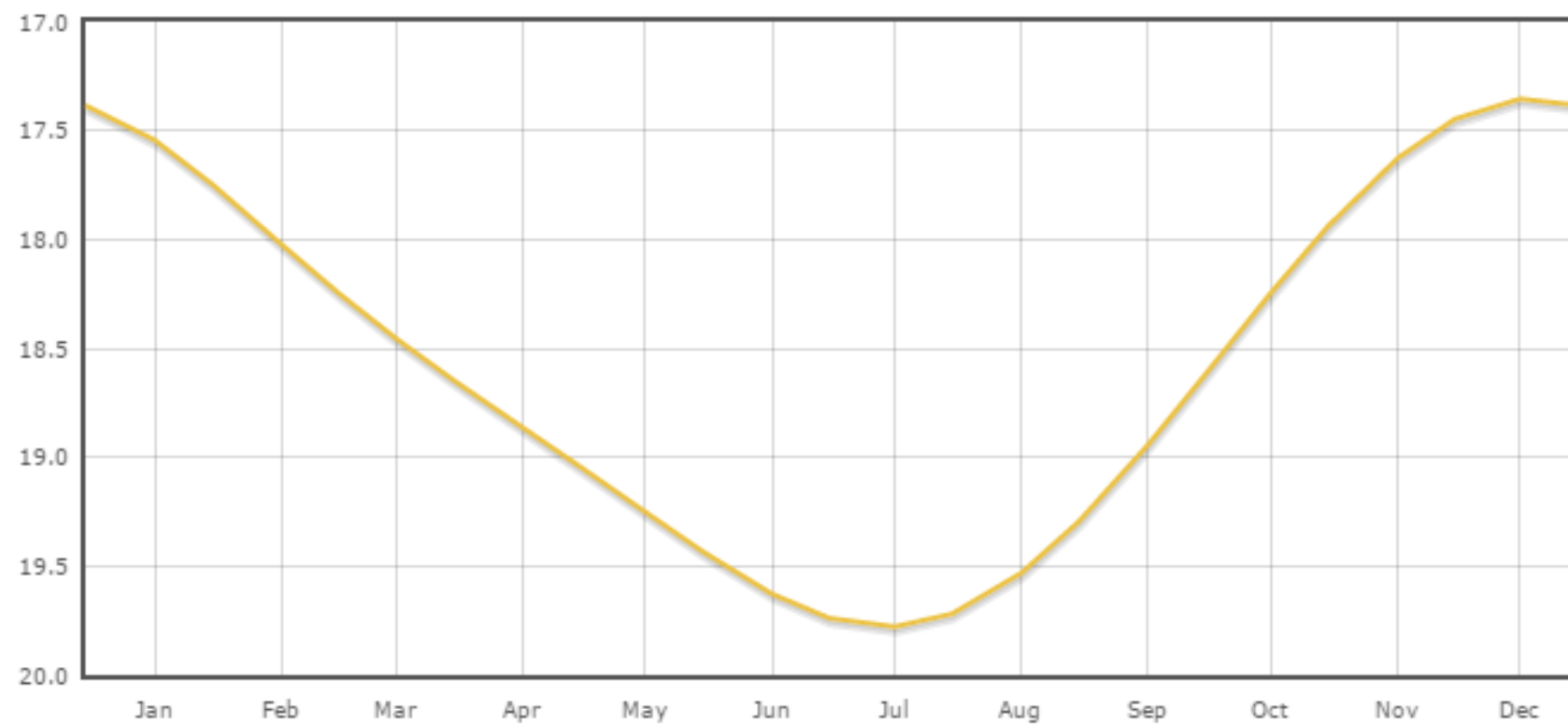
Ventilation Continued

- Optimizing solar radiation and heat accumulation
- Close the sides in the evening soon enough to trap in some heat for that long cold night
- Heat accumulates fast during sunny conditions so get those sides up early
- Avoid high leaf wetness and humidity while maintaining heat can be difficult
- Vent the tunnel during high moisture conditions even if it's a little chilly, you need the air movement

Sunrise over the year



Sunset over the year



Management Effects on Planting Dates

- How much work are you willing to put in?
- Row covers can be labor intensive
- Will be around to close the tunnel if the afternoon turns chilly?
- Think about how much time you want to put into this. Intensively managing high tunnels means work twice a day EVERY DAY; no excuses, vacations, or sick leave.
 - If you want a less intensive approach, choose “safer” planting dates.

Planting Dates for Zone 8a

Cool Season

- Spring Early Planting Date
 - Mid January-Mid February
- Fall Late Planting Date
 - Mid October – Mid November

Warm Season

- Spring Early Planting Date
 - Late February-Early March
- Fall Late Planting Date
 - July-Early August

These are general planting dates for a high tunnel constructed with a single layer of plastic and managed with row covers.

Extending the Winter Harvest

- Day length considerations
 - When we go below 10 hours daylight many plants slow or halt production
- However, if plants reach marketable or near marketable size before slowing production you can keep them “on the hoof” for a while extending your harvest season!
- Carrots are a great example of this. Get the seeds in your high tunnel in late summer/early fall. The carrots will form and production will slow in December. Keep harvesting those carrots through the winter months
- This works for some other cool season crops. Except spinach, that stuff grows like weeds in a high tunnel.



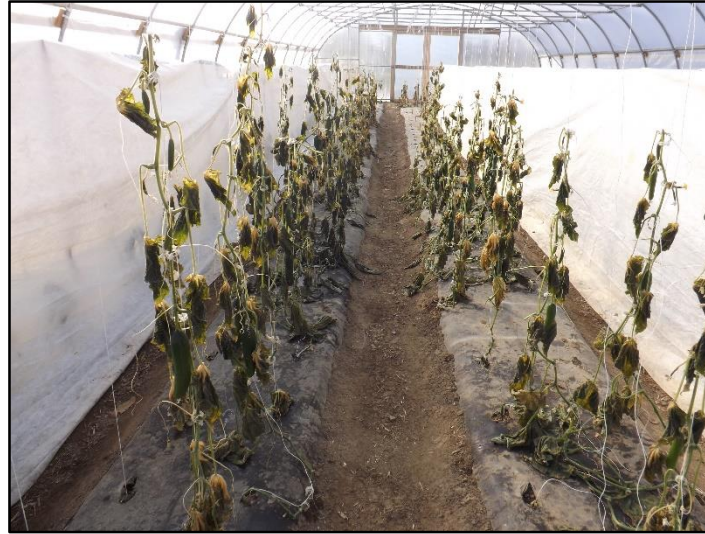
Disclaimer

- Each high tunnel is different and weather can be unpredictable! Season extension is stressful at times but worth the work and effort to master. Take these dates, consider your unique situation, and start planning your crops!



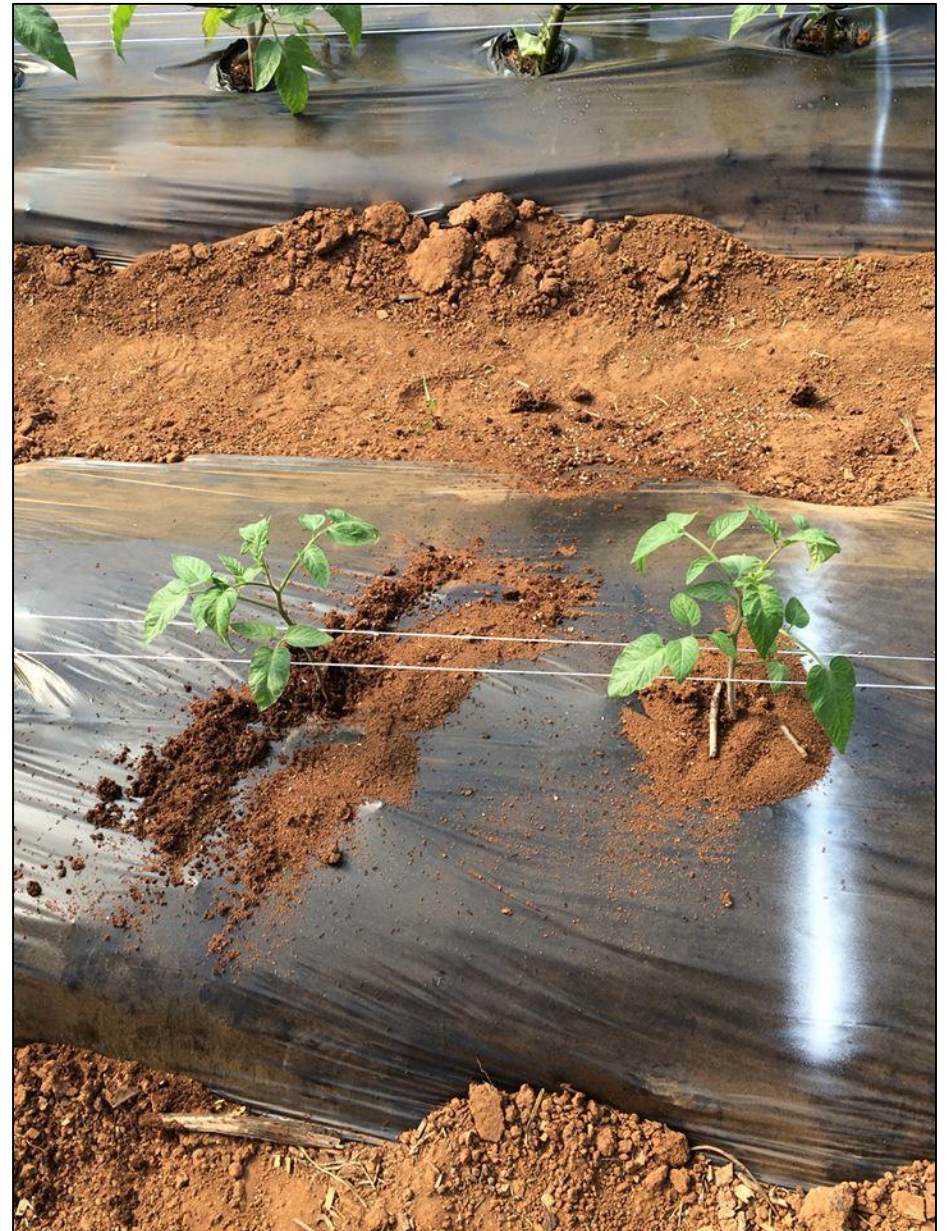
Sometimes it gets too cold!

Damage sustained by early frost in November of 2014

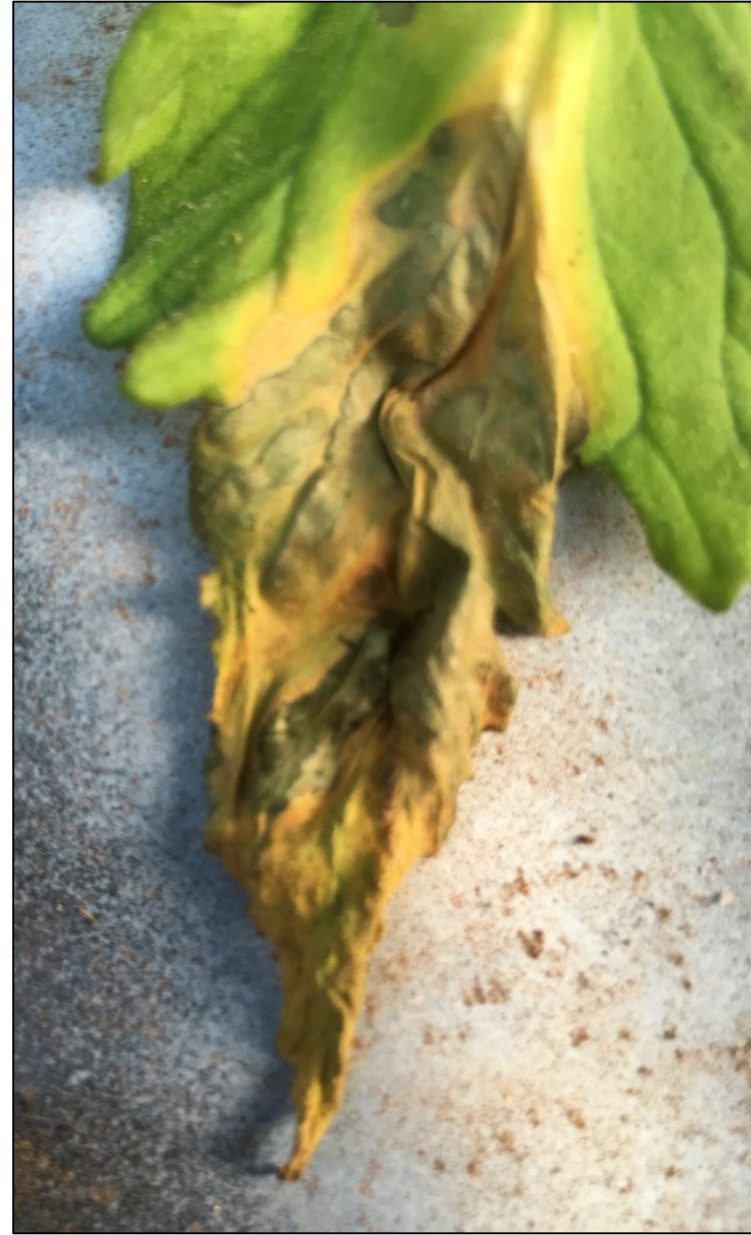


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PROBLEMS AND SOLUTIONS







Resources to Check Out

- Hightunnels.org
- SARE
- CFSA High Tunnel Consulting



CFSA High Tunnel Consulting

- Free for members
- Help to maximize your tunnel production and solve common issues associated with high tunnels
- For more information visit:
www.carolinafarmstewards.org/high-tunnel-consulting/

References

- www.timeanddate.com
- www.ncda.noaa.gov
- www.usda.gov
- <http://www.solartopo.com/daylength-course-of-the-year.htm>

DISCUSSION

Thank You!