Introduction to High Tunnel Production

Taunya Ernst

High Tunnel and Urban Ag Instructor

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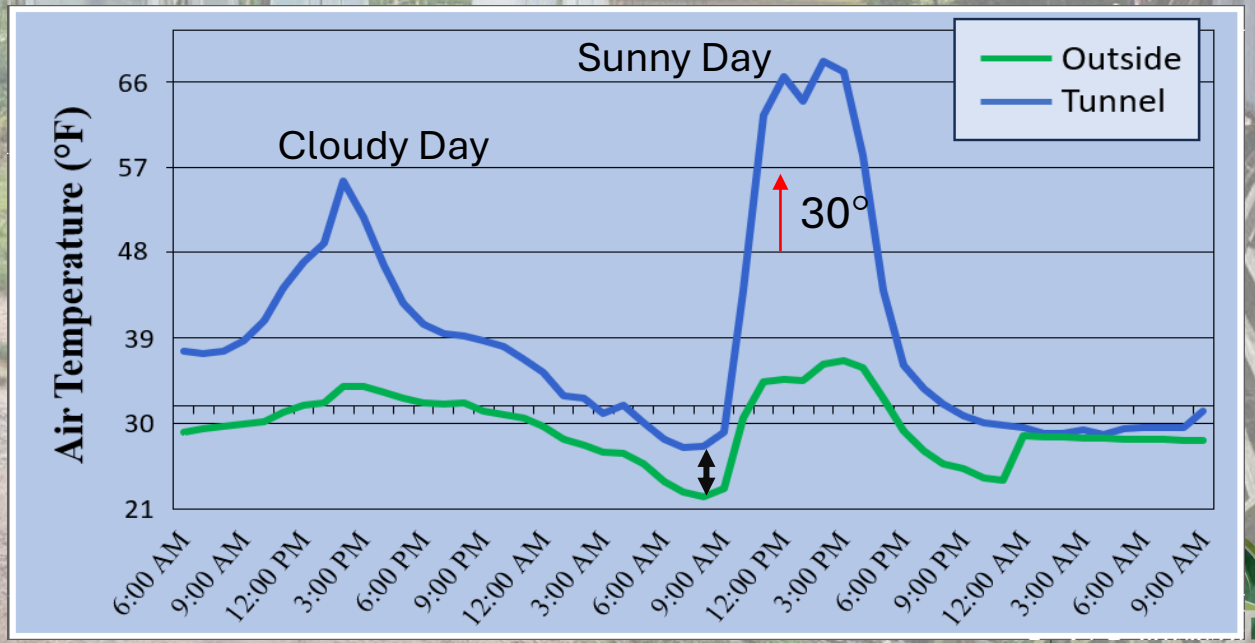
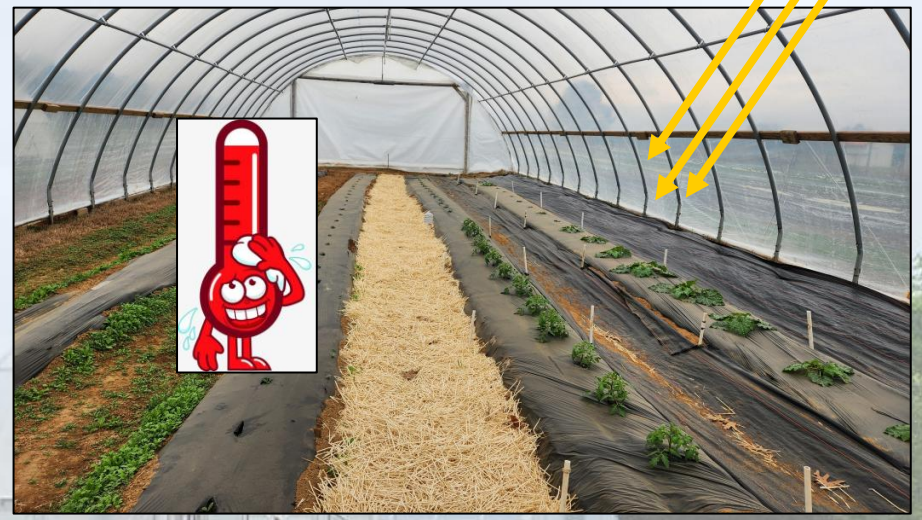
Quick Introduction to High Tunnels:

- Plastic covered structures that use solar radiation and wind to raise and lower their internal temperature.



Quick Introduction to High Tunnels:

- Plastic covered structures that use solar radiation and wind to raise and lower their internal temperature.
- No additional lighting
- Plants are grown directly in the existing soil



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Benefits of High Tunnels:

- Protection from damaging weather events
  - High wind
  - Hail
  - Frost
  - Rain
- Reduce disease pressure
- Reduce the number fungicides sprays

Good IPM Practices

- Increased quality, yields, and shelf life
- Season Extension!

Plant earlier in the spring

Earlier harvests

Get to the market first

$$

Extend harvest into the fall and winter

Staying longer at markets

Extend farm revenue periods

Year-round production

- Strengthens grower/customer relationship by maintaining contact year-round

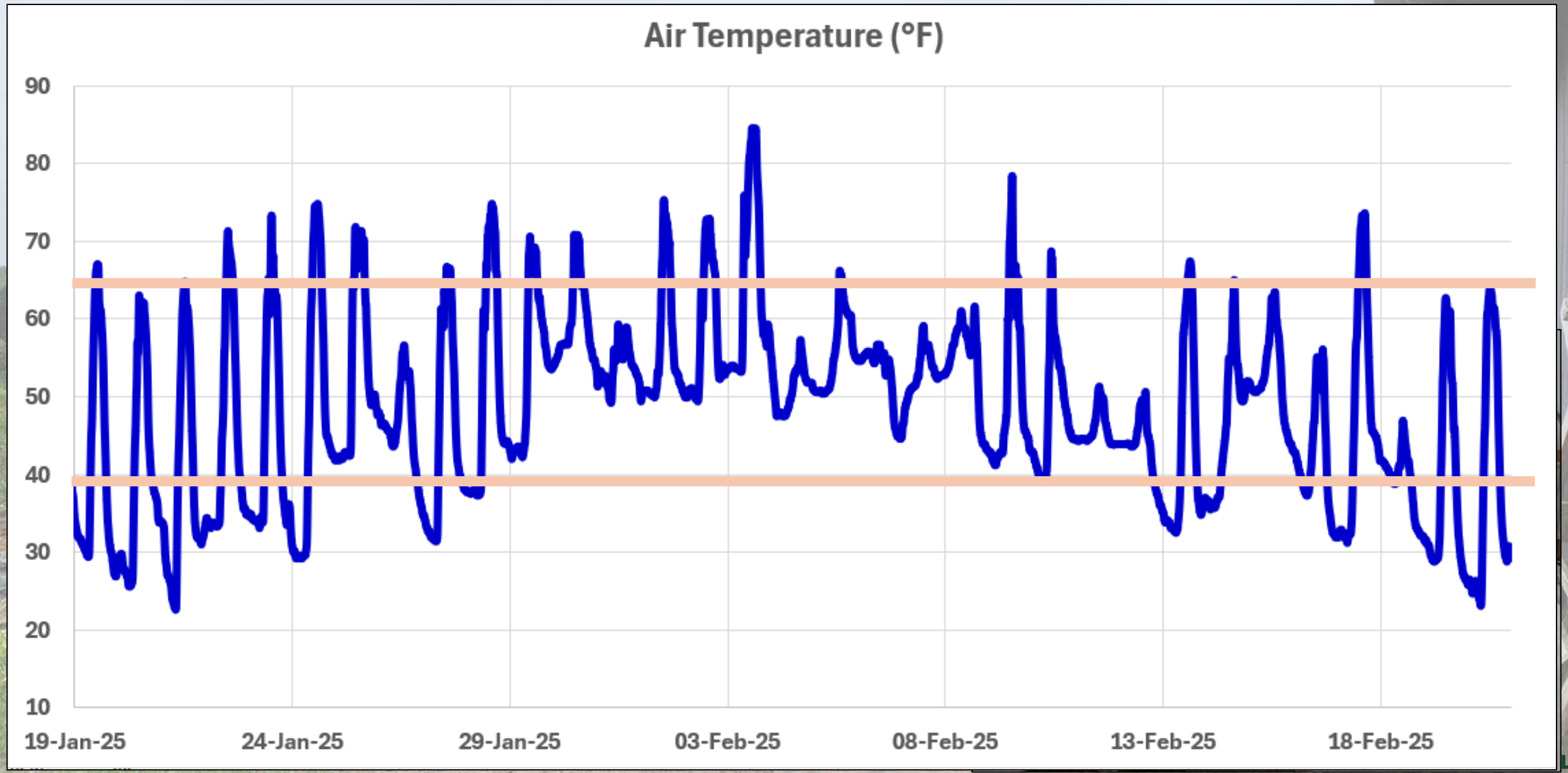
Limitations to High Tunnel Production:

Cost

- Materials:
  - Structure: **$3 - $10 per square foot**
  - Shade cloth
    70 ft by 30 ft: 30% black: **$450 - $1000**
  - Row cover or frost cloth:
    1 oz (10 ft by 500 ft): **$286**
  - Irrigation: varied
  - Plastic replacement – every 4 years
    70 ft by 30 ft
    6 mil greenhouse grade plastic: **$300 – 350**

- Labor - need for additional labor
  - Climate management
  - Pest and disease management

Limitations to High Tunnel Production:



Limitations to High Tunnel Pro

Pest Pressure

- A high tunnel will not exclude pests
- Increase in pest pressure
- Populations can explode quickly

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Site Selection and Preparation

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Key Considerations when Choosing a Location for a High Tunnel:

1. Soil Conditions:
   - Health: history? compaction? soilborne diseases? nematodes?
2. Drainage
   - Well drained soils – lower disease pressure
   - Slope or grade site to divert water away from the tunnel

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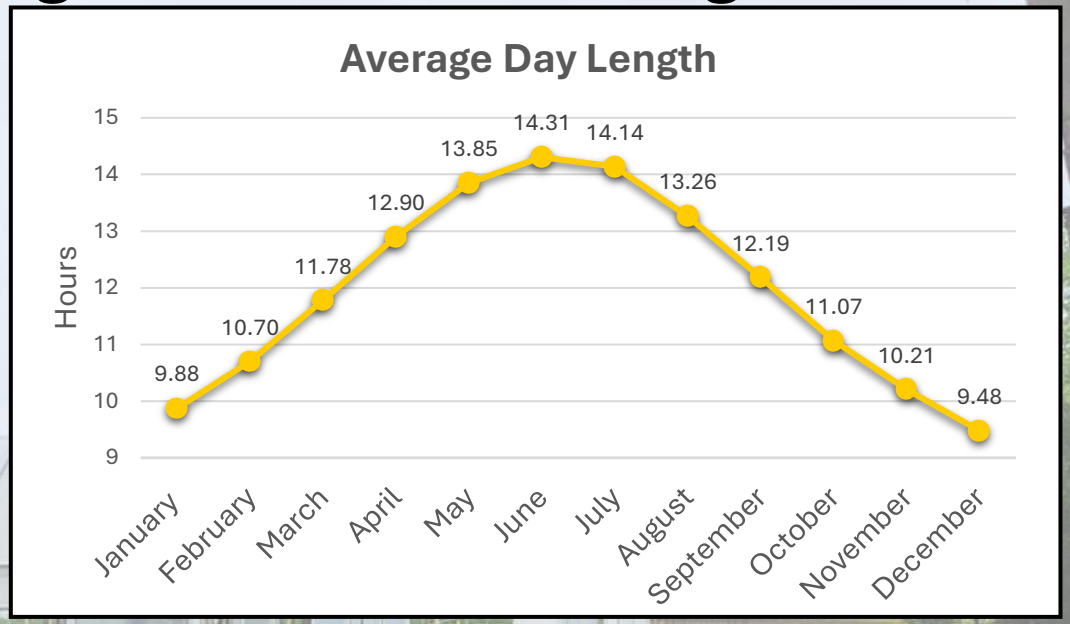
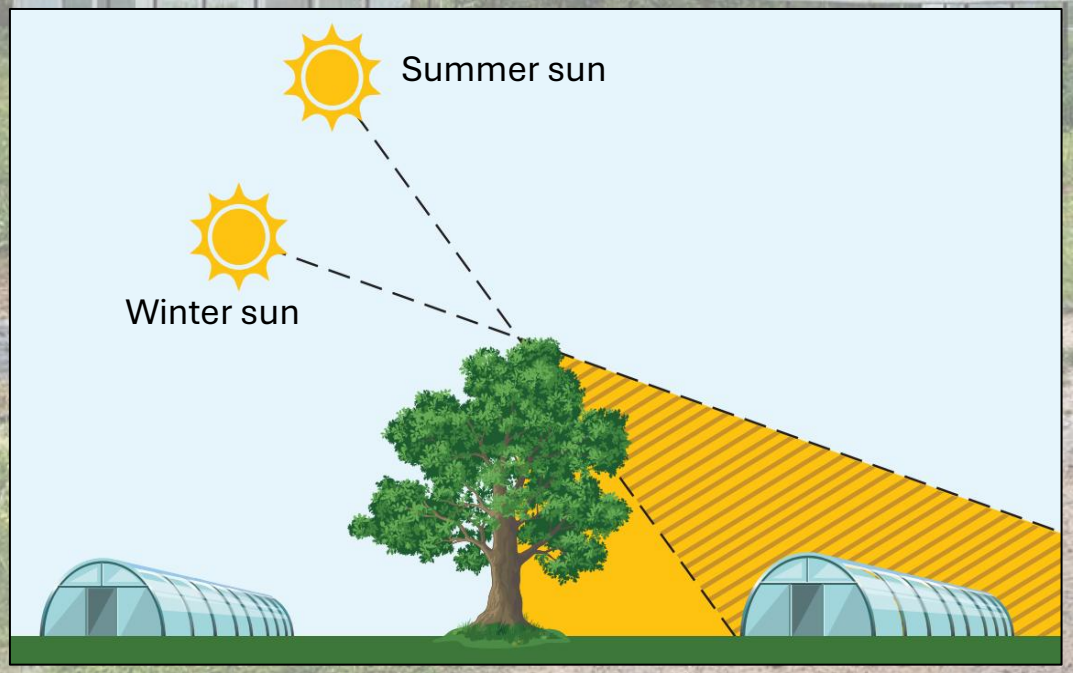
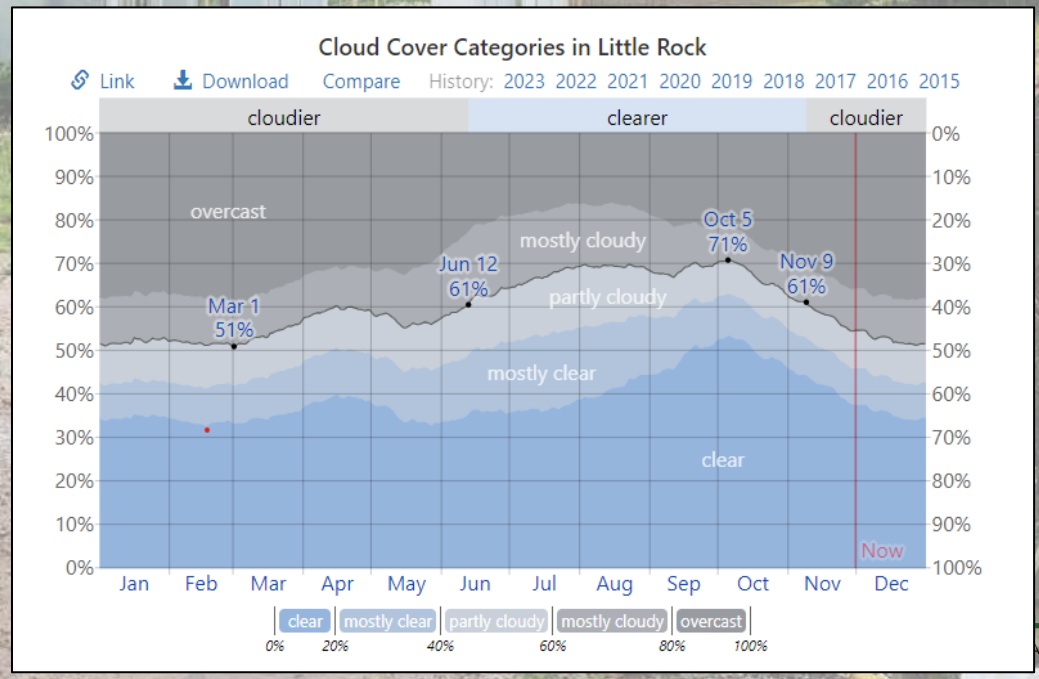
Key Considerations when Choosing a Location for a High Tunnel:

1. Soil Conditions:
   - Health:
2. Drainage
3. Sunlight:
   - limited sunlight = slow growth
   - important for winter production







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Key Considerations when Choosing a Location for a High Tunnel:

1. Soil Conditions:
   - Health:
2. Drainage
3. Sunlight:

   limited sunlight = slow growth
4. Wind:

   breezy but avoid high winds
5. Access to utilities
   - Water
   - Electricity
6. Orientation
   - Sunlight – north/south better light
   - Wind - major vents perpendicular to the prevailing wind

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Crop Selection and Planting Dates

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Crop Selection:

Any common fruit or vegetable can be grown in a tunnel

For the Market:

Vegetables are the most common and most profitable

Tomatoes $$$

- Lettuces
- Peppers
- Cucumbers
- Eggplant
- Summer squash

Small fruiting crops – strawberries

Cut flowers

Considerations for Planting Date:

SPRING likely focus on starting warm season crops early

- More hardy warm season crops:
  - such as tomatoes, peppers
  - transplant 1-1.5 months before your areas frost-free day in the spring
  - may need additional protection – frost cloths
- Tender warm season crops:
  - such as cucumber, summer squash
  - transplant 2 -3 weeks later
  - additional frost protection may be needed

FALL likely focus on establishing cool season crops for winter production OR extend the harvest of warm season crops

- Cool season crops:
  - Full heads/plants: plant early enough that plants are near full maturity before light and temperatures become too low to support growth.
  - Leaves/small plants: later plantings possible – stagger plantings

Remember growth rates will be slower

City	Avg. last frost date
Benton	April 5
Bentonville	April 24
Cabot	April 15
Conway	April 13
El Dorado	April 5
Fayetteville	April 27
Fort Smith	April 8
Hot Springs	April 2
Jonesboro	April 12
Little Rock	April 3
Paragould	April 5
Pine Bluff	March 29
Russellville	April 10
Searcy	April 7
Texarkana	March 29
West Memphis	March 29

Example of a Fall Planting Schedule:

September	October	November	December	January	February

Single Plantings

- **Single harvest**
  - Cabbage
  - Broccoli
  - Cauliflower
- **Multiple harvests**
  - Kale
  - Swiss Chard

Start Transplants

Transplant into tunnel(s)

Harvest

Cabbage	60 – 90 days
Broccoli	50 – 90 days
Cauliflower	90+ days

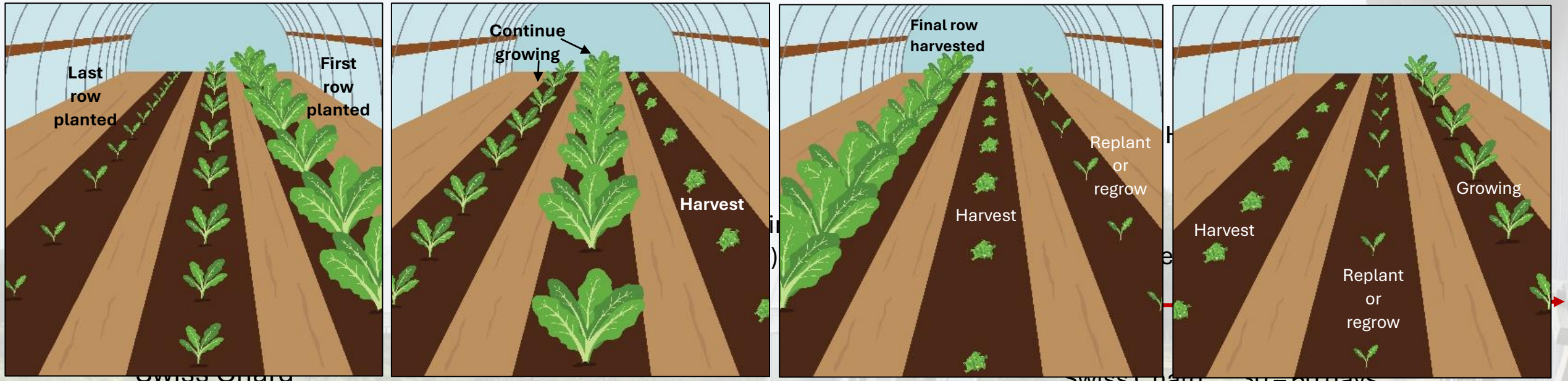
Harvest

Kale	55 – 75 days
Swiss Chard	30 – 60 days

Second planting OR Shift to Summer crops

Days to harvest will depend on weather conditions

Example of a Fall Planting Schedule:



September	October	November	December	January	February

Multiple succession plantings

- Lettuce
- Beets
- Radish
- Bok Choy
- Dill
- Spinach
- Arugula*

2 – 3 weeks Succession planting

First Planting → Harvest

Second Planting

Third Planting

Fourth Planting

etc.

Soil Health and Nutritional Management:

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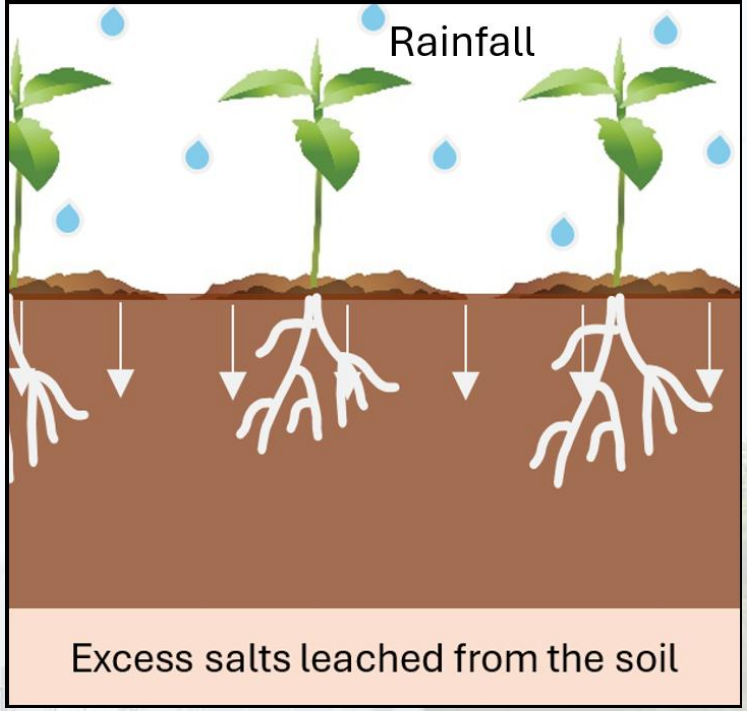
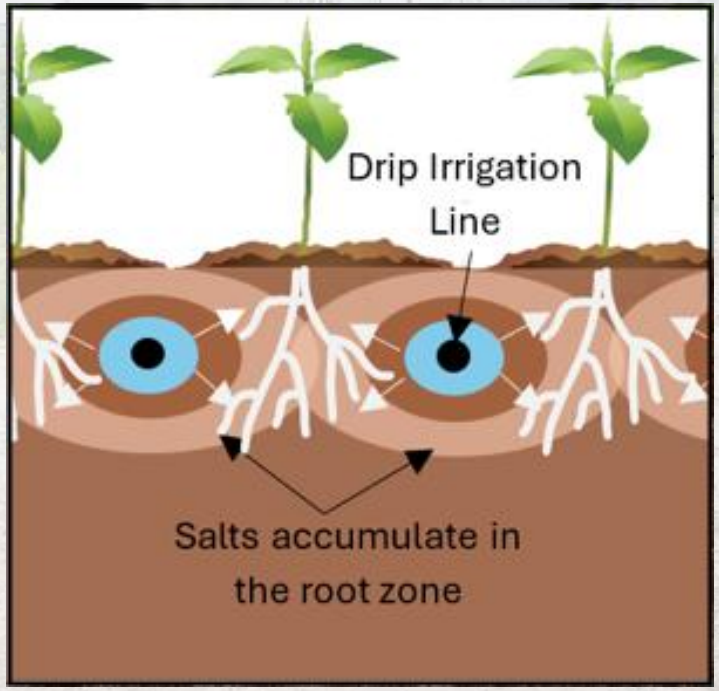
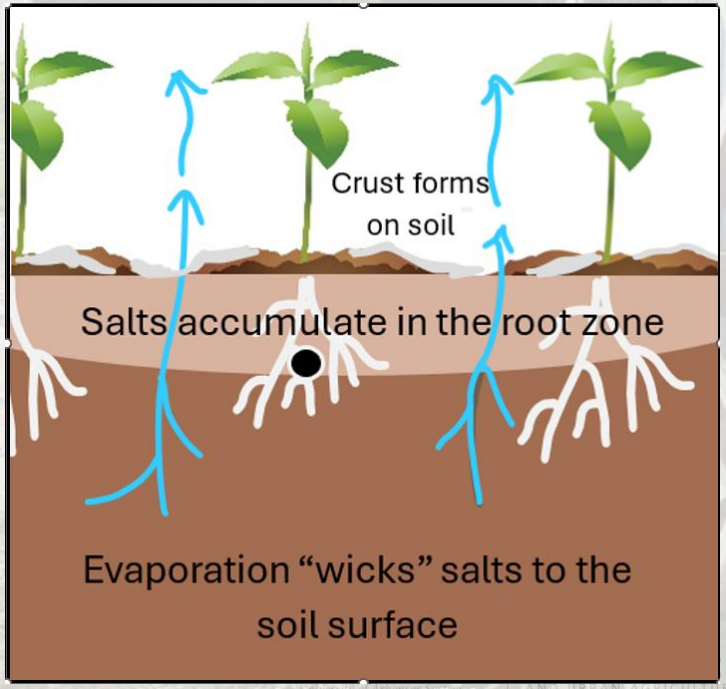
Monitor Soil Fertility

- High tunnel soils can experience a few soil health complications:
  - Accumulation of salts within the soil
  - Accelerated breakdown and loss of soil organic matter
  - Increased risk of soil compaction
- Soil sample often – Once a year
  - General soil sample is FREE!
  - Fee to test soil organic matter and salt levels
- Salt Accumulation:
  - Salts = fertilizer
    - Electrical Conductivity (EC) is how they measure soil salt levels
    - Any fertilizer can increase soil EC
    - Manures and composts can have very high salt levels
    - Drip irrigation can accelerate salt accumulation
  - Symptoms of high salts:
    - Poor plant vigor
    - Nutritional deficiencies
    - Low yields
    - Leaf discoloration and scorching







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  - Interrupting soil test results:
    - Pay close attention to testing methods and units
  - "Flush" or "Wash" soils

Guidelines to help interpret EC results using a 1:2 soil to water ratio. Table adapted from the University of Georgia (Sonon et al. 2022).

Electrical Conductivity		Rating	Interpretation
(mmhos/cm)	(µmhos/cm)		
0 - 0.15	0 - 150	Very low	Plants may be starved of nutrients.
0.15 - 0.50	150 - 500	Low	If soil lacks organic matter. Satisfactory if soil is high in organic matter.
0.51 - 1.25	510 - 1,250	Medium	Okay range for established plants.
1.26 - 1.75	1,260 - 1,750	High	Okay for most established plants. Too high for seedlings or cuttings.
1.76 - 2.00	1,760 - 2,000	Very high	Plants usually stunted or chlorotic.
> 2.00	> 2,000	Excessively high	Plants severely dwarfed; seedlings and rooted cuttings frequently killed.

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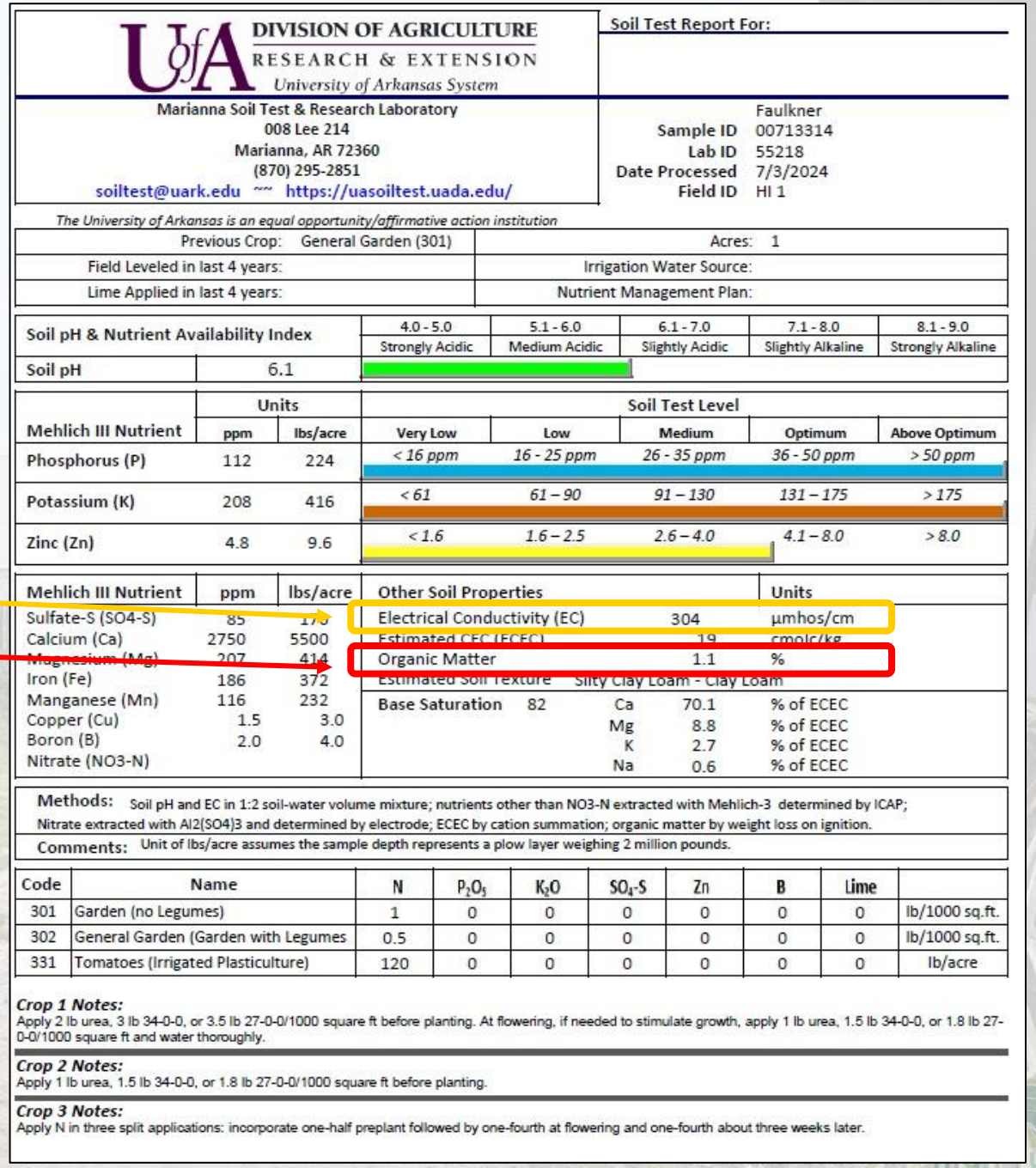
- Salt Accumulation:
- Soil Organic Matter:
  - Accelerated loss due to:
    - Warmer year-round soil conditions
    - Increased number of successive plantings
    - Removal of plant residue after crop completion
  - Necessary to add organic matter back into the soil
    - Compost, manure and mulches
      - Use a reliable, clean source
      - Rule of thumb: 1" of compost/manure across the entire tunnel
    - *Incorporating cover crops into a tunnel crop rotation plan *
      - Break disease and insect cycles
      - Will not contribute to EC accumulation
- Soil Compaction:



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Soil Test Report For:

Marianna Soil Test & Research Laboratory
008 Lee 214
Marianna, AR 72360
(870) 295-2851
soiltest@uark.edu ~~~ https://uasoiltest.uada.edu/

Faulkner
Sample ID 00713314
Lab ID 55218
Date Processed 7/3/2024
Field ID HI 1

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Previous Crop: General Garden (301)	Acres: 1
Field Leveled in last 4 years:	Irrigation Water Source:
Lime Applied in last 4 years:	Nutrient Management Plan:

Soil pH & Nutrient Availability Index		4.0 - 5.0 Strongly Acidic	5.1 - 6.0 Medium Acidic	6.1 - 7.0 Slightly Acidic	7.1 - 8.0 Slightly Alkaline	8.1 - 9.0 Strongly Alkaline
Soil pH	6.1					

Mehlich III Nutrient	Units ppm	Units lbs/acre	Soil Test Level: Very Low	Low	Medium	Optimum	Above Optimum
Phosphorus (P)	112	224	< 16 ppm	16 - 25 ppm	26 - 35 ppm	36 - 50 ppm	> 50 ppm
Potassium (K)	208	416	< 61	61 – 90	91 – 130	131 – 175	> 175
Zinc (Zn)	4.8	9.6	< 1.6	1.6 – 2.5	2.6 – 4.0	4.1 – 8.0	> 8.0

Mehlich III Nutrient	ppm	lbs/acre
Sulfate-S (SO4-S)	85	170
Calcium (Ca)	2750	5500
Magnesium (Mg)	207	414
Iron (Fe)	186	372
Manganese (Mn)	116	232
Copper (Cu)	1.5	3.0
Boron (B)	2.0	4.0
Nitrate (NO3-N)		

Other Soil Properties			Units
Electrical Conductivity (EC)	304		µmhos/cm
Estimated CEC (ECEC)	19		cmolc/kg
Organic Matter	1.1		%
Estimated Soil Texture	Silty Clay Loam - Clay Loam		
Base Saturation	82	Ca 70.1	% of ECEC
		Mg 8.8	% of ECEC
		K 2.7	% of ECEC
		Na 0.6	% of ECEC

Methods: Soil pH and EC in 1:2 soil-water volume mixture; nutrients other than NO3-N extracted with Mehlich-3 determined by ICAP; Nitrate extracted with Al2(SO4)3 and determined by electrode; ECEC by cation summation; organic matter by weight loss on ignition.

Comments: Unit of lbs/acre assumes the sample depth represents a plow layer weighing 2 million pounds.

Code	Name	N	P_2O_5	K_2O	SO_4-S	Zn	B	Lime	
301	Garden (no Legumes)	1	0	0	0	0	0	0	lb/1000 sq.ft.
302	General Garden (Garden with Legumes	0.5	0	0	0	0	0	0	lb/1000 sq.ft.
331	Tomatoes (Irrigated Plasticulture)	120	0	0	0	0	0	0	lb/acre

Crop 1 Notes:
Apply 2 lb urea, 3 lb 34-0-0, or 3.5 lb 27-0-0/1000 square ft before planting. At flowering, if needed to stimulate growth, apply 1 lb urea, 1.5 lb 34-0-0, or 1.8 lb 27-0-0/1000 square ft and water thoroughly.

Crop 2 Notes:
Apply 1 lb urea, 1.5 lb 34-0-0, or 1.8 lb 27-0-0/1000 square ft before planting.

Crop 3 Notes:
Apply N in three split applications: incorporate one-half preplant followed by one-fourth at flowering and one-fourth about three weeks later.

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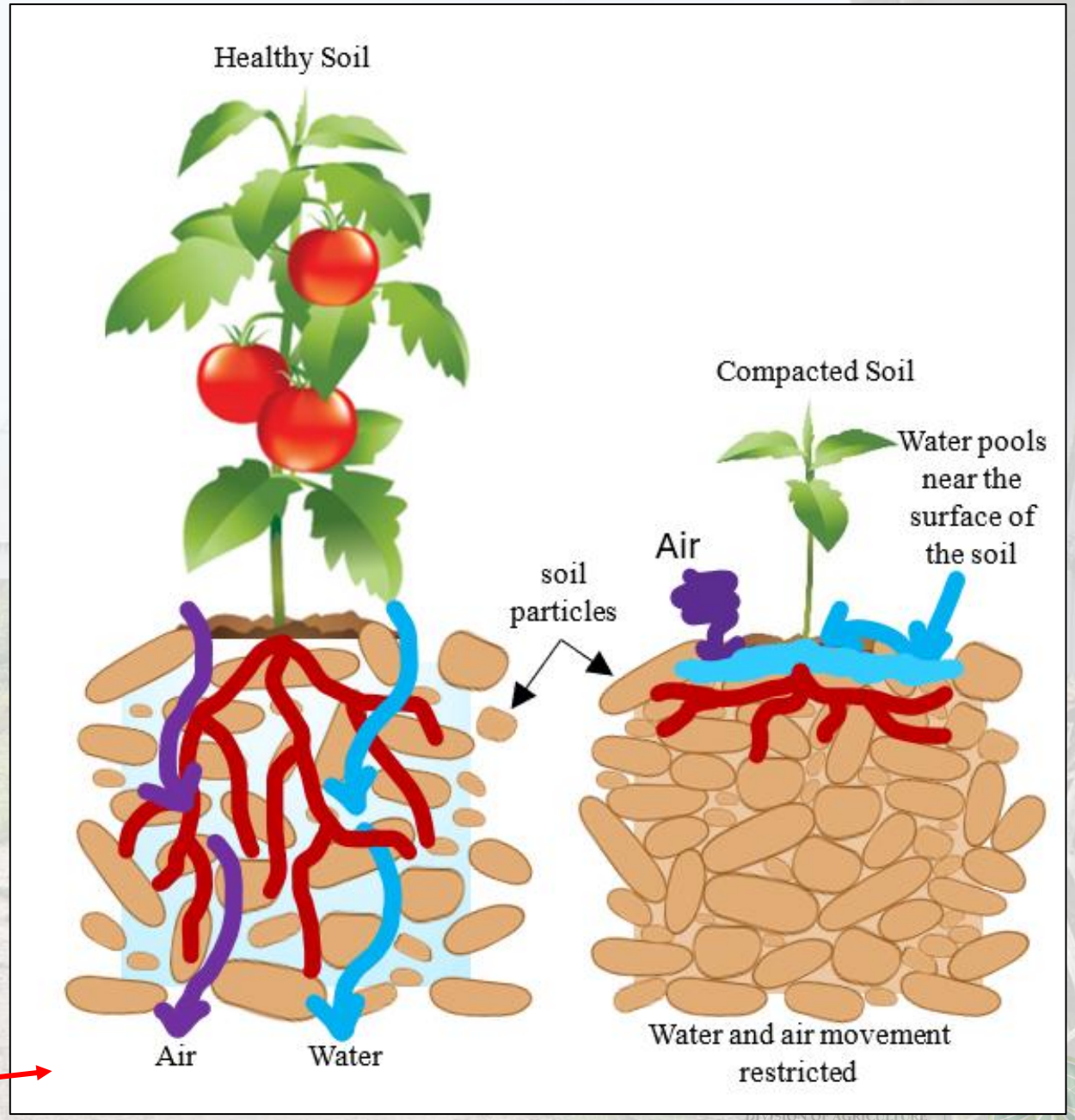

Climate Management:

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Three Key Relationships

Plant Growth and Temperature

Plant Growth and Humidity

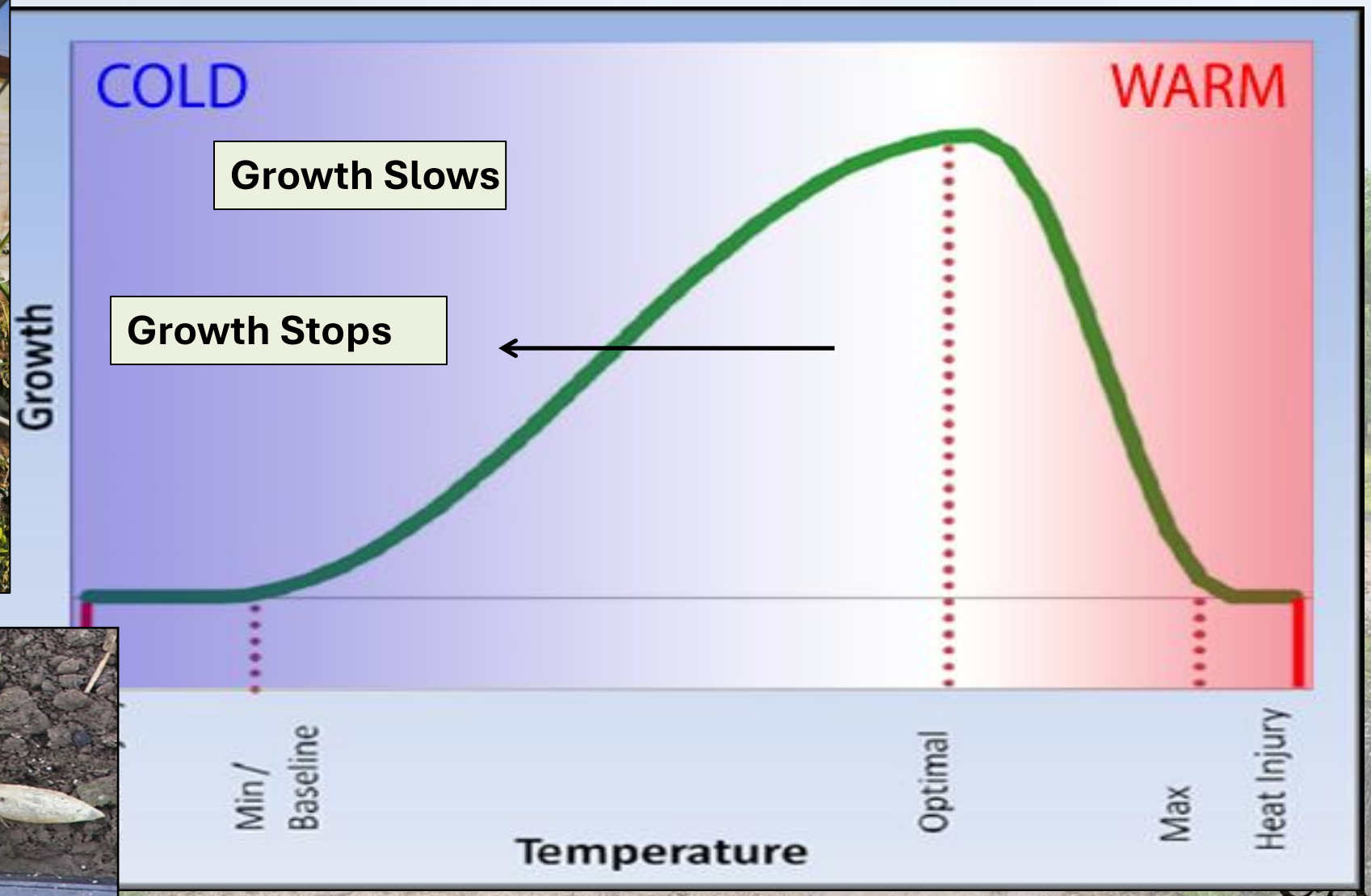
- Increased disease pressure
- Affect water movement through the plant
- Cooler air = lower humidity

Plant Growth and Light

- Inadequate light = leggy plants

  slowed growth

Plant Growth and Temperature



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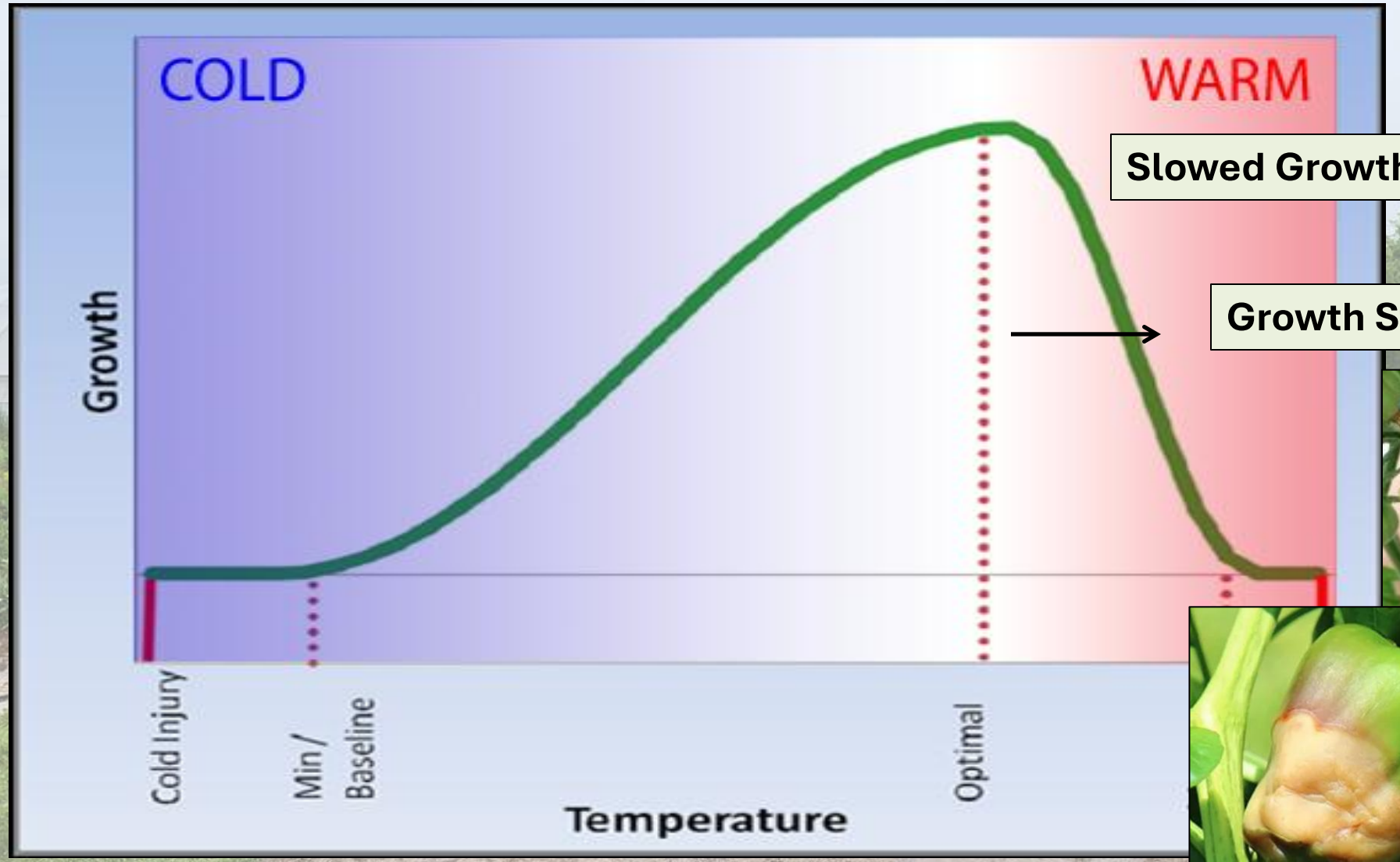
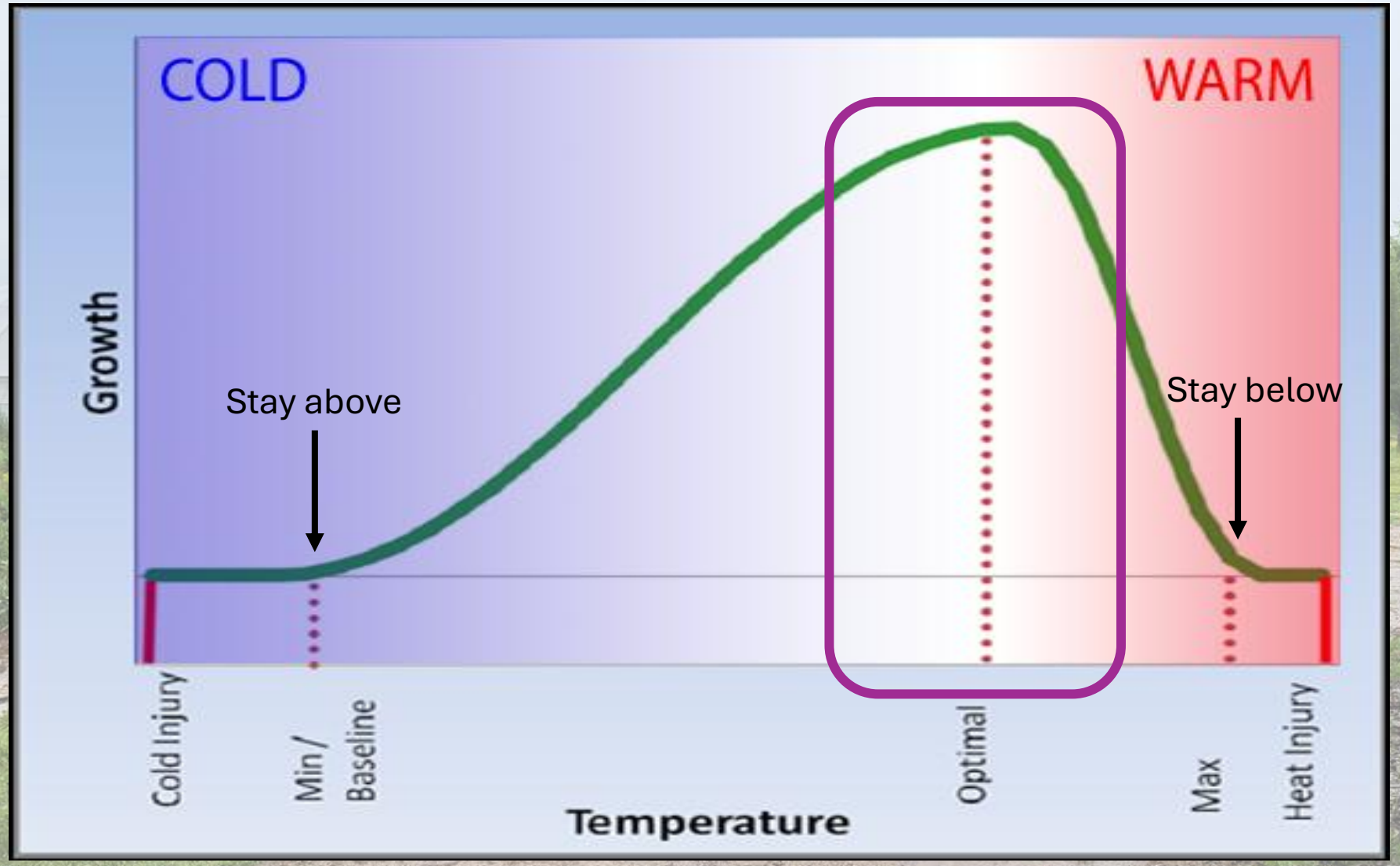
Plant Growth and Temperature



Slowed Growth

Growth Stops

Plant Growth and Temperature



Climate Management Practices

Winter:

1. Prevent or protect from damaging cold temperatures
2. Avoid excessively high temperatures (70-75°F)

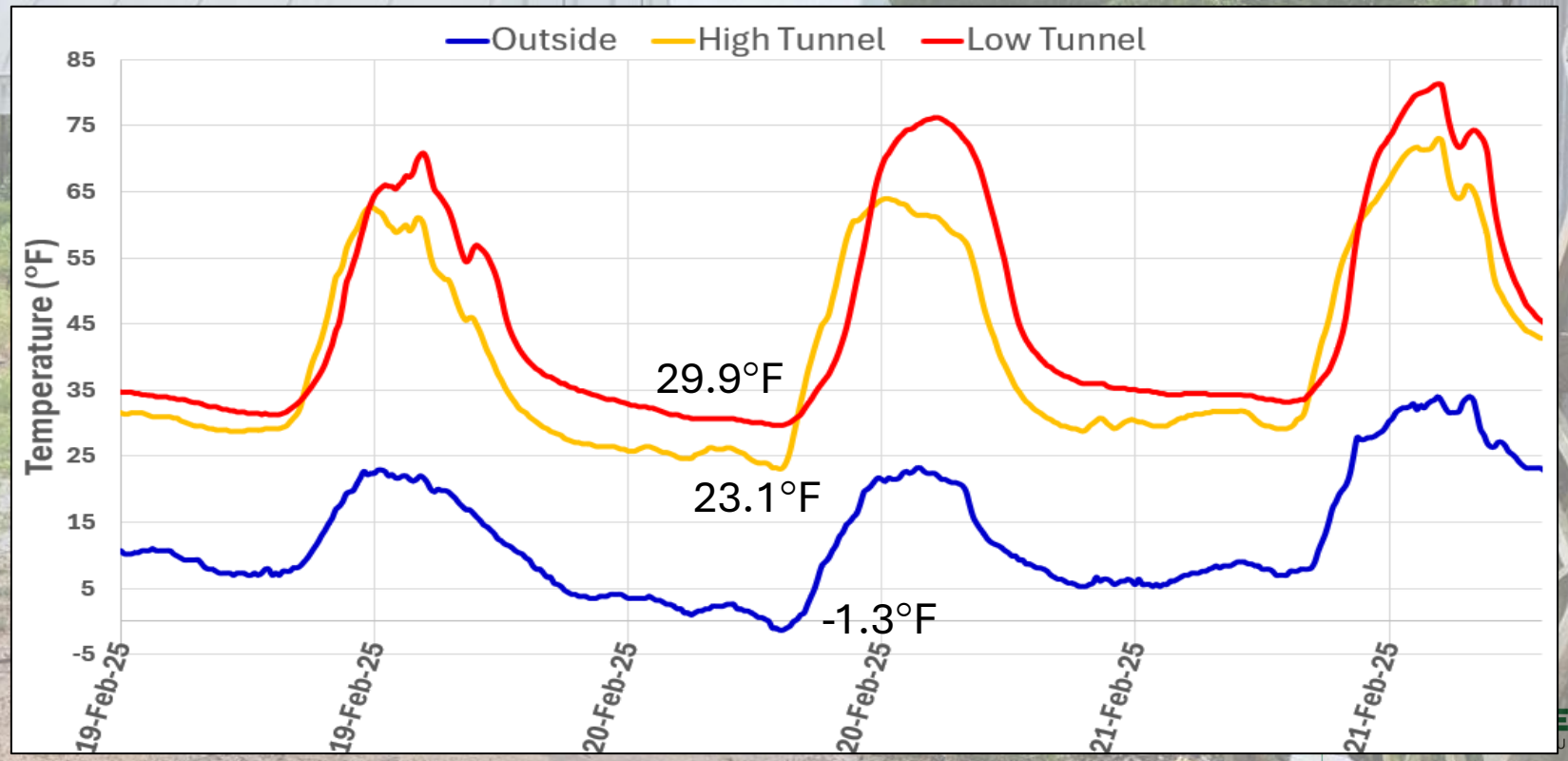
Spring and Fall:

1. Preventing high temperatures
2. Protect plants from excessively cold temperatures (40 or 50°F)

Climate Management Practices: Winter, spring and fall

Extra Protection

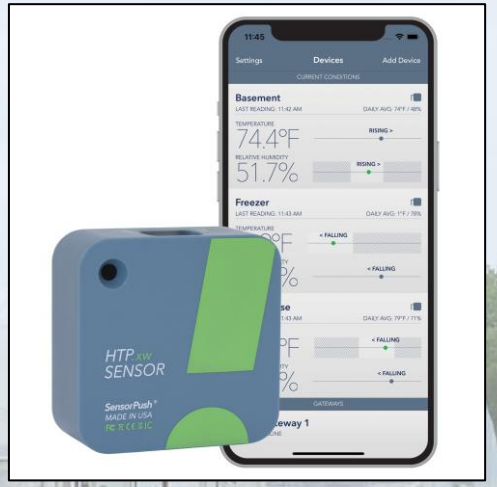
- Secondary covers
  - Plastic (greenhouse or construction grade)
  - Row cover
  - Night: additional 2 – 5° temperature protection
- Additional heating
  - Exhaust ventilation
  - Monitor humidity



Climate Management Practices: Winter, spring and fall

Daily Management Strategies

- Monitor forecasts daily
  - Indicate venting and/or secondary cover needs
  - Extremely cold and overcast = no venting
- Monitor the internal temperature of the high tunnel
- Monitor humidity
  - Remove secondary covers during the day



Standard Daily Climate Management Tools

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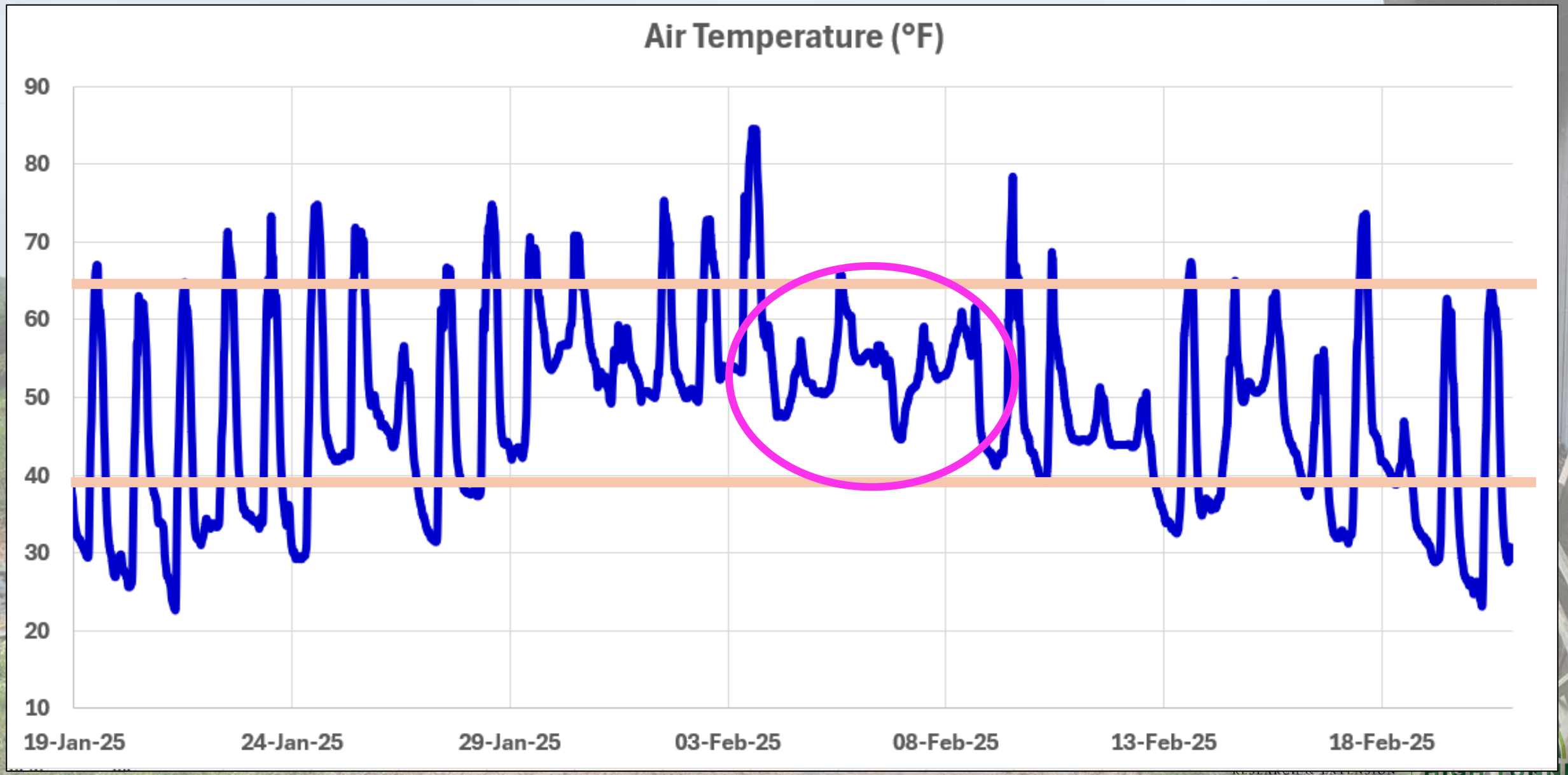
Climate Management Practices: Winter, spring and fall



Climate Management Practices: Summer

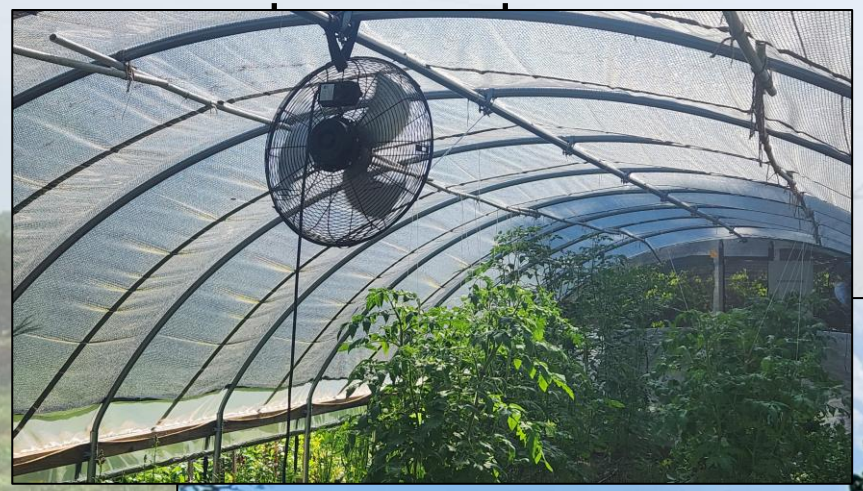
Summer Climate Goals:

1. Prevent excessively high temperatures
   - Adequate ventilation

Climate Management Practices: Summer

Summer Climate Goals:

1. Prevent excessively high



- Adequate ventilation
- Shade cloth is essential!
  - Varying degrees of shade: 10-80%
  - Apply when day temperatures are consistently 80-85°F
  - Remove in the fall
- Fans

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High Tunnel Production Guide for the Southeast

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U.S. DEPARTMENT OF AGRICULTURE

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