Purdue Hydroponics and Greenhouse Crop Production Webinar Series (2024)

1. Nutrient Management in Recycling Hydroponic Systems (April 15, noon to 1 pm)
2. Temperature Management (Summer/ Winter) in Greenhouses (May 15, noon to 1 pm)
3. Organic Lettuce Production in Hydroponic Systems (June 12, noon to 1 pm)
4. How to Build an Indoor Hydroponic Production System for Homes and Schools? (Aug 21, noon to 1 pm)
5. Fundamentals of Soilless Substrates for Floriculture Crop Production (Sep 18, noon to 1 pm)

Purdue Controlled Environment Agriculture Research & Extension

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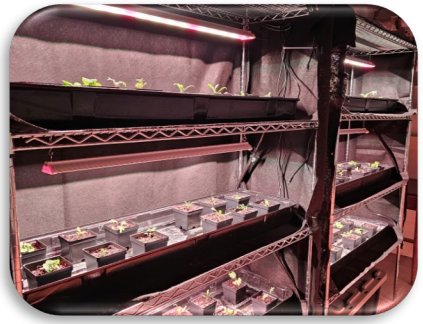

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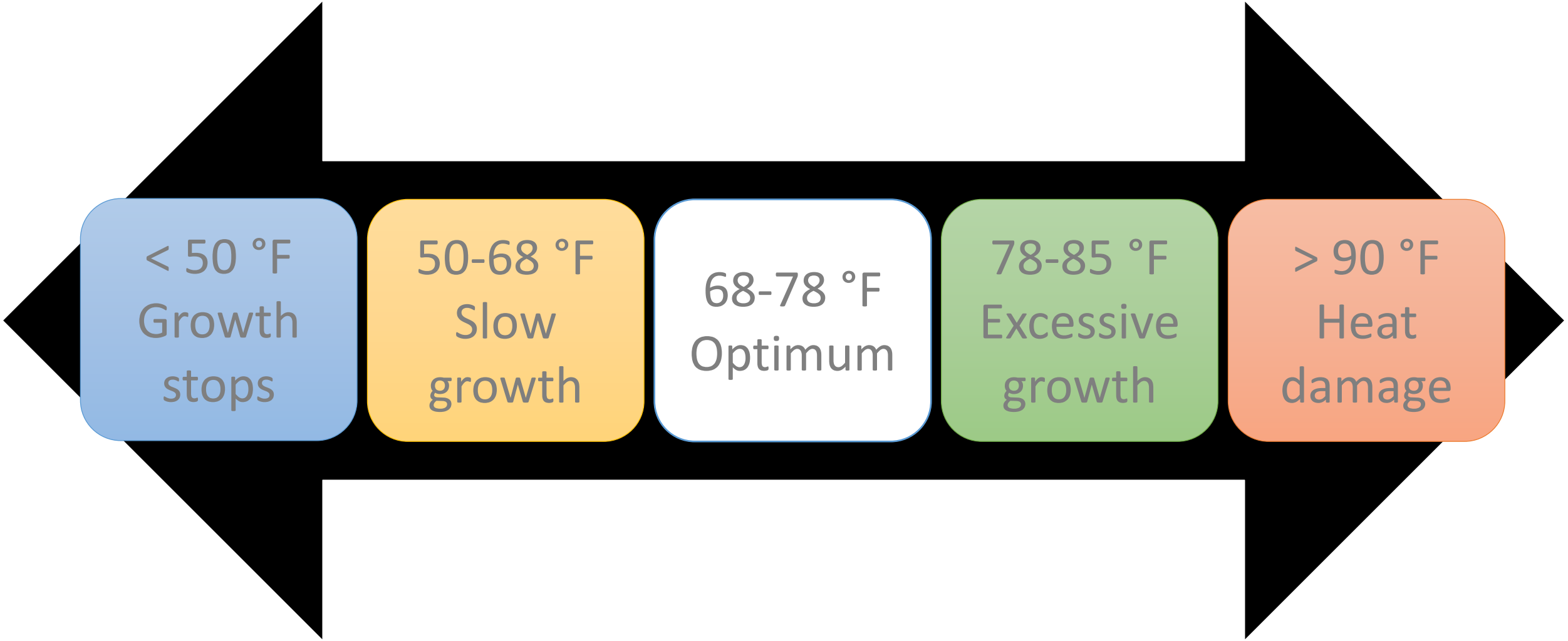
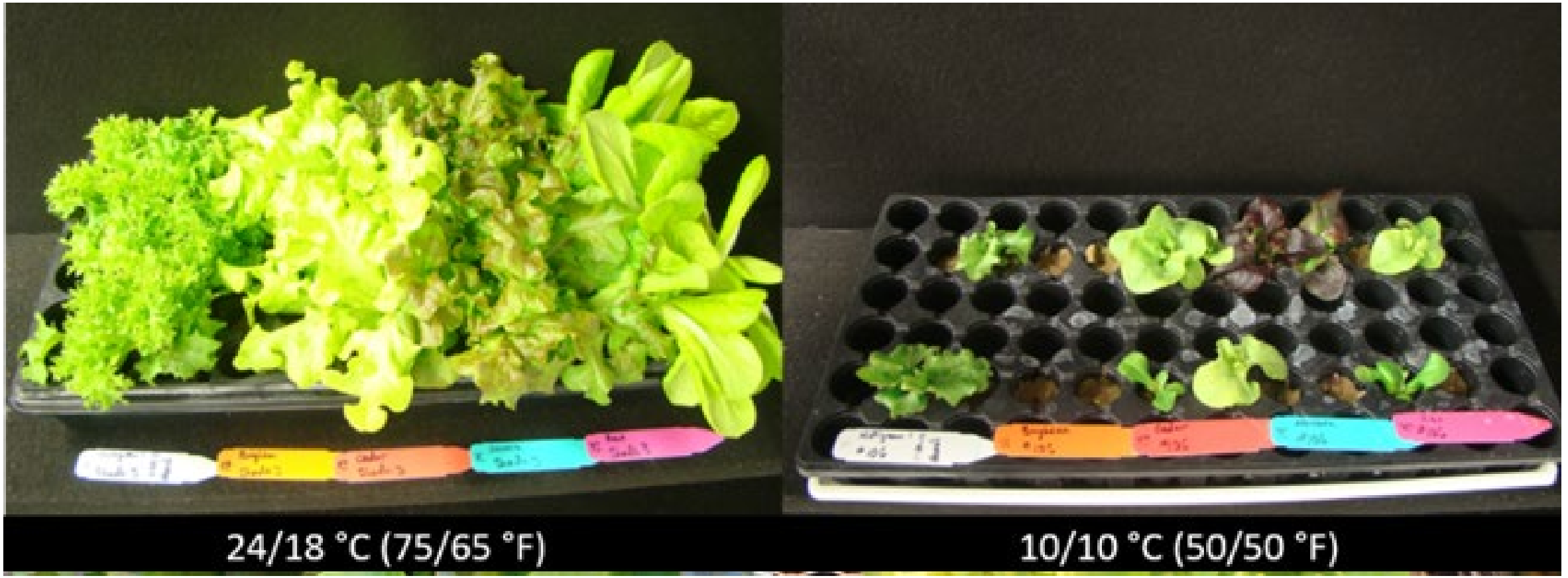
Plant responses to temperature



Growth of lettuce varieties at low temperature

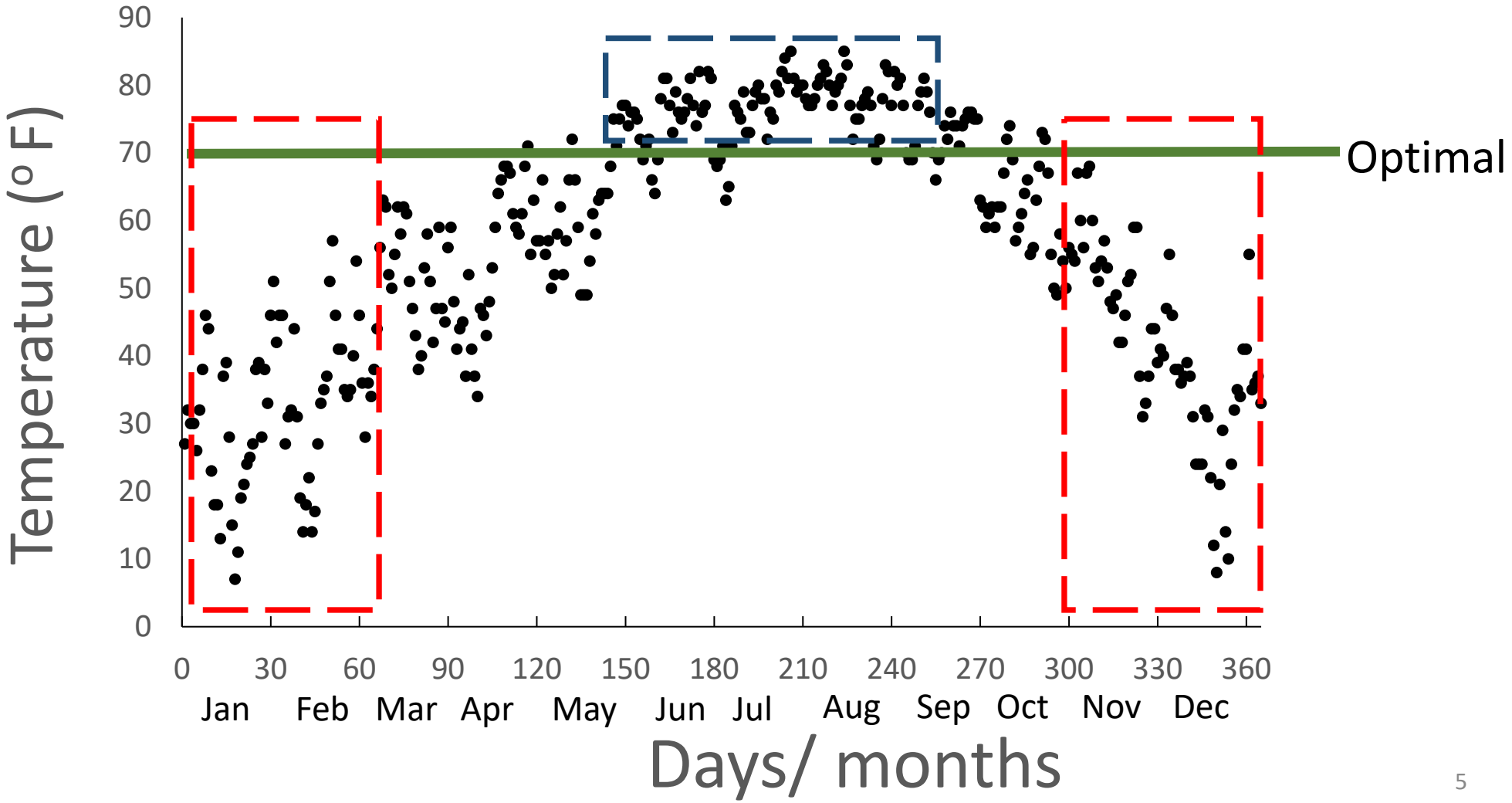


Heat Damage on Salvia

77 F 86 F 95 F 104 F

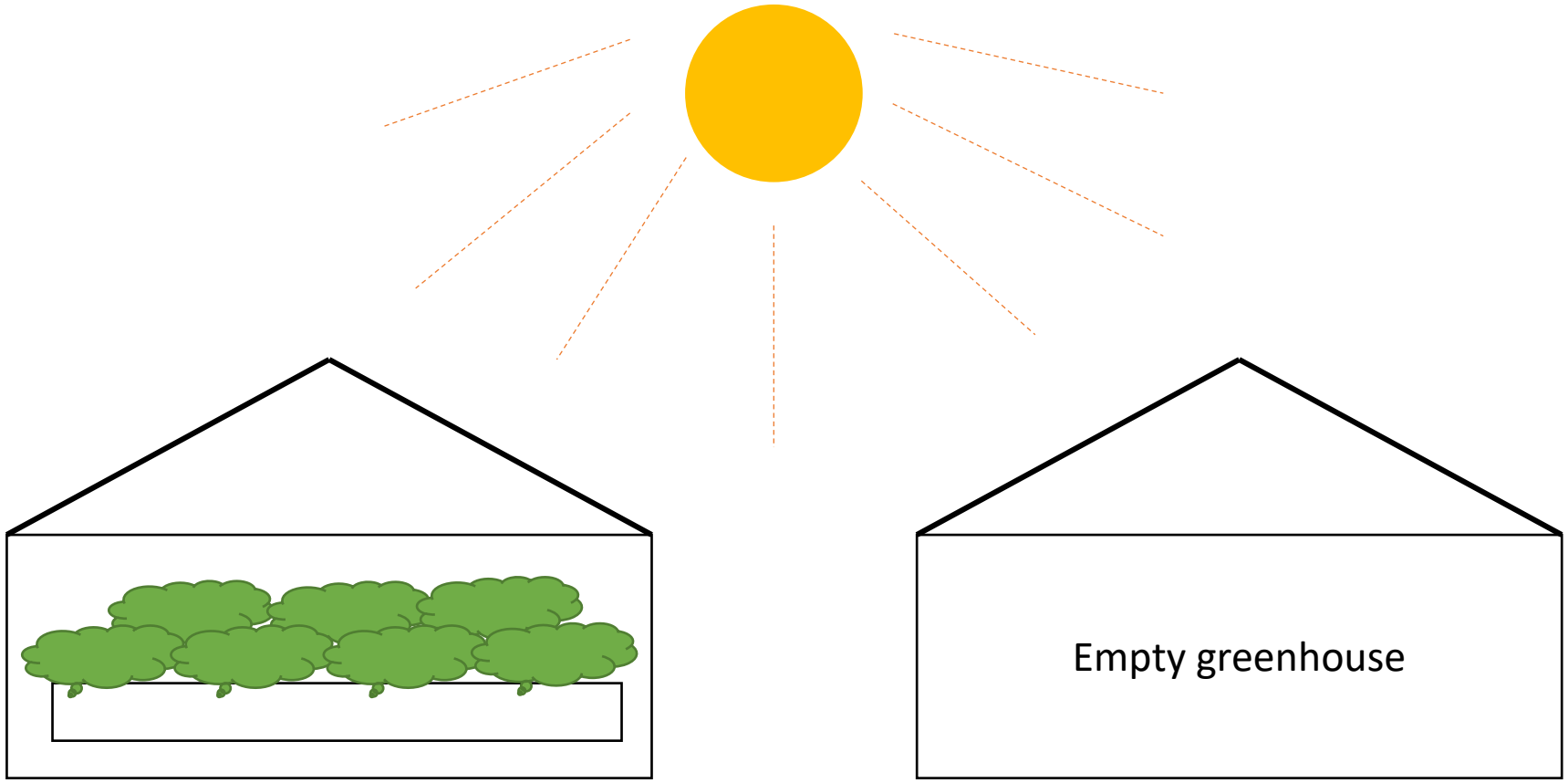
Courtesy: LSU Ag Center

Average outside temperature in Indiana



Different Methods of Cooling a Greenhouse

1. Plant water loss



It takes 970 btu to evaporate a pound of water

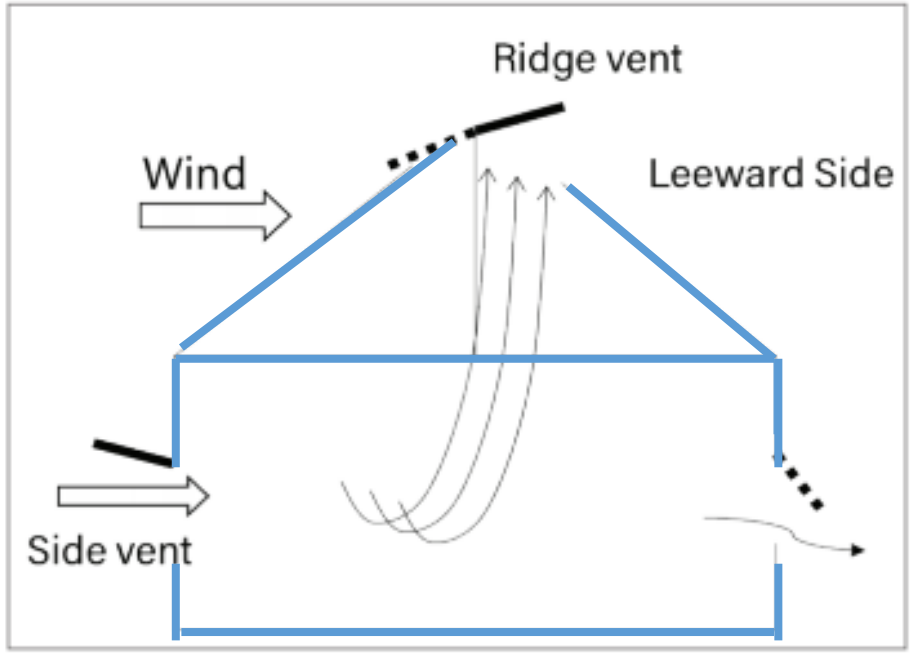
As plants transpire, they absorb heat from the sun to evaporate water from inside of the leaves and cool their surfaces

2. Shade Cloth or Thermal Screen

- Reduces the percentage of solar radiation received by plants
- Thermal screen operation can be automated
- Available in a wide range of shades. The most popular are 35% and 50% shade cloth
- Should be used when other methods do not reduce temperature
- Lowers light intensity in the greenhouse, thereby light received by plants
- A minimum of 10-12 mol/m^2/d to be maintained for normal growth, even using shade cloth

3. Natural Ventilation

- Side covers rolled up to allow wind to enter
- Sometimes, a vent along the ridge (60 ° angle) in addition to side ventilation can further lower temperature (for large greenhouses)
- Open roof system (50% of the roof is open) is also effective
- Cooling is limited and depends on winds and crop transpiration
- The area of the side wall and ridge vents individually should be 15-20% of the ground area for effective cooling

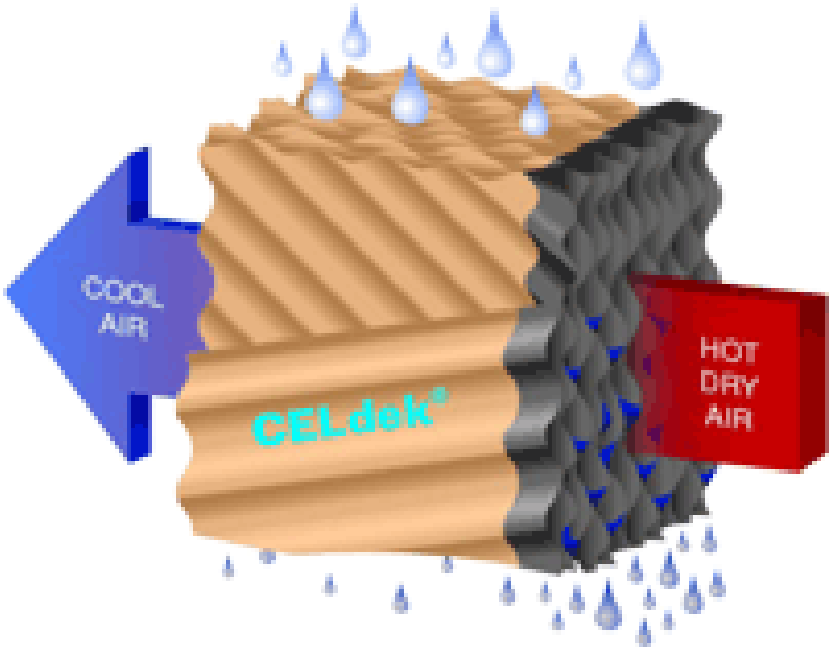


4. Forced ventilation

- Hot air is forced out of the greenhouse using exhaust fans
- For an effective cooling, an air volume approximately 1.5 times the volume of the greenhouse or 8-10 cfm per square feet of greenhouse should be ventilated every minute
- Fans should not be spaced more than 25’ apart
- Fans should be placed on **the leeward side**; if not, increase capacity by 10%
- A clear space at least 4 to 5 fan diameters to be maintained in front of fans
- Fans consume electricity, so power requirement should be considered in selection

5. Cooling Pads and fans

- Cooling pads reduce dry bulb temperature of inlet air; usually 5-10°F reduction in air temperature can be expected
- Pad area (ft^2) needed will be determined by dividing volume of air to be exhausted by air velocity specification
- Pads come in different thicknesses (4-8 inch). Increasing pad thickness can increase 'cooling efficiency' but lowers air flow into greenhouse
- Pads should be on **the windward side**; adjacent fans should be at least 50 feet away
- Pad vertical height is usually 4'. Preferred distance between fan and pad is 100 to 150 ft
- About 5-6 L/min of water should flow through pads; a bleed-off to water sump ensures that sediments are discharged



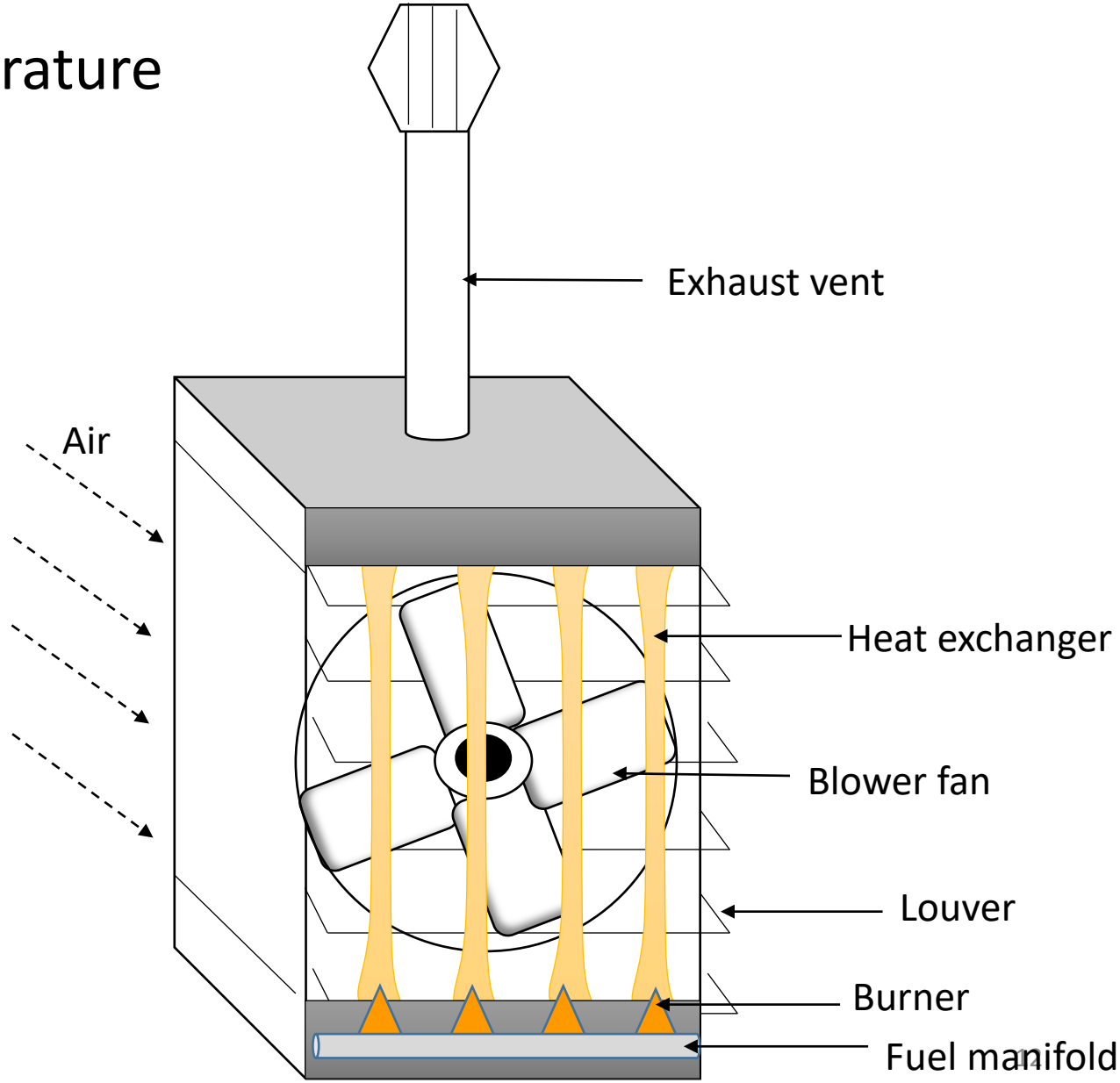
Source: Munters CELDEK

6. Fogging

- Fogging consists of spraying fine water droplets of water into the air
- Droplet size is critical: not more than 50 µm or microns for effective cooling
- Water droplets absorb heat in the air to evaporate. This decreases air temperature and increases the relative humidity of the air
- Larger droplets will condense on plants (can cause pest problems)
- High-pressure pump used to atomize water to generate fine water droplets
- Nozzles should be evenly spaced
- Water quality should be good to prevent clogging
- As fogging increases RH, it is good for propagation
- The fogging method of cooling is expensive

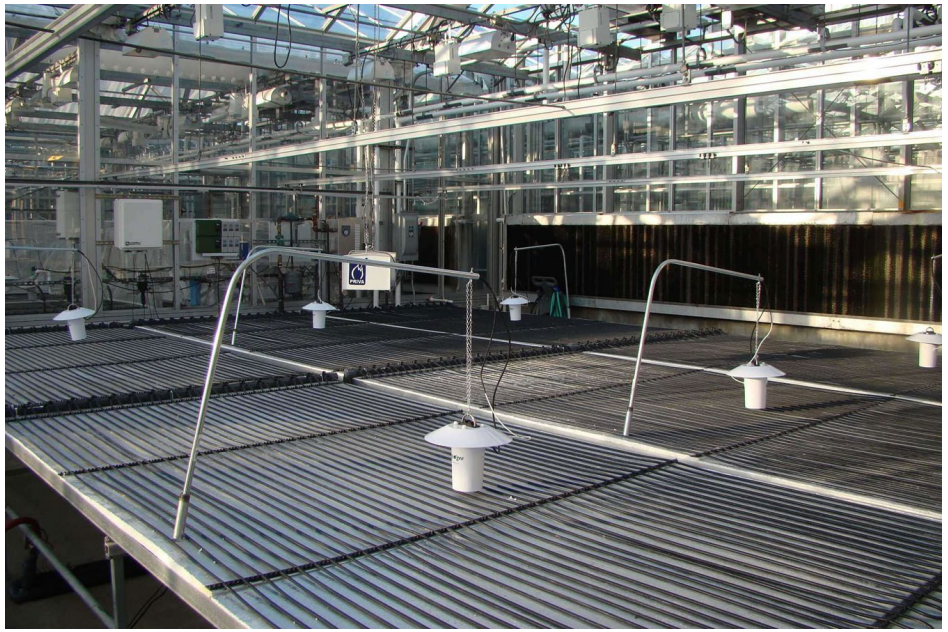
Different methods of heating a greenhouse

1. Maintain greenhouse air temperature

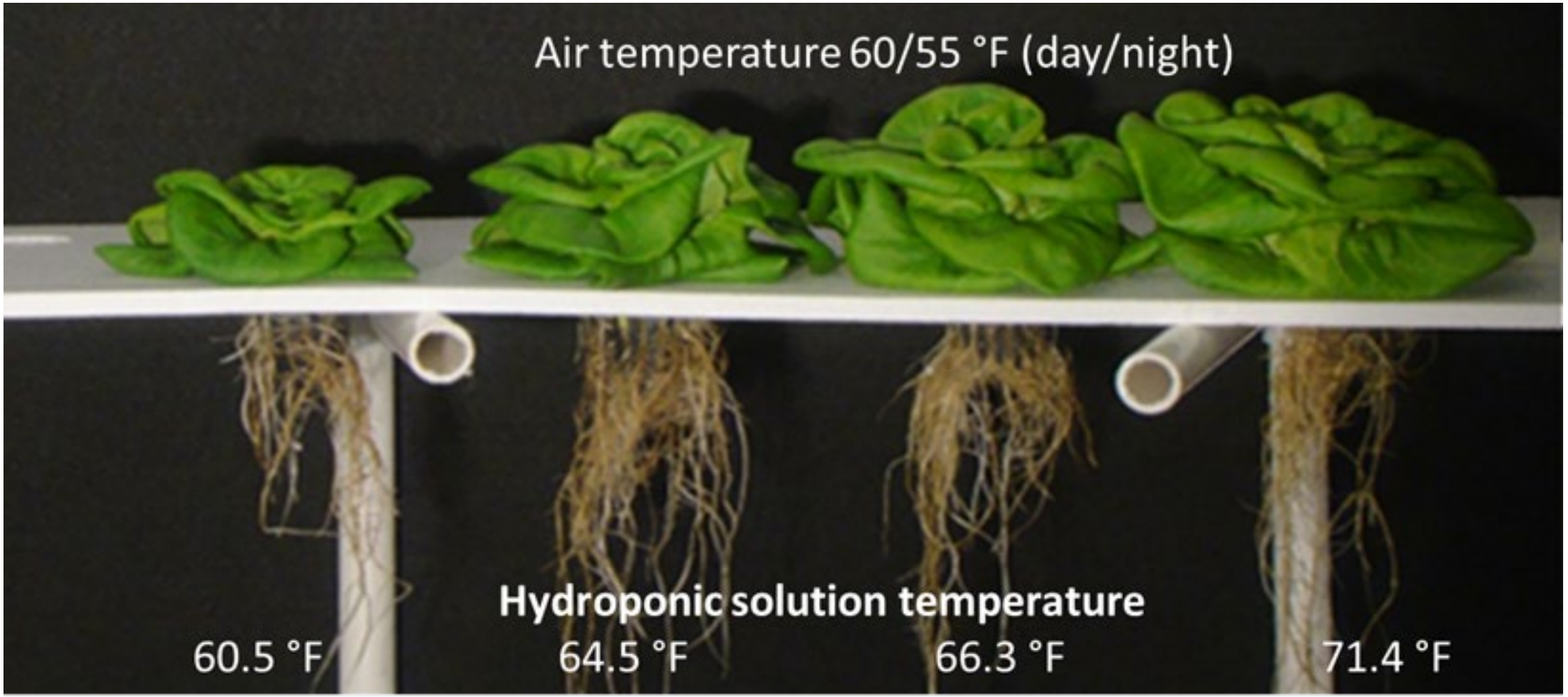


2. Maintain temperature in the plant microclimate

- Provides optimal temperature to root zone
- Hot water at 35 to 40 °C (95 to 104 ° F) is circulated through 0.5 inch polyethylene tubing
- Flow rate should be high enough to minimize difference between supply and return sides and avoid sedimentation
- Tubing can be placed on the bench. A polystyrene sheet at the bottom ensures heat is directed towards roots
- Usually 4-inch spacing between tubes, less spacing if more temperature uniformity is desired
- Sometimes hot air is directed to the lower side of the bench as opposed to entire greenhouse



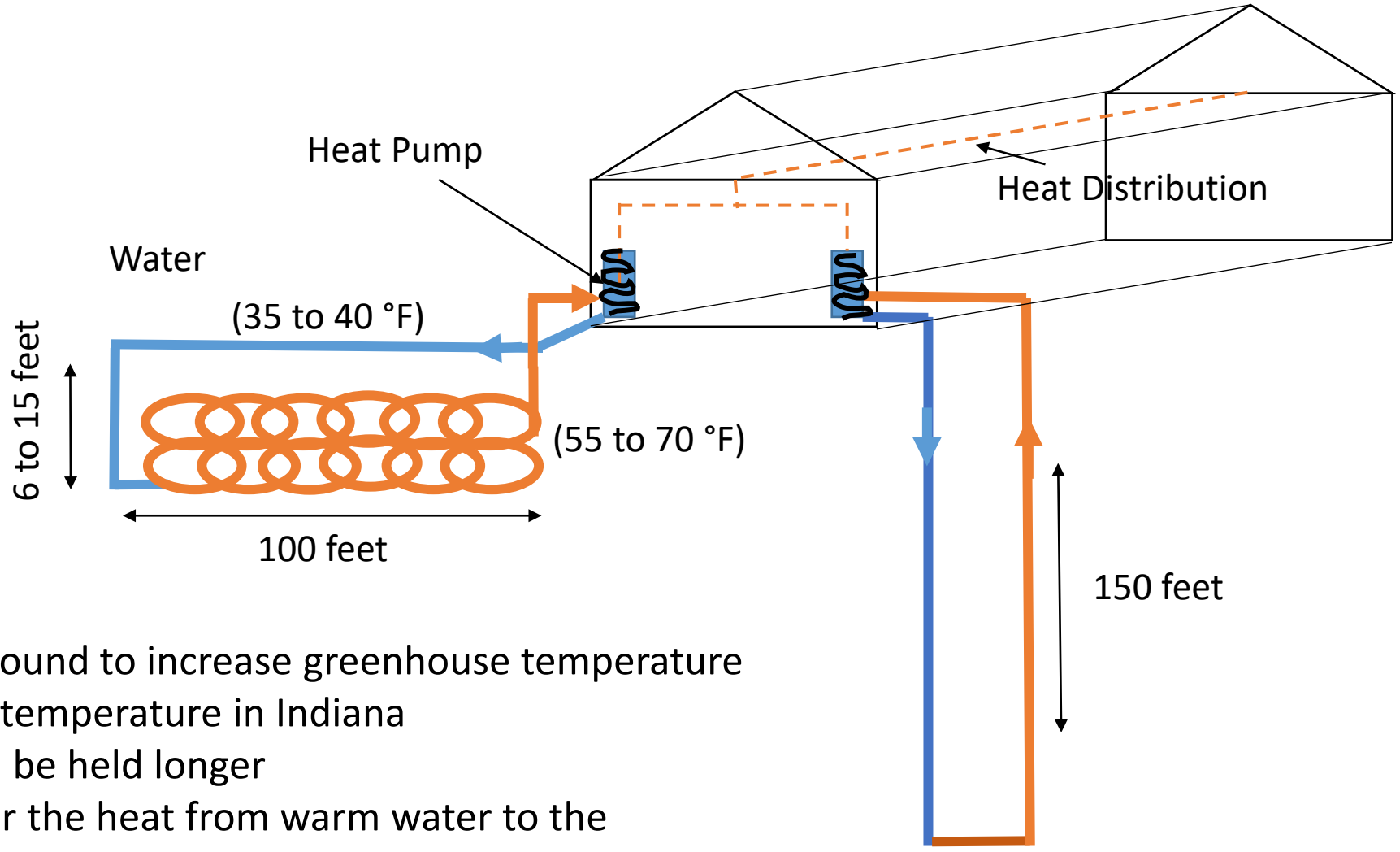
Using a warm hydroponic solution under cooler air temperature



3. Passive heating: solar greenhouse

- Heat gained from sun during the day by walls, soil, plants, structure is released back into greenhouse by convection at night
- Blanket or IR coated polythene used as thermal insulation to minimize heat loss at night

4. Geothermal heating



- Using the heat stored in the ground to increase greenhouse temperature
- About 55 °F is the geothermal temperature in Indiana
- With good insulation, heat can be held longer
- A heat pump is used to transfer the heat from warm water to the greenhouse air ducts. The pump requires electricity to operate