Tobacco Transplant Production in Greenhouses

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Outside Bed Construction

- Plastic Bed Liner
  - 6 mil best
  - Drape over bed and form fit
  - Fill bed with water
    - To desired depth
      - 5” common
  - Tack Plastic down
- Bows
  - Form to support cover
  - 2 to 4 ft apart
  - Prevent swags
    - Water Accumulation
  - Prevent damage to covers

Outside Bed Construction

- Covers
  - Sturdy
  - Freeze protection
  - Rain protection

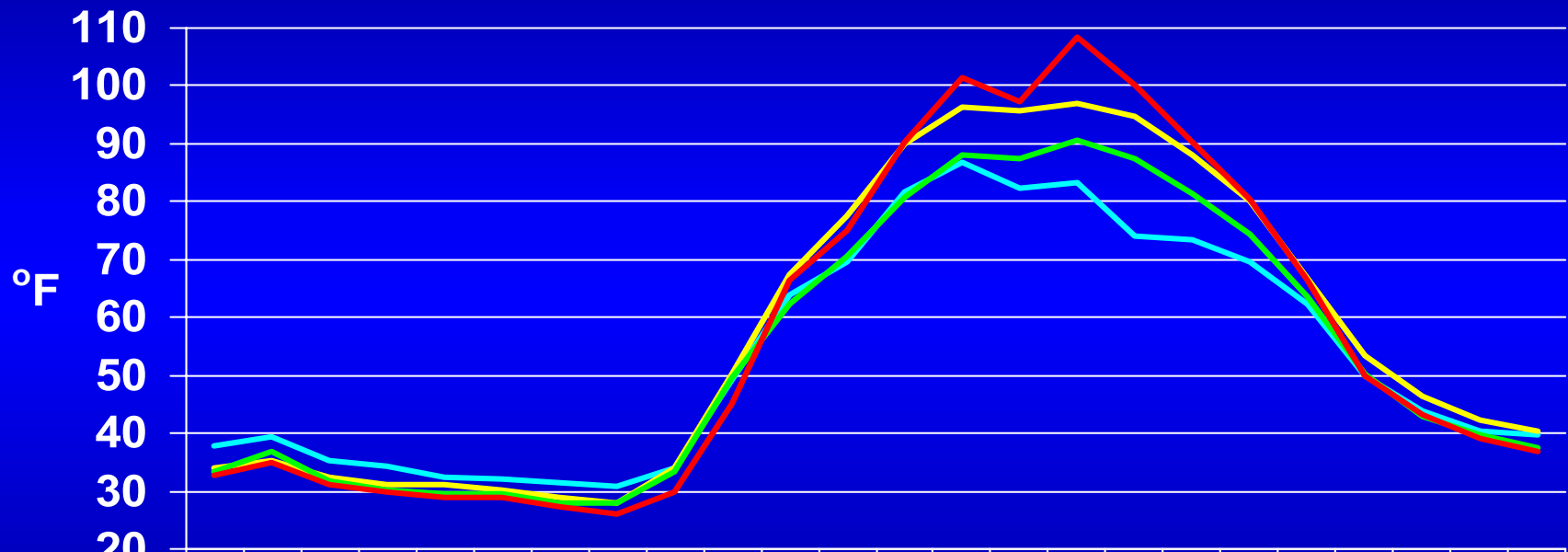
Outside Bed Construction

- Level area
  - Water will find level
  - Avoid swimming pool syndrome
    - Deep end & shallow end
- Free of debris
  - Sand or lime for good surface
- Used 2 x 8's to form box
  - Inside dimensions
    - Consider trays 14" X 27"
    - Determine number wide and long
    - Approximately 30-35 trays per acre
      - Depends on cell number/tray

Types of Covers for Outside Beds

- Continental
  - Expanded Polyethylene
  - More heat retention
  - More rainfall protection
- Typar
  - Expanded Polypropylene
  - Cooler
- Vispore
  - Plastic with tiny pores
  - Heat buildup
  - Doesn’t retain heat energy at night
- Plastic
  - Rainfall protection
  - Heat buildup

INFLUENCE OF FLOAT BED COVERS ON DAILY FLUCTUATIONS IN TEMPERATURE



	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11
Ambient	38	39	35	34	33	32	31	31	34	49	64	70	82	87	82	83	74	73	70	62	50	44	40	40
Continental	34	35	33	31	31	30	29	28	34	50	67	78	90	96	96	97	95	88	80	67	53	46	42	40
Typar	33	37	32	30	30	30	28	28	33	50	62	71	81	88	87	91	87	81	74	64	50	43	40	38
Vispore	33	35	31	30	29	29	27	26	30	45	66	75	90	10	97	10	10	90	80	66	50	43	39	37

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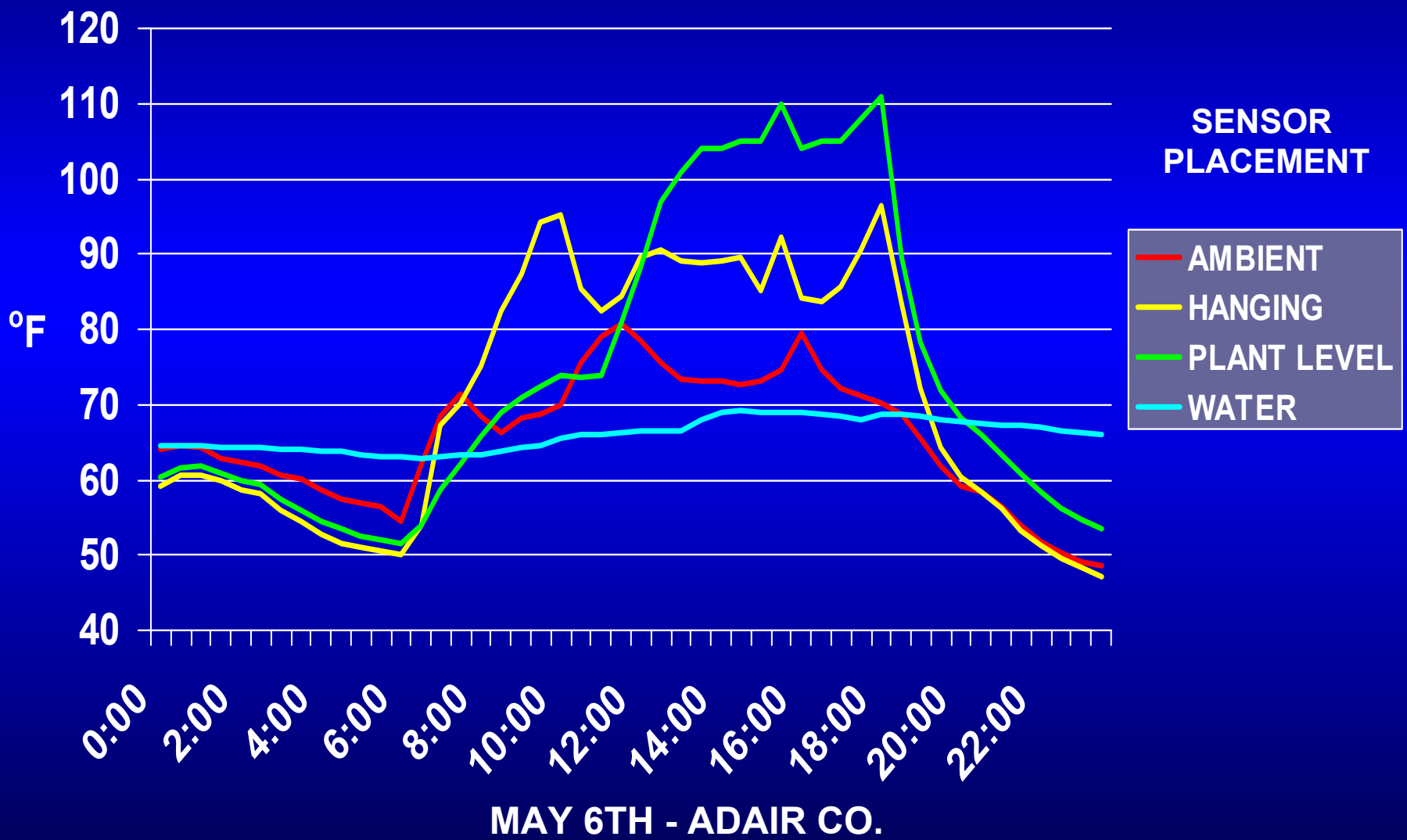
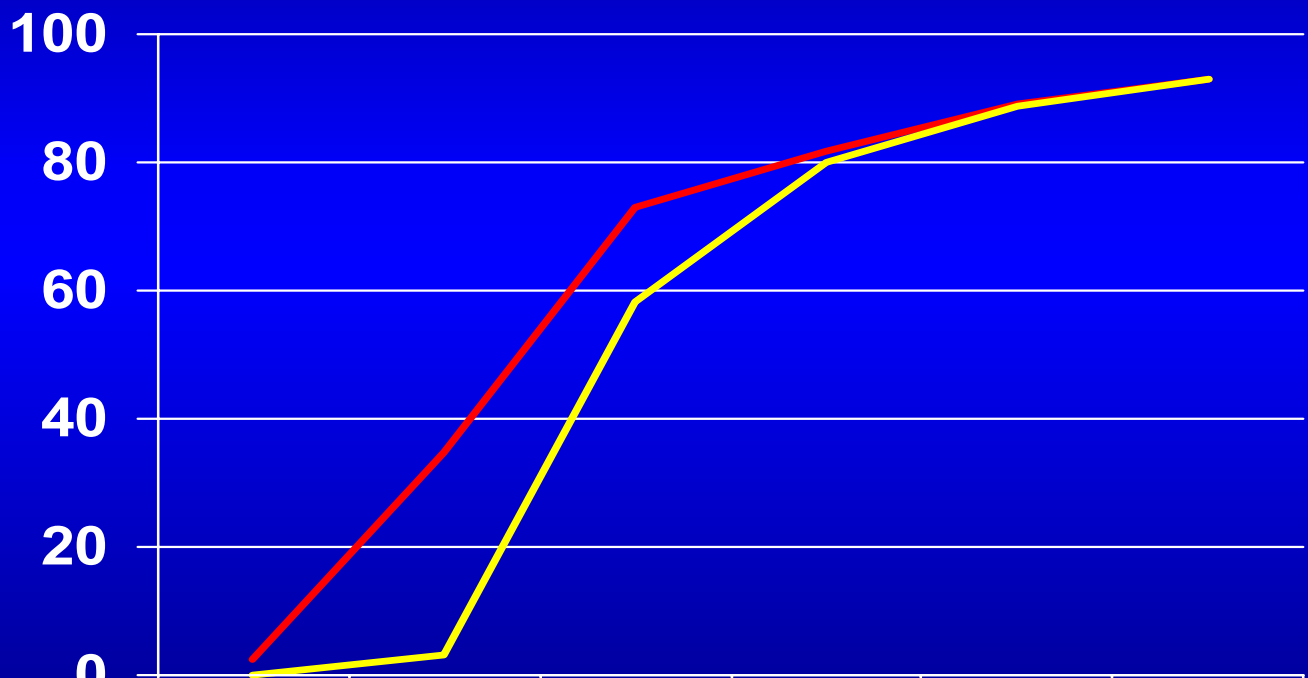
MINI-GREENHOUSE TEMPERATURE STUDY



PERFORMANCE OF PRIMED SEED IN AN OUTSIDE FLOAT SYSTEM - CASEY COUNTY



	5	7	9	11	13	15
PRIMED	2.49	34.863	72.9	81.9	89.25	92.88
NONPRIMED	0.12	3.242	58.34	79.88	88.89	93

Thermostat

- Locate near plant level
- Don’ts
  - Locate on end walls
  - Near cracks
  - Doors
  - Fans
  - Shutters
  - Locate in direct sun
  - Distorts ventilation control
  - Fans operate while heating is still occurring

Greenhouses

- **Germination**
  - **Optimum Temperature**
    - **Soil**
      - **70° to 75°F**
    - **Air**
      - **Above soil**
      - **High end 90°F**
        - **Damage or kill germinating seeds**

Germination

- Variety
  - TN 86 slow
  - 7-14 days
- Chambers
  - 3 ½ days
  - High humidity
    - 90% +
  - Optimum temperature (70º - 75 º)

Faster transplant growth

- Daytime temperatures
  - **70° to 80°F**
    - Lower temp/Slower growth
  - Nighttime temperatures
    - **60° to 70°F range initially**
    - **50° to 65°F**
      - ***After four-leaf stage***
      - **Conserves heating costs**

Heaters

- Vented
  - Location
    - Inside the greenhouse usually
    - Some outside
  - Advantages
    - Cleaner, safer environment
    - Dry heat
  - Limitations
    - large and heavy to mount to bows.

Radiant heaters

- Normally unvented
- Directs heat to soil and plant surfaces
- Less heating of the air
- Cleaner combustion
  - Reduces fuel usage
- Temperature control
  - More difficult
  - Sensor must measure soil/plant surface
- Goes through plastic
  - Extra heat loss can occur
- Moisture
  - Still produced
- Fresh air needed
- Cost of units
  - Usually higher than comparable air-heating units

Unvented

- Advantage
  - Heat kept inside
  - Simpler to install
- Location
  - Inside or outside
- Limitations of Unvented
  - High risk for plant damage from fumes
  - Needs oxygen (fresh air) inlet to burn fuel
  - Requires air outlet
    - Allow combustion products to escape
  - Produces extra moisture
    - Humidity
    - Condensation

Combustion byproducts

- **Ethylene**
  - ***Causes necrotic spots, leaf curl & yellowing***
  - **Can harm tender young seedlings**
- **Sulfur dioxide**
  - **Damages leaf tips**
- **Nitric oxide**
- **Carbon monoxide**
  - **Very dangerous to humans**

Thermostat

- Do's
  - Shade top and sides
  - Allow free air circulation
    - Aspirated chamber or enclosure
      - Small fan moves air by the thermostats
  - Located near plant level
  - Mount to swing out of way of clipping system

Ventilation

- Objectives
  - Maintain the inside air and soil temperature below 85° to 90°F.
  - Remove excess moisture
  - Provide fresh air for heater fuel combustion

Side curtains

- Passive
- Allow natural air exchange
- **Dependent on Wind**
- **Thermal currents**
- Advantages
  - **Cost less**
  - **Can be automated**
  - ***Reduce labor***
  - ***Precise control.***

Limitations

- **Manual operation requires human presence**
- **No uniformity of temperature**
- ***Cold drafts***
- **Heaters may operate when open**
- **Air leakage**
- ***Non-tight fit***
- ***Added heat costs***
- **Require straight sidewall**

“Flushing” the air each evening and morning

- **Helps ventilate excess moisture**
  - **Opening side curtains**
  - **Operating the ventilation fans for several minutes**

Combination: Fans and Curtains

- Automates first stage
- Advantages
  - **Reduces human presence**
  - **Drafts**
  - **Potential cold injury**
- Limitations
  - **Curtains have to be checked, opened or closed as required**
  - **Tradeoff between costs and better temperature control**

Ventilation needs: In 30 x 100-foot greenhouse

- One-half air leakage per hour
  - Dispel 22 pounds of moisture
  - Assuming movement of 70°F, 90 percent relative humidity air out
  - 40°F, 50 percent air in, heated up to 70°F
  - Equivalent to 400 to 500 cubic feet per minute (cfm) of steady fan capacity

Operate Fans in stages

- **1st stage**
  - ***20 percent of requirement***
- **2nd stage**
  - ***40 percent of requirement***
- **3rd stage**
  - ***40 percent of requirement***

Ventilation requirements

- **Air change per minute (CFM)**
- **Equivalent of removing and replacing all the air in the greenhouse once each minute**
  - **Spring & Fall**
    - ***¾ to 1***
    - **Ex. ¾ in 30 X 100 with 4 ft side wall**
  - **Summer**
    - ***1 to 1.25***

Curtain Styles

- **Manual Curtains:**
  - **Role up**
  - **Role down**
    - ***Reduces cold injury***
    - ***Cold air mixes with inside air before dropping down onto the plant***
- **Automated Curtains**
  - **Operating by thermostatic control**
  - **Reduce need for human presence**
  - **Must be reliable**
  - **Not overreact**
  - **Open too wide**
    - ***Producing harmful drafts***

Size determination for curtains

- **Wind**
  - **Velocity**
  - **Direction**
  - **Orientation**
- **Outside air temperature**
- **Air blockage**
  - **Vegetation**
  - **Buildings**
  - **Two or more greenhouses side by side**
- **Width of the house**
- **Rule of thumb**
  - **1 foot sidewall opening per 10 feet of house width**
  - **30- to 36-foot houses**
    - ***3- to 4-foot opening***

Shutter Installations

- **Gravity-type**
- **Opens before Fans**
  - ***8 to 10 sec delay***
  - ***Or thermostat set 2-3 degrees cooler***
- **Close when fan stops**
  - ***Prevents cold air from entering***
- ***Location***
  - **Opposite end of the greenhouse**

Shutter Size

- Equal to the size of the fan
  - Or 1.25 to 1.5 times larger
- Located 3 feet above the plant level
  - Minimizes drafts
  - Baffles deflect air upward
  - Provide mixing
  - Reduces cold injury

Air Circulation

- **Forced air**
  - **Uniform environment**
  - **Improved plant growth**
    - **Horizontal air flow system**
    - **Simple & Common System**
      - **16- to 24-inch fans**
        - ***Suspended in the greenhouse***

Locating a Circulation Fan

- *Spacing*
  - 40 to 50 feet apart
  - One-fourth of the house width from each sidewall
- *Height*
  - Halfway between plant level and the roof
- *Angle*
  - 10 to 15 degrees inward and downward

Moisture and Humidity

- Problem in most greenhouses
- Sources
  - Evaporation
    - Water surface
    - Soil surface
  - Transpiration
  - Combustion
- Condensation on plastic or structural surfaces
  - Surface cools to dew point
  - Drip
    - Erodes seedlings from tray cells
    - Causes disease problems
    - Corrodes structures and equipment

Double-layer plastic

- Insulates better
- Warmer inside surface temperature
- Less condensation potential
- Condenses the excess moisture
- Provides Stability in high winds
  - Inflation Fan

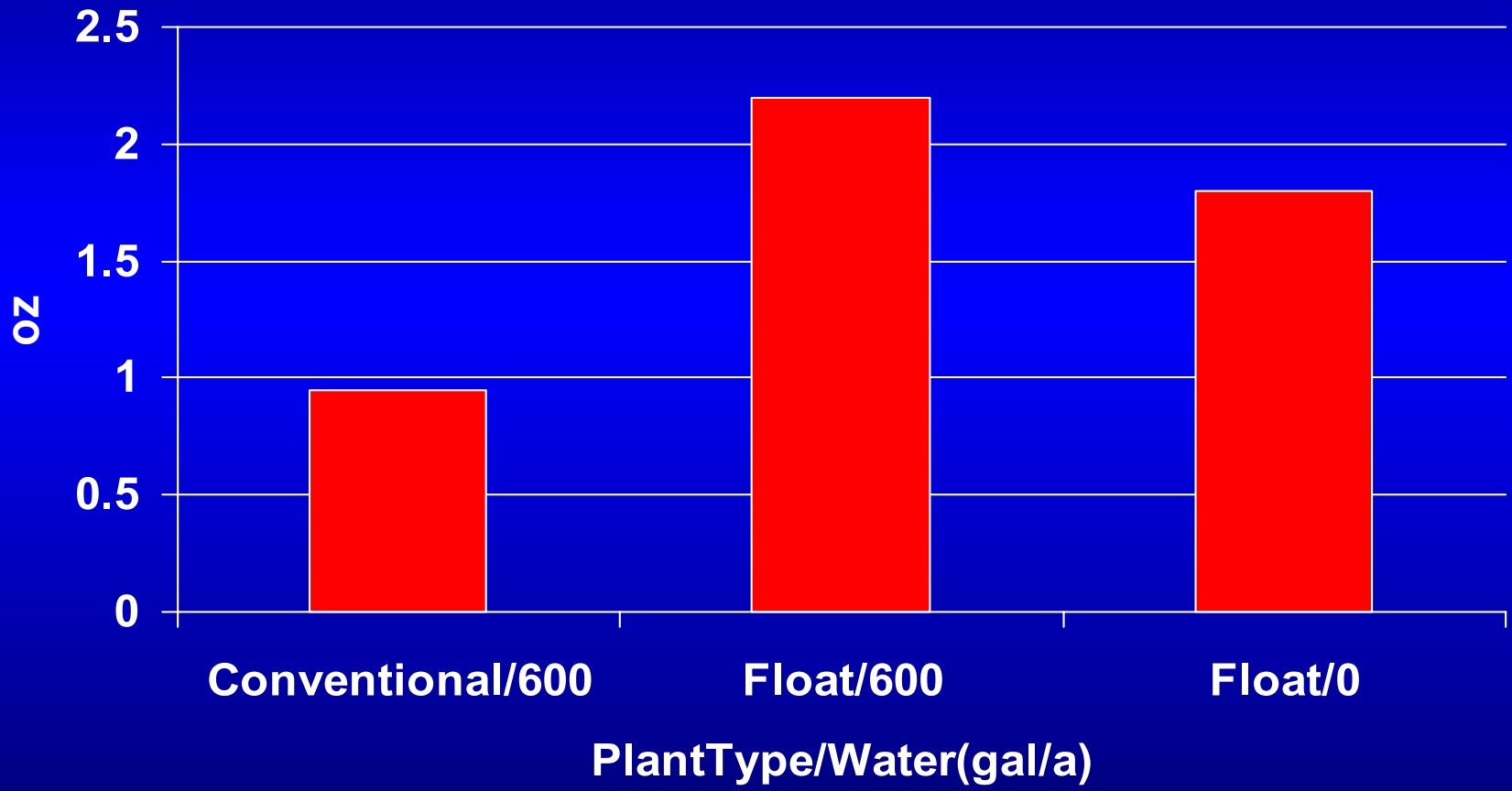
Problem Situations
Moisture and Humidity

- Run Small fan continuously
- Larger fan on interval timer
- Open side curtain
  - Downwind side
  - 1 to 2 inches
  - Causes heat loss
    - Cost of reducing high humidity and condensation

Float Systems

- Advantages over conventional plant beds
  - Producer has control of growth
  - Timing
    - Set all day
    - More set per day
    - More time for other farming activities
  - No transplant shock
  - ***More uniformity***
- Disadvantages
  - Allows producers to set more than can manage
  - Tend to set shallow

Root Development of Float Plants



Float Systems

- Plug & transfer
  - Trays seeded and plugs produced by 2nd party
  - Bought by producer at 4 week old

Plug & transfer

- Transferred to Finishing Tray
- Advantages
  - Difficult part is over
  - Plants are more uniform
- Disadvantages
  - Cost
  - Labor

Plug & Transfer

- Fill Trays with Media
  - Do not over fill
- Transfer to Finishing Tray
  - 1000+ /hr
- Place on Bed
  - Avoid Excessively Cold, Windy Weather
  - Must have 2 to 3 days to acclimate

Direct Seeding

- Seed Pelletized Seed into Finishing Tray
- Place in outside Float System or Greenhouse

Dibble

- Depression for seed
- Micro climate
- Depth ¼ to ¾
- Type
  - Round
  - Pyramid
  - Mechanical

Mechanical seeding

- Automated seeding
  - Pelleted seed
    - Singulation
    - Placement
  - Fast/high capacity
  - Drum

Hand Seeder

- Vacuum
  - Most common
  - Quicker
  - Holes may plug
  - Noisy
- Portable
  - Material
    - Plexi-glass
  - Slower
  - Double seed
  - Static electricity

Media

- Characteristics
  - Solid particles of medium
  - Pore space
    - Small Pore Space
      - Capillaries
      - Water coating surfaces of particles
    - Large Pore Space
      - Air occupying the center pores
      - Drainage
  - Cornell mix
    - 50% peat moss
    - 50% vermiculite

Components of media

- Peat moss
  - Water & nutrient retention and rooting
  - Maintains root ball
  - Initially hydrophobic
    - **Wetting agents**
- Vermiculite
  - Water & nutrient retention and rooting
  - Heat expanded mica
    - Glassy material in flat layers

Components of media (cont'd)

- Perlite
  - White, crumbles easily
  - Aeration
  - From glass-like volcanic rock
- Polystyrene beads
  - Aeration
  - Drainage
- Rock wool
  - Water retention and aeration
  - Spun molten rock
- Coir - Coconut hull fiber
  - Water & nutrient retention and rooting
  - Does not maintain root ball

Trays

- Sizes & attributes
  - 200 = 27cc v shaped bevel
  - 242 = 23.6cc straight side wall beveled at bottom
  - 253 = 16cc shallow v shaped bevel
  - 288 = 17cc straight side wall beveled at bottom
  - 338 = 13.6cc v shaped bevel
  - 595 plug tray 1 inch deep |
  - 882 plug tray ¾ inch deep | **Not suited for float system**

Tray filling

- Methods
  - Hand –

    sift soil on top allow gravity to fill, clean with straightedge

  - Hopper box - prevent weight of media from pressing on tray.

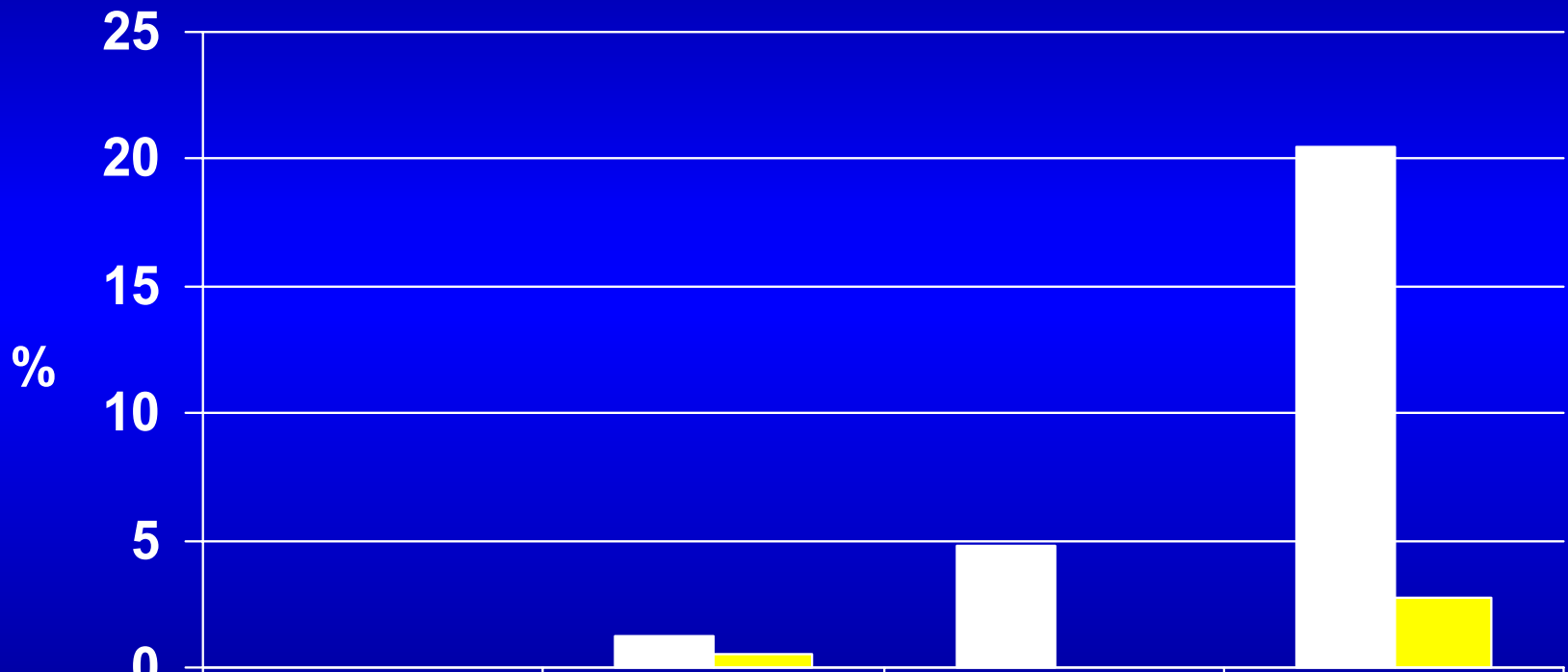
Over Packing

- Saturation of media
- Heavy tray
  - 200 cell tray = 8.3 lbs
- Tray sinks lower into water

Over Packing

- Algae
  - Nitrogen
  - Sunlight
- Slow plant growth

Over Packing - Spiral Root



	Dry/Gravity	Medium/Gravity	Medium/Light	High/Tight
Dibbled	0	1.25	4.75	20.5
NonDibbled	0	0.5	0	2.75

Moisture/Pack

Spiral root

- Causes
  - Hard Seed Coat
  - Drying Conditions
    - Sunny, hot weather
  - Poor Wicking Media

Fertility

- Water volume
  - Tray # X depth in inches X 1.64
  - Example: 759 * 4.5 * 1.64 = 5600gal
- Fertilization
  - Nitrogen
    - Amount
      - 100 ppm ideal
    - Calculations
      - 20-10-20 to get 100 ppm N
      - Water = 8.34 lb/gal
      - 8.34 X 1000 gal = 8340 lbs
      - 100 ppm = 1/10000 or .834 lb/ 1000 gal
      - 20-10-20 is 20% N. .834/20% or .834/.2 = 4.17 or 4.2
      - If 15-5-15 - .834/.15 = 5.56 lbs.

Source of Nitrogen

- Nitrate
  - Best
  - Readily available form
- Ammoniacal
  - Marginal
  - Ammonium form
- Urea
  - Worst
  - Can convert to ammonia or nitrite which can be toxic to plants

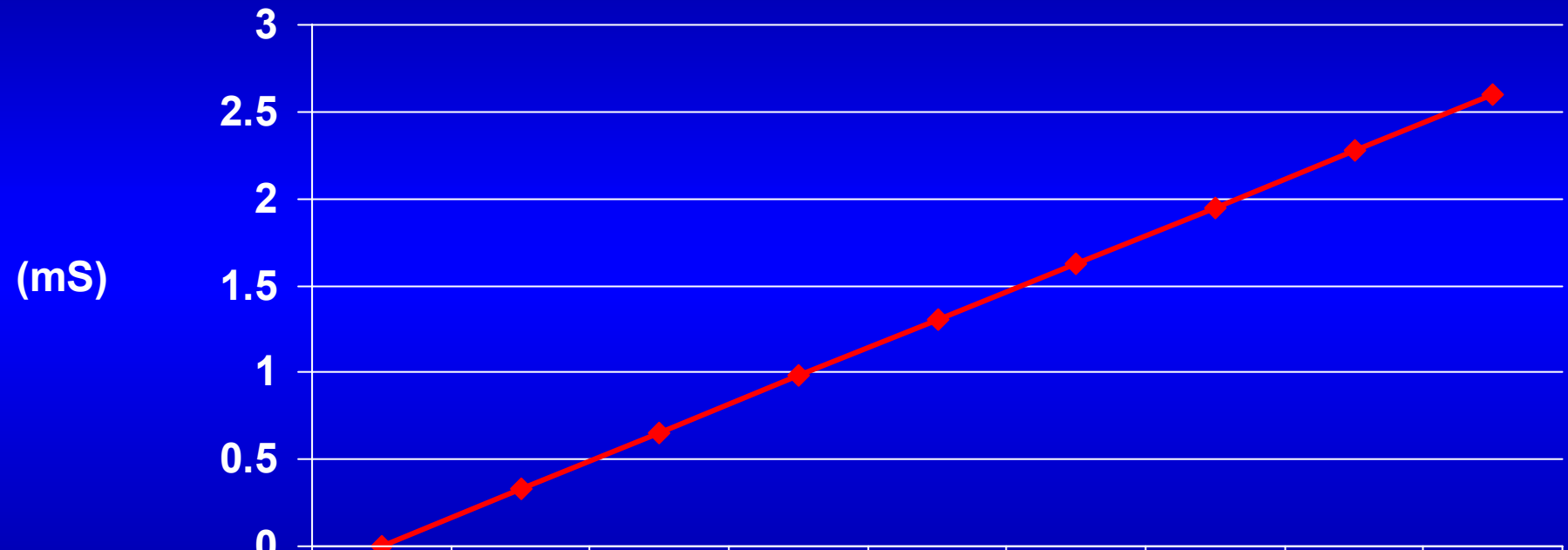
Estimating fertility

- Conductivity - Measure of electrical flow
  - Units
    - mS milli-Siemens
    - 100 micro-Siemens or mmhos
  - Method
    - Take water source reading (ex. 0.4)
    - Measure fertilized water (ex. 1.3)
    - Know fertilizer conductivity (ex 20-10-20 is .33/50 ppm) or check chart
      - 1.3 – 0.4 = .9, .9/.33 = 2.73
      - 2.73 * 50 = 136 ppm

CONDUCTIVITY READINGS

STANDARDS CHART FOR 20-10-20

1 mS (DiST 4 meters)



PPM N	0	50	100	150	200	250	300	350	400
Salt Content	0	0.33	0.65	0.98	1.3	1.63	1.95	2.28	2.6

PPM N

1. TAKE WATER SOURCE READING (PLAIN WATER)
2. TAKE FERTILIZED WATER READING
3. SUBTRACT WATER SOURCE FROM FERTILIZED

EXAMPLE: IF PLAIN WATER = .4 & FERTILIZED WATER = 1.4,
1.4-.4=1.0, PPM N = 150

Clipping

- Clipping
  - 3 – 5 times
  - 1st level bed
  - Remove small amount
- Benefits
  - Uniformity
  - Stem diameter
  - Toughness

Clipping

- Types
  - Rotary mower
    - Sharp blade
    - Slow speed
  - Electric
    - One speed (fast)
    - Rheostat

Reel mower

- Cuts whole pieces
- less maneuverable
- Cuts in one direction

Tray sterilization

- Contaminated trays
  - New trays versus old
- Bleach 10%
- Steam
  - must reach 140^{o} F for 30 min
  - 180^{o} F damages Trays
- Methyl Bromide
  - Cheap
  - Quick
  - Dangerous
  - Environmental concerns