

# Successful Cutting Propagation is Rooted in the Basics

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# Stages of Cutting Propagation

Cutting propagation can be divided into five stages.  
These include:

Stage 0 - Preparation for cutting propagation

Stage 1 - Cutting procurement to sticking

Stage 2 - Root initiation (callusing)

Stage 3 - Root formation

Stage 4 - Acclimatization (toning)



# Stages of Cutting Propagation

## Stage 0 - Preparation for cutting propagation

Stage 0 - is the period prior to cutting procurement and sticking cuttings

Make sure environmental control area is fully functional

Moisture control

Air and substrate temperature

Light levels





# Stages of Cutting Propagation

Stage 0 - Preparation for cutting propagation

Select appropriate flats and substrate.





# Stages of Cutting Propagation

## Stage 0 - Preparation for cutting propagation

Select appropriate beds and substrate.





# Stages of Cutting Propagation

## Stage 0 - Preparation for cutting propagation

Budget enough labor for sticking cuttings.





# Stages of Cutting Propagation

## Stage 1 - Cutting procurement to sticking

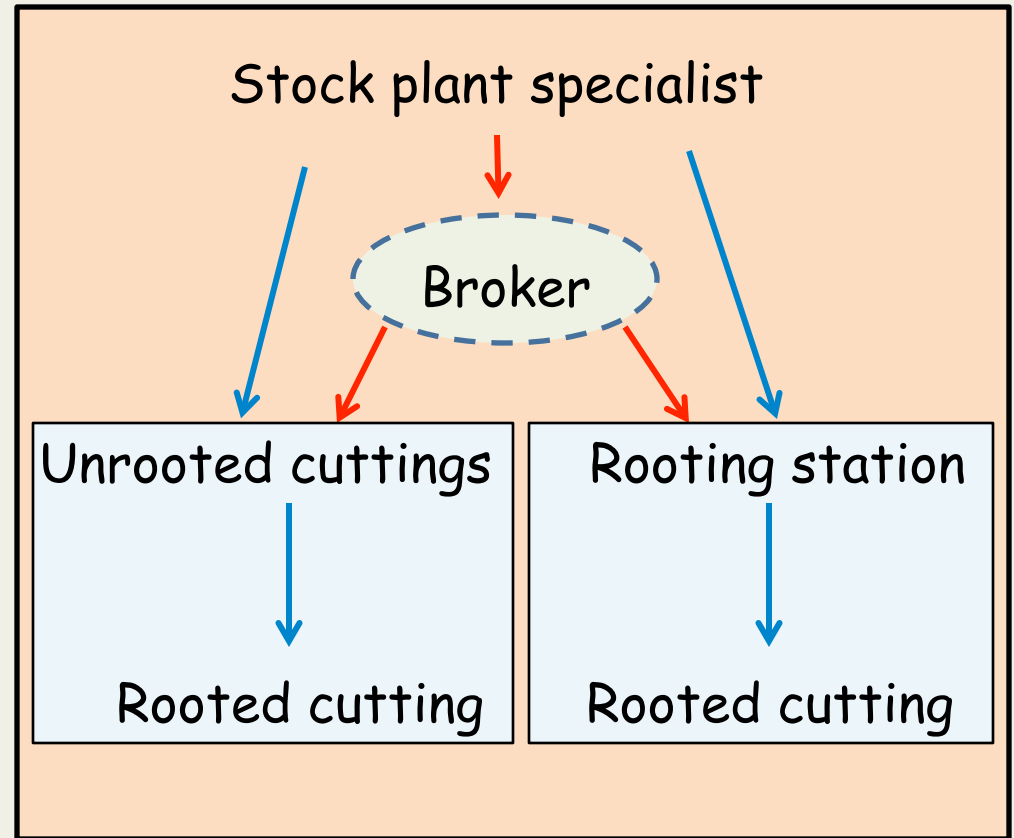
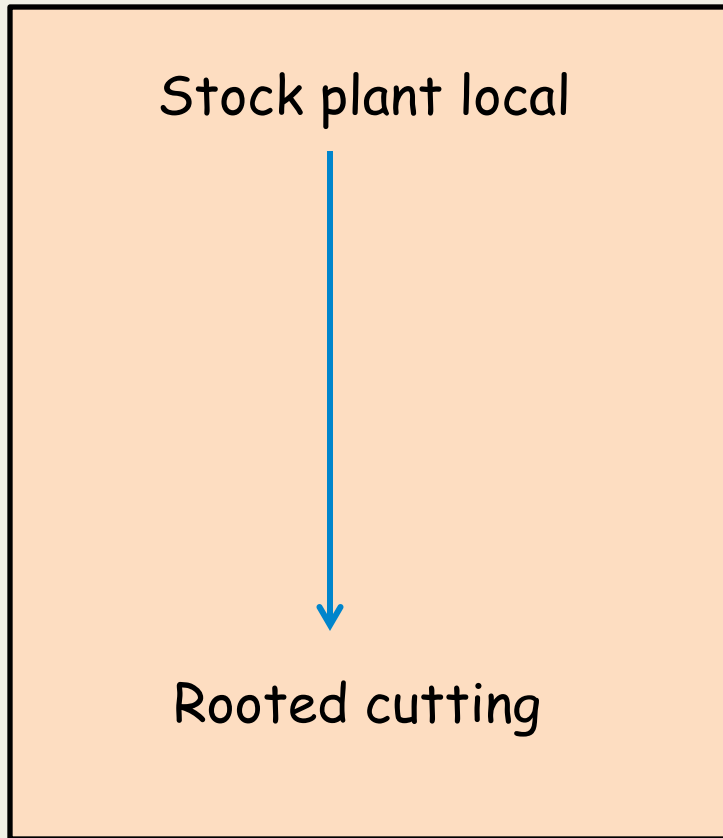
Stage 1 - is the period from when cuttings are taken from stock plants until they are stuck for propagation.

Stock plants may be maintained by the grower or the grower can purchase cuttings from a cutting stock plant specialist.



# Stages of Cutting Propagation

## Stage 1 - Cutting procurement Cutting supply chain.



# Stages of Cutting Propagation

## Stage 1 - Cutting procurement

Advantages and disadvantages of growing your own stock plants.

<u>Advantages</u>	<u>Disadvantages</u>
Control of quality	Cost of maintaining stock plants
Cost of propagation	
Unique plants - limited availability	Structural imbalance
	Disease detection and elimination
	Plant patents

# Stages of Cutting Propagation

## Stage 1 - Cutting procurement

Unrooted vs. rooted cuttings

	<u>Unrooted</u>	<u>Rooted</u>
Coleus	\$ 0.09	\$ 0.36
New Guinea impatiens	\$ 0.17	\$ 0.40





# Stages of Cutting Propagation

## Stage 1 - Cutting procurement

### Stock plant management





# Stages of Cutting Propagation

## Stage 1 - Cutting procurement

Stock plants should be maintained under a strict sanitation program.





# Stages of Cutting Propagation

## Stage 1 - Cutting procurement Stock plant specialists

Screen house to keep out  
disease carrying insects.



Sticky tape to  
detect insects.



# Stages of Cutting Propagation

## Stage 1 - Cutting procurement Stock plant specialists

Insect screening on  
greenhouse access.





# Stages of Cutting Propagation

Stage 1 - Cutting procurement  
Maintain a clean stock plant program.



Disease detection

Clean-up



# Stages of Cutting Propagation

## Stage 1 - Cutting procurement

Stock plants are pinched to increase branching.

Plant Growth Regulators (ethephon) to inhibit flowering.



# Stages of Cutting Propagation

Stage 1 - Cutting procurement  
Collecting cuttings from stock plants

Uniformity

Nutritionally sound

Correct stage





# Stages of Cutting Propagation

Stage 1 - Cutting procurement  
Establish and maintain high standards

Cutting uniformity



Cutting size guidelines for workers.



# Stages of Cutting Propagation

## Stage 1 - Cutting procurement Collecting cuttings from stock plants

Harvest early (<30°C)  
Keep turgid



# Stages of Cutting Propagation

Stage 1 - Cutting procurement  
Sharp clean cutting tools





# Stages of Cutting Propagation

## Stage 1 - Cutting procurement



# Stages of Cutting Propagation

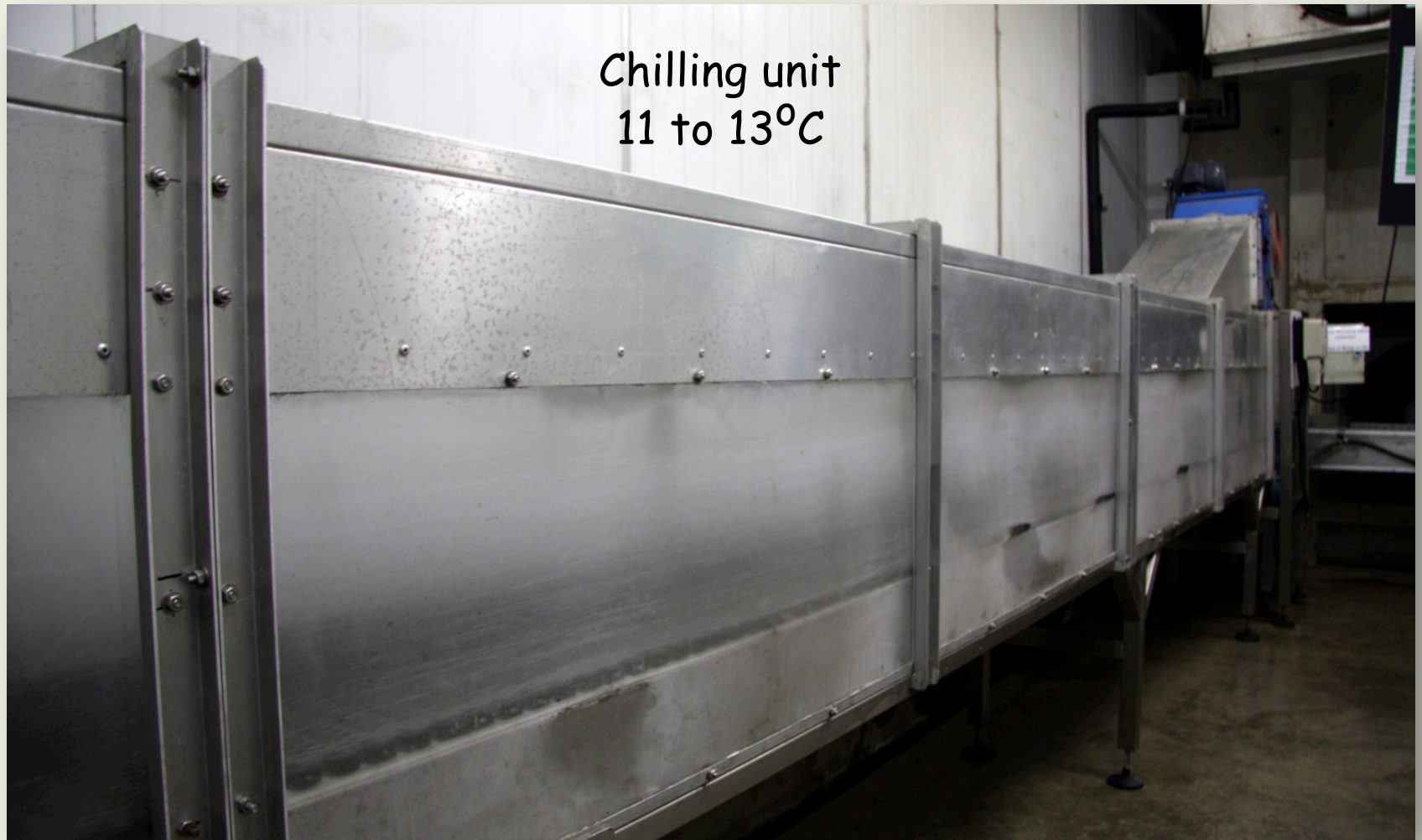
Stage 1 - Cutting procurement  
Stock plant specialists





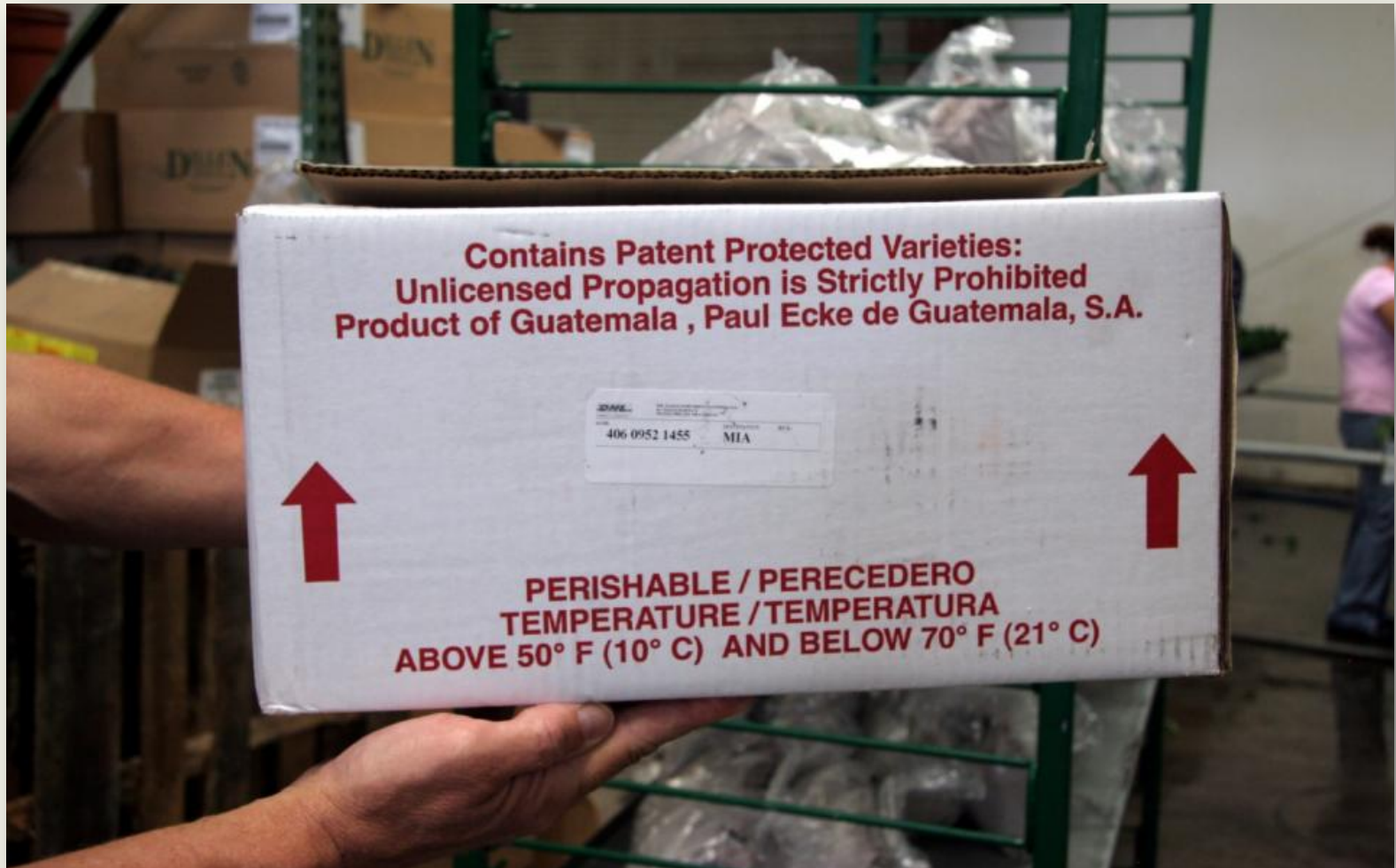
# Stages of Cutting Propagation

## Stage 1 - Cutting procurement Stock plant specialists



# Stages of Cutting Propagation

Stage 1 - Cutting procurement  
Stock plant specialists





# Stages of Cutting Propagation

Stage 1 - Cutting procurement  
Plant entry stations



# Stages of Cutting Propagation

Stage 1 - Cutting procurement  
Plant inspection stations





# Stages of Cutting Propagation

## Stage 1 - Cutting procurement Plant inspection stations





# Stages of Cutting Propagation

## Stage 1 - Cutting procurement Plant inspection stations





# Stages of Cutting Propagation

## Stage 1 - Cutting procurement Plant inspection stations



# Stages of Cutting Propagation

## Stage 1 - Cutting procurement

Plant inspection stations

Gas chamber





# Stages of Cutting Propagation

## Stage 1 - Cutting procurement

Upon arrival, open box and check to see if cuttings are turgid.

Cuttings can be stored in a cooler overnight, but should be stuck as soon as possible.



# Stages of Cutting Propagation

## Stage 1 - Cutting procurement

### Record keeping





# Stages of Cutting Propagation

## Stage 1 - Sticking cuttings

Minimize water stress





# Stages of Cutting Propagation

## Stage 1 - Sticking cuttings





# Stages of Cutting Propagation

## Stage 1 - Sticking cuttings

Hormone (IBA) treatment - dipping station





# Stages of Cutting Propagation

Stage 1 - Sticking cuttings  
Maximizing sticking efficiency





# Stages of Cutting Propagation

Stage 1 - Sticking cuttings  
Maximizing sticking efficiency



# Stages of Cutting Propagation

## Stage 1 - Sticking cuttings

### Sticking boxwood cuttings





# Stages of Cutting Propagation

## Stage 1 - Sticking cuttings

Boxwood in unit containers





# Stages of Cutting Propagation

## Stage 1 - Sticking cuttings



Boxwood in a prepared bench





# Stages of Cutting Propagation

## Stage 1 - Sticking cuttings

Auxin (IBA)

Liquid quick dip

Talc

Post-sticking Spray





# Stages of Cutting Propagation

## Stage 1 - Sticking cuttings

Auxin (IBA)

Post-sticking Spray





# Stages of Cutting Propagation

## Stage 1 - Sticking cuttings

### Auxin and rooting in mum cuttings

<u>Treatment</u>	<u>Duration</u>	<u>Roots per cutting</u>
Untreated		19.7
Quick dip	1 seconds	41.3
	3 seconds	40.5
Talc		29.5
Spray		38.2

# Stages of Cutting Propagation

## Stage 2 - Root initiation (callusing)

Stage 2 - is the period between sticking and visible root emergence.



"Callusing" in poinsettia





# Stages of Cutting Propagation

## Stage 2 - Root initiation (callusing)

Stage 2 - environmental conditions.

Air temperature	24 - 27 °C days; 21-24°C nights
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# Stages of Cutting Propagation

## Stage 2 - Root initiation (callusing)

Stage 2 - environmental conditions.

Air temperature	24 - 27 °C days; 21-24°C nights
Substrate temperature	21-27 °F



# Stages of Cutting Propagation

## Stage 2 - Root initiation (callusing)

Stage 2 - environmental conditions.

Air temperature	24 - 27 °C days; 21-24°C nights
Substrate temperature	21-27 °F
Light	600 - 1000 fc (120 - 200 $\mu\text{mol}/\text{m}^2/\text{sec}$ )

# Stages of Cutting Propagation

## Stage 2 - Root initiation (callusing)

Stage 2 - environmental conditions.

Air temperature	24 - 27 °C days; 21-24°C nights
Substrate temperature	21-27 °F
Light	600 - 1000 fc (120 - 200 $\mu\text{mol}/\text{m}^2/\text{sec}$ )
Shade	For light and temperature control



# Stages of Cutting Propagation

## Stage 2 - Root initiation (callusing)

Stage 2 - environmental conditions.

Air temperature	24 - 27 °C days; 21-24°C nights
Substrate temperature	21-27 °F
Light	600 - 1000 fc (120 - 200 $\mu\text{mol}/\text{m}^2/\text{sec}$ )
Shade	For light and temperature control
VPD control - initial	Mist, tent or fog (24 hr)
VPD control	Mist, tent or fog (daylight hrs); adjust for environment

# Stages of Cutting Propagation

## Stage 2 - Root initiation (callusing)

### Stage 2 - environmental conditions.

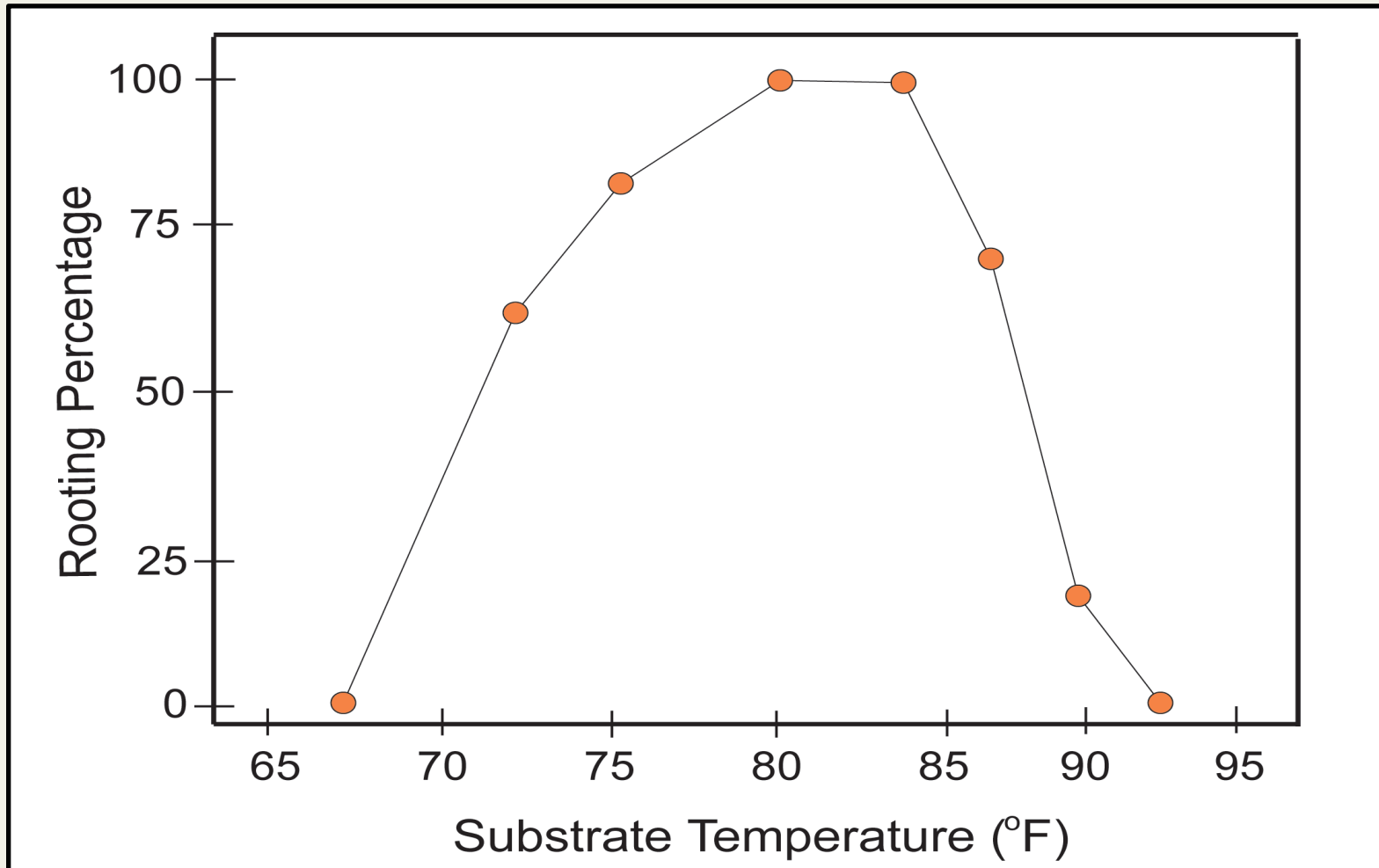
Air temperature	24 - 27 °C days; 21-24°C nights
Substrate temperature	21-27 °F
Light	600 - 1000 fc (120 - 200 $\mu\text{mol}/\text{m}^2/\text{sec}$ )
Shade	For light and temperature control
VPD control - initial	Mist, tent or fog (24 hr)
VPD control	Mist, tent or fog (daylight hrs); adjust for environment
Substrate	pH 5.5 - 6.2; EC below 0.80 mS/cm



# Stages of Cutting Propagation

## Stage 2 - Root initiation (callusing)

Rooting in poinsettia at various substrate temperatures.



# Stages of Cutting Propagation

## Stage 2 - Root initiation (callusing)



Temperature sensor



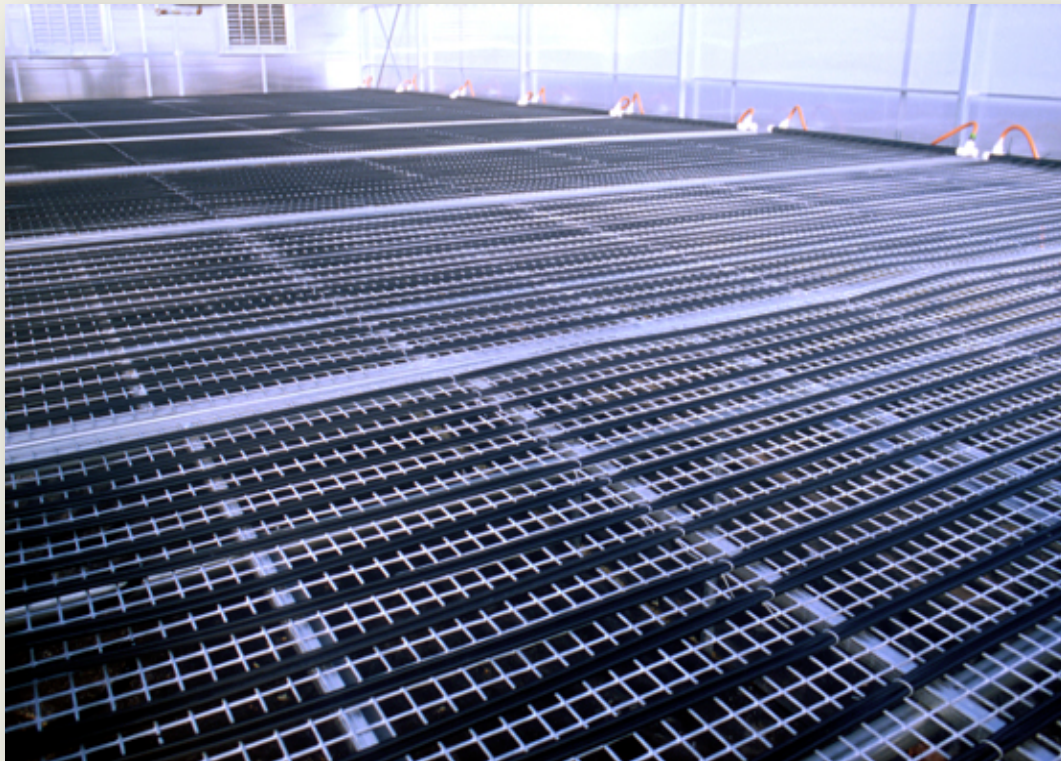
Temperature control unit



# Stages of Cutting Propagation

## Stage 2 - Root initiation (callusing)

Root zone heating using re-circulating hot water.



Hot water heater



# Stages of Cutting Propagation

## Stage 2 - Root initiation (callusing)





# Stages of Cutting Propagation

## Stage 2 - Root initiation (callusing)

### Light

600 - 1000 foot candles

(120 - 200  $\mu\text{mol}/\text{m}^2/\text{sec}$ )



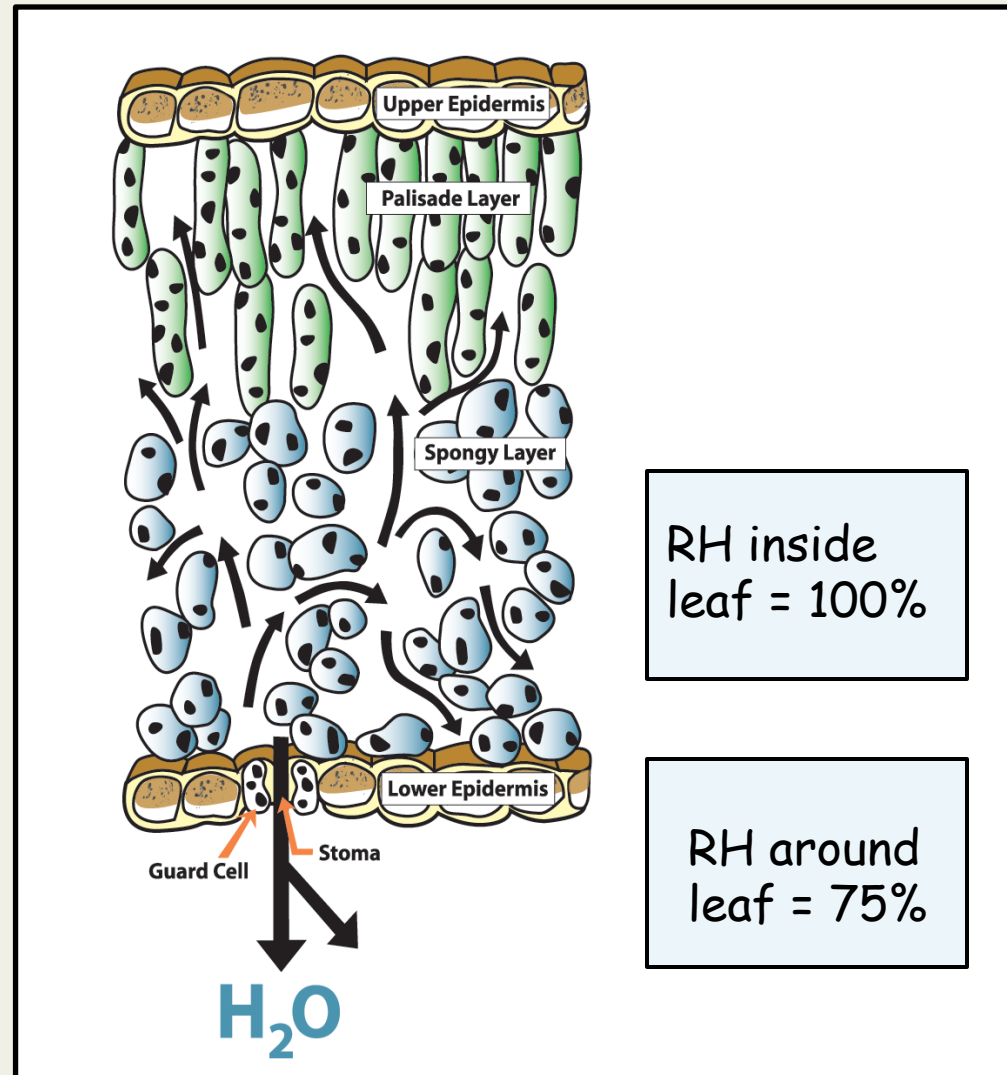
# Stages of Cutting Propagation

## Stage 2 - Root initiation (callusing)

### Vapor pressure deficit control

VPD (vapor pressure deficit) is the gradient between the vapor pressure in the leaf vs. the vapor pressure in the air.

It is determined by the leaf temperature and the relative humidity.





# Stages of Cutting Propagation

## Stage 2 - Root initiation (callusing)

### Vapor pressure deficit control

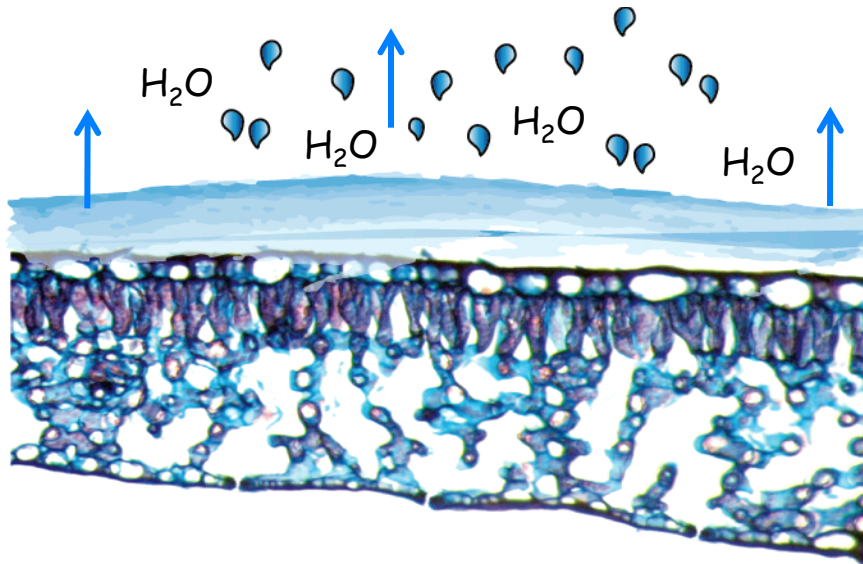
1. Intermittent mist
2. Enclosed systems
3. Fog systems



# Stages of Cutting Propagation

## Stage 2 - Root initiation (callusing)

Misting





# Stages of Cutting Propagation

## Stage 2 - Root initiation (callusing)

2 to 4 days after sticking





# Stages of Cutting Propagation

## Stage 2 - Root initiation (callusing)

Intermittent mist systems

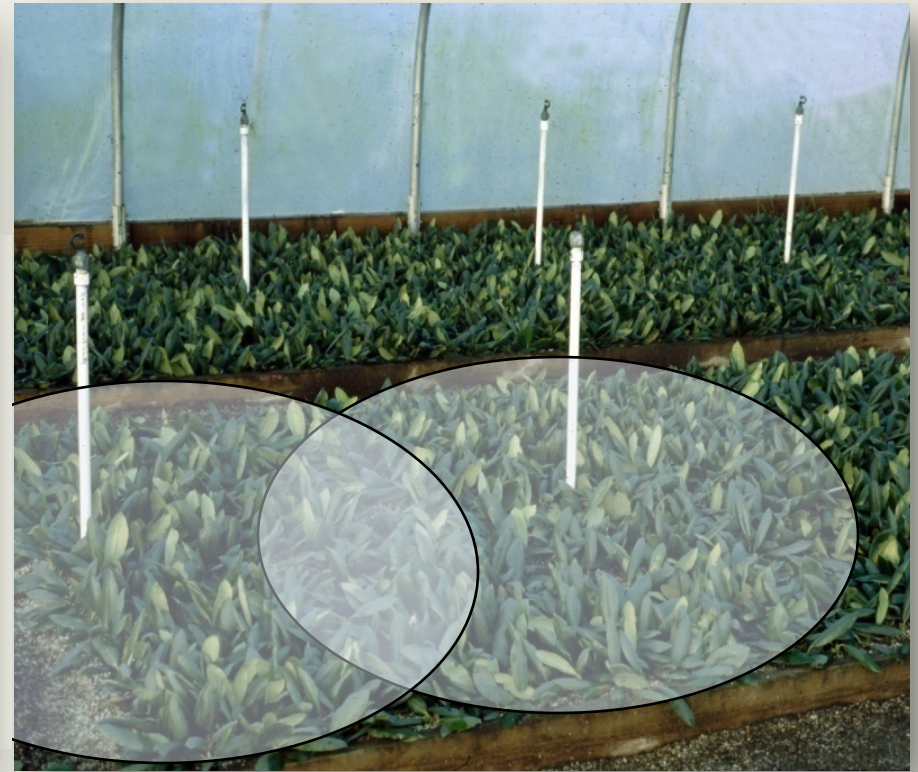
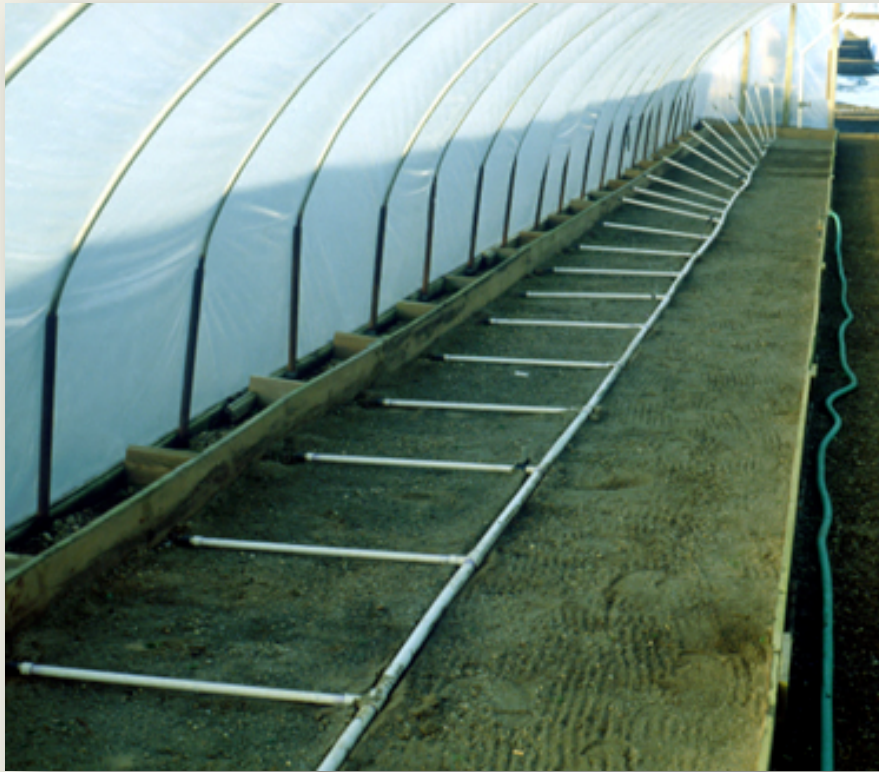




# Stages of Cutting Propagation

## Stage 2 - Root initiation (callusing)

PVC pipe bed system.



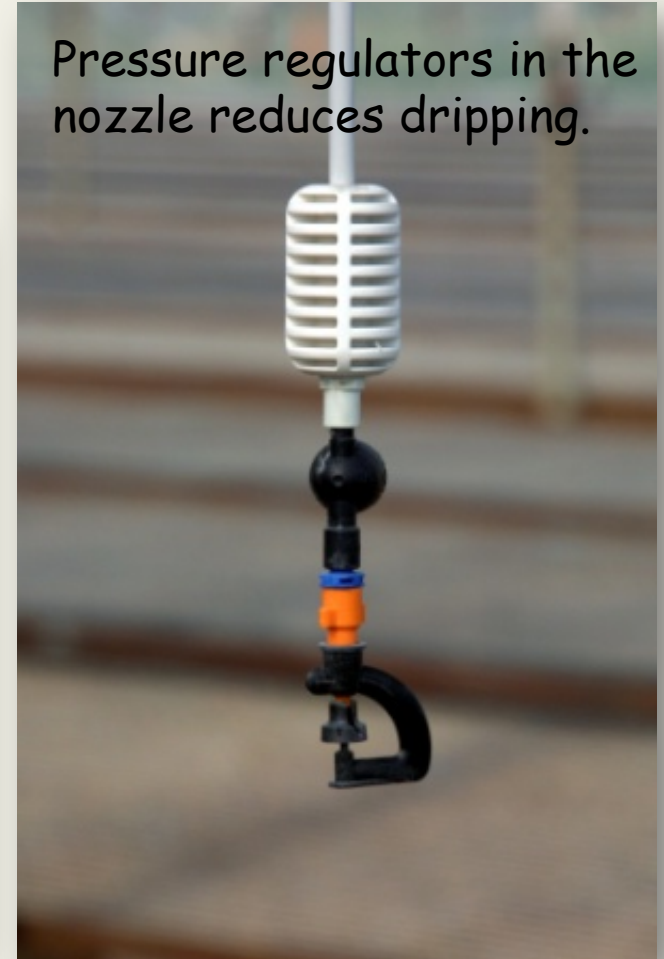
# Stages of Cutting Propagation

## Stage 2 - Root initiation (callusing)

Overhead hanging mist nozzles.



Pressure regulators in the nozzle reduces dripping.





# Stages of Cutting Propagation

## Stage 2 - Root initiation (callusing)

Traveling boom system.





# Stages of Cutting Propagation

## Stage 2 - Root initiation (callusing)





# Stages of Cutting Propagation

Stage 2 - Root initiation (callusing)  
Scheduling mist - static vs dynamic

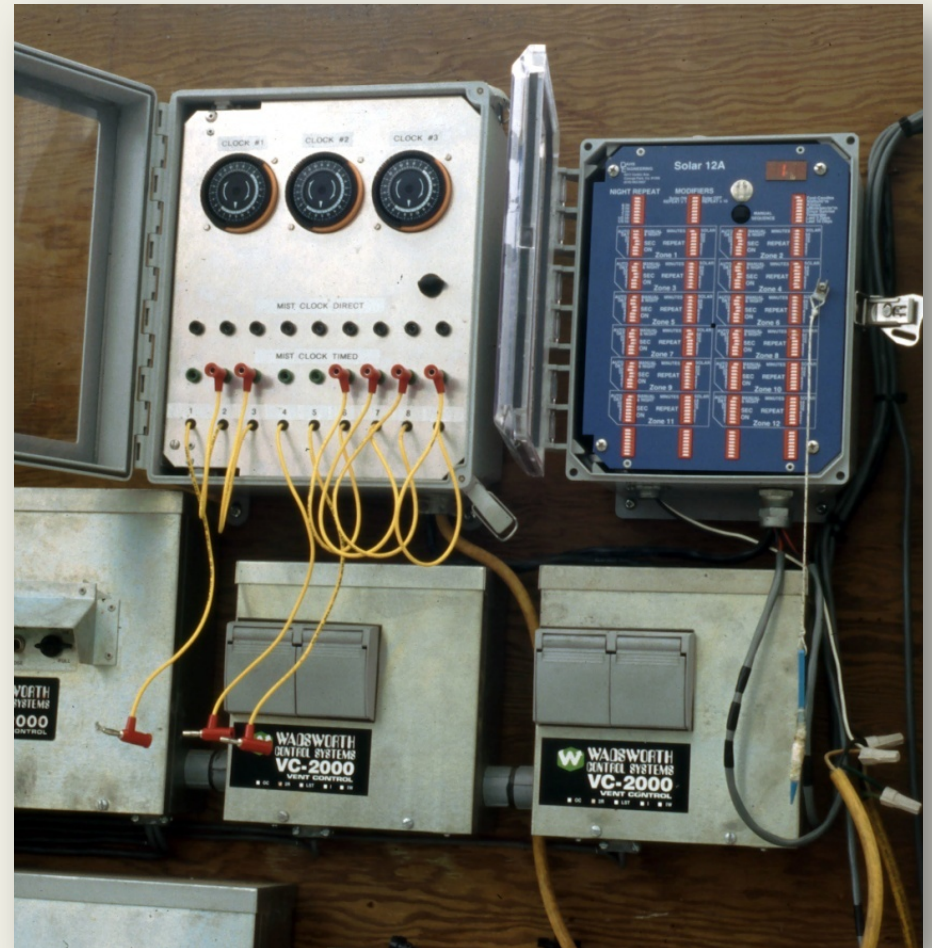
Static controllers use a time clock  
- 5 sec every 10 min.



# Stages of Cutting Propagation

Stage 2 - Root initiation (callusing)  
Scheduling mist- static vs dynamic

Dynamic uses the environment or signals from the plant to schedule mist.





# Stages of Cutting Propagation

## Stage 2 - Root initiation (callusing) Scheduling mist

Examples of dynamic mist control include:

- Electronic leaf
- Artificial leaf (screen balance)
- Quantum light sensors
- Vapor pressure models



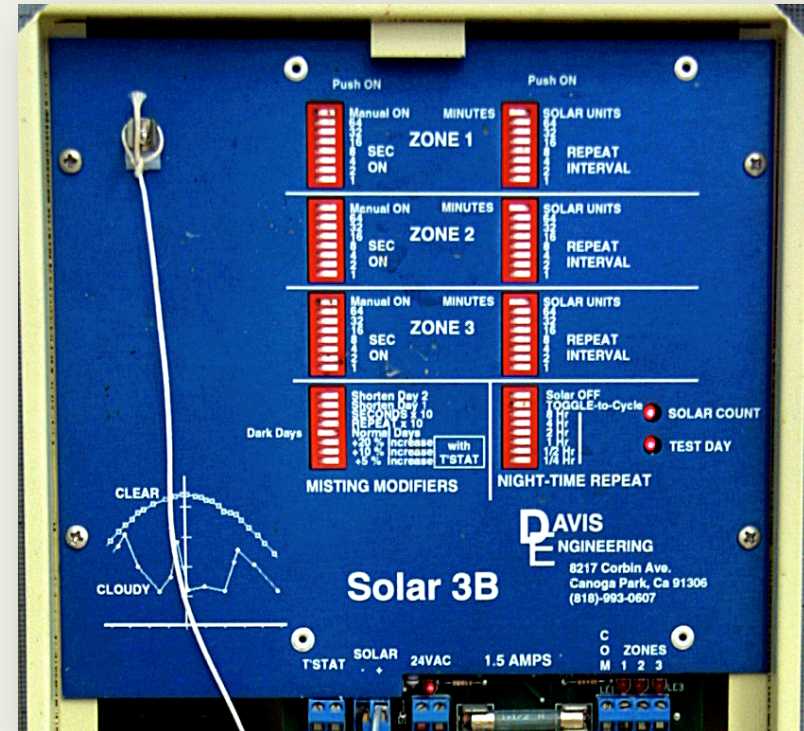
# Stages of Cutting Propagation

## Stage 2 - Root initiation (callusing)

Scheduling mist

Quantum light sensors

The computer triggers a misting event after a certain number of accumulated light units.





# Stages of Cutting Propagation

## Stage 2 - Root initiation (callusing)

Poly tents are enclosed systems that maintain high relative humidity.





# Stages of Cutting Propagation

## Stage 2 - Root initiation (callusing)

Fog systems also maintain high relative humidity.





# Stages of Cutting Propagation

## Stage 3 - Root formation

Stage 3 - is the period after 50% of cuttings show visible root formation at the container edge.



# Stages of Cutting Propagation

## Stage 3 - Root formation

Stage 3 - environmental conditions.

Air temperature	24 - 27 °C days; 19 - 21°C nights
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to fill container



# Stages of Cutting Propagation

## Stage 3 - Root formation

Stage 3 - environmental conditions.

Air temperature	24 - 27 °C days; 19 - 21°C nights
Substrate temperature	18 - 24 °C

# Stages of Cutting Propagation

## Stage 3 - Root formation

Stage 3 - environmental conditions.

Air temperature	24 - 27 °C days; 19 - 21°C nights
Substrate temperature	18 - 24 °C
Light	1000 - 2500 fc (200 - 500 $\mu\text{mol}/\text{sec}/\text{m}^2$ )



# Stages of Cutting Propagation

## Stage 3 - Root formation

Stage 3 - environmental conditions.

Air temperature	24 - 27 °C days; 19 - 21°C nights
Substrate temperature	18 - 24 °C
Light	1000 - 2500 fc (200 - 500 $\mu\text{mol}/\text{sec}/\text{m}^2$ )
Shade	For light and temperature control

# Stages of Cutting Propagation

## Stage 3 - Root formation

Stage 3 - environmental conditions.

Air temperature	24 - 27 °C days; 19 - 21°C nights
Substrate temperature	18 - 24 °C
Light	1000 - 2500 fc (200 - 500 $\mu\text{mol}/\text{sec}/\text{m}^2$ )
Shade	For light and temperature control
VPD control	Mist, tent or fog; reduce mist interval as roots develop



# Stages of Cutting Propagation

## Stage 3 - Root formation

### Stage 3 - environmental conditions.

Air temperature	24 - 27 °C days; 19 - 21°C nights
Substrate temperature	18 - 24 °C
Light	1000 - 2500 fc (200 - 500 $\mu\text{mol}/\text{sec}/\text{m}^2$ )
Shade	For light and temperature control
VPD control	Mist, tent or fog; reduce mist interval as roots develop
Substrate	pH 5.5 - 6.2; EC below 1.10 mS/cm

# Stages of Cutting Propagation

## Stage 3 - Root formation

### Stage 3 - environmental conditions.

Air temperature	24 - 27 °C days; 19 - 21°C nights
Substrate temperature	18 - 24 °C
Light	1000 - 2500 fc (200 - 500 $\mu\text{mol}/\text{sec}/\text{m}^2$ )
Shade	For light and temperature control
VPD control	Mist, tent or fog; reduce mist interval as roots develop
Substrate	pH 5.5 - 6.2; EC below 1.10 mS/cm
Fertilization	100 - 150 ppm N per week as roots begin to fill container



# Stages of Cutting Propagation

## Stage 3 - Root formation

Cuttings are becoming able to take up water from the substrate





# Stages of Cutting Propagation

## Stage 3 - Root formation

Mist interval can be reduced

Fog set point to a lower RH

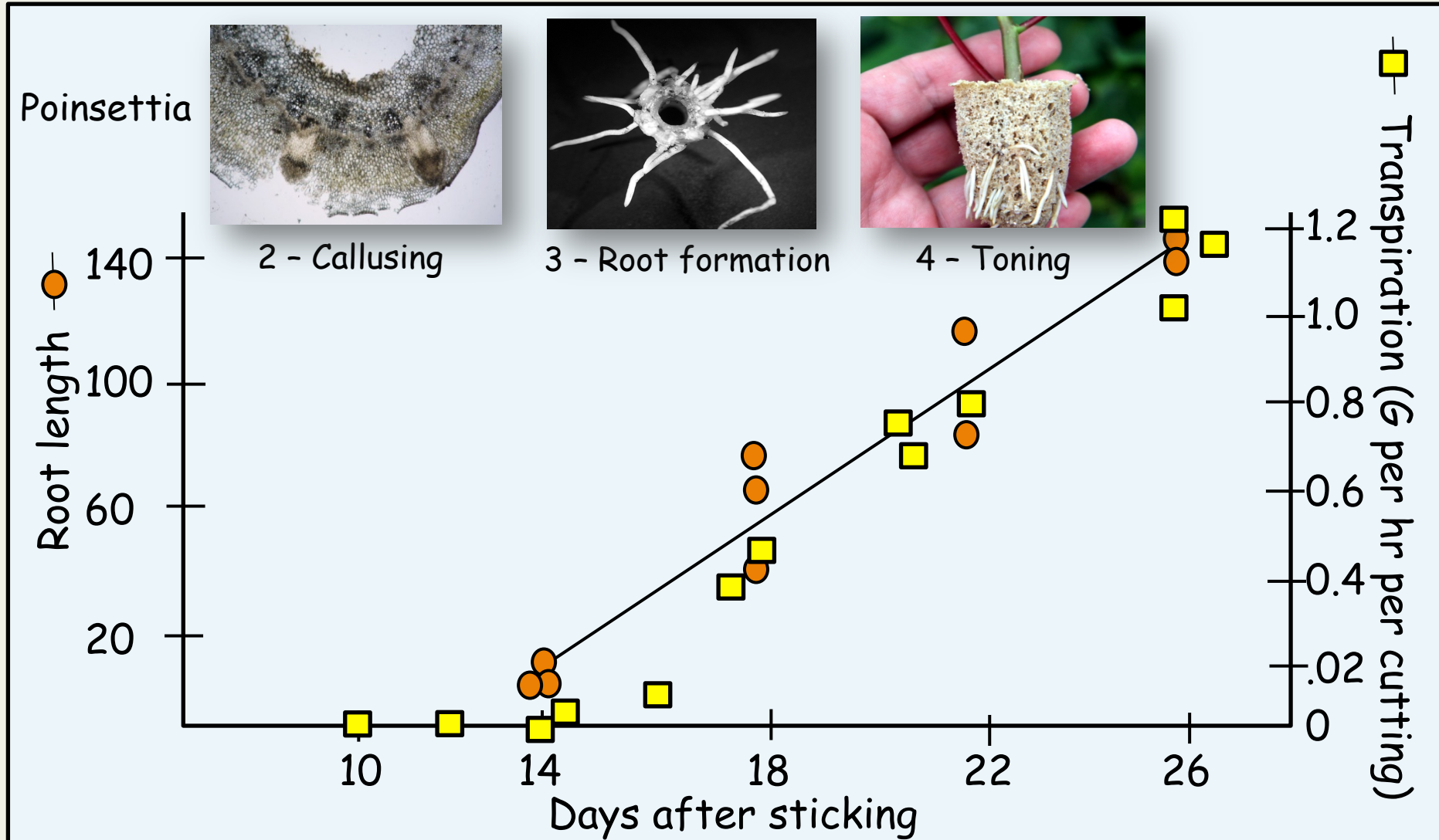
Vent tents





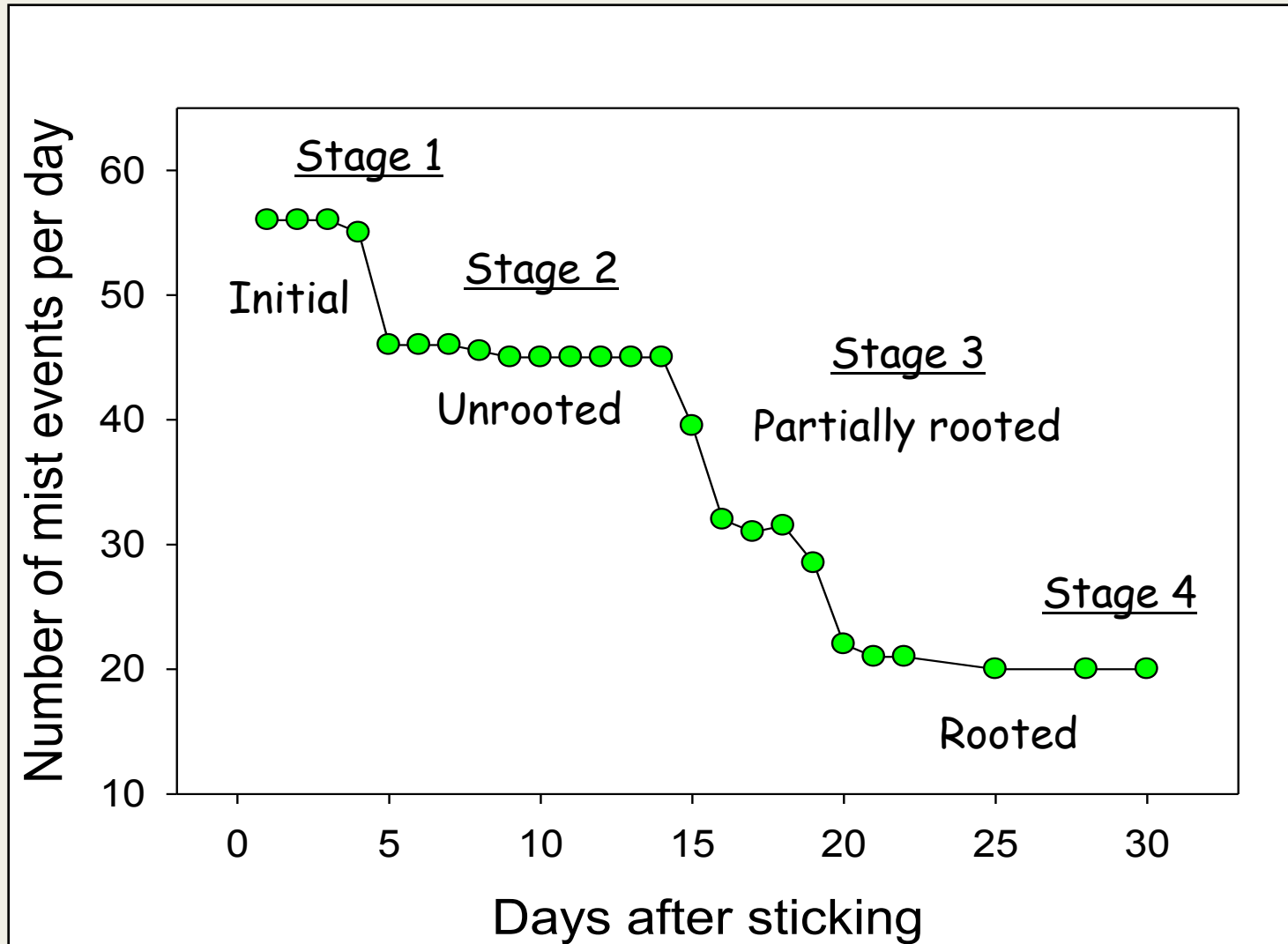
# Stages of Cutting Propagation

## Stage 3 - Root formation



# Stages of Cutting Propagation

## Stage 3 - Root formation





# Stages of Cutting Propagation

## Stage 4 - Acclimatization (toning)

Stage 4 - is the period from when cuttings show roots at the container edge to being fully rooted.

This is a period for preparing the rooted cutting for transplanting to its final container sale size.



# Stages of Cutting Propagation

## Stage 4 - Acclimatization (toning)

Stage 4 - environmental conditions.

Air temperature	24 - 27 °C days; 17- 19°C nights
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# Stages of Cutting Propagation

## Stage 4 - Acclimatization (toning)

Stage 4 - environmental conditions.

Air temperature	24 - 27 °C days; 17- 19°C nights
Substrate temperature	~18 °C

# Stages of Cutting Propagation

## Stage 4 - Acclimatization (toning)

Stage 4 - environmental conditions.

Air temperature	24 - 27 °C days; 17- 19°C nights
Substrate temperature	~18 °C
Light	2500 - 4000 fc (500 - 800 $\mu\text{mol}/\text{m}^2/\text{sec}$ )



# Stages of Cutting Propagation

## Stage 4 - Acclimatization (toning)

Stage 4 - environmental conditions.

Air temperature	24 - 27 °C days; 17- 19°C nights
Substrate temperature	~18 °C
Light	2500 - 4000 fc (500 - 800 $\mu\text{mol}/\text{m}^2/\text{sec}$ )
Shade	Only during mid-day to reduce temp

# Stages of Cutting Propagation

## Stage 4 - Acclimatization (toning)

Stage 4 - environmental conditions.

Air temperature	24 - 27 °C days; 17- 19°C nights
Substrate temperature	~18 °C
Light	2500 - 4000 fc (500 - 800 $\mu\text{mol}/\text{m}^2/\text{sec}$ )
Shade	Only during mid-day to reduce temp
VPD control	Gradual reduction; only to avoid wilting



# Stages of Cutting Propagation

## Stage 4 - Acclimatization (toning)

Stage 4 - environmental conditions.

Air temperature	24 - 27 °C days; 17- 19°C nights
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# Stages of Cutting Propagation

## Stage 4 - Acclimatization (toning)

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Air temperature	24 - 27 °C days; 17- 19°C nights
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Shade	Only during mid-day to reduce temp
VPD control	Gradual reduction; only to avoid wilting
Substrate	pH 5.5 - 6.2; EC below 1.10 mS/cm
Fertilization	120 - 200 ppm N per week



# Stages of Cutting Propagation

## Stage 4 - Acclimatization (toning)

Stage 4 - environmental conditions.

Air temperature	24 - 27 °C days; 17- 19°C nights
Substrate temperature	~18 °C
Light	2500 - 4000 fc (500 - 800 $\mu\text{mol}/\text{m}^2/\text{sec}$ )
Shade	Only during mid-day to reduce temp
VPD control	Gradual reduction; only to avoid wilting
Substrate	pH 5.5 - 6.2; EC below 1.10 mS/cm
Fertilization	120 - 200 ppm N per week
Plant growth regulator	As necessary for height control

# Cutting Propagation

## Stages of commercial propagation





# Successful Cutting Propagation is Rooted in the Basics

Robert Geneve  
University of Kentucky



IPPS - 2014

