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Propagation of challenging plants: Creating a system that works

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Discussion points

- The propagation system
  - Research protocols
  - Back to the basics
  - Controlling variables
  - Supplemental lighting
  - Developing a propagation system
- Results of propagation experimentation
  - *Cornus kousa* 'Scarlet Fire'
  - *Corylus avellana* – various selections
  - *Vaccinium macrocarpon* 'Haines'
  - *Ilex x? & Ilex crenata* 'Beehive'
- Moving toward the future

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What are “challenging” plants

Experimental design: Using a systematic approach

Propagation variables

Limiting the variables

Auxins

Control of variable combinations

RESEARCH PROTOCOLS & BACK TO THE BASICS

What are challenging plants?

- I describe challenging plants as plants that others have had problems propagating
- How to review scientific literature
  - Look for hints at propagation history or propagation of related plants
  - Always check experimental design to be sure there are adequate controls built into the experiment
  - Without proper experimental controls, information is nearly useless
- Recognize that timing is very important
  - Plants are more successfully propagated at certain times of the year
  - BUT, don’t necessarily eliminate other times of the year if it’s possible to change experimental designs and protocols

Experimental design: Use a systematic approach

- Since one never knows if a new system will *really* work
  - Limit your exposure by starting with a manageable number of plants
    - There is the potential for crop and financial losses
    - Make sure you have enough cuttings to see a difference
    - Have an appropriate "control" group of plants*
    - Decide if the experiment is a "proof of concept", a comparison against the "present best treatment" or a combination of the two.
  - Allow space for sequential propagation cycles
    - Optimal timing can be measured in days
    - Success can vary by the hour of the day one collects cuttings
    - Rooting success for tissue cultured shoots will vary by size and maturity
  - Remember that plant propagation is nearly as much an art as a science

Propagation variables

- Air & media temperatures: turgidity & transpiration
- Auxins: which one, what carrier, how to apply
- Fertility: how much & how long after root initiation
- Humidity
  - Condensing (wet leaves as with misting)
  - Non-condensing (dry leaves as with true fog)
- Light: quality, intensity, duration
- Media: texture, moisture content, cation exchange capacity (CEC)
- Timing: based on the physiological stage of growth
- Types of cells & trays

Limiting the variables

- Focus: avoid looking for a bunch of answers at the same time
- Keep the number of test plants high to see differences
- Temperature & humidity
  - Ventilation for heat will reduce both temperature and humidity
  - Condensing humidity can cause foliar and root disease problems
  - Condensing humidity can leach foliar nutrients
  - Non-condensing humidity can resolve many of the temperature/humidity issues but it can be costly
- Media & containers
  - Use a porous medium to limit excess water issues
  - Use a deep cell or tray to maximize useful media
- When one removes a competing variable, rooting success increases

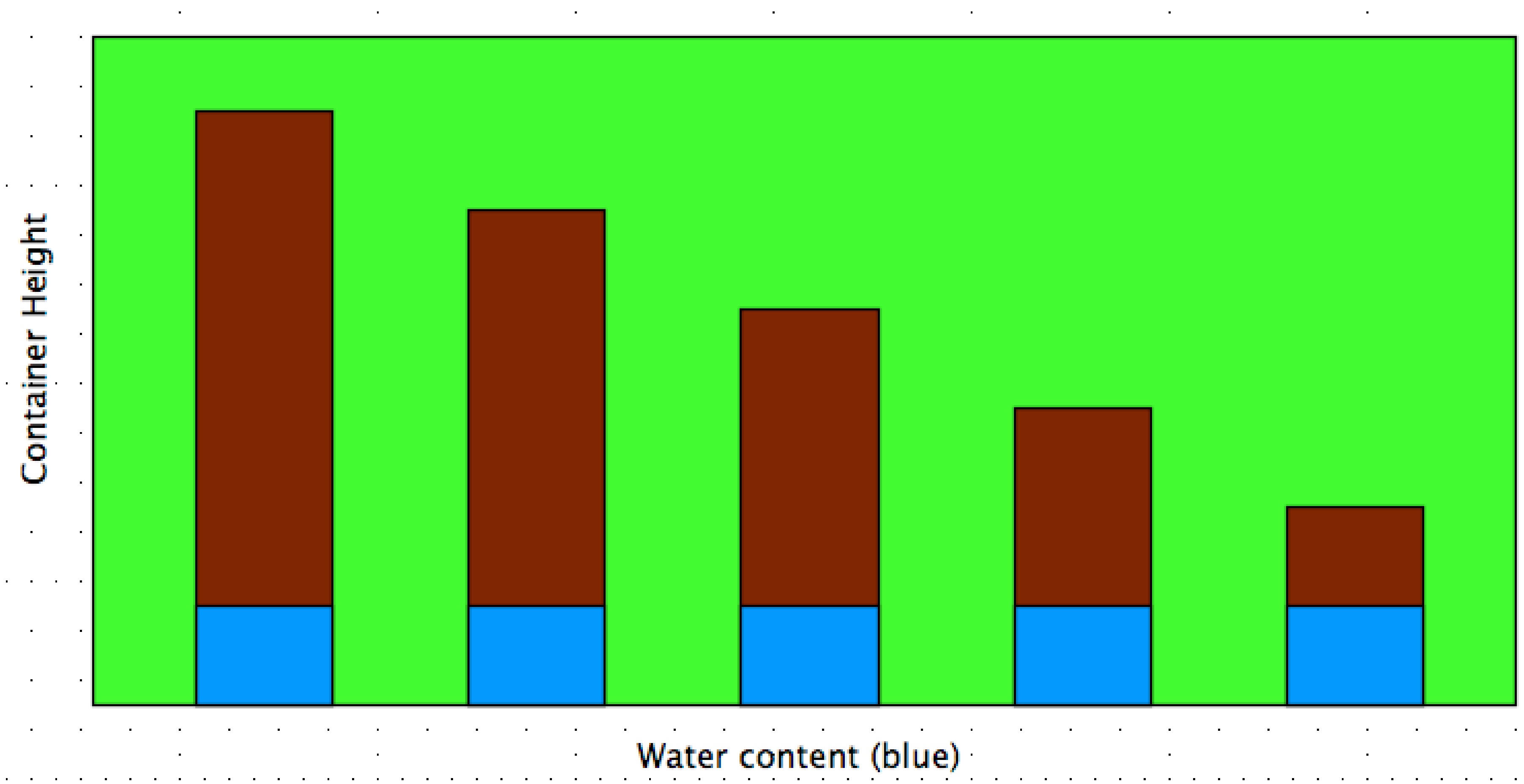
Auxins

- IAA
  - Indole-3-acetic acid
  - Naturally occurring plant hormone
- IBA
  - Indole-3-butyric acid
  - A synthetic rooting hormone
- NAA
  - 1-napthalene-acetic acid
  - A synthetic rooting hormone
- Auxin movement
  - Foliar applied auxins move more readily with more light (2, 4-D)
  - Basal applied auxins more through the xylem in the transpiration stream

Control of variable combinations

- Temperature & humidity
  - Ventilation for heat will reduce both temperature and humidity
  - Supplemental condensing humidity can cause foliar and root disease problems
  - Supplemental condensing humidity can cause leaching of foliar nutrients
  - Non-condensing humidity can resolve many of the temperature/humidity issues but it can be costly
- Media & containers
  - Perched water table
  - When using the same medium, success is largely controlled by the height of the container

Perched water table



Supplemental lighting

Photosynthesis: we don't see what plants see

A system that can work in the real world

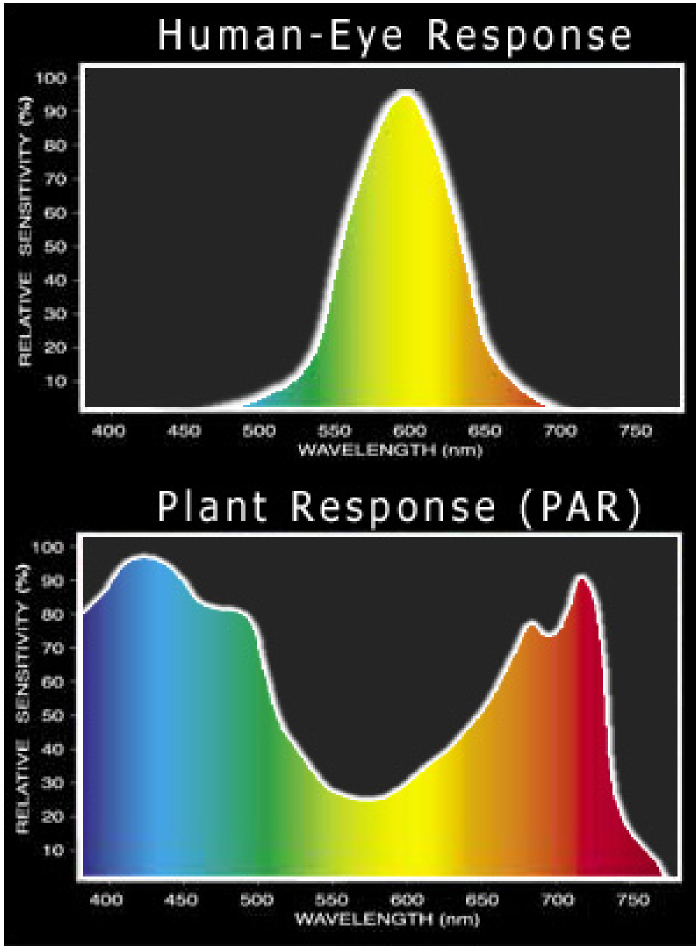
DEVELOPING A PROPAGATION SYSTEM

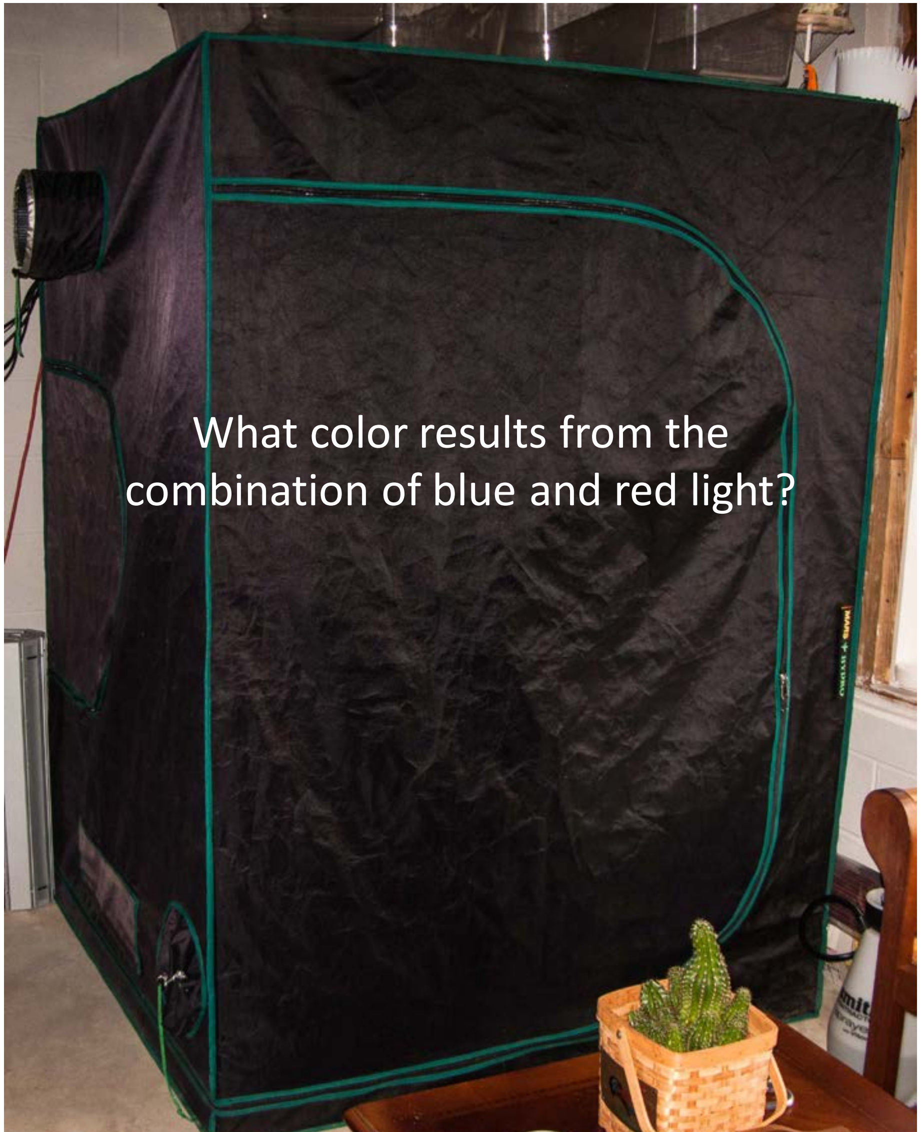
Supplemental lighting

- Has the ability to can change the season
- LED's (light emitting diodes) produce light by electroluminescence
  - They generate less heat and use less electricity than conventional lights
- Light quality can be fine tuned by use of different wavelength generating LED's
  - Most LED lights have lights for vegetative growth and a second set of lights for flowering built into a single light-set
  - Propagation only needs wavelengths suitable for vegetative growth
- Cost effective
  - LED lighting has a higher initial investment but has longer life
  - From my experience, the system has enhanced rooting

Photosynthesis: we don't see what plants see

- Plant chlorophylls efficiently harvest blue and red light with peak efficiency at about 440 and 640 nm
- They don't capture light between 500-575 nm
- Plants reflect light they can't capture





What color results from the combination of blue and red light?

The system

Reflector Led Grow Light 576w (192-3w LED's)	$304
Heavy duty light timer	$ 15
Grow Tent (4' 9'' x 4' 9'' x6' 7'')	$136
Ductwork, ductstat, thermostat & rheostat	$134
15 amp heavy duty power station/surge suppresser	$ 28
Propagating heat mats w thermostat & tall domes	$326
50 deep cell plug trays (1.94” x 4.5”)	$121
D.B. Smith Contractor Sprayer (mist)	$ 26
Honeywell 1 Gal. Cool Mist Humidifier (fog)	$ 58
Plastic pallet bench	$ 11
Total system cost	$1159

A system that can work in the real world

- Set goals when evaluating propagation system changes
- Supplemental lighting can enhance rooting
  - Lighting can effectively change and/or extend the season
- Reduction of environmental impact
  - Water use is limited by the use of non-condensing humidity
  - High humidity levels also reduces loss of water through transpiration
- Worker safety
  - Spray applied auxin offers a method of minimizing worker contact with auxins
- Cost effective
  - LED lighting has a higher initial investment but has longer life
  - LED lighting has a lower operational cost

Cornus kousa ‘Scarlet Fire’

Corylus avellana – various selections

Vaccinium macrocarpon ‘Haines’

Ilex x? & Ilex crenata ‘Beehive’

RESULTS OF PROPAGATION EXPERIMENTS

Cornus kousa 'Scarlet Fire'

- Dogwoods
  - Production of tissue cultured shoots has worked very well
  - Producing roots on those shoots has not been successful in TC
  - An experiment was initiated that looked at hormone rates and frequency of application of foliar applied auxins
- Optimal treatments
  - Tray size: 50 cell, deep tray (4.5" deep)
  - Auxin: 1 foliar application to drip of K-IBA at 350-400 ppm
  - Fertilization: complete at 70 to 75 ppm when rooting is initiated
  - Shading for the first 7 days didn't make a difference
- Results
  - Typically between 95 and 100% success

Cornus kousa ‘Scarlet Fire’ TC shoots

Newly stuck *Cornus kousa* 'Scarlet Fire'

Cornus kousa ‘Scarlet Fire’ propagation procedure

- Keep the shoots in the covered agar medium for 2 days to harden
- Day 1: Stick the shoots and gently water them in so they are in good contact with the medium. Be careful not to dislodge the shoots.
  - Operate the LED vegetative grow lights for 14 hour days
- Day 2: Apply the K-IBA at 350 to 400 ppm as a foliar spray that fully wets the leaves
  - Mist the inside of the domes, supplementing the humidifier
  - Check the shoots later in the day and mist the inside of the dome as well as the leaves again if they are dry
- Day 3 onward: Check the humidity and mist 2 to 3 times a day as necessary (it’s normal early in the propagation period).

Propagation procedure

- Day 7: Start checking for root initiation. As soon as the first roots appear, start fertilization at 75 ppm-N. Continue misting until top growth is established.
- Day 12: Top growth should be initiating
- Day 20: Start reducing humidity by removing the domes. Continue growing plants until the desire size is reached.
  - New growth is fairly active at about 22 or 23 days
  - Plants may be as much as 4 to 6 inches tall in 60 days
- Notes:
  - There seems to be some variability in success based on the maturity of the tissue cultured shoots.
  - Use of NAA was not successful

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Cornus kousa ‘Scarlet Fire’ at 60 days

Corylus avellana

- Hazelnuts: a tough nut to crack
  - I used the same general system as for dogwoods
  - Cuttings were traditional stem cuttings, usually from immature suckers
  - Rooting was normally in 38 cell deep trays (5”deep)
  - A combination of IBA and NAA seemed to work best
  - Mid-September dates seemed to offer the most success
    - Cuttings were taken from August through November and in late-January
  - Excess callus was consistently an issue
  - The rooted stick
  - Success with hazelnuts was really not successful with the best treatments achieving around 20% to 50% rooting
  - There was a high degree of varietal variability in success rate
  - Once rooted, they grow exceptionally well

Callus and the rooted stick

Corylus avellana

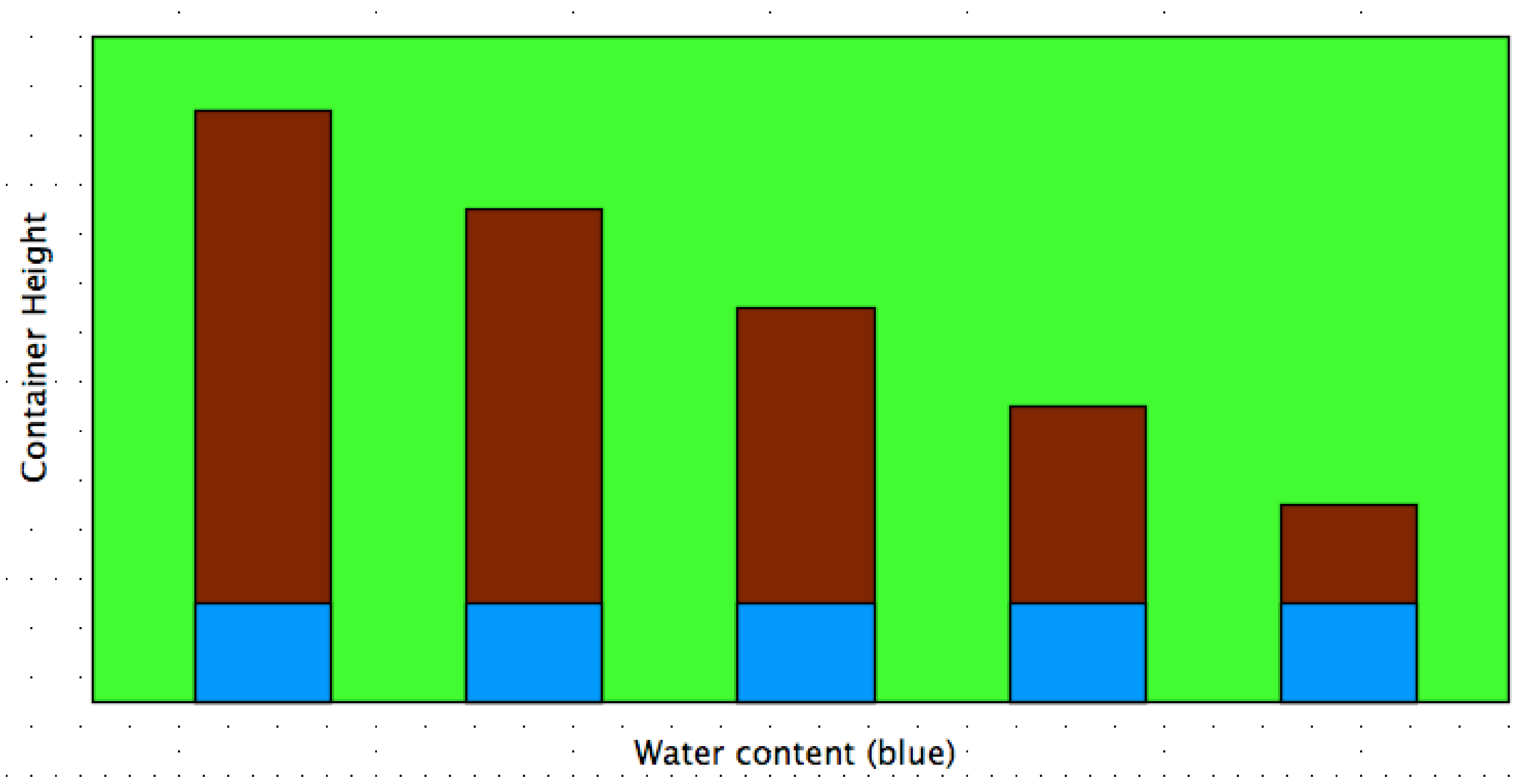
Vaccinium macrocarpon ‘Haines’

- Rutgers researchers have developed a new, hardier variety of cranberry that is able to withstand disease and has a larger round berry with a more even color than other varieties
- It’s focused on the Craisins® market

Propagation of the ‘Haines’ variety

- Production of tissue cultured shoots with roots has been successful
- Traditional multiplication by softwood cuttings had poor results
- An experiment was set up to evaluate hormone rates
- Ultimately, rooting without hormones was the best treatment as is traditionally done
- The problems were associated with short cells and a perched water table causing cuttings to be stuck into saturated zones

Perched water table



Additional notes and unintended consequences

- Cuttings rooted above 95% without IBA in deep cell trays
- While no hormone was ultimately the preferred treatment, cuttings rooted more aggressively with the use of IBA at 200 to 400 ppm as a spray application
- The unintended consequence is that top growth was effectively inhibited when using foliar applied IBA
  - The higher the rate of IBA applied, the longer it took for top growth to restart
- I was unable to experiment with basal applied IBA as a treatment due to time constraints
  - Economically, it would probably not be cost effective anyway

Ilex x?

Ilex x? - Surprises happen

- Over 30 years ago while walking through the Rutgers Gardens with Dr. Elwin Orton, I came across a holly tree that had no leaf miner and a glossy ovate leaf with spines
- I asked Dr. Elwin Orton what variety it was and he indicated, colorfully, that years earlier the USDA had initiated a variety evaluation trial and then lost the plot plan
- I took quite a few cuttings and rooted a few using traditional methods of an IBA talc basal dip
- I continue to like the plant so I took cuttings in mid-March in an effort to root some to take with me into my retirement
- Out of 10 cuttings, all rooted.

Ilex crenata 'Beehive'

- This is a plant that Dr. Elwin Orton selected quite a few years ago
- It's also another that I wanted to have in my retirement landscape
- I took cuttings in mid-March
- Of the 30 cuttings taken, 29 rooted


Rutgers University photo

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Moving toward the future

- We are looking at more of the same
  - More regulation
  - Less labor
- That results in the need for
  - More intensive agricultural operations
  - Less employee exposure to risks
  - More mechanization
- This system has lower operational cost
- The system can produce a lot of plants in a small space using LED lighting, non-condensing humidity and bottom heat
- Existing propagation space can be integrated as a step-down system

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Cornus kousa ‘Scarlet Fire