Chase News

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How to Prevent Virus Movement in Greenhouses

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Minimizing losses due to virus infection begins by keeping viruses and their vectors out of your structures. This is influenced by all of the cultural practices within an operation that includes weed and insect management, worker training, emphasis on scouting, and response to a disease outbreak. An operation that has good cultural practices reduces the number of potential outbreaks because both the pathogen (virus) and vector (insect) pressures are reduced. Know your crops, learn which common viruses they are susceptible to, and learn where you are most vulnerable to incoming threats. Once inside a greenhouse, plant viruses are moved by one of three routes: 1) infected plant material (which may not show symptoms), 2) vectors (includes workers), or 3) contaminated materials/surfaces (includes workers hands and tools).

Exclusion – of BOTH viruses and their vectors out of your growing operation. REMEMBER: Vectors can arrive already carrying a virus (i.e. they are viruliferous) and you cannot tell the difference. Use reputable sources of clean, virus-indexed plant material. Stock plants should be maintained in a greenhouse separate from young plants.

Inspection – each shipment of cuttings should be inspected for signs and symptoms of pests and diseases (e.g. deformed leaves, mosaic, necrotic lesions, and insect damage) – these are all red flags. Do NOT assume that because all of the cuttings of a particular cultivar have an unusual appearance that this is normal. Cuttings can be taken from infected stock plants. Ideally, new material and/or material from different sources should be quarantined.

Scouting – scouting is designed to detect problems early enough to save some of the crop. Viruses like INSV that are vectored can quickly expand beyond an isolated infection point in a short period of time. Regular inspection of plants for symptoms of virus infection, signs of insect presence (e.g. feeding scars and/or frass), or presence of vectors on sticky cards. To be effective, yellow sticky cards need to be placed at crop level AND monitored regularly. Spend extra time near doorways, air intakes, high traffic areas, highly vulnerable crops, plants that are blooming or otherwise favorites of vectors (e.g. *Gerbera* or petunia and WFT), and problematic crops from past seasons. Plants in bloom are more likely to attract insect vectors. Blooming should be minimized when possible, and if not possible, more intensive scouting of these plants is required. Train your workers to look for unusual symptoms.

Sanitation – Infected plants should be destroyed, not composted near the operation. Pots and plug trays containing infected plants should not be reused (roots contain virus). Benches and other surfaces in contact with infected plants should be disinfected with one of the commercially available disinfectants (e.g. quaternary ammonium salts, hydrogen peroxide-based) following label instructions. Tools used to take cuttings or clean up plants should be regularly disinfected (ideally between plants), at least every few minutes, and always between cultivars. Weed management is a component of a clean operation, both inside and outside of the structures.

Tool Disinfectants – In collaboration with Dr. Scott Adkins, USDA USHRL, Fort Pierce, FL, we have established systems to compare products to sanitize cutting tools used for plant propagation. Our work with viruses belonging to the *Tobamovirus* genus, which includes TMV (*Tobacco mosaic virus*) in both petunia and tropical hibiscus have found that a 1:10 dilution of household bleach or a 20% (double-strength) solution of Non-fat dry milk when we add a surfactant are the most effective. Recently, we have found that when a laboratory surfactant (Tween-20) was replaced by liquid dishwashing detergent (e.g. Joy), Non-fat dry milk solutions remained highly effective at preventing TMV transmission from contaminated tools. Various milk fractions have performed better than others, and generally when used at a high concentration. Surprising to us, traditional materials (e.g. TSP, or trisodium phosphate) were not effective to prevent TMV transmission.

(Originally published in the Proceedigs of the SAF Pest Management Conference, 2010).

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Controlling Woody Ornamental Leaf Spots in Propagation

There are a number of leaf spots and blights that commonly occur in propagation of woody ornamentals. Sometimes they continue to be a problem in production of the crop and other times they stop as soon as they are out of the mist. We have been working on a number of diseases that are mainly problems during production including Cylindrocladium leaf spot on myrtle and Alternaria leaf spot on pittosporum.

Cylindrocladium on myrtle

For the myrtle trial we started with rooted cuttings of common myrtle (*Myrtus communis*) that were free of disease. Plants were sprayed three times on a 7 day interval. They were inoculated three days after the first spray with a spore suspension of *Cylindrocladium pauciramosum*. They were placed under intermittent mist (30 sec/hour for 12 hr/day). The number of spots was counted four days after the final application. Treatments included:

- Noninoculated
- Inoculated
- Heritage (4 oz/100 gal)
- Insignia (10 oz)
- Veranda O (4 oz)
- Veranda O (8 oz)
- Trinity (4 oz)
- Trinity (8 oz)
- Trinity (12 oz)
- Trinity (24 oz)
- Pageant (12 oz)

Excellent control was seen with all fungicides including Insignia, Trinity and Pageant (table, right). None of the treatments affected plant growth.

Severity of Cylindrocladium leaf spot on Myrtle

Numbers followed by the same letter are not statistically significant.

Treatment	Rate/ 100 gal.	# spots
Water noninoculated	-----	0.1 a
Water inoculated	-----	5.5 b
Heritage	4 oz	1.0 a
Insignia	10 oz	0.5 a
Veranda O	4 oz	1.6 a
Veranda O	8 oz	1.3 a
Trinity	4 oz	0.1 a
Trinity	8 oz	1.0 a
Trinity	12 oz	0.3 a
Trinity	24 oz	0.5 a
Pageant	12 oz	0.1 a

The Alternaria leaf spot on Pittosporum was performed similarly. In this case, plants were sprayed three times on a 14 day interval. They were inoculated with spores of *Alternaria pittospori* six days after the first application. Treatments included:

- Noninoculated
- Inoculated
- Trinity (4 oz)
- Trinity (8 oz)
- Trinity (16 oz)
- Hoist (4 oz)
- KleenGrow (12.5 oz)
- Medallion (2 oz)

Alternaria on pittosporum

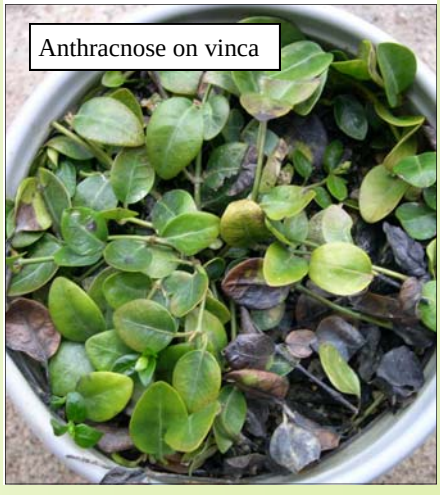
The most effective products in the first rating was KleenGrow, a quaternary ammonium from PACE 49 and Medallion. The sterol inhibitors, Hoist and Trinity were very effective at 8 or 16 oz/100 gal.

We also just finished a trial on *Vinca minor* with anthracnose caused by *Phyllosticta* sp. We used many of the same products induced in the previous two trials but after two months, none of them gave any significant control of this very common disease. One of the active ingredients actually caused damage that looked identical to anthracnose. More work is needed on all anthracnose diseases or woody ornamentals to determine if any products are really safe and effective.

Severity of Alternaria leaf spot on Pittosporum

Numbers followed by the same letter are not statistically significant.

Treatment	Rate/ 100 gal	# spots
Noninoculated	——-	0 a
Inoculated	——-	20 d
Trinity	4 oz	13 c
Trinity	8 oz	4 ab
Trinity	16 oz	8 b
Hoist	4 oz	4 ab
KleenGrow	12.5 oz	1 a
Medallion	2 oz	2 a



Anthracnose on vinca

Woody Ornamental and Nursery Update

Controlling Hydrangea disease in the landscape—Auburn University researchers, Hagan, Olive and Stephenson reported on a landscape trial in Alabama in 2010. They used a variety of fungicides applied mainly on a weekly interval for prevention of two foliar diseases: Treatments included:

- Non-treated
- Bonide Liquid Copper Fungicide
- Bonide Citrus, Fruit and Nut Orchard Spray Concentrate
- Green Light Neem Concentrate
- Heritage 50WDG
- Immunox
- MilStop 85WP
- Serenade Disease Control (RTU)
- Southern Ag Liquid Copper Fungicide

Severity of Powdery Mildew and Corynespora Leaf Spot in the Landscape
Numbers followed by the same letter are not statistically significant.

Treatment (interval—week)	Powdery mildew	Corynespora leaf spot
Non-treated	94 a	42 bc
Bonide Liquid (1)	0 c	6 e
Bonide Citrus (1)	0 c	54 ab
Green Light Neem (1)	0 c	39 cd
Heritage (3)	12 b	2 e
Immunox (2)	0 c	6 e
MilStop (1)	19 b	26 d
Serenade (1)	0 c	57 a
Southern Ag (1)	0 c	2 e

All products gave excellent control of powdery mildew. The slight development of powdery mildew with Heritage was perhaps due to the 3-week spray interval. Control of Corynespora leaf spot was best with the copper products (Bonide Liquid and Southern Ag), Immunox and Heritage. Serenade (ready-to-use, biological), Bonide Citrus and MilStop did not provide significant control. For the complete report see: Plant Disease Management Reports 55:OT0006.

Control of Cercospora leaf spot on Crape Myrtle in the landscape—Hagan and Akridge (Auburn University) performed two landscape trials in 2010. The first trial was performed with some of the same products as the Hydrangea trial although most products were compared on a 1 or 2 week interval. The cultivar used was 'Byers Wonderful White'. Treatments included:

- Non-treated
- Bonide Liquid Copper Fungicide
- Bonide All Seasons Horticultural and Dormant Spray Oil Conc.
- MilStop 85WP
- Heritage 50WDG
- Daconil Ultrex

Slightly better control was seen when products were used on a weekly compared to a two-week spray interval. Bonide Liquid Copper and Bonide All Seasons were the best in the trial when applied weekly. See Plant Disease Management Reports 5:OT015.

The second trial was conducted with Crape myrtle 'Carolina Beauty' included the following treatments:

- Non-treated
- Palladium (2 oz/100 gal)
- Palladium (4 oz)
- Palladium (6 oz)
- Medallion (2 oz)
- Heritage (4 oz)
- Banner MAXX (8 oz)
- Hoist 40WP (8 oz)
- 3336 4.5F (20 oz)

Products were applied on a two week interval. I have provided the rates here since these are "professional" products you might choose to use in a nursery. Palladium and Medallion (both share one active ingredient—fludioxinil) did not give significant control of disease in this trial. Significant control was achieved with sterol inhibitors, Hoist and Banner MAXX as well as Heritage (strobilurin) and thiophanate methyl (3336). For the complete report see: Plant Disease Management 55:OT014.

Kasugamycin for fire blight on Pear—Adaskaveg, Forster and Wade at the Universiyt of California, Riverside and Arysta LifeScience have been working on a new antibiotic for agricultural use. Disease control with copper is adequate only when disease pressure is low to moderate and control with streptomycin sulfate is problematic due to bacterial resistance. Both Asian and Barlett pears were used for field trials in California. Kasugamycin has been tested previously on fire blight with variable results. The current research showed equal or better efficacy for kasugamycin compared to streptomycin sulfate and oxytetracycline. This was true for both preventative and curative uses. In 2007, additional treatments with tank-mixes were added. None of them were more effective than kasugamycin alone. However, resistance management strategies would favor tank-mixing or rotation. The expected labeling of kasugamycin for this use is sometime in 2012. This will be the first new antibiotic labeled in the US for agricultural use in the past 40 years and is long overdue. We are hoping to see labeling for ornamentals at some point. See: Plant Disease 95:448-454.

Control of Fire blight on pears with bactericides
Numbers followed by the same letter are not statistically significant.

Treatment	2006 trial	2007 trial
Control	15.9 a	27.3 a
Kasugamycin	1.5 c	5.7 b
Streptomycin	2.0 c	2.5 b
Oxytetracycline	4.5 b	7.3 b
Mancozeb	——	4.0 b
Kasugamycin and mancozeb	——	4.0 b
Kasugamycin and streptomycin	——	3.2 b
Kasugamycin and copper hydroxide and oxytetracycline	——	4.8 b

New Products for Downy Mildew

We have seen a large increase in the number of mode of action groups registered for ornamentals in the past few years. The most recent addition is fluopicolide (Adorn) which is in MOA group 43.

One of the numbered compounds which is being researched is a combination of dimethomorph and another active ingredient from BASF Corp.—BAS651. Preventative trials on Coleus downy mildew by Harlan and Hausbeck (Michigan State University) and Ivors et al. (North Carolina State University) show great promise.

Harlan and Hausbeck reported on a trial in 2010 with the following treatments:

- Untreated
- BAS651—11 oz/100 gal
- BAS651—14 oz
- BAS651—28 oz
- Stature SC—12.25 oz
- Adorn 4SC—1 oz
- Alude—2.5 qt
- Heritage—4 oz
- Aliette—4 lb
- Subdue MAXX—1 oz (drench)

All products were applied once as sprays (except Subdue MAXX). BAS651 (all rates), Stature SC, Adorn and Heritage gave 100% prevention of Coleus downy mildew. The phosphonates (Alude and Aliette) were statistically significant but did develop some downy mildew. For a complete report see: Plant Disease Management Reports 5:OT018. 2010.

Ivors et al. tested some of the same products including:

- Untreated
- Adorn—1 oz/100 gal
- Adorn—2 oz
- BAS651—11 oz/100 gal
- BAS651—14 oz
- Disarm 480SC—2 oz
- Disarm 480SC—4 oz
- Heritage—4 oz
- Mandipropamid—4 oz
- Mandipropamid—8 oz
- Regalia SC—0.5%
- Regalia SC—1%


Coleus downy mildew

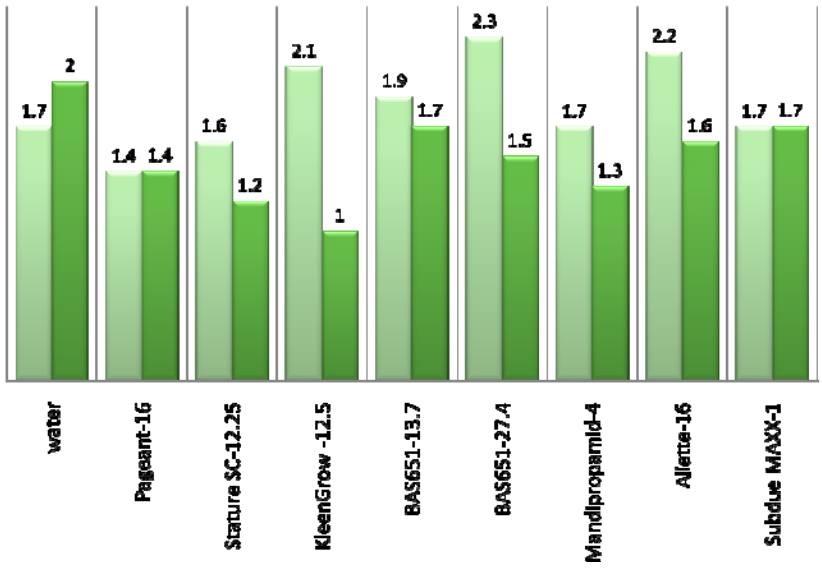
All products were applied once as a spray. Almost all products controlled spore production by more than 99%. The only one to give a lesser degree of control of spore production was Regalia which gave 86-91% control. Leaf abscission was significantly reduced by all treatments with Regalia doing the best. For the complete report see: Plant Disease Management Reports 5:OT019. 2010.

The final trial I am reporting here was conducted on stock with active downy mildew in our greenhouses. We started the trial on February 10, 2011 when we collected six packs of *Matthiola incanae* with active downy mildew (*Peronospora parasitica*). Our trial was performed with three weekly sprays of the following treatments:

- Water
- Pageant—16 oz/100 gal
- Stature SC—12.25 oz
- KleenGrow—12.5 oz
- BAS651—13.7 oz
- BAS651—27.4 oz
- Mandipropamid—4 oz
- Aliette—1 lb
- Subdue MAXX—1 oz

The largest eradication was seen with KleenGrow which was followed by BAS651 (27.4 oz rate) and Aliette. Little effect was seen with Stature SC, BAS651-13.7 oz rate, Mandipropamid and Subdue MAXX. It was interesting that the quaternary ammonium product, KleenGrow performed best in this trial. This product would traditionally be thought of as a disinfectant but was labeled as a fungicide in most states last year. These results demonstrate that the best control of downy mildew is preventative and that even very effective products may fail when disease is allowed to become established. Don't jump to conclusions regarding efficacy—test new products yourself whenever possible.

Eradication of downy mildew on stock using a variety of fungicides. Disease was rated on the following scale: 1 (none), 2 (slight) and 3 (moderate). The bars show the rating before sprays (light green) and after three sprays (dark green).



Research Reports

High temperatures cause bleaching in some geraniums—Last summer I visited some nurseries in Texas and saw geraniums with bleaching. This was due to high temperatures and was seen on only a few cultivars.

When I saw a recent research report from Dhir, Harkess and Bi (Mississippi State University) on temperature induced chlorosis on ivy geranium I was reminded of my Texas trip.

Their work investigated whether or not heat induced an iron chlorosis. They tested effects of 75 F (24 C) root zone temperature with 88 F (31 C) combined with applications of iron chelate at different rates delivered as a drench and a foliar spray. They also tested effects of air temperature. Although the iron chelate affected plant growth it did not affect development of chlorosis. Root zone temperatures did not affect chlorosis either. Air temperatures of 97 F (36 C) significantly increased bleaching compared to temperatures of 82 F (28 C). In conclusion, foliar bleaching is caused by "prolonged exposure" to elevated air temperatures and was not affected by iron treatments. The most practical way to reduce losses in quality should be to avoid highly sensitive cultivars. The complete report can be found at: HortScience 46(3):411-415. 2011.

Titanium dioxide on Xanthomonas on Geranium and Poinsettia—University of Florida researchers, Norman and Chen performed trials to determine effect of titanium dioxide on two bacterial diseases. Work on use of titanium dioxide for grain diseases in Korea led to the University of Florida work on ornamentals. Plants were sprayed twice on a one week interval with titanium dioxide at a low or high rate. They were inoculated with their respective isolates of *Xanthomonas*. Geranium (*Pelargonium* x *hortorum* 'Patriot Bright Violet') was inoculated with *Xanthomonas hortorum* pv. *pelargonii* and poinsettia (*Euphorbia pulcherrima* 'Snowcap') was inoculated with *Xanthomonas axonopodis* pv. *poinsettiicola*). The trials were performed twice on each ornamental. Results of one set of trials are shown in the table below.

Effect of titanium dioxide sprays on severity of Xanthomonas on geranium and poinsettia.

Treatment	Rate	# spots geranium	# spots poinsettia
Noninoculated	——	0 a	0 a
Inoculated	——	110 b	44 b
Titanium dioxide	Low	52 a	54 b
Titanium dioxide	High	36 a	26 ab

Numbers in the same column followed by the same letter are not statistically significant.

The number of spots was reduced in one of the geranium trials by 53-67% but not in the other trial. For the poinsettia spots were reduced significantly in both trials by 85-92%. The authors found no phytotoxicity at the rates tested and suggest that titanium dioxide might be an effective alternative to currently registered products for bacterial diseases on ornamentals. The complete report can be found at: HortScience 46(3):426-428.

Switchgrass cultivar susceptibility to rust and anthracnose—Hagan, Bowen and Akridge (Auburn University) reported on tests with switchgrass (*Panicum virgatum*) susceptibility to anthracnose (*Colletotrichum navitas*) and rust (*Puccinia emaculata*). The trial was started at the end of March and disease occurred naturally and was rated at the end of the season (mid August). All cultivars except 'Prairie Sky' were completely resistant to anthracnose. The results of the rust rating are shown in the table below. The species *P. virgatum* showed low resistance to rust. The highest resistance (nearly immunity) was seen with 'Prairie Sky' which was unfortunately the only cultivar tested that was susceptible to anthracnose. The cultivars which might be good for resistance to both diseases were 'Shenandoah' and 'Rotstrahlbusch'.
For the complete report see: Plant Disease Management Reports 5:OT001.

Switchgrass cultivar resistance to rust

Cultivar	Rust resistance
Prairie Sky	Very high
Shenandoah	Moderate
Rotstrahlbusch	Moderate
Northwind	Some
Hanse Herms	Some
Thundercloud	Low
Cheyenne Sky	Low
Heavy Metal	Low
Badlands	Low
P. virgatum	Very low
Dewey Blue	Very low
Dallas Blues	Very low
Cloud Nine	Very low

Handling & Propagation Protocols for Unrooted Cuttings & Tissue-Cultured Microplants—Jim Faust (Clemson University) and John Dole (North Carolina State University)

Arrival of cuttings
Unpack immediately and decide what to do with the cuttings based on condition of the box upon arrival. Check temperature with an IR gun or a temperature probe.

1. Stick immediately. Some species need to be stuck immediately or rooting success will be reduced.
   A. Cuttings that are poor shippers/ storers: Coleus, crossandra, lantana, portulaca, sweet potato.
   B. Difficult to root species or cultivars: Thunbergia, lavender.

2. Hold cuttings in cooler for less than 24 hours.
   A. 50°F works for most species. Some species are moderately cold sensitive to temperatures and should not be stored below 40°F: double impatiens, heliotrope, New Guinea impatiens, poinsettia, verbena
   B. 35 to 40°F works for cold-tolerant species, such as petunia and geraniums
   C. A few tropical species prefer 55°F and many are damaged at 50F or less: Coleus, crossandra, lantana, portulaca, sweet potato, thunbergia.
   D. Based on the temperature of the cuttings within the box, handle accordingly:

Temperature greater than 70°F: Remove cuttings from box to cool them as fast as possible. Don't place warm boxes packed with cuttings in the cooler as they will take a long time to cool, especially if well insulated.

Temperature is 60 to 70°F + cuttings were received on time (48 hours or less in transit) and cuttings can be stuck the same day: Place box in cooler and stick cuttings same day.

Temperature is 60 to 70°F + cuttings were delayed in transit or cannot be stuck until the next day: Remove cuttings from box to cool them as fast as possible. .

Temperature is 50 to 60°F: Place box directly in cooler.

3. Hold cuttings on a propagation bench for less than 24 hours. Make sure cuttings to do not dehydrate and avoid heat. Turn mist on and bottom heat off.

4. Store cuttings in a cooler for more than 24 hours. Not recommended but some species store well including argyranthemum New Guinea impatiens, osteospermum and petunia.

Sticking and Handling

1. Take only enough cuttings in the greenhouse that can be stuck within an hour. Keep cuttings out of the direct sunlight or air movement. Be aware of when work breaks will occur and plan accordingly.

2. Use IBA as needed to improve uniformity of rooting and increase rooting, but be aware that IBA will also promote leaf yellowing and possibly senescence.

First 24 to 48 hours in propagation.

1. Provide the following light levels for 12 to 13 hours/day:
   A. Stick to callus: 600 to 1,000 fc. (3 to 5 moles/day)
   B. Root initiation: 1,000 to 2,000 fc. (5 to 10 moles/day)
   C. Half plug: 2,500 to 3,000 fc. (5 to 10 moles/day)
   D. After transplanting: 10 to 20 moles/day

2. Supplemental lighting can be very helpful, especially in low light areas.

3. Prevent dehydration:
   A. Mist
   B. Fog
   C. Non-mist enclosures
   D. Contact systems, such as remay or plastic

4. Decrease mist or humidity and increase light over time.

5. Maintain warm enough temperatures to encourage rooting but not so much to cause heat stress.
   A. 70 to 75°F for most species.
   B. 65 to 70°F for cool season crops such as argyranthemum, osteospermum, regal geraniums.

Troubleshooting
Document problem by taking digital pictures of cuttings and enclosed labels. Record date of arrival, stick and photograph. Communicate with your cutting suppliers.

1. Cuttings arrive **defoliated or drop leaves** soon after sticking.
   A. Species is sensitive to ethylene: lantana, portulaca, begonia (some cultivars), thunbergia, fuchsia.
   B. Species is sensitive to ethylene after chilling damage: New Guinea impatiens.

2. Leaves **yellow** in propagation within the first week.
   A. Postharvest period was too long or too warm.
   B. Cuttings were dehydrated after sticking.

3. Leaves **yellow** in propagation after first week.
   A. Temperature too warm or too cold.
   B. Misting too much.
   C. Nutrients leached out of cuttings.

4. Leaves or cuttings are **mushy** upon arrival.
   A. Freeze damage.

5. Leaves or cuttings are **mushy** shortly after sticking.
   A. Postharvest period too long or too warm
   B. Pathogens such as *Erwinia* are active.

6. Leaves or cuttings are **mushy** after being in propagation for a while.
   A. Pathogens such as *Botrytis* or *Erwinia*.
   B. Temperatures too warm or too cold.
   C. Too wet.

7. Shoot **tips are rotted** within first week.
   A. Too cold during postharvest.

8. Shoot **tips are rotted** after first week.
   A. Excessive water on cuttings.

9. Leaves are **discolored** upon arrival or shortly thereafter.
   A. Physical damage.
   B. Cold damage, especially water soaking appearance.

10. Cuttings **stop developing** but are not mushy or yellow.
    A. Temperatures are too cold.
    B. Mist too much.
    C. Woody cuttings are still dormant.

Handling TC Microplants

Postharvest requirements for TC are different than for URCs: Tissue culture contains a food supply (sugars), so containers do not immediately need sunlight (for photosynthesis) or cold temps (to minimize respiration) to survive for several days up to a week.

Humidity Management: Once the TC container is opened, it is critical to maintain the tissue in a high humidity environment, since the TC has a poorly developed cuticle and is very susceptible to dehydration. The transplanting line should be away from drafts and air movement (fans). Provide mist, spray or fog ASAP after the containers are opened. Foliar fertilizer can be beneficial with the initial washing/misting.

Temperature Management: Tropicals can be handled at 75°F, while temperature woody species should be held at 55-65°F.

Quality Control: TC always has variability in plant size. Transplanting is an opportunity to segregate/grade the plantlets by size. The ideal TC product has many root initials without elongated roots. Elongated roots should be removed during transplant. If you are receiving a lot of plants with elongated roots, this should be communicated with your TC lab to be corrected.

Cleanliness: Molds growing in TC containers are not dangerous to humans. These are saprophytes (bread molds) and can simply be washed off.

Light Management. The cuticle, trichomes (leaf hairs) and root hairs develop quickly (in the first 24 hours) once the plantlets are removed from TC containers, but the plants require several days to acclimate to higher light levels, so light management is important. Once the miniaturization characteristics of the TC are outgrown, i.e., the leaves are normal looking, the plant can be treated like a rooted cutting.