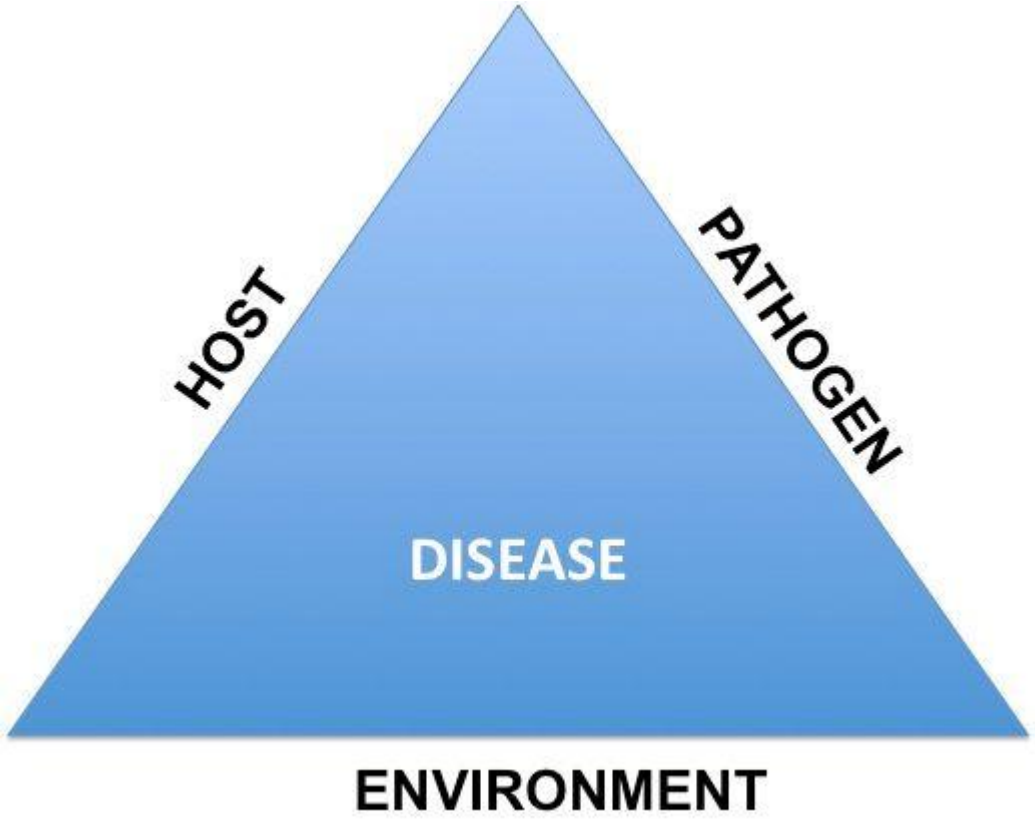


# Effective Cleaning Practices to Prevent Plant Diseases

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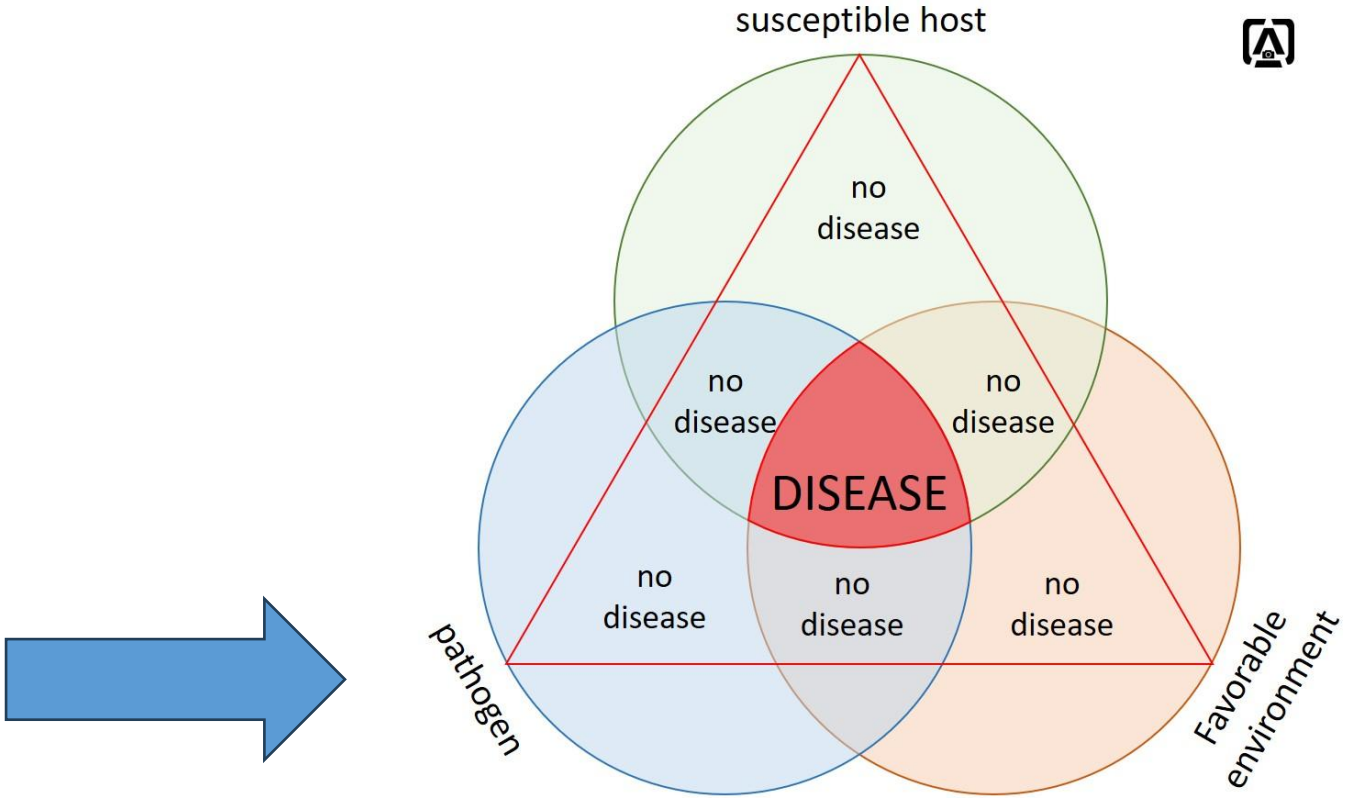
# What is a plant disease?

*A plant disease is a condition where a plant's normal functions are disrupted due to a living organism (pathogen) like a fungus, bacteria, or virus, or by environmental factors like nutrient deficiencies, causing abnormal growth or appearance in the plant.*

# Why should I care about diseases?

- **Plant stress:**
  - **Lower yield**
  - **Changed susceptibility, performance, taste, appearance**
- **Plant death**

# How can I prevent plant diseases?




**Plant disease is prevented when any one of these three components is eliminated!!**

# What should I avoid?


# First steps


Source: Farmbiosecurity

# Critical steps to a good clean-out

1) Remove all plant material
2) Remove the drippers from the substrate and collect and trash the old substrate

Dry out plants

Cut stems

Cut down plants

# Critical steps to a good clean-out

3) Remove all surface debris:
   - Soil and organic residues from plants and growing media reduce the effectiveness of disinfectants
   - They can allow pathogens to **over-winter**
   - **Do not** compost this plant debris nearby the greenhouse. Trash and kill them properly.

Picture source: Farmbiosecurity

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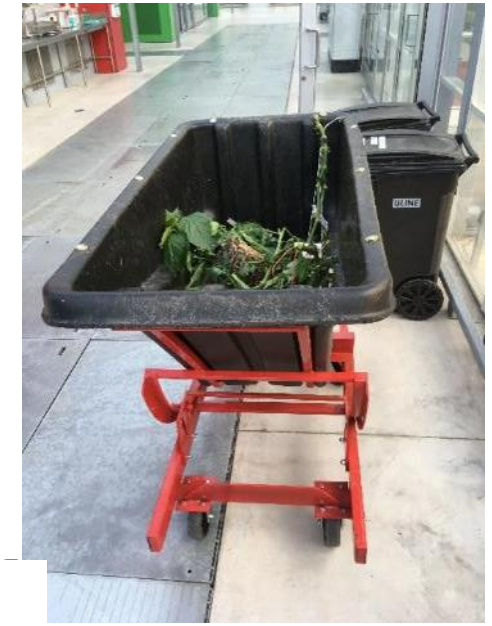
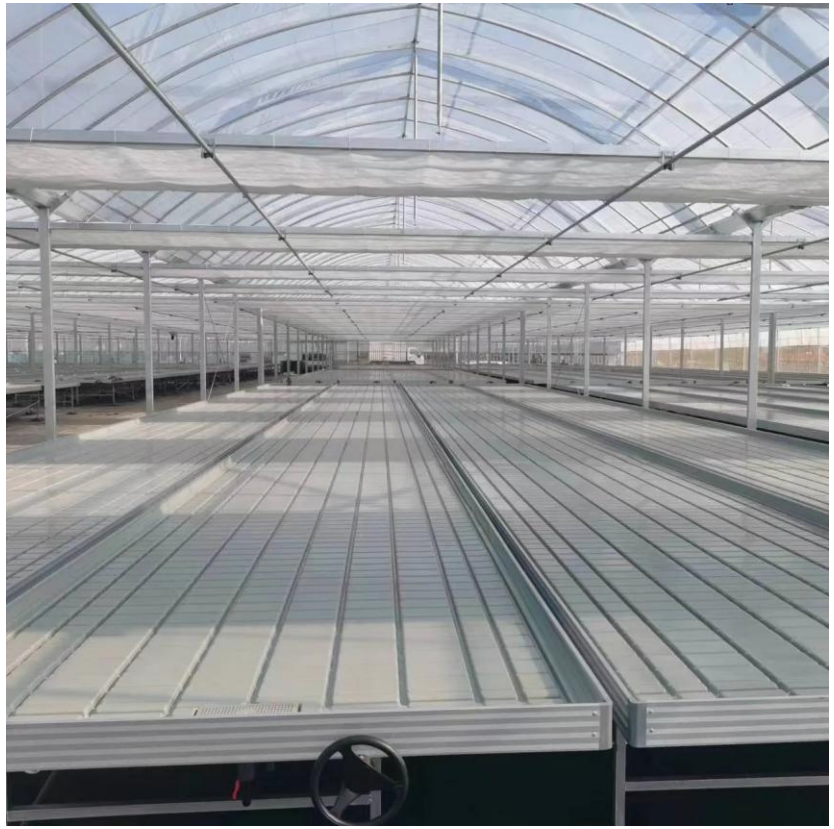




EMPTY

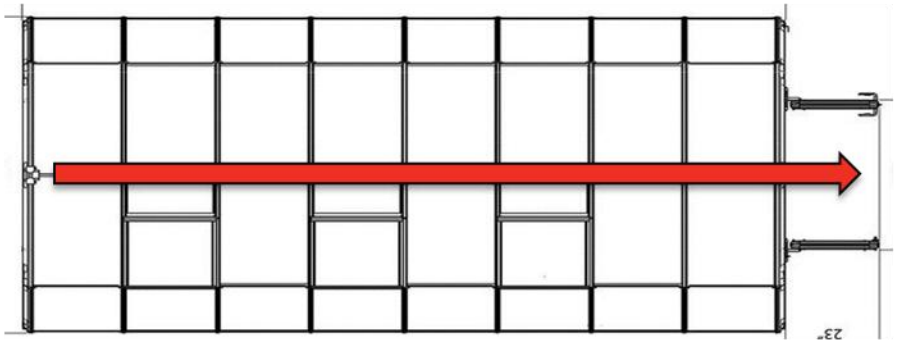
NO PLANT DEBRIS

NO ORGANIC MATTER

Source: Horticultural Development Company

# Critical steps to a good clean-out

4) Scrub down with soap and water (2% by volume concentration)
5) Rinse off any suds, as it could inactivate the sterilizing agent to follow
6) Allow to drip-dry
7) Apply a sterilizing agent
8) Allow to drip-dry
9) Clean up any residual debris from the cleaning area



# Decontaminating Tools


- ✓ Nicks, scratches, and ridges on tools create pockets that harbor microorganisms and protect them from disinfecting agents.
- ✓ Tools must be free of debris and plant sap before disinfecting.
- ✓ **Cleaning Methods**
  - **Soap and water**
  - **High-pressure water or soaking hot water**
  - **Paint thinner** – Effective for removing latex (milky sap) from tools.

# Decontaminating Tools

- ✓ **Flame Sterilization**
  - **10 seconds** reduces pathogenic fungi by **95%**.
  - **40 seconds** eliminates **100%** of fungi (Downer et al., 2009).

- ✓ **Boiling water** – a cheaper alternative when steam equipment is unavailable.

- ✓ **Steam sterilization** - useful for sterilizing larger equipment like carts and machinery.

# Which sterilizing agent should I use?

KleenGrow™
Algicide • Fungicide • Bactericide • Disinfectant • Virucide

ZeroTol 2.0

SaniDate 12.0

OxiDate 2.0
BROAD SPECTRUM BACTERICIDE/FUNGICIDE

PHYSAN 20



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# Chlorine Bleach

- ✓ Effective disinfectant if used properly; has a long history of use by growers.
- ✓ Recommended dilution: 1 part household bleach to 9 parts water (0.5% strength).


- ✗ Corrosive, can damage plastics and metals with repeated use.
- ✗ Requires longer soaking time and rinsing afterward.
- ✗ Phytotoxic to some plants.
- ✗ Ventilation is needed when using bleach.
- ✗ Chlorine bleach is less stable than other disinfectants for greenhouse surfaces.
- ✗ Recommended for pots or flats, but not walls, benches, or flooring.
- ✗ Short-lived solution: the chlorine concentration reduces by half every two hours.
- ✗ Must be prepared fresh before each use to ensure effectiveness.

# Isopropyl Alcohol (70%)

- ✓ Very effective sanitizer.
- ✓ Acts immediately upon contact.
- ✓ It can be used as a dip or swipe treatment on knives and cutting tools.
- ✓ No rinsing with water is required.

- ✗ Not suitable for soaking pots, flats, walls, benches or flooring due to flammability.




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# Quaternary ammonium chloride salts

- ✓ Kills bacteria, fungi, viral plant pathogens and algae.
- ✓ Can be used on floors, walls, benches, tools, pots, and flats.
- ✓ Physan 20® can also be used on seeds, cut flowers, and plants.
- ✓ Active solutions tend to foam; when foaming stops, they are no longer effective.
- ✓ No rinsing off with water is needed after application.

PHYSAN 20

KleenGrow™

Algicide • Fungicide • Bactericide • Disinfectant • Virucide

- ✗ Contact with organic matter will inactivate Q-salts → KleenGrow™ offers higher organic tolerances and longer residual activity on hard surfaces.
- ✗ Prepare fresh solutions frequently, ideally twice a day.

Quaternary Test Kit

# Hydrogen Dioxide and Peroxyacetic Acid

- ✓ Kills bacteria, fungi, algae, and their spores immediately on contact.
- ✓ Approved for disinfecting greenhouse surfaces, equipment, benches, pots, trays, tools, and plants.
- ✓ SaniDate® 12.0 can be applied through irrigation systems.
- ✓ OxiDate® and SaniDate® are certified organic products.

- ✗ Strong oxidizing agent; do not mix with other pesticides or fertilizers.
- ✗ All surfaces should be thoroughly wetted before treatment.
- ✗ Concentrate is corrosive, and can cause eye and skin irritation.
- ✗ Can cause phytotoxicity if applied above labeled rates or on stressed plants.


OxiDate® 2.0
BROAD SPECTRUM BACTERICIDE/FUNGICIDE

ZeroTol® 2.0

SaniDate® 12.0

# Others

- ✓ Kills virus, bacteria, fungi, and some spores immediately on contact. One of the best virucides in the market.
- ✓ Non- corrosive when used according to recommendations.
- ✓ Effective in the presence of organic matter.
- ✓ Biodegradable.

- ✗ Potential phytotoxicity if improperly diluted or applied to close to plants.
- ✗ Can be more expensive than other disinfection options.
- ✗ Short shelf life once mixed.
- ✗ It requires careful handling and the use of PPE to avoid health risks.
- ✗ Improper disposal could lead to environmental concerns, particularly in water systems.
- ✗ Not reviewed and approved for use in CA greenhouses or plant nurseries.


**Active Ingredients**

| | |
|---|---|
| Potassium peroxymonosulfate | 21.41% |
| Sodium Chloride | 1.50% |
| Other ingredients | 77.09% |
| Total ingredient | 100.00% |

# MOST IMPORTANT!


# Heating Methods

- ❖ good tilth
- ❖ neither too wet nor too dry
- ❖ **80ºC/176ºF for 30 min**

- ❖ Hot water
- ❖ Aereated steam
- ❖ **60ºC/140ºF for 10 min**

Source: Horticultural Development Company

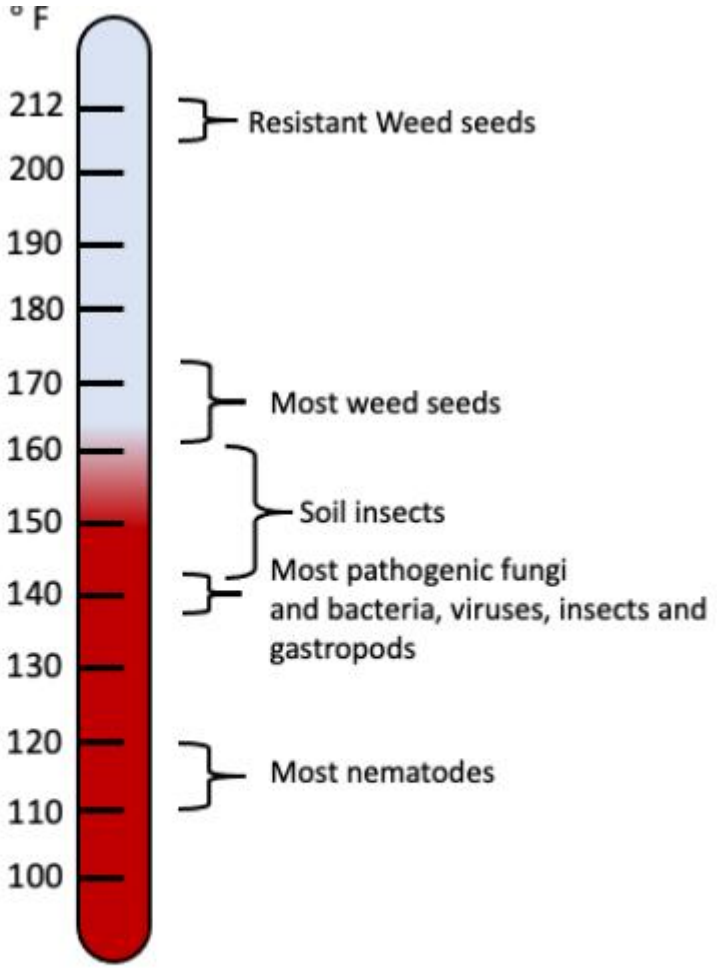


**Figure 2. Generalizing the temperatures required to kill common plant pathogens, pests, and weeds. Heat treatment can be used to kill unwanted pathogens on tools.**

Source: University of Hawaii

# After it is Clean, Keep it Clean!

**"It's not the cleanest person who cleans the most, but the one who makes the least mess."**

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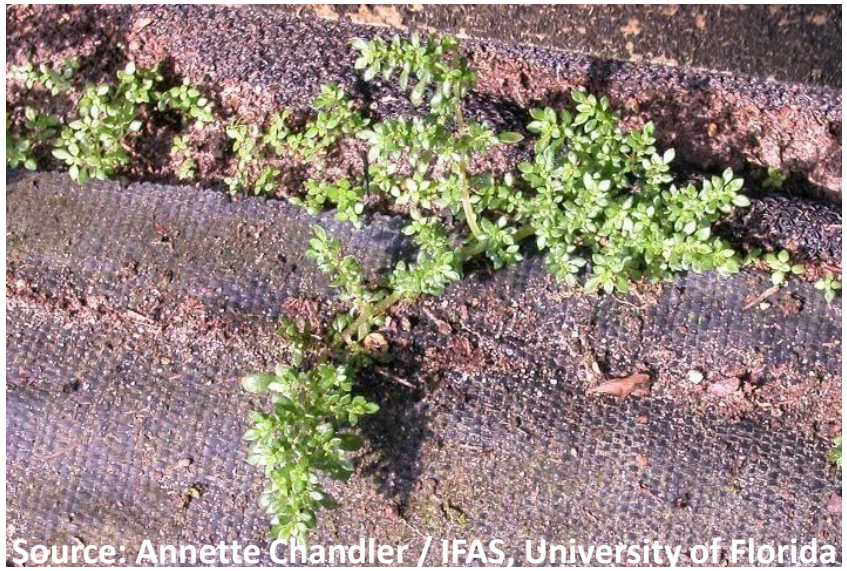
Source: Annette Chandler / IFAS, University of Florida


Source: Del Castillo, J.


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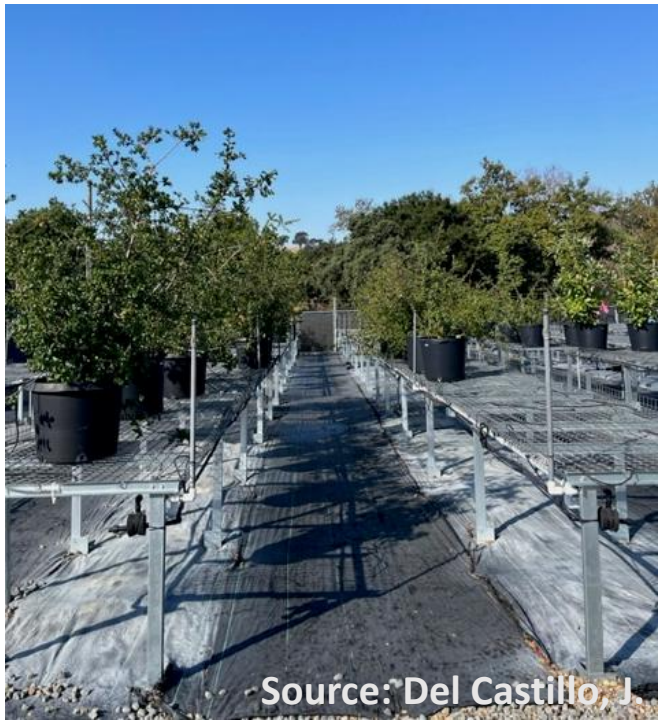
# Keep ground clean

Direct contact between soil and containers.


Raised benches, add a gravel or rock barrier between them.




Source: Del Castillo, J.

# Keep ground clean

Splash dispersal of pathogens from contaminated ground.


Prevent standing water, avoid overwatering, improve drainage.


Source: Del Castillo, J.

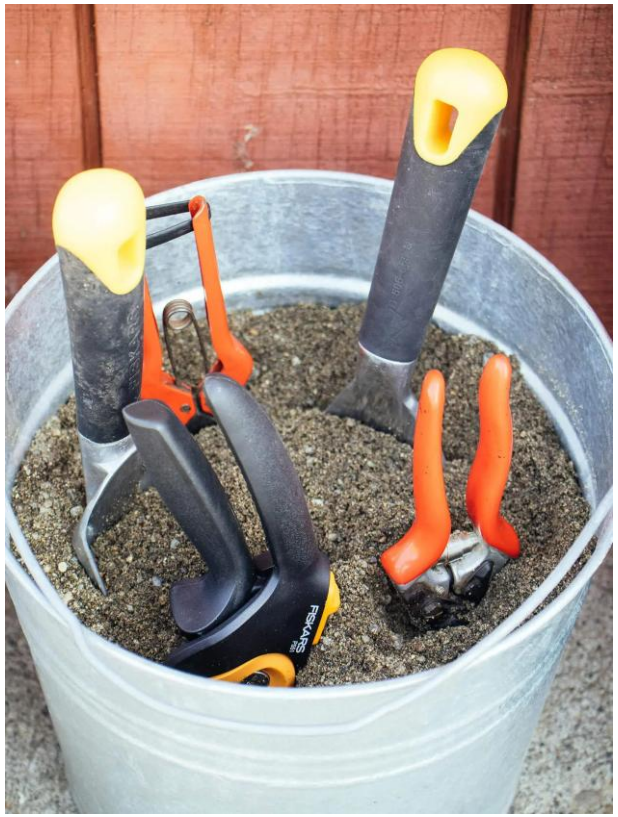
# Keep ground clean

Contamination of soil.


Prevent and remove leafy debris from accumulating on the soil.


Source: Del Castillo, J.

# Exclusion

# Decontamination Stations

Source: OMAFRA


Source: OMAFRA

Source: Royal Brinkman


**Figure 3. Decontamination station containing footbath, brushes, and hand-spray bottle with 70% isopropyl alcohol to clean and sanitize footwear and clothes prior to greenhouse entry.**

Source: University of Hawaii

# Use Certified Plants

- Buy plants from certified nurseries.
- Scout new material incoming to the greenhouse.
- Reject loads with infected plant material.
- Place in quarantine new plant material (60 days from arrival).


Source: Del Castillo, J.

- Do not mix new plant material with existing stock, until you are confident the new ones are pest-free.

Source: Del Castillo, J.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