

Hawai‘i Rare Plant Restoration Group

Phytosanitation Standards and Guidelines

December 2010

The objective of this document is to state the level of sanitation that will be required during *ex situ* operations, and the transition into natural habitats via reintroduction or augmentation projects. Sanitation is a key factor in reintroductions or augmentations by preventing the introduction of foreign organisms into the wild. Plants must be visibly weed-free, pest-free, and pathogen-free. All plants to be used for reintroduction or augmentation projects must be rigorously checked for compliance with the requirements described in the narrative below. If the plants do not meet the standards stated in the guidelines at the time of inspection, they should not be used. The infected plants must be treated so that all alien plant species, pests, and pathogens are eliminated before the plants can be reconsidered for reintroduction or augmentation projects. If any plant becomes infected with a virus that plant must be immediately removed from the growing area and destroyed. The surrounding plants should be monitored or tested (if available) for signs of virus infection as well.

The phytosanitation checklist outlines the range of threats that must be monitored and controlled in the nursery setting. Threats to be monitored and controlled are arthropods, alien plant species, mollusks, pathogens, small mammals, and other pests. These threats are major problems that affect the overall health of the plants and can cause possible contamination to the environment if transported into the wild. The table below summarizes the threats and suggested actions to eliminate these problems.

**Summary of pests and diseases commonly found in *ex situ* propagation facilities.
Prevention and monitoring procedures are identified below.**

Prevention and Monitoring Planning & Procedures	Virus, Bacteria, Fungi	Nematodes	Arthropods	Mollusks	Weeds	Small Vertebrates
Nursery design			X	X	X	X
Plant media preparation and handling		X			X	
Plant and nursery sanitation	X	X		X	X	X
Pest and disease control program	X	X	X	X	X	X
Nursery and plant inspection	X	X	X	X	X	X
Threat monitoring and control	X	X	X	X	X	X

REQUIREMENTS

1. Nursery Facility/ Adjacent Growing Area

- The nursery and it's adjacent area must be kept free from alien plant species, any encroaching live roots from nearby trees or shrubs, and other foreign plant material. The floor shall be paved or covered with coarse gravel to ensure that no dirt areas are exposed. The walkways must be paved with concrete, black top, or gravel.
- A six foot buffer zone around any growing area or greenhouse building must be maintained and kept free from any vegetation to minimize insect pest and disease infestations.
- The plants should be grown in an enclosed area to prevent weed seeds from blowing into pots.
- Plants should be grown in sterilized or disinfected pots, containers, or beds or use new containers for each plant.
- Plants must be placed on disinfected benches or disinfected supports which are at least 18 inches above the ground or floor level.
- Plants and aerial roots should not be grown lower than 18 inches from the ground level to top of benches.
- Water hoses must be stored off the ground.
- No plants are to be placed over the propagative stock (hanging containers or secondary benches), nor under the benches to prevent contamination to plant material.

2. Media

- See Approved Growing Media Section for a list of approved growing medium that can be used singularly or in media mixes.
- Media should be new and sterilized or pasturized if they are not sold sterilized. Do not reuse plant media.
- All medium and media mixes must be stored in closed bins or containers.
- Care should be taken if inoculating with mycorrhiza to prevent the introduction of new mycorrhizal stains to areas where not previously known.
- Fungal pathogens must be treated even in mycorrhizal inoculated plants; reinoculation of the plants may be necessary before reintroduction.

3. General Sanitation

- The grower must sterilize/disinfect tools regularly, ideally before moving to a new batch of plants.
- The grower must keep all growing areas, benches, and work surfaces clean to minimize threats (*i.e.*, alien plant species, pathogens).
- Benches, plant boxes, used pots, flats, and implements must be washed free of soil and plant matter, and disinfected prior to use.
- All dead, diseased, or infected material in or around the pots should be appropriately disposed of on a daily basis.
- Dead, diseased, or decaying plant material should be pruned off with sterilized tools (and re-sterilized between cuts) to prevent further contamination (*i.e.*, flaming tools).
- Adequate spacing between plants is necessary in order to have good air circulation between and around the plants to minimize pest problems.
- Propagules must be free from threats (*i.e.*, pathogen). Use appropriate methods to clean plants (*i.e.*, bleach solution). Do not use any propagules that are infested with a virus.
- Plants and growing media should be sampled using methods approved by the Department of Agriculture.

4. Threat Control Program

*NOTE: The use of pesticides is governed by state and federal regulations. Ensure pesticide use is in compliance with the law and follow all label directions. If there are any questions, please contact the State of Hawaii, Department of Agriculture Pesticide Division for further information.

- Insure that pesticide applicator personnel are properly trained and outfitted.
- It should be noted that if restricted pesticides are used, the applicator must be a certified pesticide applicator or supervised by a certified applicator.
- The grower must have a monitoring and treatment program for each threat category.
- Maintain records of all monitoring and spraying schedules, plant species treated, threat/pest treated, last time sprayed, and chemicals and rate of application.
- See Threat Monitoring and Control Section for more information on specific threats.
 - a) Monitor on a weekly basis for signs and symptoms of infestation.
 - b) Identify the target pests.
 - c) Monitor for pests presence and their levels of abundance.
 - d) Familiarize yourself with seasonal infestation trends and pest life cycles.

- e) Contact your local agriculture extension agent, CTAHR, DOA agent, or other experts for proper identification, up-to-date chemicals and current control practices.

5. Nursery and Plant Inspections

- The nursery facility and all plants will be subjected to inspection by the project lead as part of the approval process. Areas and plants not designated for project use will still be subjected to inspection, since it may still serve as possible sources of inoculum. Plants grown by contractors must be inspected and certified as pest-free at the nursery facility before acceptance; plants will be rejected until all pest or disease infestations are eradicated.
- Use traps and baits (*i.e.*, sticky traps, ant traps, and slug bait) to monitor the presence of threats. Check on a weekly basis.
- Project lead will inspect the nursery and outplanting sites for arthropods, mollusks, pathogens, and alien plant species.
- Project lead is responsible for coordinating the transfer of plants from nursery to the outplanting site. This is to reduce the amount of handling and to prevent the detainment of the plants in less than desirable holding areas, which would increase the chances of contamination and plant stress. This is especially the case for plants obtained from contracted nurseries.
- Sources of transportation (*i.e.* cars, trucks, vans) need to be free of pests, especially ants.
- All *ex situ* outplantings should be periodically monitored post-planting to detect any weed seedlings (or other pests) emerging from the root ball area of the plants.

6. If Plants Are Rejected

- If possible, remove and isolate the infected/infested plants from the uninfected plant inventory. Preferably, remove the infested plants from the facility.
- Immediately treat infected and surrounding plants with the appropriate control method to prevent further infestation.
- Check the surrounding plants and rest of the nursery plant inventory for signs of infection.
- Once the plants are treated and pests are no longer detected, they can be reconsidered for use in reintroduction or augmentation projects.
- Remove and destroy all plants and plant parts infected with a virus. Make sure that no part of the plant (*i.e.*, leaves) is remaining. Infected plant material is a source for potential contamination to the surrounding plants. Be sure to wash your hands after handling the plants and disinfect any tools that were used.

OUTPLANTING

- Clothes, gear, tools, *etc.*, should be clean and free from any foreign soil and plant material.
- Use on-site mulch if needed instead of bringing mulch in from an external source.
- See Hawaii Rare Plant Restoration Group (HRPRG) reintroduction guidelines.

Phytosanitation Checklist

This checklist must be followed by all growers and will be used to ensure compliance prior to the acceptance of any plant material.

Nursery Facility

- Follow sanitation requirements listed above
- Walkways covered with coarse gravel or paved with good drainage
- No plants over or under growing area
- Benches at least 18" above ground
- Water hoses stored off ground
- Adequate storage for media (enclosed on all sides)
- Approved DOA preparation and storage areas for pesticides
- Adequate facility for washing and disinfecting pots
- At minimum, weekly inspections by greenhouse staff

Equipment

- Use recommended growing media listed below
- Use sterilized tools and benches, new or disinfected pots and trays (if reused)
- Clean transportation vehicles to pick up and drop plants at other sites
- Conduct daily inspections to identify pest problems and initiate early pest control; provide proper equipment and training for staff. (*i.e.*, magnification loop)
- Adequate chemical application equipment and Personal Protective Equipment
- Maintain all equipment and protective gear in good working order

Chemical

- Compliance with State DOA regulation regarding use of all pesticides
- Completion of State Restricted Use Pesticide Applicator Certification if restricted chemicals are the only means of pest control
- Apply broad and narrow spectrum fungicides, herbicides, and insecticides for prevention and control as necessary.

- Conduct routine disinfection treatment (contact DOA for a list of approved chemicals) of all greenhouses, and to the adjacent areas as needed.
- Maintain an accurate pesticide and fertilizer spray history log.

Phytosanitation

- Clean benches when rotating crops at least every other month
- Optimize watering schedule (*i.e.*, not too wet or too dry) to minimize pest and disease problems.
- Water/irrigate in a manner to minimize splash-over into adjacent pots
- Remove dying/dead plants and any decomposing leaf or plant matter from benches
- Space plants on benches to allow for adequate air movement
- Inspect and clean propagules before planting

Threat Monitoring and Control

The following reference is a general summary provided to help the nursery grower identify threats, signs, and symptoms, and suggest methods for their control. For more information, contact your local agriculture extension agent, Department of Agriculture personnel, or the University of Hawaii Diagnostic Laboratory or Agricultural extension agent.

1. Arthropod Monitoring and Control

- Look for signs and symptoms.
- Identify the target pest.
- Monitor for presence of pests and their levels of abundance.
- Know their life cycle and seasonal fluctuations.
- Monitor on a weekly basis.
- Contact your local agriculture extension agent or DOA agent for proper identification, current control practices, and up-to-date chemicals to use.

a) Ants:

- **DESCRIPTION:** There are many types of ants that affect plants in the nursery as well as in the wild. They have six legs and have a chewing mouthpart. They can range in color and size. They live in colonies and the queen lays thousands of eggs in individual sacs.
- **SIGNS AND SYMPTOMS:** Ants are usually found on plants that have scale, mealy bug or any other insect that produces honeydew. The ants farm these insects for the honeydew they produce. They can be seen crawling all over the plant and/or pot. "Tunnels" built by ants that are made out of potting media from the pot can be found on the stems protecting insects that produce honeydew.
- **CONTROL:** There are two distinct types of ants to control. One type is sugar loving and the other prefers an oil-based food. Bait for ants at first sign of presence. If population increases, find and destroy the nest.

b) Aphids:

- **DESCRIPTION:** There are many types of aphids that attack plants; however, all of them are soft-bodied and have piercing sucking mouthparts. Their bodies are pear-shaped and can range in colors from yellow to green to black. Aphids secrete a sweet, sticky substance, which is called honeydew. Ants farm aphids for a constant source of honeydew, which is the ant's source of food. The females bear live young. Once they reproduce, aphids can have many generations a year.
- **SIGNS AND SYMPTOMS:** When aphids are present on the plant, pale yellow spots are visible on the foliage. Also, leaves may be curled, puckered or stunted. Presence of sticky honeydew is also a good indicator of aphids. Sooty mold may be visible growing on the honeydew. Check under leaves and at growing points for aphid infestation.
- **CONTROL:** If population numbers increase, spray insecticide as directed on the chemical label. Just a note: aphids are usually attracted to plants over-fertilized with nitrogen.

c) Beetles:

- **DESCRIPTION:** Beetles range in size, shape and color; however all have hard bodies and wings (Ball and Ball 1990). They have chewing mouthparts.
- **SIGNS AND SYMPTOMS:** Check for chewed up plant parts such as leaves and flowers. If left unattended, the beetle can totally denude the plant.
- **CONTROL:** Manually pick beetles from the plant by hand. Remove leaf litter or other possible beetle and beetle larvae habitat around the plant.

d) **Black Twig Borer:**

- **DESCRIPTION:** Adult females are twice as big as the males at about 1/16 inch long and are shiny black in color. The males are reddish-brown in color and can't fly. The entire life cycle can take about a month to complete (Tenbrink and Hara 1994). They have chewing mouthparts.
- **SIGNS AND SYMPTOMS:** Stems become weakened and breakage often occurs. Look for small round holes. The twig borers will create holes in the branches and create a living area. Die back of the plant is not caused by the borers feeding on the plant. Instead, it is caused by the physical infestation and the introduction of pathogens (Tenbrink and Hara 1994).
- **CONTROL:** Remove and destroy infested parts. There may be some biological control insects, but more information is needed. Not too much is known about control methods.

e) **(True) Bugs:**

- **DESCRIPTION:** True bugs range in body shape, size and color. Typically, the body is shield shaped and about 1/6-1/2 in long (Ball and Ball 1990). When smashed, they often exude a distinct odor. They have piercing-sucking mouthparts.
- **SIGNS AND SYMPTOMS:** The infested plant may have disfigured growth such as discolored spots, stunted growth, or wilted shoot tips (Ball and Ball 1990).
- **CONTROL:** If infestation is low, hand pick the insects. Clean the area surrounding the plant of leaf litter to decrease suitable habitat.

f) **Cutworms:**

- **DESCRIPTION:** Cutworms are soft-bodied caterpillars that are dull gray or brown in color, and are 1 to 2 inches in length. They are nocturnal feeders that find refuge in the soil or leaf litter during the day. As adults, they change into moths. The females lay the eggs in the soil, and they can produce an average of 5 generations a year. (Ball and Ball 1990).
- **SIGNS AND SYMPTOMS:** If seedlings are mowed down or chomped down near the soil line, that's a good indicator of cutworm damage. Some cutworms also attack the seedlings from below the soil line, damaging the roots and causing the plants to wilt. (Ball and Ball 1990). Damage look similar to mollusk damage or rodent damage.
- **CONTROL:** Put up biological, chemical or physical barriers around the seedlings to deter the cutworms. There may be some beneficial biological control.

g) **Leafhoppers:**

- **DESCRIPTION:** Leafhoppers have wedge-shaped bodies that are 1/8-1/4in long. They have a hunched look to them since their folded wings are slightly protruding from their bodies. (Ball and Ball 1990, Kessing and Mau 1993a). They range in

- colors from green, brown or yellow. They are not very active, however, when disturbed, they can jump suddenly or move sideways with agility. They have piercing-sucking mouthparts and can spread virus (Ball and Ball 1990).
- **SIGNS AND SYMPTOMS:** They feed on all part of the plant (except the roots). As they feed, toxins are released into the plant causing yellowing or discoloration. Leaves will turn yellow and fall off. Leafhoppers excrete honeydew, so ants and sooty mold may be present. (Ball and Ball 1990)
 - **CONTROL:** There may be some beneficial biological control (*e.g.* mymarid wasp) (Kessing and Mau 1993b). Keep area around plants clear of leaf litter and alien plant species.

h) Mealy bugs:

- **DESCRIPTION:** Mealy bugs have piercing-sucking mouthparts, and can attack either the foliage or the root system, depending on the species. They are mobile throughout their lifecycle. Depending of the species, males are relatively short-lived, living an average of 27 days, while the females can live around 115 days (Martin and Mau 1992). Their bodies are covered with a white waxy substance that gives it a “mealy” look (Tenbrink and Hara 1993).
- **SIGNS AND SYMPTOMS:** Leaves will look droopy and the areas they feed on will be yellow and discolored. They excrete honeydew, which can cover portions of the plant. Look for sooty mold, which grows on honeydew. If ants are present, that’s a good indicator that mealy bugs are there. They can be vectors of pathogens.
- **CONTROL:** There may be some beneficial biological control (*e.g.*, parasitic wasps). Mixing white oil with the chemical will aid in smothering the scale.

i) Scale insects:

- **DESCRIPTION:** Scales are related to mealy bugs and aphids, and have bodies that range from 1/12 inch to 1/5 inch (Ball and Ball 1990). Most scales are only mobile during the first stage of their lifecycle. Usually, after their first instar, the female scales become immobile attaching themselves to the plant and form a protective coat. This protective coat can vary from cottony white masses to waxy shells. Males, if present, are not able to feed since they don’t have mouthparts. The females either lay eggs or bear live young under the protective scale (Mau and Kessing 1992). Several generations can be produced per year. (Ball and Ball 1990)
- **SIGNS AND SYMPTOMS:** Areas where they are feeding on will turn yellow and may drop. They excrete honeydew can cover portions of the plant. Look for sooty mold, which grows on honeydew. If ants are present, that’s a good indicator that scales are there. They can be vectors of pathogens.
- **CONTROL:** There may be some beneficial biological control (*e.g.*, parasitic wasps). Spraying the scale during their mobile stage is the most effective chemical practice. The dead scales are persistent on the plant, so check the scale population prior to spraying (it may just be dead scale shells). Just a note: Over use of nitrogen fertilizer can encourage growth of scale attracted to succulent new growth.

j) Spider mites:

- **DESCRIPTION:** Spider mites are extremely tiny. Adult females, which are larger than the males, are not any bigger than 1/20 inch (UCDANR 1995). They have

- piercing-sucking mouthparts that they use to feed on the underside of leaves and flowers. As they feed, toxins are injected into the plant that result in distorted growth and discoloration of the plant. New generations can be produced as quickly as 2 weeks if the conditions are right (Ball and Ball 1990).
- **SIGNS AND SYMPTOMS:** Check the underside of leaves and on flowers for webbing and tiny excrement pellets as this will indicate the presence of spider mites. Also, if the foliage begins to turn yellow and develop a dry, sandpapery texture, or become distorted in growth that is a good indicator of spider mites. To check whether the spider mites are still on the plant, use a hand lens and examine the underside of leaves. Tap the branch tip or leaves while holding a white paper underneath to catch the spider mites. (Ball and Ball 1990, UCDANR 1995)
 - **CONTROL:** There may be some beneficial biological control (*e.g.*, parasitic mites and ladybird beetles). Spider mites thrive in hot, dry, dusty conditions. The warmer the conditions, the faster they reproduce. Make sure the plants have adequate water because when plants are water-stressed, they are more susceptible to spider mite damage. Be aware that some chemicals such as carbaryl and pyrethroids can actually increase spider mite production (UCDANR 1995).

k) **Thrips:**

- **DESCRIPTION:** The adult thrips are winged and are less than 1/25 inch long. They are shiny and usually black or yellow in color and have a rasping mouthpart. Thrips can produce approximately 8 generations per year. They thrive in dry environments so make sure the plants are adequately misted and watered (Ball and Ball 1990).
- **SIGNS AND SYMPTOMS:** Check the new growing tips or buds for thrips. If the leaves are curled, or if tiny, black excrement on the leaves is visible, that's good indicator that thrips are present. Also, if there is dried tissue on the leaves, or discoloration or disfiguration of the leaves or flowers, that can be another indication of thrips (Ball and Ball 1990 UCDANR 1996).
- **CONTROL:** There may be some beneficial biological control (*e.g.*, predatory mites). Prune affected flowers and foliage, and dispose of properly. Use sticky traps to monitor. Keep plants adequately watered, and do not let it become water-stressed (Ball and Ball 1990, UCDANR 1996).

l) **Whitefly:**

- **DESCRIPTION:** Whiteflies are white, tiny moth-like four-winged insects with piercing-sucking mouthparts. The immature whiteflies resemble aphids, however they are legless and not very mobile once they start feeding (Ball and Ball 1990, Flint and Parrella 1995). They produce many generations per year, sometimes one generation in less than three weeks depending on the temperature. They thrive in warmer climates (Flint and Parrella 1995).
- **SIGNS AND SYMPTOMS:** Check the underside of the leaves for whiteflies. If present, the leaves will prematurely turn yellow and then fall off. The plant growth will also be stunted. Whiteflies produce honeydew, so check for presence of sooty mold or ants.
- **CONTROL:** There may be some beneficial biological control (*e.g.*, parasitic wasp). Use sticky traps to monitor the whitefly population on a weekly basis in conjunction with a weekly foliage inspection (Flint 1995). Horticultural soaps and other

insecticides can be effective in controlling the population. “Try to time treatments when your monitoring results indicate that most of the population is in the first, second, or third instar stage” (Flint 1995). When spraying, make sure there is good coverage of insecticides to the underside of the leaves.

2. Weed Monitoring and Control

- Any plant (alien or native) in the pot other than the designated plant is considered a weed.
- Monitor on a weekly basis.
- Install weed mat in and around the growing area.
- Have a buffer area around the growing area/nursery of at least 6 feet.
- Enclose growing area to prevent weed seeds from blowing in to pots.
- Pull alien plant species from pots and growing area as they come up. Do not let them go to seed.
- If weed problem gets out of hand, apply herbicide.
- Contact your local agriculture extension agent or DOA agent for proper identification, up-to-date chemicals and current control practices.

3. Mollusk Monitoring and Control

- Look for signs and symptoms.
- Identify the target pests.
- Monitor for pests presence and their levels of abundance.
- Know their life cycle
- Monitor on a daily basis, usually early morning is best.
- Contact your local agriculture extension agent or DOA agent for proper identification, up-to-date chemicals and current control practices.

a) Slug

- **DESCRIPTION:** Slugs are terrestrial mollusks that do not have shells. They have slimy bodies, are usually 1 to 2 inches (some can even reach 8 inches) long and travel on a foot that leaves a trail of slime behind. The colors range from white, yellow to black. They have a rasping mouthpiece. The eggs are in translucent-white, individual sacs, which form a cluster, and are usually found in dark, cool, moist areas or underground. Slugs can produce about 6 generations per year and take about a year to mature. (Deputy and Murakami 2000).
- **SIGNS AND SYMPTOMS:** Look for the slime trail, which is usually silver in color. Damage to the plant, such as large ragged holes in leaves, flowers, and stems, is done by the slug. They can quickly defoliate the plant if not controlled. Check the undersides of pots and in drainage hole of the pot to see if they are present. .
- **CONTROL:** Keep area around plant and in pot clear of leaf litter. Manually dispose of any slugs in growing area. Set up traps to lure slugs and then dispose of them. Set up a physical or chemical barrier to deter slugs. Use baits to kill slugs (Deputy and Murakami 2000).

b) Snails

- **DESCRIPTION:** Snails are soft-bodied mollusks that are protected in a shell. They can range in color from cream, pink to gray. The markings on the shell vary from species to species. They can be found in moist, dark areas, usually coming out at night to feed with their rasping mouthpiece (Ball and Ball 1990). They produce about

- 80 eggs at a time, and can lay eggs up to 6 times a year. The eggs are rounded and white in color, and can be found in the upper layer of the soil. The snails mature in two years (Deputy and Murakami 2000).
- **SIGNS AND SYMPTOMS:** Look for the slime trail, which is usually silver in color. Damage to the plant, such as large ragged holes in leaves, flowers, and stems, is done by the snail. They can quickly defoliate the plant if not controlled. Check the undersides of pots to see if they are present (Ball and Ball 1990).
 - **CONTROL:** Keep area around plant and in pot clear of leaf litter. Manually dispose of any snails in growing area. Set up traps to lure snails and then dispose of them. Set up a physical or chemical barrier to deter snails. Use baits to kill snails (Deputy and Murakami 2000).

4. Pathogen Monitoring and Control

- Look for signs and symptoms.
- Identify the pathogen.
- Know their life cycle.
- Monitor on a daily basis.
- Contact your local agriculture extension agent or DOA agent for proper identification, up-to-date chemicals and current control practices.

a) Bacterial disease

- **SIGNS AND SYMPTOMS:** Infected plants often have rotted leaves, stems, branches, or tubers, which have a foul odor. When cutting into an infected area, a small amount of whitish or yellowish ooze will seep out. Other symptoms include wilted leaves or stems, or odd shaped galls on the stem or on the roots near the soil line. Symptoms can spread quite quickly by splashing water (such as irrigation or rain) or by infected soil. They can enter a plant either through wounds or through the stomata (Ball and Ball 1990).
- **CONTROL:** Besides chemical control methods, also remove all infected plants, and wash hands and sterilize tools after handling infected plants. Provide ample spacing between plants to encourage good air circulation. Clean up and remove diseased plant parts and dispose of them by placing in plastic bag or sealed container right away.

b) Fungal diseases

- **SIGNS AND SYMPTOMS:** Look for rust-colored or powdery-white looking spots on either side of leaves. These spots will eventually make the leaf chlorotic and will eventually kill the leaf tissue. Also, look out for water soaked spots, greasy looking areas, or black streaks or blotches on the leaves or stems (Ball and Ball 1990).
- **CONTROL:** Besides using fungicide control methods, remove affected areas and dispose of in a plastic bag or a sealed container. Be sure to wash hands and sterilize tools after handling infected plants. Provide ample spacing between plants to encourage good air circulation (Ball and Ball 1990).

c) Viral Diseases

- **DESCRIPTION:** “Viruses are basically parasites, multiplying inside their hosts or if no host is available, lying inactive but viable in dead plant material for up to 50 years while waiting for a new victim” (Ball and Ball 1990).
- **SIGNS AND SYMPTOMS:** Be aware of plants that have poor overall growth (like stunted leaves, and flowers). There may be yellowish mottling patterns on the leaves, stems or blossoms that make the plant look sickly (Ball and Ball 1990).
- **CONTROL:** Viruses are generally spread by insects with piercing-sucking mouthparts such as aphids and leafhoppers. Garden tools and humans are other vectors of viruses. Do not take cuttings from infected plants as the cuttings will also have the virus. Remove and destroy (not in the compost pile) the infected plants, and wash hands and sterilize tools after use (Ball and Ball 1990).

5. Small Mammals and other pest monitoring and control

- Look for signs and symptoms.
- Identify the target pests.
- Monitor for pests presence and their levels of abundance.
- Know their life cycle
- Monitor on a daily basis.
- Contact your local agriculture extension agent or DOA agent for up-to-date chemicals and current control practices.

a) Rats/Mice

- **SIGNS AND SYMPTOMS:** Look for seedlings and/or seeds dug up, uprooted and eaten, droppings and tracks.
- **CONTROL:** Traditional mousetrap and bait. Use good sanitation practices by cleaning up all possible food sources, using rodent-proof containers of metal or glass, and removing tall grass, alien plant species and shrubby growth.

b) Birds

- **SIGNS AND SYMPTOMS:** Young seedlings and/or buds may be nipped off. Look for droppings and feathers.
- **CONTROL:** Barriers and deterrents like metallic ribbon and owl figures.

c) Toads and Frogs

- **SIGNS AND SYMPTOMS:** Look for evidence of nestling in pots such as vegetation in pots that are smashed or pushed to the side of the pot. Toads and frogs are potential carrier of nematodes.
- **CONTROL:** Do not have standing water anywhere that would make it favorable to toads or frogs. Remove or kill any individuals.

Approved Growing Media

Material should be packaged, not purchased in bulk, to lower likelihood of contamination.

- 1) Peat
- 2) Bark

- 3) Bark charcoal
- 4) Perlite
- 5) Vermiculite
- 6) Rock wool
- 7) Pumice
- 8) Volcanic cinder - sterilized
- 9) Coir - low in salt levels
- 10) Crushed blue rock - sterilized
- 11) Sphagnum – not to be used for air-layering in wet forest to avoid introduction of new species.
Sphagnum may not be dead.

Note: Compost is NOT allowed in the growing media at any time. It can carry pathogens, weed seeds/spores, other pests, and is not a uniform medium.