KIRC KIHEI NURSERY MANAGEMENT PLAN

Palapalai (*Microlepia strigosa*)

Prepared by

KAHOʻOLAWE ISLAND RESERVE COMMISSION

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Introduction

The Kahoʻolawe Island Reserve Commission (KIRC) Kihei Nursery is a State of Hawaii run facility and therefore needs to be managed according to State of Hawaii and U.S. Federal regulations. The U.S. EPA Workers Protection Standard is covered as well as the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA). Pesticide storage is discussed along with ant bait and barrier protocols and proper use. Strict Biosecurity will be implemented according to the Kahoʻolawe Island Reserve (KIR) Biosecurity Plan. Safety Data Sheets (SDS) will be readily available on site for safety concerns and proper use of Pesticides. The facility manager will keep this Management Plan file on hand for all personnel at the Kihei Nursery to read and sign.

Figure 1. KIRC Kihei Nursery Site

KIRC Health and Safety Plan

To protect the health and safety of workers and handlers, employers are responsible for training them in the safe use of pesticides. Pesticides are defined as any substance or mixture of substances intended for preventing, destroying, repelling or mitigating any pest. The KIRC Health and Safety Plan (2003) complies with Title 29 of the Code of Federal Regulations part 191 of the U.S Department of Labor Occupational Safety and Health Administration (OSHA) and the Hawaiʻi Occupational Health and Safety Division (HIOSH) and U.S. EPA regulations. A Pesticide Risk Reduction Course is available through CTHAR (2015).

U.S. EPA Workers Protection Standard (WPS)

All employers are required to comply with the WPS (40 CFR part 179) when pesticides with labeling referring to the WPS are used. The requirements in the WPS are intended

to inform workers and handlers about pesticide safety, provide protections from potential exposure to pesticides, and mitigate exposures that do occur. It will provide;

> "*Pesticide safety training for workers and handlers; Access to labeling information for pesticide handlers and early-entry workers; Keep workers out of areas being treated with pesticides; Keep workers out of areas that are under a restricted-entry interval (REI), with a few narrow exceptions; Protect early-entry workers who are doing permitted tasks in pesticide-treated areas during an REI, including special instructions and duties related to correct use of personal protective equipment; Notify workers about pesticide-treated areas so they can avoid inadvertent exposures. Monitor handlers using highly toxic pesticides; Provide required personal protective equipment to handlers; Decontamination supplies— a sufficient supply of water, soap, and towels for routine washing and emergency decontamination; Emergency assistance making transportation available to a medical care facility in case of a pesticide injury or poisoning, and providing information about the pesticide(s) to which the person may have been exposed*."

There is a quick reference guide to the WPS at the U.S. EPA website (http://www.epa.gov/oecaagct/htc.html).

Federal Insecticide, Fungicide and Rodenticide Act (FIFRA)

The storage of pesticides is regulated under FIFRA which governs the sale, distribution and use of pesticides in the U.S. Pesticides are regulated under FIFRA until they are disposed. Then they are regulated by Resource Conservation and Recovery Act (RCRA) which ensures the responsible management of hazardous and non-hazardous waste.

Emergency Response Plan

An Emergency Response Plan will be in place in case of an accident or Pesticide spill. Contact names and phone numbers to the KIRC and Hawai‘i Poison Control Center emergency response personnel will be available on site. The list of pesticides should be readily available for emergency responders. Please use Proper Personnel Protective Equipment (PPE) and immediately report all spills and accidents to KIRC personnel.

Integrated Pest Management (IPM)

Integrated Pest management is a strategy that prevents pest damage with minimum adverse impact on human health (MDAR, 2010). IPM refers to diseases, insects, mites,

slugs, snails, nematodes and weeds. In the IPM approach, the grower uses their knowledge of pest biology to take actions that reduce pest establishment and increases in populations. IPM uses monitoring techniques and combinations of biological, mechanical, chemical, environmental and physical control. Pesticides are utilized only if monitoring stipulates they are needed. If pesticides are chosen, they are applied that avoids disrupting other IPM methods.

Bayer, 2016 states, “when applied correctly, non-crop herbicides are useful and necessary tools to manage unwanted vegetation that can lead to safety, financial, and economic losses. However when applied incorrectly, non-crop herbicides have the potential to cause off-target injury to desirable vegetation. Training and education about proper herbicide performance can help eliminate these risks. This results in economic, aesthetic and environmental benefits to the treatment site”.

Chemical Selection

Understand the herbicide solubility, mobility, persistence, and volatility properties. Know the chemical sensitivity of adjacent vegetation, crops and ornamentals. Match the correct herbicide, rate and timing to the target vegetation. Research the site history and presence of resistant weeds in the area. Tank-mix herbicides with multiple modes of action on the target when possible. Repeated use of the same herbicide can result in resistance. Treat weeds during optimum growth stage of life cycle for best activity. Evaluate performance at the end of the season to consider any program upgrades needed (Bayer, 2016).

Application Accuracy

Select the proper equipment and licensed personnel for the spray job. Use the proper nozzle type for accurate herbicide placement. Calibrate nozzles periodically for spray output accuracy. To reduce spray drift: - Match spray pressure, nozzles and driving speed to obtain good weed coverage while minimizing the production of fines (small droplets most prone to drift) that can lead to drift . Apply with spray boom or nozzle height as low as possible. Use a drift control agent as recommended by product labeling. Use caution when making treatments next to desirable vegetation. Maintain detailed spray records. Please be aware: Tree or plant roots may extend or grow into the treatment area. Slopes will impact fixed nozzle application rates. Draining or flushing spray equipment near or on desirable vegetation may result in injury or loss of desirable vegetation (Bayer, 2016).

Target Area Stability

Sites disturbed by mechanical means or vehicle traffic may lead to herbicide inactivity or movement to off-target areas. Know the soil texture or road ballast composition as it relates to wind or water erosion potential, as well as herbicide leaching potential. Treat asphalt or concrete surfaces only if specifically directed by the product labeling (Bayer, 2016).

Environmental Conditions

High wind, high temperatures and low humidity may increase potential off-target drift. Saturated soils, frozen soils, soil-impedance layers, sloped areas or heavy rainfall may increase potential off-target movement. Be cautious of passing vehicle wind shear when spraying (i.e. large trucks). Avoid applications to: Powdery, dry soils and light, sandy soils when there is little likelihood of rainfall soon after treatment. Weeds hardened off by cold or hot weather or drought conditions. Understand local weather patterns to make a proper timing of the herbicide treatment. Do not apply during a temperature inversion. Know the location of water bodies prior to making application. Avoid applications directly to the water's surface. Observe label buffers from water and other sensitive areas. A heavy rain shower may cause product to dissolve and be carried to the lowest point in or near the treatment area. Movement of any product during a heavy rainfall is possible. Be aware of areas with shallow ground water tables and select herbicides accordingly (Bayer, 2016).

Pesticide Storage Practices

Limit the amount of pesticides stored. The storage area should be properly labeled with signs that say "Pesticide Storage Area". A list of product being stored should be posted on the outside of the storage facility. A shelf life for pesticides longer than two years is unpredictable, so pesticides can be labeled with the date purchased. Containers should be kept off the ground to prevent the accumulation of water in or under the containers. Separation of pesticides by hazard and function is essential. Flammable product should be stored separately in a fire proof cabinet away from non-flammable materials, dry pesticides should be stored away from wet. Fungicides, herbicides and insecticides should be stored in separate locations of the storage area to prevent cross contamination and accidental misuse.

Safety is the key element in pesticide storage. Accidents involving pesticide spills or leakages have serious health and environmental consequences. It is important the storage facility be locked and access limited only to those personnel who are properly trained in the use of pesticides.

Safety Data Sheets (SDS)

SDS sheets will be readily available and filed in a box on site in a prominent location. These not only include proper use and safety concerns, but also carry the National Fire Protection Association (NFPA) Hazardous rating placard symbol to be displayed at the entrance to the pesticide storage facility.

NFPA Hazardous Rating Placard

The NFPA Hazardous Rating Placard should be posted at entrances to the pesticide storage facility. These ratings are also located in the SDS for the pesticide. Personnel must follow the label for each pesticide.

Figure 2. NFPA Hazardous Rating Placard

Globally Harmonized System (GHS)

In 2003, the United Nations (UN) adopted the Globally Harmonized System (GHS) of Classification and Labeling of Chemicals. The GHS includes criteria for the classification of health, physical and environmental hazards, as well as specifying what information should be included on labels of hazardous chemicals as well as safety data sheets. Under the Hazard Communication Standard chemical containers must all display a specific label and this helps facilitate the safe shipping and use of hazardous substances. In order to ensure chemical safety in the workplace, information about the identities and hazards of the chemicals must be available and understandable to workers. OSHA's HCS requires the development and dissemination of such information.

Personnel Protective Equipment (PPE)

According to the pesticide label, U.S. EPA chemical resistant gloves (Category B) may be used by trained personnel using pesticides which require more protection. Safety glasses and chemical splash protection for face and eye wear will be available.

Chemical aprons and Tyvek suits should be worn when necessary. Shoes and socks, long pants and long sleeved shirts are required when mixing certain pesticide formulas. Access to faucet and soap for washing your hands after mixing will be available. Respirators will conform to the directions on the Pesticide label.

Proper Use of Pesticides

Use the label and obtain the proper training before mixing pesticides (MDAR, 2010). Limit the frequency of treatments whenever possible. Treat small areas first instead of all of the plants in the entire nursery. Avoid treatments that apply selection pressures on both the larval and adult stages of development. Measure accurately when mixing pesticides. It is during mixing that the majority of spills will occur. After mixing an insecticide with water, spray immediately or within a few hours. Never let a mixed chemical stand overnight before applying.

Miticide

Use directions on label when mixing and applying Miticide (Avid®). A NIOSH approved respirator with R, P or HE filter will also be worn according to the label directions. These must be properly fitted to each person's face and properly tested for efficiency.

Mixing Areas

Mixing areas should occur on site where spills can be contained. Absorbent materials such as re-usable gelling agents, vermiculite, clay, or activated charcoal should be on-site along with a garbage can and shovel to quickly contain and clean up any spills. The spilled pesticide should be contained and not hosed down. Rinse liquid pesticide containers three times and destroy the container so it **cannot** be used again. Rinse material (waste) should be applied to a registered site. Triple rinsed containers are considered non-hazardous and may be disposed of according to State recommendations. A dry well will be constructed on-site for the proper disposal of pesticide waste product. It should be maintained and kept clear. Spill trays should be used and the MSDS sheets will list specific actions for disposal.

On Site Emergency Equipment

An emergency eye wash station (Figure 3) will be available on-site meeting the ANSI standard Z358.1-1990 that allows for hands free irrigation for both eyes for at least 15 minutes at a flow rate of at least 0.4 gallons/minute. An AED and First Aid kit will be stored on site. A proper chemically rated fire extinguisher will be available on-site.

Figure 3. Portable Eye Wash Station

General Nursery Information

The following excerpts (in italics) are from Lilleeng-Rosenberger, 2005.

When maintained properly, a nursery provides a controlled environment that promotes maximum plant growth and development. There are five basic environmental factors that need to be maintained at the proper level in order to grow healthy plants. They are; Moisture, Soil temperatures, oxygen, light, and nutrients. Young plants and unrooted cuttings need this added sanitation protection from diseases and pests.

Overhead misting or hand watering should take place every other day. Overwatering can cause damping-off (a horticultural condition caused by pathogens that weaken seeds or seedlings before or after they germinate) which may kill seedlings. Sanitation is an essential part of greenhouse management. Good sanitation can reduce or prevent plant dieses and the invasion of insects, pests and weeds.

*Make sure all new plant materials are disease and insect free **before** they come into the propagation area. During germination and rooting periods, use pasteurized soil-less mixes to eliminate weed seeds and pathogen problems. Always use clean containers, flats or pots. If they are soiled wash them in a weak bleach solution of 1 part bleach to 10 parts water (1:10). Physan also works well. Also disinfect any tools or implements used in the propagation process. The floor of the nursery should always be free of plant debris and weeds. Keep pests from crawling up the bench legs (water in buckets) and keep hose nozzles off the ground where they might pick up disease pathogens.*

Transplant your container plants into larger pots every year, replacing media or just changing the top layer of the mix. Nitrogen (N) stimulates new foliage, stem growth, and promotes the dark green color of leaves. Phosphorus (P) stimulates root growth, Potassium (K) stimulates overall plant strength. Miracle Gro (15-30-15) fertilizes the plant through the foliage and the root system, helping them grow faster and greener. When leaves turn yellow form the lack of nitrogen and/or iron in the plant, foliar feed with Miracid (30-10-10) or iron chelate fertilizers.

Pest Control

To protect seeds and cuttings from pests the area should be closed in with secure shade cloth walls (or stainless steel screen mesh). It helps to have the entire propagation area closed. Native plants do not respond well to harsh insecticides, use botanical insecticides as much as possible. The most damaging pests to cultivated native Hawaiian plants are the introduced insects, aphids, mealybugs, mites, scale, thrips, whiteflies, nematodes and ants. The new growth is for sucking insects. They produce honeydew, which in turn is harvested by ants to feed their nestmates. Keeping a consistent and regular application regime is important part of keeping the pests under control.

Aphids

Aphids cause foliage to become shriveled and wrinkled and they can also carry diseases (viruses) from plant to plant. They are tiny insects usually dark green in color to yellow to black. Management consists of applying systemic pesticides (Marathon OHP 1%) neem oil, soap spray (Simple Green with water @10:1), or horticultural oil.

Mealybugs

Mealybugs in large populations can cause a plant to shed its leaves and become stunted or even die. They appear as small puffs of cotton in the joints, the undersides of leaves, in the roots, or any protected crevice on the plant. Management includes applying systemic pesticides (Marathon) neem oil, soap spray, or horticultural oil.

Slugs

Slugs eat leaves and stems of more herbaceous plants. To control them, use a granular slug bait or remove them by hand and monitor the plants often looking for indications such as slime trails.

Spider Mites

Spider Mites suck chlorophyll from leaves turning them pale green or yellowish and cause them to fall off if they are left untreated. Webs occur on the leaves or in plant crotches; mites appear as tiny reddish specks moving about. To manage spider mites, rotate the use of insecticides, the red spider mites become immune to the chemical within one generation. Apply miticides, neem oil, soap spray or horticultural oil.

Scale

Scale infested plants are stunted and have yellow leaves. Their branches are ringed with scales and they may die. Scale looks like raised brown black or green spots along the stems and leaf ribs. Applying systemic pesticides, neem oil, soap spray, or horticultural oil can manage scale.

Thrips

Thrips feed by scraping the undersurface of plant tissues and sucking up the juices that leak out. The leaves of thrip infested plants appear silver with blackish spots, which is actually their

fecal matter. Damage also occurs in the flowers as in many of the Hibiscus sp. Thrips are very small blackish brown insects with straight bodies. They can be managed by applying a systemic pesticide or by using horticultural oil. Yellow stick paper traps help give an indication of what pests are in the area and can help reduce the insects that get trapped on them.

Whiteflies

Whiteflies are small white winged insects that cluster on the underside of leaves and fly about when disturbed. Plants infested with whiteflies have leaves that turn yellow and fall off it left untreated. They are often in the Hibiscus family. To manage whiteflies, wash off the infested area of the plant by hand with a strong spray of water or use systemic pesticides or horticultural oil.

Spittlebug

Spittlebug infestations resemble spit on the tips of the plants. Small green round beetles live under the spit like substance. To manage spit bugs, apply a systemic pesticide or wash them off by hand.

Chinese Rose Beetles

Chinese Rose Beetles eat holes in the leaves or in severe cases cause the plants to become weak because of the reduced amount of leaf surface (thus reducing photosynthesis). To manage the rose beetle apply a systemic pesticide or use a bacterial insecticide (bacilus).

Black or Coffee Twig Borers

Twig borers are destructive little beetles that bore a small hole into the trunk or stem of plants. They lay their eggs in these holes and when larvae hatch out, they feed on the pith causing the plant to die from the hole upwards. Cutting and burning the infested twig or stem will help control the borer and some plants may grow back from below the bore hole. To manage use a systemic pesticide.

Root Knot Nematode

Root knot nematodes are parasitic microscopic worms that live in soil and roots of most plants. Some are beneficial attacking and feeding on harmful insects while others feed on plants and cause the roots to form galls blocking the flow of water and nutrients to the plant above and leading to stunted growth, yellowing leaves and wilt. ʻOhai (Sesbania tomentosa) can be affected by them. To manage nematodes, use a nematicide mixed into the soil at the time of outplanting. Follow the directions on the manufactures label closely, or soil drench with neem oil extracts every few months.

This information is summarized in Table 1.

	Pest	**Symptom**	**Appearance**	**Miticide**	**Systemic Pesticide**	**Neem Oil**	**[1]Soap Spray**	**Horticultural Oil**	**Granular Slug Bait**
1	Aphid	Foliage shriveled	Tiny insects dark green to		X	X	X	X	

	Pest	Symptom	Appearance	Miticide	Systemic Pesticide	Neem Oil	[1]Soap Spray	Horticultural Oil	Granular Slug Bait
			yellow to black						
2	Mealy bugs	Leaves shed/ stunted growth	Small puffs of cotton		X	X	X	X	
3	Slugs	Eaten leaves and stems	Slug						X
4	Spider Mites	Leaves turn pale or yellowish	Tiny reddish speck moving about	X		X	X	X	
5	Scale	Plants are stunted and have yellow leaves	Raised brownish, black or green spots along stems and leaf ribs		X	X	X	X	
6	Thrips	Plants appear silver with blackish spots	Very small blackish-brown insects		X	X	X	X	
7	White Flies	Leaves turn yellow and fall off	Small white winged insects on underside of leaves.		X			X	
8	Spittle bugs	Spit on the tips of leaves	Small green round beetles		X				
9	Chinese Rose Beetle	Eaten holes in the leaves	Small beetle		[2]X				
10	Black or Coffee Twig Borers	Small hole in twig or trunk	Little beetle		X				
11	Root knot Nematode	Stunted growth yellow leaves and wilt. Root galls	Microscopic worm			[3]X			

Table 1. Pests, Symptoms and Management Options

[1]Soap Spray (Simple Green liquid soap with water 1:10).
[2]or bacterial insecticide (*bacilus*).
[3]or Nematicide mixed into soil at time of outplanting.

When used together, horticultural oils, neem, pyrethrum, or insecticidal soaps provide sufficient control for the insects discussed. Native plants are sensitive and can have adverse reactions such as phytotoxicity (when an insecticide is sprayed in the heat of the day and or leave a persistent residue). To avoid this, spray in the morning when it's cooler. For all pest control measures consistency is the key. As soon as you let up, they will be back and out of control, especially red spider mites. Systemic pesticides (Marathon, imidacloprid) Figure 4 are granular insecticides that are taken up by plant roots.

Figure 4. Marathon OHP 1% granular pesticide

The chemical is then incorporated into the plant and repels pests. Follow the directions carefully and do not overdo it. Incorporate a small amount in the soil mix or sprinkle on the soil surface then water it in. The chemical must reach the root zone in order for the roots to absorb it. Systemic pesticides work particularly well on the Chinese Rose Beetle and sucking insects.

Naio Thrips

Naio (*Myoporum sandwicense*) thrips (*Klambothrips myopori*) are narrow, dark brown to black and were first detected on Hawai'i Island in 2008 and the HDOA was notified in February, 2009 (DLNR, 2013). Leaf curls and folds create areas the pest can feed be protected and reproduce. Heavy infestations result in leaf curling branch dieback defoliation and host plant mortality. Mortality rates have been increasing each year ranging from 30-50% and documented at over 90% at select sites (DLNR, 2013). Physical control is performed with Safer® brand insect Killing Soap of Safer® Brand BioNEEM Insecticide/Repellent. Bags containing infested material can be transported to the MISC office at 820 Pi'iholo Rd., Makawao, HI 96768, where material will be frozen for 1 week. Naio (*M. sandwicense*) plants with thrips in the Kihei Nursery should be treated with Safari (Dinotefuran), a soil drench and a foliar spray, but not when flowering.

Rodenticide Bait Protocols

To control rodents at the Kihei Boat house, Contrac® all-weather Blox® rodenticide is used (Figure 5).

Figure 5. Contrac® Blox® Bait

The Blox® is placed in a tamper resistant Protecta® Bait station (Figure 6) to keep non-target animals such as dogs and cats from the bait.

Figure 6. Protecta® Rodenticide Bait Station

There will be stations marked with flagging located in the nursery and they should be checked periodically for take and any refill requirements (Figure 7). Nitrile gloves should be worn when handling the bait.

Figure 7. Four Rodenticide Bait Stations in Kihei Nursery Site

Nursery Sanitation

The following bullet points are from (https://ag.umass.edu/fact-sheets/cleaning-disinfecting-greenhouse)

- Disinfect benches, preferably made of wire. Pots, flats and trays should be new or disinfected. Wood benches can be a source for root rot diseases and insect infestations. Algae growing on wood surfaces create an ideal environment for fungus gnats and shore flies. Plant pathogens such as *Pythium* can grow within the wood and plants rooting into the wood can become infected.
- Disinfect potting tables preferably made of a non-porous surface such as a laminate.
- Set up washing stations for hand washing and foot baths at the entrances of each greenhouse, especially propagation houses.
- Keeping hands and fingernails clean can help reduce the spread of diseases. If wearing latex or other protective gloves, clean as you would your hands and change periodically. Change the disinfectant daily in foot baths and wash floor mats weekly.
- Keep pets off of benches and potting areas.
- Provide supports throughout the greenhouse to hang hose nozzles. Keep all containers and hose nozzles off the floor to prevent contamination with pathogens.
- Keep growing media in a clean area and covered.
- Avoid carrying over plant material.
- Avoid accumulating dirty pots, old growing media or plant debris in the media mixing area.
- Make sure trash bins in the greenhouses are covered so that disease spores do not spread to the crop.
- Use horticultural oil on vegetation/weeds outside, around the greenhouse perimeter to smother over-wintering pests.

Ant Bait Protocols

In the KIR Biosecurity Plan (KIRC, 2016), ants are identified as an Invasive Alien Species (IAS) which must be mitigated at the Kihei Boat House site. They are notoriously difficult to control around houses and other structures and can disrupt ecological balances and affect human activities. Targets at the Kihei Nursery are Red Imported Fire Ants (*Solenopsis invicta*) not yet in Hawai‘i, Little Fire Ant (*Wasmannia auropunctata*) and other invasive ant species.

Surveillance of ants is accomplished by placing vials (Biolab® 60cc) baited with attractive food items in a grid pattern over the entire area to be surveyed, and collecting the vials after 30-60 minutes exposure. While baits are in the field, any ants foraging nearby will be attracted to the baits and these can be sealed inside the vials and identified in the laboratory. Procedures that specifically target Little Fire Ants or Red Imported Fire Ants for delimiting, monitoring and general surveillance are different.

When planning the survey, work out the area you want to cover and obtain a map or aerial image of the site. Plan to do the survey during clear weather when rain is not

expected. Each team should be made up of three (3) people and one team should be able to place and collect around 200-400 vials in a day. When preparing baits, make up around 100 per person working in the survey. Different ants are attracted to different food types so a mixture of bait types is used. It's best to make only enough bait for a days' work. This way the baits will be fresh and attractive to ants (ants are not interested in old baits). If possible, make them up the day before and store in a refrigerator overnight. Two types of bait (protein and sugar) are made and laid out in alternate fashion in the field. Use vials with different colors for each bait type and keep in separate bags. When placing the vials, keep in the shade if possible, pointed away from the prevailing wind, and angle downward to keep any potential rainwater out. If it begins to rain, it is good to collect the vials already out (Figure 8).

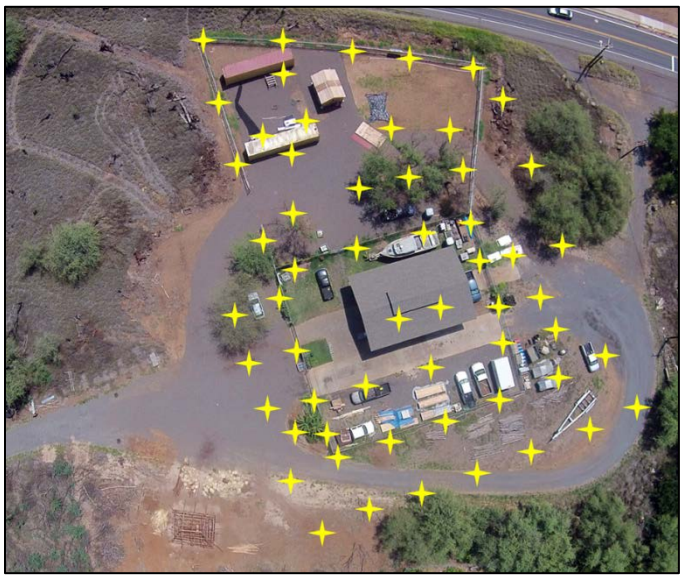

Figure 8. Ant Bait Locations around Kihei Boat House

Protein balls contain a smear of peanut butter on the inner side of the bait container and a small cube of luncheon meat inside the vial. The sugar baits contain a smear of light colored jelly or jam (no seeds, lumps or rinds) on the inner side of each bait container.
The aim of the survey is to thoroughly sample the ants at the site. This is done by approximately placing baits spaced in a grid pattern appropriate for each survey type. For example sections that are concrete or asphalt (bitumen) do not need to be sampled. Common ant habitats are listed in Table 2 and it is important that all these are sampled.

	Potential Habitat for Ants	
	Location	**Comments**
1	Tree Trunks	visual inspection and bait at base if appropriate
2	Flowers	
3	Shrubs and poles	

	Potential Habitat for Ants	
	Location	**Comments**
4	Building edges and foundations	
5	Concrete slab edges	
6	Cracked concrete	
7	Disturbed sites	
8	Drains and culverts	
9	Electrical generators and fittings	
10	Exposed rocks	
11	Fence palings	
12	Grass areas	
13	Verges	
14	Hot water pipes and heaters	
15	Isolated weeds	
16	Logs	
17	Loose gravel	
18	Low vegetation	Including grass
19	Plant pot bases	
20	Road margins	
21	Rubbish piles	
22	Shiny surfaces	
23	Soil	
24	Tree crotches and hollows	
25	Vertical Surfaces	
26	Weed and plant re-growth	
27	Wooden Structures	
28	Underneath stones or concrete rubble	

Table 2. Potential Habitat for Ants for CAPS

Management of pest ants in the KIRC Kihei nursery will reference Vanderwoude (2008) when they are observed, and it identifies three ways ants can enter the nursery system. 1.) Purchase of infested plants, 2.) Potting media or other items, ants traveling on cars and trucks driven by staff and personnel, 3.) Ants spreading from a neighboring property. To protect plant stock two products may be utilized. Sevin® is a soil drench and foliar spray. It provides short term control provided the foliage and medium is thoroughly treated. Talstar Select® is for use by licensed applicators only. It is both a drench and a spray for potted plants providing up to six months of insect control in the potting mix. Always be sure personnel are kept away from the sprayed plants until they are dry. Acquire and post the MSDS sheets for these products if used.

Ant Bait Treatments

Several ant bait treatment products are available and have been tested by the Hawai'i Ant Lab with the Pacific Cooperative Studies Unit of the University of Hawai'i. Amdro®, Maxforce Complete® and Tango® may all be used at the Kihei Nursery (Table 3).

	Name	**Description**	**Comment**
1	[1]Amdro®	Consistently Effective	Very popular
2	Probait®	Consistent Performer	Similar to Amdro®
3	[1]Maxforce Complete®	Extremely Effective	Expensive
4	Extinguish Plus®	Not as Effective	Moderately attractive
5	Advion Fire Ant Bait®	Professional Use Only	Inconsistent Results
6	[1]Tango®	Concentrate	Forms a gel

Table 3. Types of Ant Baits
[1]May all be used at Kihei Nursery.

Dry days are better than wet ones to apply bait. It is important to treat the entire property and systematically apply the bait to each section. It is also very important to apply bait treatments 2 weeks before barrier treatments. In feeding tests, Argentine ant, (*L. humile)* workers chose 25% honey water or sucrose water over granulated brown sugar or other solid foods with high protein content such as tuna meal (Table 4).

	Taxa	**Bait Preference**
1	*Linepithia humile*	Honey Water
2	*Paratrechina longicornis*	Sugar Water and Boric Acid

Table 4. Bait Preference for Ant Taxa

Ant Barrier Treatments

Barrier treatments are insecticides that are sprayed or sprinkled around areas where ants are to be excluded. They should not be mixed with bait treatments and should be applied to wet soil or when rain is expected, making a wide band 3 - 6 feet wide. Granular barrier treatments are easiest to apply because there is no mixing required. While both bait treatment and barrier treatment may be applied with a spreader, it is important to have two labeled spreaders to keep them separate. It is important to apply the barrier treatment two weeks after the bait treatment so the ants taking the bait poison back to the colony will not be killed. Any ants that come into contact with the chemical will die. Barrier treatments usually have a residual activity and can be effective for months (Figure 9). Barrier treatments may also occur around the legs of the planting tables.

Figure 9. Location of 3 - 6 Feet Wide Ant Barrier (Yellow) Around Kihei Nursery Site

If any ants or other non-native organisms are found, they should be collected for identification in an IAS Biosecurity Rapid Response jar and/or vials (Figure 10) located in the Kihei Nursery.

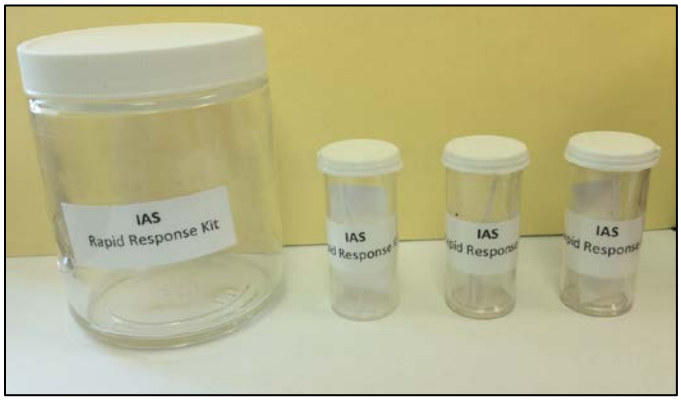

Figure 10. Biosecurity Jar and Vials to Collect Ants or Other Non-native Organisms at the Kihei Nursery

Weed Management

Maintaining weed-free growing conditions is necessary to produce high quality Nursery crops while reducing pesticide use. Weeds are a primary source of insects such as aphids, whiteflies, thrips and other pests such as mites and slugs. Weed cloth will be laid down beneath the plant tables to keep down weeds and insects (nests). It is important to keep the cloth clear of gravel and debris and to periodically sweep and clean. Repair any damage to the cloth.

Disease Management

Before propagation, clear the area of debris, weeds, wash and disinfect (Physan® 20 or 10% Bleach and water) empty benches, potting tables, storage shelves, tools, pots.

After the Nursery has been sanitized, avoid recontamination with pathogens. Provide a hook to keep nozzles off the floor. Monitor roots for rot symptoms. Space plants for good air movement and sunlight. Irrigate early in the day to allow foliage to remain dry overnight.

Potting Mix

The potting mix should be kept as sterile as possible to minimize fungal pathogens. Use no soil, no cinder, and no compost. Coco peat, Black Gold, Perlite and Sunshine Soil Mixture (#4) may be used only right out of the bag. Plants should be grown from seed or cuttings to minimize introduction of pathogens. Any leftover mix should be stored in a secure vessel and not left outside exposed to the elements.

Sterilizing Dibble Tubes, Trays, 48 cell packs

When sterilizing used dibble tubes, trays and 48 cell packs, use Physan® 20 @ 90ml/125gal dunk tank (or 36ml/50 gallon drum) to completely submerge the items (Figure 11). Soaking the nursery materials in Bleach at 10% for 10 minutes is another option. They should be dried and stored in a sterile location.

Figure 11. 125 Gallon Dunk Tank for Physan 20

Packing Plants for Kahoʻolawe

All plants coming from the Nursery and going to Kahoʻolawe must be in good condition and free of Invasive Alien Species (IAS) according to the KIR Biosecurity Plan (KIRC, 2016). Inspect each plant in a dibble tube or 48 cell packs for any animals, insects, ants, lizards, slugs, snails, etc. If using cardboard boxes, make sure they are placed on a pallet off the ground. Plants should be treated with any chemical sprays before a trip to Kahoʻolawe. Plants should be inspected and packed no more than 24 hours before departure. Any pots over 4" should not be allowed to travel to Kahoʻolawe. Preferable sizes are 48 cell packs, 6" dibble tubes and 2" pots.

Quarantined Plants

If any plants delivered from nurseries or farms are quarantined at the Boathouse, they should not be brought into the vicinity of the Kihei Nursery. This will avoid introducing any unwanted organisms from the quarantined plants.

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Common Name and Taxa of Pests for Kihei Nursery Management Plan

Black Twig Borer - *Xylosandrus compactus*
Chinese Rose Beetle - *Adoretus sinicus*
Hibiscus snow scale - *Pinnaspis strachani*
Leaf Miner - *Liriomiza spp*.
Mealy bug - *Plannococcus spp. Psuedococcus spp*.
Powdery mildew - *Spaerotheca spp. Erysiphe spp*.
Root fungus - *Phytophthora spp*.
Root Knot Nematode - *Meloigyne incognita*
Rust - *Phragmidium spp*.
Silverleaf Whitefly - *Bemisia argentifolia*
Slug - *Vaginulus plebeius*
Snail - *Achatina fulica*
Spider Mites -*Tetranychus spp*.
Spittle bug - *Aphrophora alni*
Thrip - *Heliothrips haemorrhoidalis*
Whitefly - *Trialeurodes vaporariorum*