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Formed in June 1986, the Landscape Industry Council of Hawai'i is a state wide alliance representing Hawai'i's landscape associations: Aloha Arborist Association, American Society of Landscape Architects Hawaii Chapter, Hawaii Association of Nurserymen, Hawaii Island Landscape Association, Hawaii Landscape and Irrigation Contractors, Hawaii Society of Urban Forestry Professionals, Kauai Landscape Industry Council, Maui Association of Landscape Professionals, Professional Grounds Management Society, Big Island Association of Nurserymen, and the Hawaii Professional Gardeners Association.

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Editors

Russell Galanti
Hannah Lutgen

Advertising Sales

Michael Roth
rothcomm@gmail.com

Executive Director

Garrett Webb
palmsinkona@yahoo.com

Designer

Roann Gatdula

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COMMON CITRUS PESTS IN HAWAII

Edible landscapes can provide food, shade, and a healthy outdoor space for recreation and family time. Edible landscaping with fruit trees provides multiple benefits. For instance, citrus trees can be hardy and long lasting landscaping plants, producing fruits year after year. They can provide nutritious and healthy snacks for guests and families, cutting down on food costs. Also, when the right citrus tree, suitable to your local climatic region is planted, these trees are relatively low maintenance.

Citrus trees are highly desirable plants for landscaping areas due to their floral scent and delicious fruits, however, citrus can be threatened by several pests in Hawaii. If you want to maximize harvest, monitor citrus trees for the pests outlined below and treat them accordingly. The most important pests in citrus are California red scale, black scale, broad mites, citrus blackfly, citrus leaf miner, and citrus scab.

California Red Scale (*Aonidiella aurantii*)

This pest is an armored scale that settles on the trunk, branches, fruit, and leaves of citrus. They develop a roundish waxy brownish cover and live under it during its entire lifetime, except when emerging or mating. California red scale attacks all parts of the tree

except the flowers. Severe infestations cause leaf yellowing and drop, dieback of branches, and occasionally death of the tree. Heavily infested fruit may be unmarketable. Tree damage usually occurs in summer and dry seasons when scale populations are highest.

Black scale (*Saissetia oleae*)

Black scale is a soft scale, they produce a soft, thin, cottony, powdery or waxy cover that cannot be separated from their bodies. Female black scales can lay from 1,000 to 2,000 eggs in her life cycle. Crawlers (newborn scales) move around for some time before settling on leaves. After the second molt, crawlers migrate to branches where they settle and grow rapidly, becoming nearly circular, dark mottled gray and leathery. Once egg laying starts, the covers become harder and darker. Scale insects feed by sucking sap from trees and shrubs through piercing-sucking mouthparts. The feeding activity causes fruit drop, wilting of leaves, stunting or unthrifty appearance of the plants, branches dieback and eventually death of all or part of the plant when infestations are heavy.

Citrus Blackfly (*Aleurocanthus woglumi*)

The citrus blackfly is considered the most damaging insect infesting citrus trees, reducing citrus yield more quickly than any other known citrus pest. The adult flies are dark gray to black and measure 1.33-1.66 mm in length. Females produce approximately 100 eggs in her life cycle, the larva and pupa do not move, and they look like tiny black scales attached to the undersides of leaves. The adults can fly and congregate on new leaves to lay their eggs. This pest feeds on citrus leaves by sucking sap, which removes water and nutrients. Additional damage is caused by the excretion of honeydew that encourages the development of sooty mold fungus on the upper surfaces of leaves. A heavy growth of sooty mold on leaves results in reduced respiration and photosynthesis. The feeding activity of high numbers of blackflies and large amounts of sooty mold causes a decline in the general health of the tree and a reduction in fruiting.

Citrus scab (*Elsinoë fawcettii*)

It is a fungal disease that develops brownish scabs on the outer skin of the citrus fruits, while it does not make the fruit inedible, it does reduce marketability in most cases. Citrus scab affects all citrus types and appears on leaves, stems, and twigs. Fruits are only vulnerable during the first few weeks of their development. One to 2 hours of wetting are sufficient for spore production, and only an additional 3-4 hours are needed for infection. Spores are spread to healthy tissues by water splash.

Broad Mites (*Polyphagotarsonemus latus*)

Broad mites are dimpled, translucent, covered in white speckles, the adults are usually yellowish, females have a white stripe on the back. These mites are so small you need a hand lens to see them. They often are found in depressions on fruit where the females lay their eggs. Broad mites cause leaf curling by feeding on new growth. They also feed on the rind of the fruit, causing a bronzing effect. However, the damage caused by broad mites is cosmetic only and does not affect the flavor of the fruit, but fruits can be unmarketable.

Citrus Leafminer (*Phyllocnistis citrella*)

Citrus leafminer is a very small, light-colored moth with brown and white markings on its wings, measuring less than 1/4 inch long. The larval stage is found only inside mines of citrus leaves. As it feeds and develops, the larva leaves a frass (feces) trail, in a serpentine thin dark shape just under the surface of the leaf. In its last stage the larva emerges from the mine and moves to the edge of the leaf. It rolls the leaf around itself and pupates, creating a rolled and distorted leaf. Citrus leafminer can survive as a larva only in the tender, young, shiny leaf flush of citrus. Mature trees (more than 4 years old) can tolerate damage on new leaves during part of the growing season with low effect on tree growth and fruit yield. Young trees may experience a reduction in growth.

For more information about citrus pests, contact your local extension agent.



Black Scale. Photo credit: D. Radtke



Citrus Leafminer. Photo credit: R. Gutierrez-Coarite



Hawaii Floriculture & Nursery Association (HFNA) P.O. Box 5640 * Hilo, Hawaii 96720

The Hawaii Floriculture & Nursery Association (HFNA) will be holding their annual Growers' Import Replacement Educational Research Seminar at the USDA Daniel K. Inouye Pacific Basin Agricultural Research Center (PBARC) in Hilo on Friday, September 16th.

The seminar will be the first "in-person" event since 2019 and will include the most current updates by researchers from USDA DK1 ARS PBARC and UH-Manoa College of Tropical Agriculture & Human Resources along with UH-CTAHR's Cooperative Extension Service. Please save the date! Registration information will be forthcoming and available at HFNA's membership website: www.hawaiifloriculture.org. You may also send questions to Judy at hfnajudy@gmail.com.

This program is sponsored by the Hawaii Department of Agriculture, the Hawaii County Department of Research & Development, USDA DK1 ARS PBARC, UH-Manoa CTAHR and UH-Manoa CES.

HFNA will hold their Wedding Celebration 2022 Seminar and related events in Hilo October 6, 7 & 8th to educate wedding industry professionals on the benefits of using Hawaii grown flowers and foliage in wedding floral designs. The seminar will include the new Breeders' & Growers' Forum on Thursday, October 6th which will include UH-CTAHR researchers and breeders who will have roundtable discussions with the audience in order to ascertain which traits (i.e., color, scent, size, longevity, etc.) the industry is seeking. Hawaii growers of floriculture products will also participate in order to talk with the audience and breeders to discover which varieties of flowers and foliage are widely sought after, as well as upcoming trends in floral design. This will provide the growers with an opportunity to make alterations to their crops and production to stay current with the marketplace.

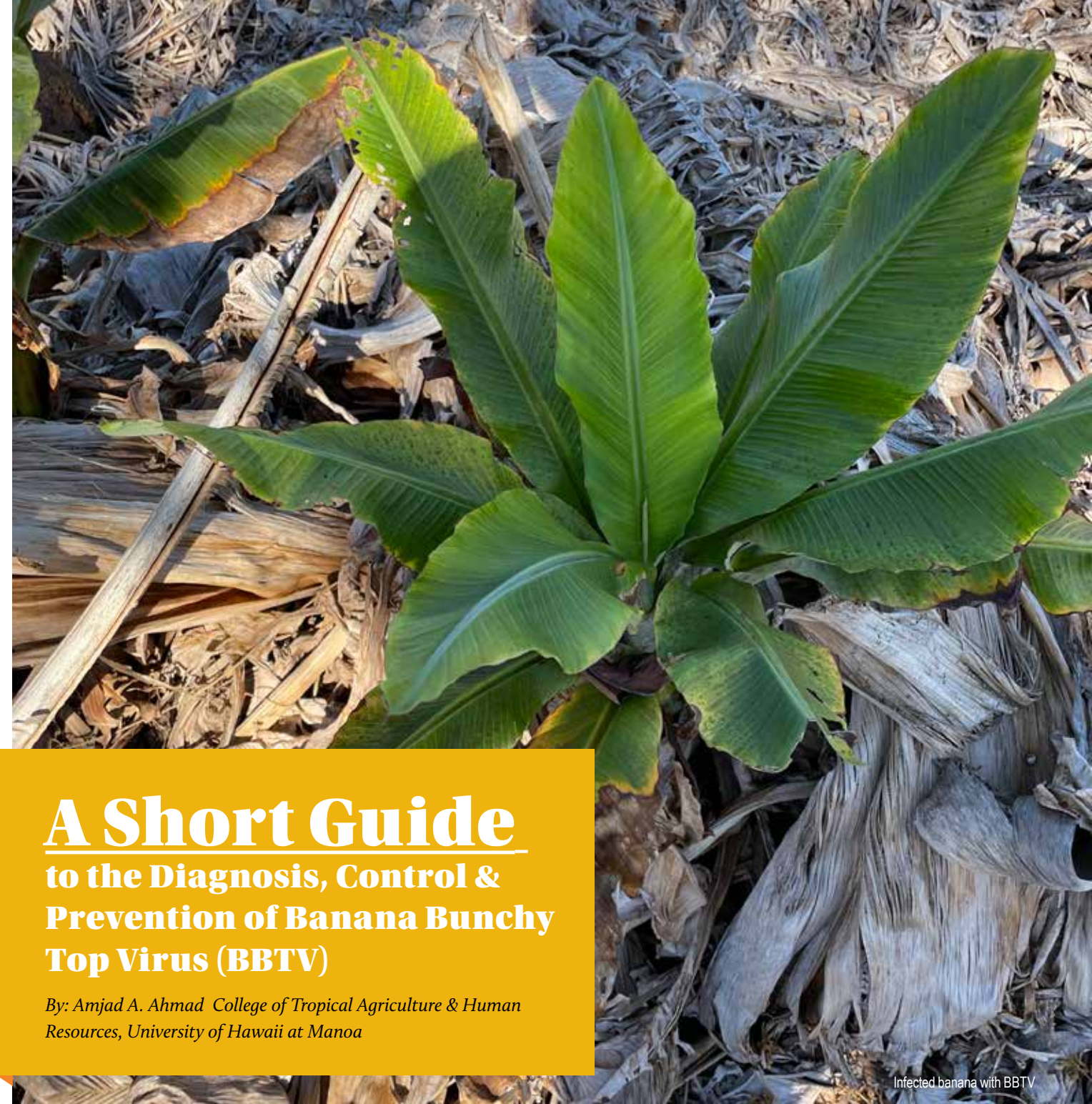
Also included in the seminar will be floral design demonstrations from professional AIFD, Canadian and island designers. World renown floral designer Hitomi Gilliam AIFD will conduct a hands-on floral design workshop and contest. This year's Wedding Celebrations will also include a guided nursery bus tour of Big Island floral and foliage nurseries and a celebratory Hawaiian luau on the last evening.

Information on Wedding Celebrations 2022 and upcoming registration availability will be available on HFNA's marketing website, www.hawaiineotropica.com.

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A Short Guide to the Diagnosis, Control & Prevention of Banana Bunchy Top Virus (BBTV)

By: Amjad A. Ahmad College of Tropical Agriculture & Human Resources, University of Hawaii at Manoa

Banana bunchy top virus (BBTV) is a plant pathogenic virus of the family Nanoviridae known for infecting banana plants and other crops. The virus is transmitted by the banana aphid (*Pentalonia nigronervosa*) and is also spread through infected planting material. Once infected, plants do not recover, which shows the importance of preventive measures. Infected banana keiki may take up to a month or more (based on variety) to show infection symptoms. The typical symptoms of BBTB are very distinctive and readily distinguished from those caused by other viruses of banana.

The most distinctive symptoms are:

- Infected plants exhibit a rosetted or 'bunchy top' appearance;
- Yellowing and curling of leaf margins on BBTB-infected banana;
- Stunted plants arising from infected suckers, and
- Dark green 'dot-dash' patterns in minor leaf veins forming 'hooks' where they enter the edge of the midrib.

Infected banana with BBTB

If an infection is suspected, a BBTV testing kit would confirm the visual diagnose (example of BBTV testing kit: <https://orders.agdia.com/amplifyrp-acceler8-for-bbtv-acs-24700>). Testing the plants is very important, prior to using them for propagation (macro- and micro-propagation techniques) to ensure all propagated plant materials are disease-free.



Tissue Culture (micro-propagation) Tissue or micropropagation is an artificial method for multiplying plants in a relatively short duration of time using the tissue or cell culture technique in a controlled environment. Micro-propagation technique is used to produce a large number (up to 500 plantlets from each mother) of identical plants. Testing the mother plant prior to the processing of tissue culture production is important to ensure all plantlets are disease-free. Visual diagnose is not 100% accurate. However, disease-free does not equal disease-resistance to Banana Bunchy Top Virus (BBTV). So, the implementation of BBTV control and prevention steps are very important to protect the plantation.



Rooted banana plantlets ready to be moved into the nursery.

Chemical Control of BBTV (Conventional & Organic):

The use of crop protection chemicals may help to prevent and delay BBTV infection in a field setting. The banana aphid (*Pentalonia nigronervosa*) is the insect vector for BBTV. The use of crop protection chemicals in a rotation, of at least 3 products, will prevent the banana aphid from developing resistance to the chemicals, allow chemicals to be used over a longer duration of time, and reduce the chance of reaching the maximum allowed rate or applications of each product.

Table 1 & 2 present a list of approved synthetic and organic pesticides to manage banana aphids on banana. Plants (or banana mat) which exhibit signs of BBTV should be removed immediately and destroyed (since no cure if plant become infected with the virus and banana keiki may take over a month to show symptoms). Consult your local Extension Agent for BBTV symptoms verification. Only clean, disease-free plantlets should be used for re-planting.

Table 1: Examples of Currently Licensed Synthetic Insecticides Approved for Use in Banana in Hawaii.

Product Name	IRAC Group	Active Ingredients (A.I.)	EPA No.	Rate per acre	
				From	To
Admire Pro	4A	Imidacloprid	264-827	14.0 fl oz Soil, 2.8 fl oz Foliar	
Sivanto Prime	4D	Flupyradifurone	264-1141	10.5 fl oz	14.0 fl oz
Movento	23	Spirotetramat	264-1050	16.0 fl oz	
Evergreen Pro 60-6	3A	Pyrethrins+Piperonyl butoxide	1021-1770	2.0 fl oz	12.6 fl oz
Tersus	3A	Pyrethrins	1021-2616	4.5 fl oz	16.3 fl oz



Low density banana mat.

Low vs High Banana Mat Density:

Managing a banana mat on a low-density may be costly (due to labor cost), but it is a very important strategy for the control and prevention of BBTV. The low-density plan (by removing banana keiki overtime and planting them in new areas, removing dead leaves, and removing harvested stems). Keeping banana mat on a low-density comes with many benefits, including: It will be easier to spot the aphids in a low-density setup compared to high density setup.

Low-density will allow for better coverage during an application of chemicals. Continuous removing of the newly emerging keikis will provide clean planting materials for expansion. Allowing better air-flow between the banana plants and less humidity accumulation, which could become a suitable condition for other infections and diseases. Low-density will keep the plants short (high density cause the plants to compete for sunlight and become taller).

Table 2: Examples of Currently Licensed Organic Insecticides Approved for Use in Banana in Hawaii.

Myriad Pro	IRAC Group	Active Ingredients (A.I.)	EPA No.	Rate per acre	
				From	To
M-Pede	N/A	Potassium salts of fatty acids	10163-324	1% v/v	2% v/v
Neemix 4.5	UN	Azadirachtin	70051-9	5.0 fl oz	7.0 fl oz
PyGanic EC 5.0	3A	Pyrethrins	1021-1772	4.5 fl oz	15.61 fl oz
Trilogy	UNE	Neem oil	70051-2	1% v/v	2% v/v
Debug Turbo	UN+UNE	Azadirachtin+Neem oil	70310-5	32.0 fl oz	104.0 fl oz

Disclaimer: Mention of a trademark or proprietary name does not constitute an endorsement, guarantee, or warranty by the University of Hawaii Cooperative Extension Service or its employees and does not imply recommendation to the exclusion of other suitable products. Pesticide use is governed by state and federal regulations. **Read the pesticide label to be sure that the intended use is included on it, and follow all label directions.**



Aphids and Ants Symbiotic Relation and BBTV Infection:

Banana aphids produce large quantities of plant juice "honey-dew" which attracts ants to feed on the excess juice. The ants usually transfer aphids between banana plants (which could cause an increase in the BBTV infection) to expand feeding sources. The ants also protect the aphids from their natural enemies (e.g. ladybugs which feed on aphids). The control of ant's colonies is an important strategy for reducing the infection rate of BBTV.

Banana as Wind-breaker:

It's highly discouraged to use banana trees as wind-breakers. Wind-breakers as usually kept at high density (to reduce wind speed) and on a low-management routine. This strategy will lead to a continuous source of BBTV infection to the entire area.

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Amjad A. Ahmad is an Assistant Extension Agent of Sustainable and Organic Agriculture Program at The College of Tropical Agriculture & Human Resources, University of Hawaii at Manoa.



High density banana mat

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One of Maggie's favorite plants is the Cecile Brunner rose.
Photo by: Russell Galanti

Tropical Edibles Nursery - Still Going Strong

By: Diana Duff

Note: This article first appeared in the West Hawaii Today Newspaper

Revisiting Tropical Edibles Nursery in South Kona, I found the same two plant-knowledgeable women keeping local gardeners and farmers supplied with edible plants. Maggie and Momi continue to supply local growers with fruit trees, vegetable starts, herbs and flowering plants all that produce food.

Maggie McDermott was quick to remark, "We have been promoting island self-reliance for over a decade here by encouraging people to grow edibles."

Maggie was one of the early employees at Tropical Edibles and is now the Nursery Manager. Her years of experience on site means her propagation skills are top notch and she can offer expert advice to those who want to grow some of their own food. She enjoys giving folks tours of the nursery and showing off some of her favorite plants like the miniature climbing rose, Cecile Brunner. The delicate pink petals are great for decorating cakes or to add color to a green salad. Maggie's engaging smile goes a long way toward making the experience at Tropical Edibles a pleasant one.

She and Momi continue to encourage gardeners to grow food. They not only can supply growers with edibles but also can offer tips on the best way to grow the plants they sell. Their partnership with Emmerich Grosch of Captain Cook Trading Company means they also offer 100% Kona coffee and locally sourced mac nuts in the nursery shop. Emmerich is also working on a line of teas for the shop. These include coffee cherry tea as well as tea from cacao and the leaves of loquat and mamaki. The shop also sells Momi's healing salves and some of her unique clothing line. When you go to the nursery, be sure to check out the shop.

Momi Subiono is an important part of the experienced team at Tropical Edibles. In addition to helping to propagate new plants and maintaining their supply of edibles, she works on her days off teaching art through SKEA. She is also working with kids teaching ethnobotany at Milolii Educational Garden through the Honey Bee Educational Program. She has studied native Hawaiian plants and ethnobotany for years and is knowledgeable about medicinal and cultural uses of plants as well as growing them for food.

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Momi collects plants, including native Hawaiian medicinals like mamaki, for her healing salves.
Photo by: Russell Galanti

Both Momi and Maggie are interested in working with young growers. Maggie's two boys, Cisco and Elvis really enjoy picking vegetables for their dinner or just eating a few fresh beans off the vine. Momi pass on works with young people hoping to pass on her knowledge to the next generation.

Sales at the nursery has picked up over the last few years. Momi remarked that she noticed an increase in clients during the recent lockdown.

"I was happy to see that being at home for so long inspired people to start growing some of their own food," she said.

During the lockdown, people often called the nursery to request plants and would do a quick drive-by to pickup their orders. Now that people are getting out, they want to continue growing

edibles and often stop by the nursery to see what's available and get some growing advice.

Momi and Maggie spend about half their work day propagating new plants and ordering fruit trees from suppliers like Plant It Hawaii. They are both experienced in propagation whether from seeds, cuttings or by air layering. They also spend part of each day maintaining the nursery stock, potting, weeding, fertilizing and treating the occasional pest issue.

One of my favorite parts of a visit to Tropical Edibles is a tour through their "U-pick" garden. Salad greens, herbs and veggies are growing and many are ready to harvest. I usually come away with ingredients for a salad and often find an unusual herb to add an interesting flavor to my next meal.

Of course, you can also find lots of citrus trees, several avocado varieties and other exotic tropical fruit trees displayed on rock terraces for sale. They soon will have some new tropical varieties of apples and pears as well as peaches, plums and nectarines.



The drive up to Tropical Edibles Nursery has recently been repaired allowing for easy access to peruse their wares. Photo by: Russell Galanti

These have been bred to grow well in our climate but will likely do best at upper elevations where nighttime temperatures are lower.

Standard vegetables like tomatoes, peppers and eggplant are available as well as squash and bean plants. Taro and 'awa plants are among those that offer an opportunity to grow native Hawaiian edibles and medicinals. Herbs like parsley, cilantro, basil, comfrey and oregano can be found on the nursery tables alongside strawberries and edible flowers like sweet violas, dianthus, begonia, marigolds, and calendula. You'll even find some more unusual herbs like spilanthus (the tooth ache plant) and gotu kola. Maggie and Momi are happy to offer information on how to use plants like these and others that they sell.

Occasional education tours and classes as well as on site consultations are part of Tropical Edibles dedication to community service. To further serve local growers Tropical Edibles offers scheduled use as well as sales of their equipment including coffee pulpers and roasters. Their parent company, Captain Cook Trading Company, also supplies farmers with processing equipment for local crops including coffee, macnuts and cacao. The Trading Company also ships Kona coffee and local macnuts to all fifty states.

Many former visitors to Tropical Edibles Nursery will be happy to note that the driveway has been repaved. It is now easy to drive right up to the nursery tables to make you selections. Once at the top of the drive, you can also enjoy an expansive view of the South Kona coastline.

Get started growing edibles or add to your edible garden by visiting Tropical Edibles Nursery. They accept phone orders and can also deliver for a fee. They are currently open Wednes-

day through Saturday from 10 a.m. to 4 p.m. Call them at 808-328-040 or e mail them at tropicaledibles@gmail.com with any of your plant inquiries. You can also follow them on Facebook at Tropical Edibles Nursery in Captain Cook and on Instagram @tropical_edibles_nursery. Go meet Maggie and Momi and start expanding your edible garden. You'll be happy you did.

.....
Diana Duff is a plant adviser, educator and consultant living part time in Kailua-Kona.



Part of the day at the nursery is spent intaking new fruit trees. Photo by: Russell Galanti



The nursery offers an array of fruit trees. This photo shows how the nursery utilizes plastic planter bags as nursery pots. Photo by: Russell Galanti



Young seedlings and shade loving plants are tabled inside the shade house. Photo by: Russell Galanti



Momi makes her own medicinal salves and offers them for sale in the nursery's shop. Photo by: Momi Subiono



Controlling Little Fire Ants in an Edible Landscape

By: Heather Forester, Hawaii Ant Lab

Edible plants can add another dimension to your landscape, but it can also add complexity to your Little Fire Ant (LFA) treatments. There is only one LFA bait available that is effective and labeled for use on edible crops that are taller than head height; Tango™ contains the active ingredient of S-methoprene which is an insect growth regulator. It does not kill the ants, but rather tricks the queen into thinking she is a juvenile, and she is unable to produce viable brood. Tango™, mixed in the Hawaii Ant Lab (HAL) Gel Bait, is effective long term, but you must have patience to see results. To learn more about this baiting option visit: www.littlefireants.com/how-to-mix-hal-gel-bait/

Landscaping with tall trees and vines can create habitat for LFA that is very difficult to treat. With the right equipment (such as a piston pump backpack sprayer), the HAL Gel Bait can be applied to heights of thirty feet, but the top portions of windbreaks and crowns of tall palms are not always reachable. Often times, LFA will meet you part way down the trunks, but for best results, you should apply throughout the tree, so keeping landscapes to a height that you can reach is ideal. Vines growing on trees provide a lot of protected homes for LFA, so removing vines will reduce the habitat and

allow for more effective chemical control.

Since LFA are a tropical rain forest species, they love irrigated environments that we create for them. Planting drought tolerant plants, limiting irrigation, xeriscaping, and removing leaf litter make the environment less desirable for LFA.

If you find that your business or client has LFA, the Hawaii Ant Lab is here to help. The Hawaii Ant Lab is a program of the University of Hawaii, Pacific Cooperative Studies Unit. On the Big Island, the Hawaii Ant Lab offers free site visits to educate on prevention, survey, and treatment options. Hawaii Ant Lab will work with you to develop a management plan. On other islands, there is a collaborative effort to manage infestations which include agencies such as: Hawaii Department of Agriculture, local Invasive Species Committees, Coordinating Group on Alien Pest Species, and other agencies. All information is kept confidential, so please do not hesitate to contact us with questions.

For more information on Little Fire Ants, visit: www.littlefireants.com

DON'T LET CITRUS GREENING DESTROY CITRUS IN HAWAII!

By: Lissa Strohecker, Outreach specialist
Maui Invasive Species Committee

Citrus is an ideal crop for an edible landscape in Hawaii.

From dwarf varieties to large trees, citrus can be at home on a patio or be the focal point of a garden. Many yards are already home to an orange, tangerine, lemon, or pomelo that offer up a bounty of fruit to share with friends and neighbors.

Western explorers and settlers first planted citrus in the late 1700's, bringing the "Polynesian gold" from Tahiti. By the 1820s, whaling had become big business, and hungry sailors stocked up on citrus and other provisions.

Trees infected with Citrus Greening have a misshapen fruit that remains green even when ripe. Photo by: Jeffrey W. Lotz, Florida Department of Agriculture and Consumer Services, Bugwood.org





Yellowing leaves warrant further inspection. Credit: J.M. Bové, INRA Centre de Recherches de Bordeaux, Bugwood.org



Asian citrus psyllid vector the disease between plants. The insect is present in Hawaii. Photo courtesy: Jeffrey W. Lotz, Florida Department of Agriculture and Consumer Services, Bugwood.org

When miners struck it rich in 1849, kicking off the gold rush, citrus was among the food exported from Hawaii to feed miners in California. But the gold rush ended by 1855 and oil from the ground replaced oil from whales around 1859. The demand for Hawaiian grown sugar grew during the Civil War (1861-1865) as sugar supplies from the southern US were cut off. Sugarcane, already in production, became even more profitable.

Today, there's renewed interest in the crop. On Maui, over 600,000 citrus seedlings now grow on former sugar cane land. In 2018, citrus contributed nearly \$400,000 annually to agriculture in Hawaii; lemons being the primary crop.

Backyard gardeners never gave up on citrus. Trees grow from sea level to 2000 + foot elevation and tolerate wet windward yards as well as the dry leeward. Regular inspection and pest management keep trees healthy. Pests already present in Hawaii include scale, whitefly, Chinese rose beetle, citrus Tristeza virus, and citrus blight. The most significant threat to citrus worldwide is a disease not yet known to be present in the state: citrus greening disease.

Citrus greening, also known as yellow dragon disease or huanglongbing, has devastated the citrus industry in the US and in other countries. Caused by a tiny bacterium, *Candidatus liberibacter asiaticus*, this disease has triggered the loss of millions of acres of citrus. In 2005, the disease made it to Florida orchards. In the five years that followed, researchers estimated over 8,000 jobs were lost and the economic impact was estimated at \$4.5 billion. Today, Florida's citrus industry covers half the acreage it once did.

The disease moves long distances when people move infected plant material. The Asian citrus psyllid spreads the disease between plants. The tiny insect picks up the bacteria when it feeds on an infected tree, then spreads it to an uninfected tree, similar to how mosquitoes vector dengue or zika. Unfortunately, the Asian citrus psyllid has already made it

to Hawaii. First detected in 2006, the insect is on all the main Hawaiian Islands. Preventing citrus greening is even more critical since the stage is set for the spread of the disease. If it does reach our shores, finding the diseases early can protect backyard citrus and potential citrus crops. The USDA sponsors a lab at UH-CTAHR to test psyllids and germplasm in Hawaii and the Pacific to help safeguard citrus. Growers and nurseries can help.

Prevention: Consider the distribution of the disease when sourcing plants. The USDA National Clean Plant Network produces and distributes clean propagation material for citrus and other plants.

When sourcing from quarantined areas, vendors must be in compliance with USDA and have certification. Individual plants should be tagged verifying USDA inspection. As of 2022, Florida, Georgia, and

some counties in South Carolina, Texas, and California are quarantined. Updated quarantine maps are available at www.aphis.usda.gov/aphis/maps/plant-health/citrus-map Citrus from unquarantined areas should still be inspected for symptoms of the disease

Early Detection:

The earlier you find any pest or disease, the better off you will be in your attempts to control it. While there is no cure for individual plants, finding and removing infected plants can keep the disease from spreading.

Symptoms include:

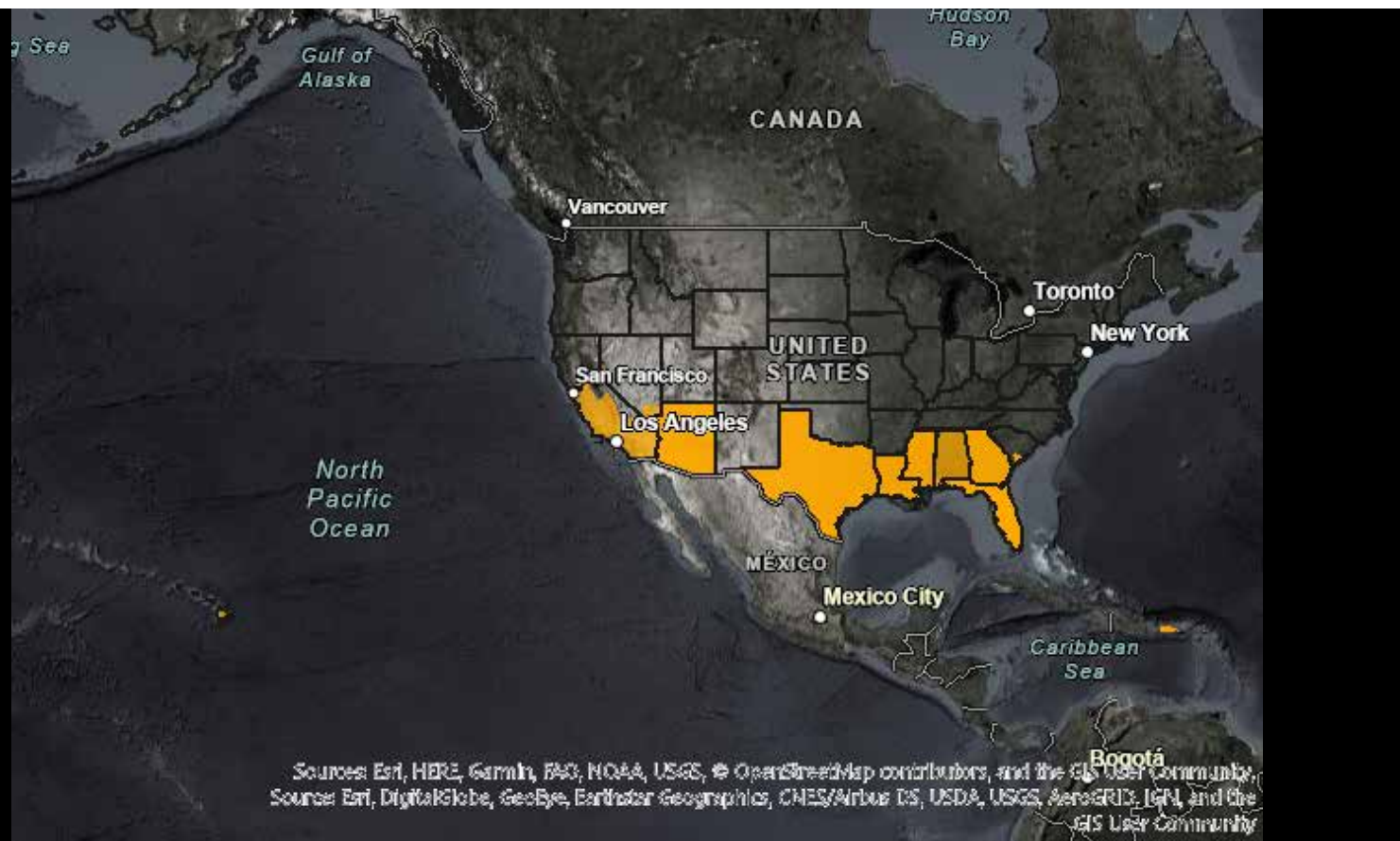
- The first symptom of infection is a yellow shoot on an otherwise healthy green tree.
- Infestation of Asian citrus psyllids, sometimes recognized by their waxy droppings.
- Fruit remains green as it ripens or ripens irregularly: lopsided, bitter, and hard with small, dark seeds.

• The leaves show asymmetrical, blotchy mottling. Other pests, pathogens, and nutrient deficiencies may cause similar symptoms and laboratory testing are necessary to confirm the presence of citrus greening. If you suspect citrus greening, report it to 643-PEST (7378) or online at 643PEST.org

Citrus greening is one of many pests that have not yet reached Hawaii. The USDA Alien Plant Health Information Service has a list of priority pests and diseases that the growers and nursery industry can help prevent from spreading. Thanks to a grant from USDA Plant Protection Act 7721 Plant Pest and Disease Management and Disaster Prevention Program, the Coordinating Group of Alien Pest Species and the Invasive Species Committees (under the University of Hawaii Pacific Cooperative Studies Unit) have developed a training to help growers better protect against the arrival and



USDA Citrus Federal Quarantines for Citrus Greening Yellow indicates that the vendors in these counties must be in compliance with USDA, based on the presence of citrus greening.



USDA Citrus Federal Quarantines for Citrus. Note that there are USDA quarantines for other citrus pests including the Asian citrus psyllid and citrus black spot, citrus canker, and sweet orange scab. Hawaii is affected based on the presence of the Asian citrus psyllid.

inadvertent spread of these plant pests as well as address certain pests already present.

Join in the efforts to protect edible gardens in Hawaii. Approval for CEU's for the training is currently underway. To be notified of upcoming training, contact your local Invasive Species Committee. Learn more about the program at plantpo-no/pest-training.

And continue to be on the lookout for citrus greening in the landscape. All species of citrus can be affected. To learn more about growing citrus in Hawaii, pest management, and the threat of citrus greening, refer to the following resources:

Additional resources:

- *USDA APHIS Citrus Greening:* aphis.usda.gov/aphis/ourfocus/planthealth/plant-pest-and-disease-programs/pests-and-diseases/citrus/citrus-greening
- *UH-CTAHR Growing Citrus in Hawaii:* ctahr.hawaii.edu/oc/free-pubs/pdf/F_N-14.pdf
- *UH-CTAHR Citrus Huanglongbing:* ctahr.hawaii.edu/oc/freepubs/pdf/PD-112.pdf
- *Hawaii Department of Agriculture New Pest Alert: Asian Citrus Psyllid:* hdoa.hawaii.gov/pi/files/2013/01/npao6-01-ACP.pdf www.nationalcleanplantnetwork.org

Lissa Strohecker is the Outreach specialist with the Maui Invasive Species Committee



Yellowing branches are often the first indication of citrus greening. Florida Department of Agriculture and Consumer Services, Bugwood.org



Irregular patches of yellowing where one side of the leaf no longer matches the other side could indicate citrus greening. Jeffrey W. Lotz, Florida Department of Agriculture and Consumer Services, Bugwood.org



Citrus in the field exhibiting asymmetrical mottling that indicates citrus greening. Jeffrey W. Lotz, Florida Department of Agriculture and Consumer Services, Bugwood.org

Removing nuisance fruit from coconuts and monkey pods in Hawaii's landscapes.

By: Dr. Joe DeFrank, UH Researcher Emeritus, UH-Manoa.

Coconuts and monkey pod are commonly used species in many of Hawaii's commercial landscapes.

Two of the most iconic tropical trees used in Hawaii's landscape are coconuts (*Cocos nucifera*) and monkey pods (*Pithecellobium saman*). Both species present maintenance issues in the form of unwanted or nuisance fruits. Coconut trees represent an obvious injury hazard when large fruit form and fall unpredictably causing severe injury or death to those below. To address this hazard, resorts, golf courses and commercial landscape managers must hire specialized contractors to climb trees and remove fruit and the lower crown of fronds. A recent quote for these services at a moderate sized golf course was \$10,000.00 per year (FY-2021). In Hawaii, monkey pods can flower at any time of the year but

usually flower from April to August with seed pods dropping for 2-4 months following this period. In addition to the mess, these seed pods pose a slipping hazard when they fall onto parking lots and sidewalks and get soaked by rainfall or irrigation systems.

In 1972, Dr. Richard Criley (UH Researcher Emeritus) published a scientific article titled: Coconut fruit drop induced by ethephon and chlorflurenol, In: Hortscience 7 (2): 176. This publication described the use of two growth regulators that could remove unwanted fruit from coconuts without injuring the tree. A commercially available formulation of ethephon is available with the trade name Verve (*Nufarm*) and has a site use described on the label as "Fruit Elimination - Ornamental Use Only". The Verve product label does not specifically list fruit elimination in coconut or monkey pod but instructions do allow for users to determine suitability prior to widespread and legal use. In 2017, based on Dr. Criley's 1972 publication, an 800 ppm solution of ethephon was prepared by diluting 1.3 fluid ounces of Verve up to 3 gallons of water. The diluted Verve solution was used to fill water balloons that were shot into the crown of coconut trees using a reinforced child's toy called an "Aqua Bow" (right photo). Both newly formed flowers and golf ball sized fruit were targeted. It was

Monkey pod trees drop sticky seed pods that represent a slipping hazard on sidewalks when crushed pods get wet from rainfall or irrigation.



determined that coconut fruit stalks that are naturally starting to drop small golf-ball sized nuts (bottom photo) are the ideal stage to induce more complete drop with the Verve application. In conversations with researchers that injected ethephon into trunks of monkey pods, it was observed that fruit drop could be induced for an extended period of time, however the stem injection point failed to heal up, constantly leaked sap and so this method of treatment

was abandoned. Like coconuts, the suggested time to treat Monkey pods for maximum fruit drop would be when small bean sized pods have formed and natural drop is beginning. Some leaf drop will occur, but the tree quickly replaces lost foliage. It is clear that ethephon is a useful growth regulator to defruit both coconuts and monkey pods but the question remains how best to treat these large plants in the landscape setting. Drones or UAS (unmanned

aerial systems) have been rapidly expanding in usage in precision agricultural settings. UAS have been designed to spray in all sorts of agricultural crops in the U.S. and around the world. A UAS would be the ideal tool for applying ethephon with high precisions to coconut crowns and to the entire canopy of large monkey pods in landscape settings.

A UAS used for the release of pesticides and growth regulators (both referred to as "economic poisons" by the Federal Aviation Administration, FAA) is a relatively new area of regulation for this agency. A commercial operation seeking to use a UAS to apply an economic poison must first obtain a Drone Pilot Certificate from the FAA (referred to as a Part 107 Certificate). Drone Pilot Certification requires passing a knowledge test dealing with detailed aspects of operating a drone in the air space above our country. In Hawaii, a local merchant (Drone Services Hawaii: <https://droneserviceshawaii.com/>) that sell drones offers preparatory

Coconut fruits and lower fronds are removed to mitigate a potential hazard to users at West Loch golf course.



Dr. Joe DeFrank evaluates a toy "Aqua Bow" to shoot water balloons filled with 800 ppm ethephon (Verve plant growth regulator) into the crown of coconut trees. Golf ball sized fruit are the ideal stage of growth for ethephon treatment to induce a more complete fruit drop.



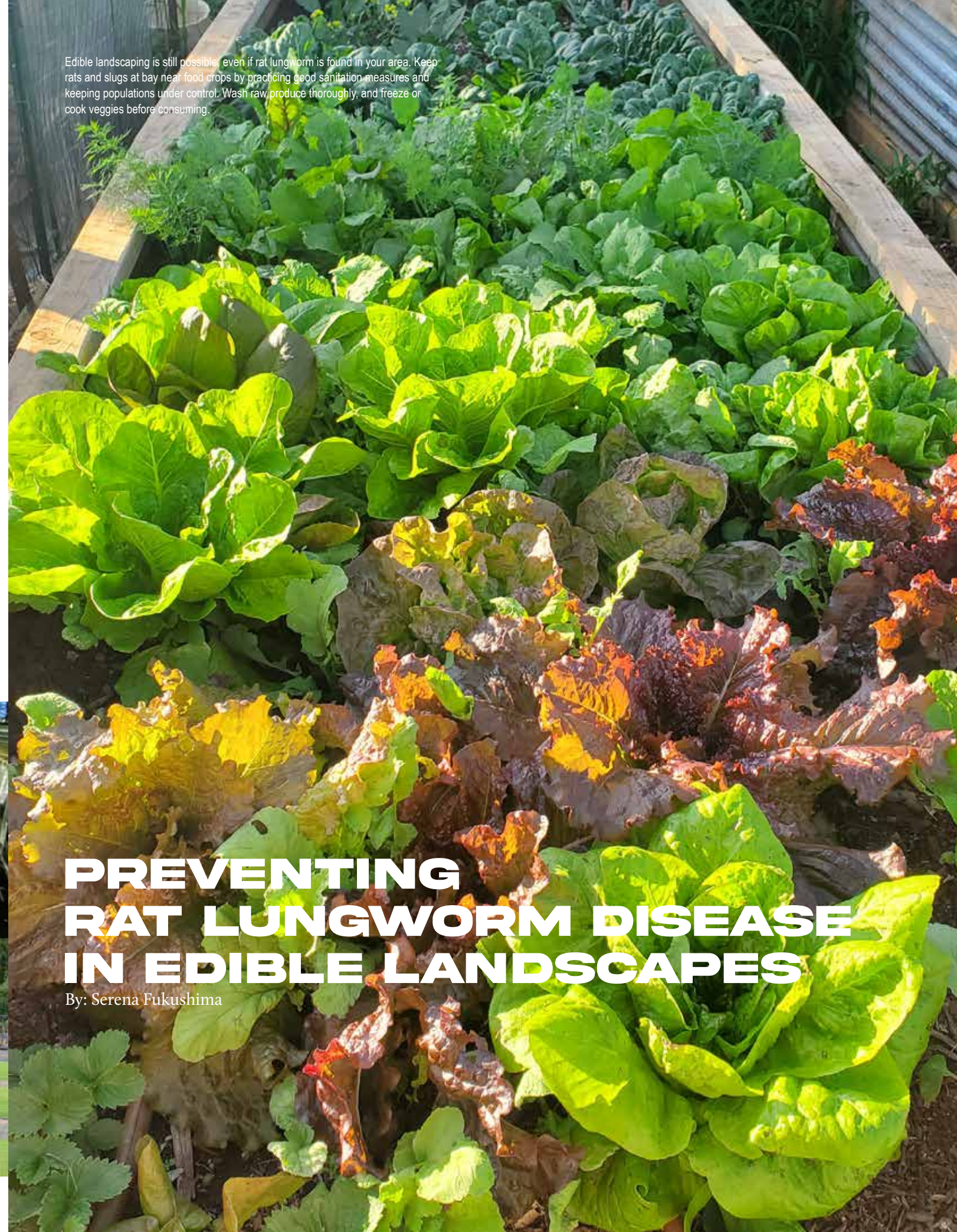
classes for this test and many online training aids are also available. With the Part 107 Certificate in hand, UAS operators must obtain a Part 137 Certificate for Agricultural Aircraft Operations administered by FAA. Each drone used for applying economic poison must have this Part 137 certification which requires an extensive process of formal application, document compliance and aircraft worthiness demonstration and inspection by a local FAA compliance team. It makes sense that any machine that flies and disperses chemicals should be fully licensed by the federal government for safe operations. For those seeking to enter this potentially lucrative business, help is available. Rantizo is a mainland company that provides drone application systems and services. Their systems for custom applications using UAS are designed to simplify and streamline the entry point for Ag retailers and custom applicators

seeking to add drone applications to their service offerings. Interested service contractors are encouraged to contact Rantizo directly (info@rantizo.com) or visit their website (<https://www.rantizo.com/>) for more information on how to get started with the commercial use of drones in landscape/agricultural settings. Dr. DeFrank has prepared a video dealing with the use of drones in precision agriculture at: https://www.ctahr.hawaii.edu/defrankj/NON_HOME_PAGE/PAGES/TPSS_300_UASag_05062021.htm#UAS_ag. Whether you need to defruit tree canopies or make precision applications of pesticides (such as fire ant bait, rhinoceros beetle control or hard to reach invasive plant management), drones will be an increasingly attractive and available choice for these special landscape issues.

Top image shows missing fruit from coconut stalk treated with 800 ppm ethephon. Bottom image shows coconut fruits induced to drop with application of Verve growth regulator. Fruit drop occurred 4-5 days after treatment.



A prototype research drone fitted with liquid tank and CO2 compress gas reservoir commissioned to apply spray solutions to coconuts and other large trees in the landscape setting (inset photo). The flying sprayer was designed to spot apply a stream of liquid to specific targets in the coconut crown.



Edible landscaping is still possible, even if rat lungworm is found in your area. Keep rats and slugs at bay near food crops by practicing good sanitation measures and keeping populations under control. Wash raw produce thoroughly, and freeze or cook veggies before consuming.

PREVENTING RAT LUNGWORM DISEASE IN EDIBLE LANDSCAPES

By: Serena Fukushima

Incorporating an edible landscape into a home or business is a great way to showcase beautiful plants while feeding people. Coconuts, bananas, lime, and breadfruit trees also provide shade and material for cultural practices. Chef gardens featuring herbs and vegetables add a place-based connection to culinary delights while inviting beneficial insects such as butterflies and ladybugs to enchant all who enjoy this space. However, landscaping with food plants is not without its hazards. Besides the stray coconut falling on unsuspecting passersby, something more sinister could be slithering in the shadows – rat lungworm.

Humans typically encounter the rat lungworm parasitic nematode (*Angiostrongylus cantonensis*) through infected slugs and snails that have come in contact with produce. Even a fingernail-sized juvenile slug hiding in lettuce leaves can carry the parasite. A freshly made slime trail left on produce can harbor rat lungworm larvae. Parasites can survive up to 72 hours in water – creating a risk from an improperly-sealed water catchment system or an uncoiled hose used by a thirsty gardener.

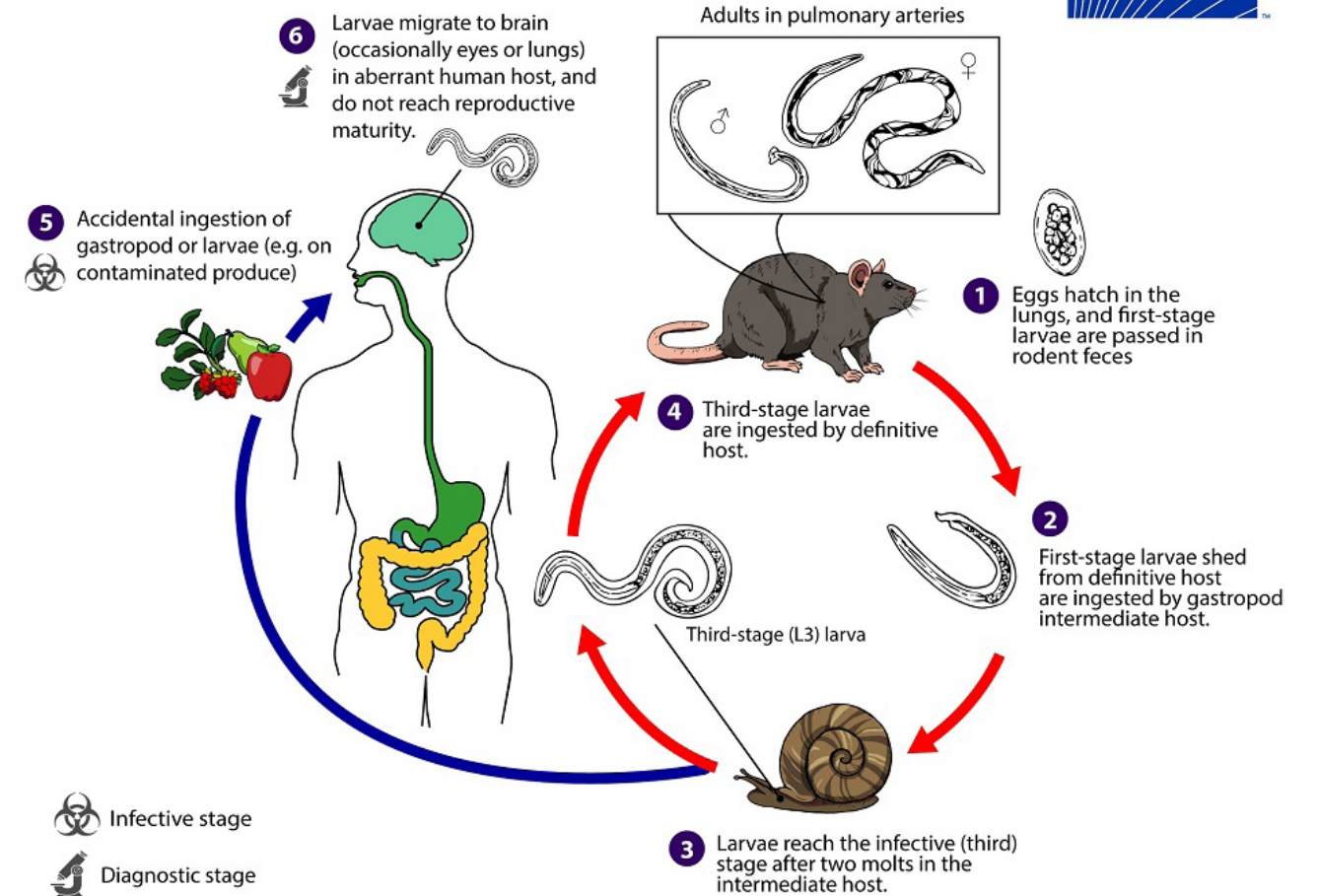
When the parasite infects humans, it becomes rat lungworm disease. In 2017, Hawai'i was rocked with a high number of cases, prompting a widespread informational campaign on proper methods to wash produce, along with landscape-based sanitation methods to control the

invasive hosts of this parasite. Cases of the disease have declined, yet this harmful parasite is here to stay.

Rat lungworm is a nematode that begins its life cycle in a rat's lungs. The eggs hatch in the lungs and first-stage larvae travel to the digestive tract and exit through the rodent's feces. Nearby slugs and snails eat the infected poop, becoming secondary hosts. When a rat feeds on these slimy pests, the cycle repeats. Common secondary hosts in Hawai'i include invasive giant African snails, golden apple snails, garden snails, and the Cuban slug; however, it is safe to assume any marauding land mollusks in our islands could harbor this parasite. Other hosts include cane toads, coqui and Cuban tree frogs, freshwater shrimp, and centipedes. But the species known to carry the highest load of the rat lungworm parasite in Hawai'i? The semi-slug.

Semi-slugs were first detected in Puna on Hawai'i Island around 2004. They are about two inches long with a distinct partial shell on their back. This non-native pest carries an extremely high concentration of the rat lungworm parasite – a single slug collected in East Hawai'i had nearly 7,000 larvae. Prevalent around human dwellings, semi-slugs are remarkably fast and efficient climbers – commonly found in gardens, buckets, water catchments, and even slithering into open drinking containers.

After rat lungworm enters the human body, it makes



The rat lungworm parasite begins its life cycle in a rat's lungs. The eggs of the parasite hatch in the lungs and travel to the digestive tract, exiting the body through the rat's feces. Nearby slugs and snails eat infected poop, becoming secondary hosts. In the human body, rat lungworm disease causes the lining around the brain to swell. Results range from flu-like symptoms and light sensitivity to nerve damage and even death. Diagnosis is complex, and there is no specific treatment or cure. Photo: CDC

its way to the brain and eventually dies, which can trigger a rare type of meningitis that causes the lining around the brain to swell. The higher the concentration of larvae, the more severe the infection. Rat lungworm disease symptoms range from severe headaches, tingling or painful feelings in the skin or extremities, flu-like symptoms, and light sensitivity to more severe impacts such as temporary facial paralysis, nerve damage, coma, and even death. At this time, there is no specific treatment or cure for rat lungworm disease. Even diagnosing an infection is challenging, requiring a spinal tap and extensive testing to determine if the parasite is present.

Rat lungworm is thought to have originated in Southeast Asia but is now found throughout Asia, Australia, the Americas, and the Caribbean and Pacific Islands. It was first recorded in Hawai'i in the 1960s, possibly arriving from infected rats hitchhiking on ships. A survey conducted in 2021 confirmed its presence on six Hawaiian Islands, primarily in slugs and snails. (This survey did not include Kaho'olawe or Ni'ihau). From 1960 to 2021, a total of 171 cases of rat lungworm disease were reported across the state, with the majority concentrated on Hawai'i Island. In 2017, a significant uptick garnered national attention, with thirteen cases reported on Hawai'i

Island and eight on Maui. Although rat lungworm disease is severe, prevention is relatively simple. The first step is to eliminate the primary host. Edible gardens and landscapes are a magnet for hungry rats, who gravitate to fallen fruit and water sources. Controlling this pest by setting traps and practicing routine sanitation practices will help reduce the presence of disease-carrying rodents. Slugs and snails are excellent at playing hide and seek in edible landscapes. Their soft, moist bodies require cool, damp hiding places to avoid drying out in the sun. Norine Yeung, Malacology Curator at the Bishop Museum, encourages home

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Invasive semi-slugs carry a high concentration of the rat lungworm parasite. These fast and efficient climbers are commonly found in gardens, buckets, water catchments, and even slithering into open drinking containers. Photo: Wikiwand



Rat lungworm is thought to have originated in Southeast Asia but is now found throughout Asia, Australia, the Americas, and the Caribbean and Pacific Islands. It was first recorded in Hawai'i in the 1960s, possibly arriving from infected rats hitchhiking on ships. A survey conducted in 2021 confirmed its presence on six Hawaiian Islands. All slugs and snails have the potential to carry this parasite. Photo: CDC

gardeners and landscapers to be vigilant in stopping the spread of invasive slugs and snails in Hawai'i. "Limiting the number of hiding places is vital in preventing these pests from entering the landscape," Yeung says. "Removing unnecessary groundcover, cutting back overgrown vegetation, taking away rocks and fallen wood, using dripline irrigation on a timer, or even raising edible plants off the ground can make it hard for these pests to access food crops." They may also hide under and amongst potted plants. Damp, warm nurseries are ideal environments for slugs and snails and, left unchecked, could foster a population explosion of potential parasite vectors. Yeung advises, "Always use caution when moving plants by removing slugs and snails and washing hands immediately when coming into direct contact." Landscapers may also lure and trap snails and slugs by providing hiding places along the perimeter of an area and regularly checking and safely disposing of any unwanted mollusks.

Food bait pellets and granules containing metaldehyde or iron phosphate as the active ingredient have proven effective for some gardeners in reducing established populations of slug and snail populations. The bait should be placed in areas close to any hiding places while avoiding contact with water, which can cause the bait to mold and become unappealing. Be careful if using food baits because household pets may be attracted to the bait, which can cause poisoning if ingested. Another alternative is using copper barrier products, although they have not proven as effective as the bait.

Handpicking snails and slugs is an effective, non-toxic strategy; however, take precautions to avoid contact with the parasite. Always use disposable gloves when handling

slugs or snails or even better, use a dedicated (and labeled!) pair of tongs for hunting these vectors. Slug hunts are most effective at night or early in the morning, after rain or watering. You can kill slugs or snails by placing them in a wide-mouthed bottle filled with a 15% salt water solution for several days. The saltwater kills the slug and any rat lungworm larvae that may be lurking within. Dispose of any dead slugs or snails in the trash. Do not compost or empty it in the landscape, as the infected slug could be eaten and potentially restart the cycle should any larvae persist. Always wash your hands thoroughly after a slug hunt, even if you did not come into direct contact with it.

Yeung emphasizes observing the creatures crawling in your landscape or garden. "There are 60 species of invasive slugs and snails in Hawai'i, and all of them have the potential to carry the rat lungworm parasite," she warns, "Keep an eye out for any new pests in your garden, and report them to your local invasive species committee. This will help prevent any new species – especially those that can harbor rat lungworm – from spreading in our islands."

With a disease as severe as rat lungworm, it could be tempting to turn away from edible landscaping and gardening; however, the benefits of growing food far outweigh the inconvenience of simple practices needed to prevent rat lungworm disease. Carefully rinsing and drying produce before consuming it is an effective way to remove potential parasites. Soapy water, veggie sprays, or vinegar isn't more effective than a freshwater rinse. For cooked greens and vegetables, boiling, steaming, and sauteeing for at least 3-5 minutes will kill any lingering larvae. Freezing produce for 48 hours is another great practice for preventing rat lungworm

survival from plant to plate. For fruit, it is always a good practice to rinse thoroughly before consuming, even if it has a peel or rind.

The reduced number of cases of rat lungworm disease across the state indicates that simple precautions are working in combating this debilitating illness. Landscape professionals and gardeners continue to make a difference in preventing the spread of this invasive parasite and its hosts.

If you need help identifying your slug or snail, visit bishopmuseum.org/malacology. New garden pests can also be reported to the Statewide Pest Hotline at 643-PEST or online at 643pest.org.

Serena Fukushima is the Public Relations and Education Specialist for the Maui Invasive Species Committee. In her spare time, she is an avid gardener and expert slug hunter.



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EDITOR'S NOTE

We "Niu" we would make a mistake! An error was discovered in the 2022 May/June issue of Hawaii Landscape. Thank you Dr. Richard Criley for your keen eyes.

Indrajit Gunasekara is in fact co-director of Niu NOW, but the following sentence "Jacquemontia sandwicensis 'Leeward Community College White'." should have said "Soil Science Department."

Here is the corrected version of the statement:

Indrajit Gunasekara is Co-Director of Niu NOW, Financial Aid Officer at UH West Oahu and a graduate student at University of Hawaii at Manoa's Tropical Plant and Soil Science Department.

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