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Testing Citric Acid Use On Plants

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by William C. Pitt and Hans Sin

Citric acid is being used as a management tool for controlling populations of two Caribbean tree frog species (*Eleutherodactylus coqui and E. planirostris*) that have recently become established in Hawaii.

More than 300 frog populations have been identified on the four largest islands. Frog populations can reach densities greater than 20,000 individuals per hectare in heavily infested sites.

The frogs have the potential to affect Hawaii's floriculture industry, representing $88 million in annual sales, because of an interisland quarantine measure for plants infested with coqui frogs. Thus, there has been a rising concern for greenhouse owners to acquire tools to manage frog populations and to treat plants prior to shipping.

Previous studies have shown that a dermal application of 16 percent citric acid (2-hydrox-1,2,3-propanetricarboxylic acid):water solution was effective in controlling frogs and may be an effective quarantine treatment for plants prior to shipment. Lab trials have demonstrated that 16 percent citric acid is the lowest percentage resulting in 100 percent mortality of coqui frogs (Pitt unpublished data).

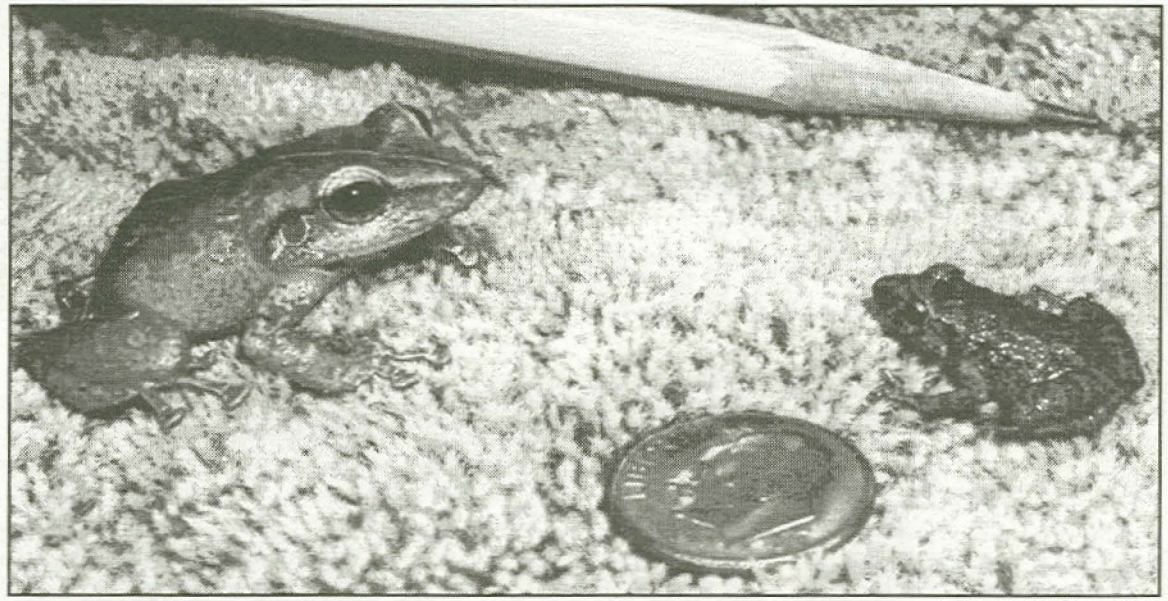

Photo by Lori Oberhofer, USDA

The loud-calling coqui frog (left) and the greenhouse frog, both alien species to Hawaii, are serious pests of the Islands' green industry. Citric acid has been used as a way to control the frogs.

Based on these results, we investigated the phytotoxicity of 16 percent citric acid on common greenhouse plants before widespread spraying occurs. We evaluated the potential phytotoxicity effects of citric acid on selected ornamental plants chosen to be representative of the most common plants grown commercially in Hawaii and representative of plants commonly planted. Common greenhouse plants were of special concern because of their high financial value to ornamental growers and the likely need to treat these plants before being shipped to another location.

We tested 16 percent citric acid solution on 10 plants (five treatment and five control) from each of the following 15 plant groups: bromeliad (*Guzmania lingulata*); orchid (*Phalaenopsis* spp.); rabbit's foot fern (*Davallia trichomanoides*); maiden hair fern (*Adiantum raddianum*); bird nest fern (*Asplenium nidus*); heart fern (*Hemionitis arifolia*); asparagus fern (*Asparagus densiflorus*); Boston fern (*Nephrolepsis exaltata*); dracaena (*Dracaena sanderiana*, and *D. deremensis*); dumb cane (*Dieffenbachia*); wax flower (Anthurium andraeanum); peace lily (*Spathiphyllum* spp.); Chinese evergreen (*Aglaonema* spp.); and English ivy (*Hedera helix*).

Individually labeled plants (4- to 6- inch pot size) were spaced on a raised nursery bench in a greenhouse. We randomly placed five plants from each plant group for treatment. Before treatment, any blemishes or plant damage were documented. Each treatment plant was sprayed with 11.5 ml of 16 percent citric acid solution with a 1.5-quart hand-held pressure sprayer, completely covering the plant until excess beads of liquid formed on the leaves and dripped off the plants. We estimated the amount sprayed on each plant by measuring the amount remaining in the sprayer before and after application. Each control group plant was sprayed with the same amount of plain irrigation water as treatments.

After 24 hours, all plants were rinsed with irrigation water and any observed phytotoxicity was then documented. We repeated the damage assessment one week later. Individual plants were watered by individual pot drip system according to greenhouse schedule. The experiment was terminated after one week, long enough for phytotoxic effects to be evident and short enough so new growth did not occur.

Two types of phytotoxicity were assessed: (1) percentage of

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Frogs

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leaves damaged and (2) percentage of leaf surface area damaged. The proportion of leaves damaged on a plant was expressed as the percentage of leaves damaged by citric acid. Leaf surface area damage was measured by observing any damage on treatment plants (brown edges, spots, etc.), through direct observations and photographs taken. Damage was quantified as percent damaged compared to entire leaf surface area. Overall phytotoxicity of 16 percent citric acid was calculated by subtracting average damage to controls from treatments. We tested for treatments effects with a multiple analysis of variance using species, treatment, and species X treatment as factors.

Phytotoxicity was evident on all treated individuals within 24 hours, and more was apparent after one week. The average percent of leaves damaged and leaf surface area affected were 16.1 percent and 2.4 percent, respectively.

Phytotoxicity effects from the application of citric acid significantly varied among species. *G. lingulata* damage mostly consisted of discoloration of leaves, whereas the fern species (*D. trichomanoides*, *A. raddianum*, *A. nidus*, *H. arifolia*, *A. densiflorus*, *N. exaltata*) exhibited browning edges on leaves or leaflets. *Guzmania lingulata* showed the highest percent of leaf surface area affected. The fern group had the highest average percent leaves damaged at 24.3 percent, but had low average leaf surface area damage at 2.3 percent.

Plant species within the Araceae family (*Dieffenbachia*, *Anthurium*, *Spathiphyllum* and *Aglaonema*) had an average of 8.9 percent leaves damaged, and the leaf surface area affected was an average of 1 percent.

The two Dracaena species averaged low percentages in leaves damaged and leaf surface area damaged at 9.2 percent and 1.3 percent, respectively.

The orchid group (*Phalaenopsis*) had a high percent of leaves damaged (23.3 percent), but the leaf surface area affected was only 5.6 percent. Frogs jumped out of treatment plants when sprayed with the citric acid solution. Citric acid residue was still evident on plants as a clear sticky substance (more than 50 percent of the surface area), although treated plants were thoroughly rinsed after 24 hours.

Overall, 16 percent citric acid treatment caused minor phytotoxic effects to the plants. The average percentage of leaves damaged was 16.1. Most damaged surface area stayed below 5 percent and the average was 2.4 percent. The damaged surface area measurements were only taken from treatment plants and did not take into account the controls. Thus, actual surfaces damaged due to citric acid phytotoxicity may be lower than reported.

One week after treatment, the greenhouse manager inspected all plants and found them to be suitable for sale. This demonstrates the potential use of citric acid in greenhouses as a pesticide or repellent for coqui and greenhouse frogs. The higher levels of damage noted on *G. lingulata* was in part due to the end of flowering in this species and it appeared that plants (both treatments and controls) were naturally reverting to vegetative stages. Fern species seemed to be the most susceptible to citric acid and the Araceae family seemed to be most resistant. This varied response among plant groups may be due to differences in cuticle thickness on the surface of leaves.

An aspect that this study did not encompass was the effect of citric acid on flowers of orchids, wax flowers and peace lilies. Whether citric acid affects flowers is important because flowers are the primary reason the plants are purchased. Spraying flowers is not necessary because frogs are unlikely to reside in the flowers of the tested plants. We recommend that growers spray plants without directly spraying flowers until citric acid effects on flowers is determined.

After the 24-hour rinse, noticeable citric acid residue remained on plants. We left the residue on leaves to determine if this had any additional phytotoxicity on plants. The residue caused no measurable damage to plants. Some Dracaena plants retained residue for up to a month with no phytotoxic reactions. More importantly, citric acid residue may be a deterrent for frogs. Frogs appeared to avoid citric acid residues. In addition to spraying plants directly, we recommend spraying potential other hiding places for frogs, such as any vegetation growing around nursery benches, inside boxes or inside pots.

Most of the plant families in this experiment are native to Hawaii. Thus, this study might indicate that 16 percent citric acid would not prove phytotoxic to plants in the field during control or eradication efforts of Eleutherodactylus frogs.

For more detailed research results and literature cited, contact William C. Pitt at (808) 961-4482 in Hilo or e-mail will.pitt@aphis.usda.gov.

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landscape industry, just as the