Hawaii Cooperative Extension Service

HORTICULTURE DIGEST

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U. S. Department of Agriculture Cooperating

Department of Horticulture
University of Hawaii at Manoa

In This Issue: FLOWER AND NURSERY INFORMATION
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Editor's Note: This special issue of the Horticulture Digest features many of the papers and summaries of presentations from the anthurium session of the Fertilizer and Ornamentals Short Course held in Hilo, January 9–11, 1986.

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SURFACE DISINFESTATION OF TISSUE CULTURED ANTHURIUMS

There is an increased interest in tissue culturing anthuriums as a means of vegetative propagation. Unfortunately, obtaining fairly clean plants directly from the field is difficult if not impractical. This usually results in higher contamination levels during the culturing process in the laboratory.

It was our intent to achieve the following in our study: 1) reduce contamination of explants (axillary buds) without phytotoxic effects, 2) reduce or eliminate the use of a dissecting microscope during the disinfestation procedure.

Materials and Methods

Matured 'Ozaki' plants were obtained directly from an anthurium field located in Hilo. These plants were considered highly contaminated due to their manner of growth directly in cinder beds and due to anthurium sheath whitefly infestation.

Cuttings 1–2 ft long with 5–7 axillary buds were randomly collected and prepared for disinfestation procedures by removing all leaves and roots. The entire stem was thoroughly washed with detergent and allowed to air dry for 2, 4, and 8 days before treatment with surface disinfectants. An equivalent number of stems were sealed with parowax on the cut surface areas and air dried for 2, 4, and 8 days. Stems that were not air dried prior to bud removal served as the control.

Following the appropriate drying periods, the upper second or third axillary buds were excised and the first leaf covering removed. The buds were then soaked in 0.52% sodium hypochlorite for 45 mins and rinsed 3 times in sterile distilled water. An additional 2 leaf coverings were removed and the buds were placed in a 16mm x 150mm culture tubes with 1 ml Murashige and Skoog liquid medium. The cultures were placed on a rotating drum and evaluated for contamination 5 days later.

Contamination was evaluated by using a Spectronic 20 colorimeter-spectrophotometer to determine the degree of turbidity in the liquid medium. It was assumed that the higher turbidity meant a higher level of contamination.

The most promising air drying treatment based on contaminant levels was used as a starting point for the surface disinfestation treatments. LD (Lethal Dose), a disinfectant, was used in addition to sodium hypochlorite. Buds were exposed to the following concentrations of LD: 1/2 recommended, (1 part base:1 part activator:20 parts water), recommended (1 part base:1 part activator:10 parts water) and 2 times recommended (1 part base:1 part activator:5 parts water). The following soaking times were used in conjunction with the most effective concentration: (hrs) 1/2, 1, 2, and 4.

Preparation of the bud involved removing two leaf coverings followed bya 45 min soak in 0.52% sodium hypochlorite. A third leaf covering was removed without the aid of a dissecting microscope and the bud soaked in LD solution. This was followed by 3 rinses in sterile water and transfer of the bud into liquid M&S medium. Buds that showed no contamination after 5 days

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were placed in M&S liquid medium plus 15% coconut water (Kunisaki, 1980) and observed for 7 weeks to determine latent contamination and phytotoxicity. Each treatment was replicated 20 times.

Results and Discussion

There was a reduction in contamination level when stems were air dried for 4 and 8 days (Table 1) but waxing had no effect. Bud leaf coverings were also much easier to remove after 4 days of air drying.

Double the recommended LD concentration produced 80% clean cultures after 5 days while 1/2 the recommended rate produced only 20% clean cultures (Table 2).

Table 1. Anthurium stem air drying treatments and its effects on contamination as correlated to optical density (O.D.)

Treatment	No wax (O.D.)	Change in O.D. from control	Waxed (O.D.)	Change in O.D. from control
Control	0.072		–	
2 days dried	0.052	0.020	0.066	0.006
4 days dried	0.037	0.035	0.044	0.028
8 days dried	0.038	0.034	0.040	0.032

* Optical density was determined at 390 nm.

Table 2. The effects of LD concentrations with a 30 minute soaking period on contamination levels 5 days following LD treatments

Treatment	Percent clean cultures
LD 1/2 rec	20
LD rec	60
LD 2x rec	80

Soaking the explants in 2x recommended LD solution for 240 mins resulted in 85% contaminant free cultures after 5 days (Table 4). A 30 min soak was nearly as effective and produced 80% clean cultures.

Seven weeks after placement of clean buds in the growth medium, 100% of the buds that were soaked for 30 mins at the recommended rate were alive and developing (Table 3). This figure was considerably higher than the 35% for the 2x treatment and 25% for the conventional treatment (Kunisaki, 1980).

The treatment that included a 30 min soak of LD at the recommended rate resulted in the greatest number of contaminant free and viable buds after 7 weeks. Although the 4 hr/LD 2x looked very promising after 5 days (85% clean), only 35% of this group survived. Phytotoxicity apparently resulted in death to the others.

Table 3. The effects of different LD soaking period at 2 times the recommended concentration on contamination levels 5 days following LD treatment

Treatment	Percent not contaminated
30 min soak	80
60 min soak	65
120 min soak	70
240 min soak	85

Table 4. Explant viability 7 weeks after placement in growth medium

Treatment	Viability of original clean cultures (%)	Total uncontaminated and viable (%)
LD 1/2x (30 min)	50	10
LD rec. (30 min)	100	60
LD 2x rec. (30 min)	63	50
LD 2x rec. (60 min)	62	40
LD 2x rec. (120 min)	57	40
LD 2x rec. (240 min)	35	30
Conventional tech.	25	10

Summary

Air drying the plant stem for 4 days prior to excising buds for disinfectant treatments resulted in a reduction in contamination. Additionally, treatment of axillary buds with LD at the recommended rate and a soaking period of 30 mins resulted in the least amount of contamination and highest viability. This procedure did not require the use of a dissecting microscope for the matured 'Ozaki' plants.

Michael J. Tanabe
Associate Professor of Plant Science
Norman Fang, Student

NUTRIENT DEFICIENCY IN ANTHURIUM

The purpose of this study was to determine symptoms caused by deficiencies of nitrogen, phosphorus,, potassium, sulfur, magnesium and iron in anthuriums. The study was conducted at the Waiakea Experiment Station in Hilo, Hawaii.

The experiment was carried out in a fiberglass greenhouse with additional saran cloth to provide 80 percent shade. Twenty-eight mature *Anthurium* cv. 'Ozaki' plants were established in perlite medium. The study was installed in a

completely randomized design with four replicates. The control treatment consisted of a modified Hoagland's solution containing all essential elements. The deficiency treatment solutions were identical to the control solution except that they lacked either nitrogen, phosphorus, potassium, sulfur, magnesium, iron, or contained 0, 100, or 200 ppm calcium. The pH of all solutions except calcium treatments was adjusted to 6.5 and 200 ml of treatment solution was applied to each plant twice a week, with 100 ml deionized water supplied once a week between treatments. Calcium treatments were adjusted to pH 6.0 and applied three times a week. Plants were observed for nutrient deficiency symptoms. Calcium content of leaf laminae associated with a 75 percent mature flower was determined spectrophotometrically for calcium treatments. When symptoms of other treatments became severe all leaf laminae were analyzed with an x-ray fluorescent quantometer. If no severe deficiency symptoms were observed, plants were allowed to grow for four years before all leaf laminae were analyzed. Tissue analyses of leaves with nutrient deficiency symptoms were compared to analyses of leaves from plants in the control treatment to confirm a specific nutrient deficiency as the cause of the symptoms.

Anthuriums are relatively slow growing plants, and nutrient deficiency symptoms did not become evident until several months after initiation of treatments. Control plants maintained dark green leaves, increased in size throughout the four years of the study, and regularly produced large flowers.

Early symptoms of nitrogen (N) deficiency included chlorosis of young leaves, followed by stunting and general chlorosis of the entire plant, with only very young leaves remaining green. In advanced stages of N deficiency, older leaves became increasingly necrotic then died, resulting in the eventual death of the plant.

Phosphorus (P) deficiency was first observed as stunting of plants and chlorosis of leaves. With increasing P deficiency, young leaves became small, narrow and dark green, with short petioles, whole older leaves were chlorotic with increasing areas of necrosis along edges of leaves.

Potassium (K) deficiency initally appeared as a yellowing of older leaves, followed by plant stunting. Older leaves then exhibited yellow edges and well-defined interveinal spots that developed into large necrotic areas; young leaves were small, narrow, and dark green.

Magnesium (Mg) deficiency first appeared as stunting of plants and yellowing of older leaves and leaf margins of young leaves. Interveinal chlorosis of older leaves, chlorosis and distortion of new leaves and severe stunting of plants followed. Prolonged Mg deficiency eventually led to death of the main terminals.

Sulfur deficiency was observed as slight stunting and chlorosis of plants. No deficiency symptoms were observed from lack of iron.

Plants with calcium (Ca) deficiency produced flowers that developed water-soaked lesions (initially at the lobe of the spathe) that eventually become necrotic. Leaves developed necrotic spots and increased Ca deficiency led to the eventual dieback of the growing tip of the plant.

For more detailed results, see Nutrient Deficiency in Anthuriums, HITAHR Research Extension Series 047.

Joanne S. Imamura, Research Associate
Tadashi Higaki, Horticulturist

EFFECTS OF METHOD OF APPLYING FERTILIZER ON ANTHURIUM

This is a final report on a study conducted at the Waiakea Agriculture Experiment Station in Hilo, Hawaii. A progress report was published earlier in 1984 (*2*) and the reader may refer back to that publication for the sections on "background", "object of the study", and "material and methods". Only the results are summarized here based on 4 years of data collected.

The effects of fertilizer application method on flower production are shown in Table I. Flower production was affected by treatment only in the first year. Subsequent years showed no significant difference due to fertilizer application method. Even in the first year, only Peters at 200 lb/A/yr showed significantly lower flower production than the treatment of Osmocote at 300 and 400 lb/A/yr.

The effects of fertilizer application method on anthurium flower size are shown in Table II. Treatments of Osmocote at 300 and 400 lb/A/yr resulted in the production of the largest flowers. Peters at 200 and 100 lb/A/yr resulted in production of the smallest flowers. The approximate length and width of the flowers for each treatment are also given in Table II. It is interesting to note that flowers produced in the first three treatments are considered large by our State Standards on flower size while those produced in subsequent treatments are all considered medium flowers (*1*).

The effect of fertilizer application method on flower stem length is shown in Table II. Again, as for flower size, treatments of Osmocote at 300 and 400 lb/A/yr were best, resulting in longest flower stems, followed by treatments of Osmocote at 200 + Peters at 200 lb/A/yr. Peters at

Table I. Effect of Fertilizer Application Method on Flower Production of *Anthurium* cv. 'Ozaki Red', Year 1

Treatment	Mean (Flowers/Plant/Yr.
Osmocote 300# *	3.8 a **
Osmocote 400#	3.8 a
Osmocote 200# + Peters 200#	3.6 ab
Peters 400#	3.6 ab
Osmocote 100# + Peters 100#	3.5 ab
Peters 300#	3.4 ab
Peters 100#	3.2 ab
Peters 200#	3.0 b

* Fertilizer rates given in pounds $N-P_2O_5-K_2O$/A/year.

** Mean separation by Waller-Duncan K-ratio t test, K=100. Means with the same letter are not significantly different.

100 lb/A/yr resulted in flowers with shortest stems. All of the flower stem lengths given in the table meet the State Standards (*1*) minimum requirement for flower stem length.

In summary, the experiment showed that: In flower production, significant difference due to treatment was only found in the first year. The difference from best to poorest production was only 0.8 flowers/plant/year. In flower size, treatments of Osmocote at 300 and 400 lb/A/yr resulted in largest flowers. In flower stem length, similar results as in flower size were obtained.

Tadashi Higaki, Horticulturist
Joanne S. Imamura, Research Associate

Table II. Effect of Fertilizer Application Method on *Anthurium* cv. 'Ozaki Red' Flowers, Years 1-4

Treatment	Flower Size: Approximate Length x width (inches)	Flower Size: sq. inch	Stem Length (inches)
Osmocote 300# *	6.0 x 4.8	34.0 a **	23.6 a
Osmocote 400#	5.8 x 4.6	32.6 ab	23.3 a
Osmocote 200# + Peters 200#	5.5 x 4.5	30.3 bc	22.6 ab
Osmocote 100# + Peters 100#	5.4 x 4.5	29.8 c	21.3 bc
Peters 300#	5.3 x 4.5	29.3 c	20.9 cd
Peters 400#	5.2 x 4.5	29.1 c	21.0 cd
Peters 200#	4.6 x 4.5	25.9 d	19.6 de
Peters 100#	4.5 x 4.5	25.0 d	18.5 e

* Fertilizer rates given in pounds $N-P_2O_5-K_2O$/A/year.

** Mean separation by Waller-Duncan K-ratio t text, K=100. Means with the same letter are not significantly different.

Literature Cited

1. Division of Marketing and Consumer Service. 1984. Standards for Hawaii-grown flowers and foliage. DOA, State of Hawaii.
2. Higaki, Tadashi and J. S. Imamura. 1984. Effects of method of applying fertlizer of anthurium flower production, a progress report. Hort. Digest. No. 74. HITAHR, University of Hawaii.

ANTHURIUM INTEGRATED PEST MANAGEMENT PROJECT

Introduction

Integrated pest management (IPM) is defined by the Council on Environmental Quality as: "The selection, integration, and implementation of pest control based on predicted economic, ecologic, and sociological consequences." IPM is not synonymous with biological control, pesticide-free, or organic farming but it is a comprehensive approach to the control of pest populations by the timely use of specific or integrated control measures as the situation requires. IPM seeks maximum use of natural controls involving combinations of various cultural, biological, physical and chemical control measures. The key to IPM, however, is the monitoring of: (1) pest populations or damage levels, (2) populations of natural control agents, and (3) environmental conditions that affect the development of pest populations and natural control agents.

IPM projects have been extremely successful with watermelons on Oahu and lettuce on Maui. Anthuriums were selected for an IPM project in order to expand this concept of pest management to other crops in Hawaii. Anthuriums were specifically selected for the following reasons: (1) It is an important (No. six by value) crop in Hawaii, (2) It has five major pests: flower thrips, false spidermite, anthracnose, bacterial blight, and burrowing nematode. Populations of several of these pest appear to have a seasonal variation and may be affected by weather. (3) Pesticide spray applications are mostly on the calendar schedule, and (4) the educational level of anthurium growers is relatively high. Most growers, therefore, appear to be receptive to changes and new ideas.

One of the unique aspects of this IPM project is that the anthurium plant is a perennial and continuously producing a flower crop. There is no dormant or nonproducing season. Therefore, there is no luxury of beginning at a zero pest or damage level on an annual basis as there is with most annual or perennial crops grown in temperate areas. Similarly, pest populations or damage levels cannot be indexed or related to a particular stage in the development of the crop.

This project is being funded by a Smith-Lever Section 3rd (Federal) Pest Management grant and is currently in its second year of a 4 year program. Reported here is a summary of the findings of the first and part of the second year's effort in the project.

Educational Programs

An anthurium IPM educational meeting was held in Hilo in May, 1985 to introduce the concept of IPM; its implementation in anthurium production and the causes of anthurium flower rejection. Two slide-tapes ("Causes of Anthurium Flower Injury" and "What is IPM") were produced to educate small groups of people. It was used at the 1985 Hilo County Fair and has been used by growers to educate their employees. A progress report on the Anthurium IPM Project was prepared and distributed to anthurium growers on the Big Island. Two articles, "Burrowing Nematodes and the Anthurium Decline" and "Thrips on Anthuriums", were printed in the Hawaii Anthurium Industry Association Bulletin in 1985.

Table 1. Cause and Distribution of Rejection for 'Ozaki' Flowers, June 1984–May 1985

Rejection	Mean Percentage of Flowers Rejected		
	Farm No. 1 (Hilo)	Farm No. 2 (Pahoa)	Farm No. 3 (Kurtistown)
Anthracnose	1.0 bc	10.5 ab	0.0 d
Bleach	0.0 c	0.0 c	0.7 cd
Mites	0.0 c	0.0 c	0.2 d
Thrips	1.1 bc	1.1 c	1.9 c
Phytotoxicity	2.4 b	0.7 c	0.4 cd
Sunburn	2.2 b	1.2 c	0.7 cd
Mechanical	14.0 a	14.9 a	15.3 a
Crooked Stem	10.7 a	6.7 b	5.5 b
Chimera	0.9 bc	0.9 c	0.8 cd
Deformed	2.3 b	0.8 c	0.6 cd
Others	1.8 b	0.1 c	0.0 d
% Total Rejected	36.5	36.9	26.1

*** Means in the same column followed by the same letter are not significantly different by the Duncan's Multiple Range Test (P=0.05)**

Anthurium Industry Baseline Data

Baseline data were gathered to determine the current status of the industry in order to evaluate the impact of this IPM project. A comprehensive survey of anthurium cultural practices including pest control methods and pesticide usage was made at the start of the project. These data will be compared to results of a similar survey at the completion of the project to document changes in pest control practices of growers.

A major part of our first year's effort was to determine the causes of rejection at the farm. Three anthurium farms at Panaewa, Pahoa, and Kuristown were selected as cooperators to gather data on causes of flower rejection or damage, and to initiate certain IPM procedures. Electronic weather monitoring devices were installed at each farm within the shadehouses to record temperature, rainfall, solar radiation and leaf-wetness data.

All 3/4 to fully matured anthurium flowers were harvested every 2 weeks from the sample plots. Data were taken on the causes of flower rejection. About 5,000 flowers of the 'Ozaki' cultivar were observed at each of the three farms during the 1 year period. In addition, four other cultivars ('Nitta', 'Oishi Orange', 'Marian Seefurth', and 'Kozohara') were monitored during the same period.

The total flowers rejected were 36.5%, 36.9%, and 26.1% at farms 1, 2, and 3, respectively. In general, insects, mites, and diseases caused very little rejection compared to noninfectious causes (Table 1). Flower rejection increased during June through November and decreased during December through May. These data suggest that insect and disease levels increase as temperature increases. Crooked stems occured more frequently during fall and winter than any other season.

At the start of our second year, 1/8 acre IPM and grower plots were established at each of the three cooperating farms. The plots are presently being monitored for pests once every 2 weeks and control measures implemented only as required for the IPM plots while the grower plots are sprayed on a calendar basis. During the first 6 months, the three growers applied pesticides (insecticides, miticides, and fungicides) a total of 26 times, whereas only seven sprays were required to maintain the same level of pest control in the IPM plots.

These preliminary results indicate that the IPM program can decrease the use of pesticides, thus decreasing the cost of production and ultimately increasing profits and making anthurium production safer for growers and the environment.

Wayne Nishijima, Brian Bushe,
Arnold Hara, and Dwight Sato

FLORAL DISEASES OF ANTHURIUM

During the past 5 years, the threat of complete devastation by bacterial blight has overshadowed all other concerns within the anthurium industry, and growers have been made aware of minimum procedures to cope with this serious problem. However, there are other disease problems of anthurium which should not be neglected.

Certain diseases, such as plant decline caused by burrowing nematode, and anthurium anthracnose, have caused heavy losses, while other diseases have been of minor economic consequence. Anthurium floral diseases are usually inconsequential in biological significance to the plant, but represent direct economic loss, since the affected flowers are unmarketable.

Among the floral diseases of anthurium, anthracnose has been known in Hawaii for nearly 30 years, but continues to be troublesome since the major cultivars ('Kozohara', 'Kaumana', 'Nitta' and 'Ozaki') have varying degrees of susceptibility. The disease is restricted to the tepals, which are the scale-like elements representing floral petals and sepals. The first symptoms of anthracnose are tiny (less than 0.5 mm diameter), circular, dark brown to black lesions. These lesions will remain tiny and circular on resistant cultivars but will expand to assume the entire tepal surface on susceptible cultivars. The fungus, and thereby the disease, will not progress from an infected tepal to the adjacent healthy tepal. The disease characteristic of sharply angular, triangular or pentagonal lesions, represent the 2 surface shapes of tepals. When the disease occurs on a spadix of a susceptible cultivar at harvest maturity, the youngest florets are generally unaffected.

Colletotrichum gloeosporioides is the pathogen which causes anthurium anthracnose. It is a fungus, common in the tropics, causing diseases of many crops, usually labelled anthracnose. Some of these in Hawaii are papaya anthracnose, mango anthracnose, banana anthracnose, and tomato anthracnose. An interesting oddity is that anthurium anthracnose has been recorded only in Hawaii, whereas the same fungal species has been reported from abroad to be a serious anthurium foliar pathogen but of no apparent consequence to flowers. As with other fungal diseases, presence of moisture is the environmental disease determinant. If moisture is continuously available, the disease is serious at temperature above 75° F but is slowed down considerably below 68° F.

The anthurium improvement program at the University of Hawaii has breeding for resistance to anthracnose as one of its objectives. Cultivars released from the program such as 'Marian Seefurth', 'Chameleon', 'Anuenue', 'Mauna Kea', 'Manoa Mist', 'Paradise Pink', and 'Diamond Jubilee', are resistant. 'Calypso' and 'Trinidad' were released as susceptible, but continued field observations at Waiakea showed that these 2 cultivars are moderately resistant, which was confirmed in subsequent laboratory testing. The program is continuing, and since the resistance characteristic appears to be very stable, the possibility that anthracnose will be reduced to an inconsequential problem is excellent.

Meanwhile, susceptible cultivars continue to be extensively grown, but requiring control measures. Benomyl, was the standby for many years, but its effectiveness has declined due to development of benomyl-resistant fungal strains. Alternatives are being sought but growers can

rely on mancozeb (Manzate 200 or Dithane M45) for anthracnose control.

Two *Phytophthora* spp. (*P. nicotianae* and *P. capsici*) have been shown to cause spathe blight, ovarial rot, as well as tepal spots. These occur infrequently, but are difficult to nearly impossible to distinguish from anthracnose, particularly when they occur on anthracnose-susceptible cultivars. *Phytophthora nicotianae* also occurs on pig-tail anthurium, and spathiphyllum, causing foliar blights.

Secondary symptoms and signs of anthurium bacterial blight, occasionally show up on flowers. Bleaching of spathes and flower abscission can occur in systemically infected plants. Vascular browning of floral petioles has been traced into the cylinder of the spadix, causing rots in rows of florets. Direct infection of tepals appear as tiny, brown, angular spots, similar in appearance to anthracnose or infections caused by *Phytophthora*. Fine, delicate, white strands, which are extrusions of enormous numbers of bacteria through stomates, can be seen on infected-tepal surface. The importance of the floral stage of anthurium bacterial blight is minimal, but in a control program requiring strict sanitation and eradication, any manifestation is useful for the recognition of residal pockets of the disease.

M. Aragaki, Plant Pathologist

COMING EVENTS

HORTICULTURAL SHOW

The Second Annual Hawaii State Horticultural show is scheduled for August 21–23, 1986 at the Edith Kanakaole Tennis Stadium in Hilo, Hawaii. The event sponsored by the HAWAII ANTHURIUM INDUSTRY ASSOCIATION, COOPERATIVE EXTENSION SERVICE, and the COUNTY OF HAWAII, will feature displays and plant sales of orchids, dendrobiums, palms, heliconias and other horticultural products.

Highlighting the show will be the HAWAII ANTHURIUM INDUSTRY ASSOCIATION'S annual Anthurium flower/plant competition. Award winning flowering plants will be displayed after judging.

SHOWTIMES are: Thursday, August 21: 2:00 p.m. to 9:00 p.m., Friday, August 22 and Saturday, August 23: 9:00 a.m. to 9:00 p.m.

INQUIRIES: Please direct any inquiries regarding the show to P. O. Box 4579, Hilo, HI 96720.

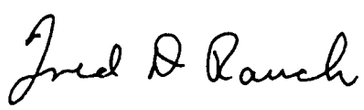
HAN ANNUAL CONFERENCE

The Hawaii Association of Nurserymen Annual Conference and Trade Show will be held at the Ala Moana Americana Hotel November 4–6, 1986.

FERTILIZER AND ORNAMENTALS SHORT COURSE

The Fifth Annual Fertilizer and Ornamentals Short Course has been scheduled for the Ala Moana Americana Hotel on March 26–27, 1987 with a field tour on Saturday, March 28. Added to this year's program will be sessions on vegetable crop production.

NOTE: The use of trade names is for the convenience of readers only and does not constitute an endorsement of these products by the University of Hawaii, the College of Tropical Agriculture and Human Resources, the Hawaii Cooperative Extension Service, and their employees.



Fred D. Rauch
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