Genetic Transformation of Pineapple for Nematode Resistance

Nematode damage is a serious pest problem in pineapple. A project is in progress for the development of transgenic pineapple plants for nematode resistance in collaboration with the Hawaii pineapple industry, University of Hawaii, USDA/ARS and Leeds University, UK.

Over 400 pineapple plants produced from protocorm-like bodies (plb) were bombarded with a nematode resistance gene, cystatin. This gene codes for cystatin protein, an inhibitor of nematode proteinases (HARC 1999 Annual Report, pp. 17-18). Molecular analyses of DNA, Southern blotting and PCR, indicated that five lines tested positive for the presence of the inserted DNA constructs.

In order to analyze these plants for the presence of cystatin, protein was extracted from leaves of transgenic pineapple plants and tested against antibody for cystatin by Western blot. In all five lines, expression of cystatin protein was detected; however, compared to potato transformants resistant to root-knot nematode, the level of cystatin production was low. These plants are being multiplied in culture and will be bioassayed at the University of Hawaii. The plants will be transferred to soil and inoculated with nematodes to evaluate their resistance to nematode infection.
L. Xiong, C. Nagai, G. Uruu (University of Hawaii)

Dr. Chifumi Nagai inspects first coffee progeny produced in the coffee breeding program

Coffee

Coffee Breeding and Selection

Characteristics, such as enhanced flavor, increased yield and disease resistance, were initiated with the support of the Hawaii Coffee Growers' Association in 1997 (HARC 1997 Annual Report, p.13). This program focuses on developing high-yielding cultivars with superior bean and cupping quality that are adapted to specific growing conditions in Hawaii. Disease resistance and mechanical harvestability have also been established as important criteria for breeding and selection. Breeding for disease resistance is considered important but is not a top priority, since coffee leaf rust *(Hemileia vastatrix)* and coffee berry disease *(Colletotrichum kahawae)* do not currently exist in Hawaii. However, even with vigilant quarantine measures, the eventual arrival of serious new diseases and pests in Hawaii's coffee fields is inevitable.

During the last four years, individual, potentially elite trees were selected from five coffee-growing areas in Hawaii and were planted as seed and cuttings at Kunia for use in a breeding program (HARC 1997 Annual Report, p.21-22). Additional germplasm was added from Central and South America. A total of 165 individual crosses were made from among the selected coffee cultivars (HARC 1999 Annual Report, p.19). The 1500 progeny resulting from these crosses were planted in June 2000. Mokka hybrids, which are grown commercially only in Hawaii, were parents of many of these progeny. Our goal for this group of crosses is to produce larger bean mokka derivatives and to increase yield without changing mokka's superior cupping quality. Progeny will be evaluated for morphological characteristics and cupping quality. C. Nagai, R. V. Osgood, W. Sun, R. Meinzer, S. Bittenbender (University of Hawaii)

Genetic Transformation of Coffee for Nematode Resistance Using Cysteine and Serine Proteinase Inhibitors

Coffee is a major crop in Hawaii and, as in other countries, is susceptible to various species of parasitic nematodes. The main nematode problem in Hawaii is a new species of root-knot nematode, *Meloidogyne konaensis* found in the Kona area of

Hawaii. Nematode-resistant coffee species exist but they do not have the high cupping quality of *Coffea arabica* cultivars. In addition, coffee growers are trying to graft the high quality *Coffea arabica* trees onto more resistant rootstocks, although this only provides partial resistance to *M. konaensis*. Owing to the lack of other successful alternatives, long-term resistance must be developed. Development of transgenic coffee containing a nematode resistant gene from rice could provide a higher level of control against this pathogen.

The gene we plan to use to transform coffee is cystatin, a cysteine proteinase inhibitor. When the gene is expressed in coffee it will result in cystatin production. This protein inhibits further growth and development of nematodes. A protocol was developed for *Agrobacterium*-mediated transformation of coffee. *Agrobacterium* cells that carry the cystatin gene can invade plant cells and thus transport the gene into the coffee plant. In our initial trials, we will use leaf disks rather than entire coffee plants. In addition, primary calli were induced from leaves of *Coffea arabica* cv. typica in tissue culture. Following a 6-8 month period, somatic embryos began to form. Over 12,000 leaf discs have been cultured to obtain somatic embryos for transformation.

A selection protocol was established through the development of a geneticin sulfate (G418) kill curve. Plants carrying the NPTII selection marker gene are resistant to kanamycin and G418. When transformed cells/tissues are placed on media containing appropriate amounts of these antibiotics, only those with successful integration of the NPTII gene will survive. Results from the kill curve suggest a level of 30-mg/L G418 added to the growth media is efficient for selection of transformed cells in coffee.

The cystatin construct, Oc-I D86, driven by a tubulin promoter, and the dual construct Oc-I D86/GO/CpTI, driven by the CaMV35S promoter, were obtained from Dr. Howard Atkinson, Leeds University. These DNA constructs were transferred to *Agrobacterium* EHA105. Transformation of *C. arabica* leaf discs and somatic embryos using these nematode-resistant gene constructs are underway.

R. Myers (University of Hawaii graduate student), C. Nagai, B. Sipes (University of Hawaii), D. Schmitt (University of Hawaii)

AFLP Analysis of Genetic Diversity Within and Among *Coffea arabica* Cultivars

Genetic diversity of *Coffea arabica* cultivars was estimated using amplified fragment length polymorphism (AFLP) markers. The natural variation within arabica cultivars sets the limits of improvement that could be achieved through traditional or marker-assisted breeding. Sixty-one *Coffea* accessions composed of six arabica cultivars, including typica, bourbon, catimor, catuai, caturra, and mokka hybrid, plus two diploid *Coffea* species were analyzed with six EcoR I – Mse I primer combinations. A total of 274 informative AFLP markers was generated and scored as binary data. These data were analyzed using cluster methods in the software package NTSYSpc®. The differences among cultivars at the DNA level were small, with an average genetic similarity of 0.933 (93.3% of the markers generated were common to both cultivars). Most accessions within a cultivar formed a cluster, although deviant samples occurred in five of the six cultivars examined due to residual heterozygosity from ancestral materials. Among the six cultivars fingerprinted, the highest level of genetic diversity was found within the cultivar Catimor, with an average genetic similarity of 0.880. The lowest level was found within caturra accessions, with an average genetic similarity of 0.993. The genetic similarities of bourbon, catuai, mokka hybrid and typica were 0.933, 0.942, 0.944 and 0.966, respectively. We also compared the diversity between *C. arabica* and two other *Coffea* species, *C. canephora* and *C. liberica* with average genetic similarities of 0.540 and 0.413, respectively, indicating that of these two species, *C. canephora* is more closely related to *C. arabica* than it is to *C. liberica*. The genetic variation between arabica cultivars was similar to the variation within cultivars, and no cultivar-specific DNA marker was detected. Although arabica cultivars appear to have a narrow genetic base, our results show that sufficient polymorphism can be found between some arabica cultivars with genetic similarity as low as 0.767 for genetic/QTL mapping and breeding. This means that there is enough diversity between coffee cultivars for a useful breeding program to be carried out. The assessment of genetic diversity among arabica cultivars provided necessary information to estimate the potential for using marker-assisted breeding for coffee improvement.

D. Steiger, C. Nagai, P. Moore (USDA/ARS), C. Morden (University of Hawaii), R. Osgood, R. Ming

Coffee Chemistry

A USDA grant was awarded to study the correlation between coffee flavor and cupping. Specifically, the objectives of the project are to profile the organic acids and sugars in coffee cultivars grown in Hawaii. In tandem with this effort, Dr. Cathy Cavaletto at the University of Hawaii will be undertaking a cupping study and will rate each cultivar based upon its taste profile. The results from chemical analyses will then be compared with the cupping results. The objective is to use information from chemical analyses of green coffee beans to predict the quality of the final brewed product. If a chemical profile can predict quality, coffee breeders can use this technology to drive breeding programs that are directed at increasing cup quality. Thus far, coffee cherry samples have been harvested from Oahu, Hawaii, Maui and Kauai. They have been processed and are now undergoing cupping evaluation at the University of Hawaii. Methods are being developed to simultaneously determine sugar and organic acid profiles from a single extract. The work is in progress and will be completed in 2002. *M. Jackson, S. Steiman (University of Hawaii)*

GLP Study for Magnitude of Residue Samples for a Fungicide in Coffee

Hawaii's coffee is valued at $21.4 million and is produced on 7,900 acres. We conducted field trials under the Environmental Protection Agency "Good Laboratory Practice Standards" to register a new fungicide for coffee. Field trials were conducted on the islands of Kauai and Maui where five foliar applications per trial were made, and two samples were collected at 7 and 14 days after the last fungicide application. The samples were pulped the same day and wet-processed. After fermenting for 15 hours, the beans were rinsed and allowed to air-dry to about 12% moisture before dry-milling to remove the parchment. The green bean coffee samples were shipped to the sponsor for residue analysis. Analytical laboratory and quality assurance services are available at HARC. *L. Santo*

Forestry

Forestry Research for 2000

Forestry research is field-based with the objective of increasing wood productivity, quality and enhancing sustainability of forestry operations. Our efforts ranged from holding training workshops with Hawaii Forest Industry Association members to installing provenance (seed source) tests on clients' land. The focus of the testing is on Hawaii's endemic timber species, *Acacia koa*, and other high value hard woods including *Dalbergia* species, *Senna siamea* and *Tectona grandis*. A eucalyptus improvement program, including species, provenance and clonal trials, is partially supported by the forest industry companies.

The provenance tests are designed to identify which species, provenances (seed sources from specific geographic locations), families (seed from a single mother tree) or clones are best adapted to specific growing environments. Growth measurements were continued for previously installed provenance and clonal trials across a range of diverse sites on Hawaii.

Nick Dudley, the HARC forester locates an elite koa tree on Maui. Seed collected from this tree and hundreds of others were placed in trials for evaluation.

Potted taro plants

Sugarcane Research

Breeding and Selection

Sugarcane crossing began on November 22, 1999, and was completed in six weeks. We used 2004 flowering stalks from 369 parents to make 222 polycrosses. In 2000, we evaluated 294 clones in FT7 yield tests with 12.5% (37 clones) yielding more sugar per acre compared to the standard cultivars.

H78-7750 was identified as the standard potential commercial cultivar for a shorter cropping cycle. Six FT7 tests of short-cropped H78-7750 were hand harvested. The estimated yield per acre was 79.4 tons of cane, 9.5 tons of sugar and 31.9 tons of dry matter. When harvested by a billet harvester from a nearby unburned commercial field, H78-7750 produced 68.1 tons of cane, 6.4 tons of sugar and 27.2 tons of dry matter per acre.

During the past two years (1999 and 2000), we have tested 201 Hawaii clones and 108 foreign clones for potential short cropping cycle cane for Hawaii. Using the sugar yield percent cane (YD/C) of H78-7750 as the standard selection criteria, we have identified five Hawaii clones (83-6179, 86-6180, 87-4319, 87-4442 and 95-4318) and 13 foreign clones (CP70-1133, CP86-1791, LF172, LF80-1205, LF80-2690, LF80-3443, LF80-5304, Q123, Q127, Q131, Q135, ROC1 and SP79-1169) as superior. They were propagated for further evaluation.

This year, we transplanted 30,848 bunch seedlings (about five seedlings per bunch) to the field for our regular FT1 selection. By the end of 2000, we selected 1062 clones from FT4 that were planted in FT5A tests. We selected 814 clones having better than average yield for inclusion in advanced yield testing.

In 2000, we harvested 22 FT7 yield trials and evaluated 294 new clones of which about 12.5% (37 clones) yielded more sugar than the commercial standard. During the year, we installed 8 FT7 tests on Kauai and 12 on Maui.

The top four cultivars based on acres planted at the end of 2000 were H78-7750, H78-4153, H77-4643 and H78-3567. H78-7750 was planted on 13,758 acres or 32% of the total cane area. Acreage of H78-4153 continued to decline occupying about 30% of the total cane area.

New clones with commercial potential are: H91-4392, H92-5867 and H93-6002 for the Makaweli soil on Kauai; H79-6503 and H90-7435 for the rocky, dry areas on Maui; H82-3569 and H83-4501 for the sandy areas on Maui; H82-3569, H85-4501, H85-1605, H86-3792, H87-4394 and H88-6401 for windward Maui. H87-5794 had the best FT7 records in the leeward region and H87-4319 performed well in mill water fields.

Leaf being inoculated with Phytophthora

Potted taro plants

Induction of Systemic Acquired Resistance in Taro Against Taro Leaf Blight

Taro leaf blight, which has devastated taro production in a number of Pacific islands, is a disease caused by the fungus, *Phytophthora colocasiae*. This pathogen is similar to *P. palmivora* that attacks papaya and it was thought that a similar approach to its control might be effective. The chemical benzol (1,2,3) thiadiazole-7-carbothioic acid S-methyl ester (BTH) has been shown to induce SAR to a broad spectrum of diseases in a number of crops in addition to papaya. This line of research was expanded to taro (*Colocasia esculenta*) cultivars.

In a series of greenhouse tests on Oahu, three-month-old potted taro plants derived from tissue culture were treated with suspensions of BTH (50% active ingredient, wettable powder) at concentrations of 0.5, 2.5 and 5.0 µM ai. The uppermost, fully expanded leaf in each potted plant was sprayed with one of the concentrations (or water as a control) until the leaf was wet. Seven days after the inducer treatment, five 4-mm diam. plugs from an agar culture of *P. colocasiae* were placed on the upper leaf surface of each leaf of the potted plants. Three days later the diameter of the lesion emanating from the agar plug was measured. Effectiveness of treatment was measured by a reduction in the diameter of the lesions as compared to those of the water-treated controls.

Experiments have shown that BTH treatment can reduce the size of the lesion caused by *P. colocasiae*-infected plugs. We are expanding this work to test the effectiveness of BTH in taro field plots. Other chemical inducers, length of effect, optimal BTH concentrations and yield will be evaluated in this field test.
J. Carr (USDA/ARS), J. Zhu, R. Osgood, P. Moore (USDA/ARS)

Micropropagation of Taro Cultivars

Micropropagation speeds up the process of initial propagation for commercial planting and large scale field experiments. We have developed an efficient taro micropropagation protocol using stationary liquid culture (HSPA 1994 Annual Report, pp.47-48). Field evaluation of micropropagules of two cultivars, 'Bun-Long' and 'Lehua Maoli', showed that there were no yield or morphological differences from conventional side-shoot ("huli") propagation.

Thirteen taro cultivars were multiplied using this protocol. Side shoots of taro plants were sent from Maui (Dr. John Cho, UH Kula Station) for initiation of culture. With surface sterilization, 36% of explants were placed in culture and an average of 31% of these explants produced propagules. It took from nine to twenty months to produce 5,000 propagules from four to five explants. Eighty percent of the genotypes in this study were multiplied successfully by this method, although the efficiency of multiplication varied. It was found that with sufficient starting material it was possible to overcome this variation. *C. Nagai and J. Buenafe*

Leaf being inoculated with Phytophthora

Growing Ginger with Cover Crops to Control Nematodes

Ginger is an important crop for small farmers in Hawaii and has a ready local market. However, ginger has a number of serious pest problems that have resulted in the use of pesticides. Both the reniform nematode, *Rotylenchulus reniformis*, and the root-knot nematode, *Meloidogyne* spp., will damage ginger roots. A site was chosen for the test that was infested with both nematodes in significant numbers. Rotational cover crops of two species of *Crotalaria* were used in the trial for nematode control in the absence of pesticides. *Crotalaria juncea* and *C. spectabilis* are leguminous plants that have been shown to reduce soil nematode populations.

The project was installed on Oahu in a 0.13-acre field divided into six plots. There were two replicate plots of each of the *Crotalaria* species and two plots left fallow. The *Crotalaria* was seeded and allowed to grow for about three months after which it was plowed into the soil. Ginger was then planted in all the plots and grew for four months until it was harvested, observed for health and any nematode damage and weighed. During the project several nematode counts were taken in each of the plots.

At the start of the trial the average counts in the field were 127 reniform nematodes per 50-cc soil and 4 root-knot nematodes per 50-cc soil. At ginger harvest, the reniform counts averaged 86 per 50 cc in the *C. juncea* plots, 107 per 50 cc in the *C. spectabilis* plots and 220 per 50 cc in the fallow plots. These counts were not statistically different. The root-knot nematode counts averaged 9 to 10 per 50 cc in all treatment plots. It thus appeared that the *Crotalaria* cover crops had no effect on nematode numbers, although none of the ginger plants showed any evidence of root damage despite the high reniform nematode counts. There was, however, a difference in the total weight of ginger harvested between treatments. Average total weight of ginger root harvested per plot was 14.3 lb in the *C. juncea* plots, 16.1 lb in the *C. spectabilis* plots and 11.5 lb in the fallow plots. The weight differences were thought to be due to nitrogen supplied to the soil by the leguminous cover crops. Under the conditions of the experiment, it was possible to grow ginger root in nematode-infested soil without the use of pesticides or chemical fertilizers.
S. Schenck

Services

Crop Services at the HARC Kunia Substation

Several crops were grown at the Kunia Substation for winter nursery, seed production, growout and research. Most temperate, subtropical and tropical crops can be grown year round at Kunia with its mild average temperature and only 9°F difference in high temperature between January and July, and daily diurnal temperature difference of 10 to 15°F. The average annual solar radiation intensity is 250 watts per square meter and the sunlight in December is 60% of that in July. The longest and shortest day lengths are 13.5 and 11 hours. Supplemental lighting was provided to grow long day length crops during the winter periods. The annual long-term rainfall total is 27 inches with most occurring during November through February. All fields are drip-irrigated.

Wheat maturing in a winter grow out

During 2000, we grew barley, coffee, corn, cuphea, eggplant, papaya, sweet and hot peppers, potato, rice, stevia, sugarcane, sunflower, watermelon and wheat. Winter growth and yield for most of the crops were excellent. Four acres of rice were grown successfully under drip irrigation. About 25 acres of potato for seed indexing was planted in 2000, with the acreage anticipated to more than double in 2001. Wheat seed production was excellent compared to previous crops. Reducing the cost of controlling birds continues to be a challenge for the cereal crops. Routine surveys are performed by a team of specialists to identify problems early and to recommend solutions. Protocols were drafted and initiated to improve all aspects of seed production from planting to harvest, and shipping and handling. *L. Santo*

Laboratory Services

U.S. EPA Pesticide Registration

Our contract laboratory provides analytical chemistry services to Hawaii's agricultural community, industries and government agencies. We analyze for natural and synthetic compounds in plants, soil, water and air using gas chromatography and high-performance liquid chromatography instrumentation. Our analytical residue determinations range from quick screens for general information to well-documented detailed studies for research and U.S. Environmental Protection Agency pesticide registration projects. A pesticide registration project for the control of leafhoppers on papaya was in progress this year. *J. Pitz*

Import Tolerances for Pesticide Levels in Food Crops and in Processed Commodities

The residues of pesticides on crops grown in the U.S. are carefully regulated. This acceptable level of residue is called the tolerance. HARC's analytical laboratory provides contract services for residue analyses of compounds on crops and processed products to determine whether the residues, if any, are below the tolerance levels. This ongoing service has provided experience with pesticides used in the U.S. and in other countries. *J. Pitz*

Entomological Consulting for HARC Substations

Inspections were conducted for HARC substations at Kunia and Maunawili for arthropod pests on a weekly basis during the growing season. Observations and recommendations for pest control were made to the substations following each inspection. Crops inspected and provided with pest control strategies included papaya, coffee, rice, wheat, potato, taro, 'awa, stevia and watermelon. In papaya, several species of mites and leafhoppers were identified and controlled. In coffee, the main effort was focused on controlling green scales using oil-based products. For seed production of rice and wheat, rice root aphid, lesser cornstalk borer and others were monitored and controlled. Potato seed indexing fields were kept free of damage from various pest species including broad mite, thrips, whitefly and leafhopper. Taro, 'awa and stevia growing in greenhouses attracted many species of insects and mites that were relatively new to us. Different control methods were tried as the problems appeared. A combination of trap cropping and protein bait sprays were applied in the watermelon cultivar test. *H. Chen and A. Ota*

Pathology Services: Dr. Susan Schenck (left) advises client about Watermelon disease

Pathology Consulting

The Hawaii Agriculture Research Center's Pathology Department offers consulting services to the Hawaii agriculture industry. Local farmers have requested disease diagnoses and disease and nematode control recommendations for a number of crops including tomatoes, watermelon, turfgrass, cucumber, asparagus, coffee and others. The pathology laboratory has the capability for isolation and identification of parasitic nematodes and for isolation, culturing and/or identification of pathogenic fungi, bacteria and viruses. In addition, several growers have received assistance in clarifying and complying with State and federal regulations for exporting agricultural commodities to foreign countries. *S. Schenck*

Quality Assurance Unit

HARC participates in the process of registering pesticides under the Environmental Protection Agency's Federal Insecticide Fungicide, and Rodenticide Act. One of the requirements is the establishment of an independent Quality Assurance Unit (QAU) to inspect and audit such studies. HARC has historically contributed to magnitude of residue and processing studies and continued its involvement in these areas. In 2000, HARC's QAU inspected and/or audited studies on papaya and sugarcane. The inspections involved the laboratory-phase analysis for residues. The reports generated from this phase of the studies were audited to check for accuracy and compliance with Good Laboratory Practice (GLP) standards.

The Master Schedule, which is mandated by the EPA for test sites conducting pesticide residue studies, was updated monthly. Staff members who work on GLP studies were issued memos to keep them aware of new developments and the EPA's current areas of emphasis. One of our sponsors conducted an inspection of the facilities. *B. Vance*

Computer System Administration

The local area network (LAN) at the Experiment Station is tightly integrated with the USDA/ARS. Technical support is provided to USDA/ARS users. Ten new PCs were added to the inventory. Ten new users to the LAN were provided with access to HARC's LAN and in some cases e-mail accounts; they were given an introduction to networking, network printing, and e-mail use. The memory in the file server was doubled. The Y2K compliance measures taken the previous year were further tested after the year 2000 had arrived. Macintosh computers were taken off the LAN and the affected users provided with PCs. Users were offered workshops to facilitate the migration from Microsoft's Office suite to Sun Microsystem's StarOffice suite. Documentation of frequently asked questions for each of the StarOffice modules was compiled. Standard Operating Procedures were written to document the restarting of the file server, the e-mail gateway PC and the telephone exchange. *B. Vance*

Miscellaneous

B. Vance was reappointed as a member of the Pesticide Advisory Committee, where he represents the sugarcane industry's perspective. Worker Protection Standard (WPS) training was given to HARC Experiment Station and Oahu substation staff. Authorization was obtained to conduct WPS training for workers and handlers. Excess chemical inventory was collected from various laboratories at the Experiment Station and properly disposed of. The laboratory hoods underwent their annual Inspection and calibration. Throughout the year, individuals (11) were given a safety orientation shortly after becoming employed. This orientation was converted into a StarOffice Impress presentation to provide uniformity and completeness. An annual safety meeting was held for all HARC and USDA/ARS staff. An adult CPR/standard First Aid course was held onsite for HARC and tenant first-aid providers. Inspections were conducted of day-to-day operations in the building to increase the awareness of safety. *B. Vance*

Environment and Quality Assurance

Complying with the myriad of environmental laws and regulations that affect agriculture can seem overwhelming. Assisting our members and clients in this task is one of our most important goals. HARC maintains working knowledge of the latest federal and State laws and rules in order to help the industry apply the law to everyday workplace situations. We continue to provide training on environmental regulations for members and others who need to know and understand this specialized information.

We also work closely with the State legislature and regulatory agencies and other stakeholders to help develop sound environmental policies and to revise laws and regulations appropriately. In this year's legislature, for example, many areas of environmental law were proposed for revision. HARC participated in the lawmaking process for issues of concern to agriculture, including the right to farm, water pollution, coastal zone management, wastewater reuse, oil taxes, endangered species and illegal "dumping" of hazardous wastes.

HARC also worked closely this year with the State Department of Health (DOH) to develop methods to better inform and educate the regulated community about the rules they must comply with. We started with the basic premise that people are much more likely to comply with regulations if they know that the rules exist and they understand what it is they are supposed to do. The new DOH Compliance Assistance Center has an energetic coordinator and the mission to act as a liaison between the regulated community and the various branches of the Division of Environmental Health. We hope that better understanding of the challenges facing agriculture and other stakeholders will result in better solutions.

Probably the most important environmental area of concern to agriculture this year was "nonpoint source pollution" - pollution that cannot be traced to a specific point such as a pipe discharging industrial wastes. Erosion control programs and the proper management of nutrients and pesticides can minimize the impact to surface, ocean and groundwater. New technologies such as global positioning systems to target fertilizer applications and precision application equipment are being examined to provide strategies that will help the farmer protect the environment. The watershed approach recently embraced by EPA to manage non-point sources of pollution was used by the Hawaiian people for many centuries. It is currently being revitalized as communities come together to manage their own watersheds. HARC continues to work with the State Department of Health on policies related to this issue, including the revision of the water quality standards, to ensure protection of the environment through reasonable, effective and achievable regulations. *J. Ashman*

Personnel

Administration and Support Staff

Stephanie Whalen	President and Director
Robert Osgood	Vice President and Assistant Director
Ruth Yamato	Secretary-Treasurer
Sandra Kunimoto	Director of Marketing and Business Development
Janet Ashman	Environmental Specialist
Tracy Bacnis	Secretary
Florida Chow	Human Resources
Becky Clark	Computer Operations Clerk
Elon Clark	Building and Grounds Superintendent
Ladislao Gonzalez	Watchman, Maintenance
Ann Marsteller	Librarian
Charlene Onishi	Accounts Payable
Cynthia Pinick	Executive Secretary
Blake Vance	Quality Assurance and LAN Administrator
Carolyn Whippo	Disbursing Agent

Staff

Henrik Albert	Molecular Biologist, USDA, ARS
Jim Carr	Biological Laboratory Technician, USDA, ARS
Hong Chen	Entomologist
Nick Dudley	Forester
Maureen Fitch	Plant Physiologist, USDA, ARS
Mel Jackson	Chemist
Rick Meinzer	Plant Physiologist
Ray Ming	Plant Breeder, Biotechnologist
Paul Moore	Plant Physiologist, USDA, ARS
Chifumi Nagai	Plant Breeder, Biotechnologist
Jerry Pitz	Chemist
Lance Santo	Agronomist
Susan Schenck	Pathologist
Ben Somera	Sugar Technologist
Weiguo Sun	Agronomist, Kunia Substation Manager
KK Wu	Sugarcane Breeder
Judy Zhu	Biochemist

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Renee Arias de Ares
Mike Clearwater
Cindy Goldstein
Cecilia Kato
Ming-Li Wang
Tim Wenslaff
Hairong Wei
David Winsor
Liwen Xiong

Laboratory Research Assistants and Experimentalists

Leslie Akashi	Special Projects Assistant
Susan Ancheta	Laboratory Technician
Josephine Buenafe	Experimentalist
Marc Crepeau	Research Assistant
Henry Cortes	Experimentalist
Amy Dela Cruz	Laboratory Technician
Peggy Hiraki	Laboratory Technician
Shelley James	Research Trainee
Tim Jones	Research Trainee
Walter Kitagawa	Experimentalist
Terryl Leong	Special Projects Assistant
Melvin Morimoto	Experimentalist
Asher Ota	Special Projects Assistant
Denise Steiger	Research Assistant
Sasa Tom	Research Assistant
Kia Weaver	Laboratory Assistant
George Yamamoto	Special Projects Assistant
Jody Yamasaki	Assistant
Aileen Yeh	Experimentalist

Kunia and Maunawili Substations

Rudy Dizor	Mechanical Operator
Angel Galvez	Mechanical Operator
Rogelio Fernandez	Experimentalist
Ernest Gamatero	Experimentalist
Richard Kinoshita	Breeding Station Superintendent
Rogelio Pascua	Experimentalist
Roger Styan	Experimentalist, Supervisor

Maui Substation

Artemio Bacay	Field Worker
Teodoro Bonilla	Field Worker
Romeo Cachola	Field Worker
Luis Dela Cruz	Weighing Machine Operator
Wilson Galiza	Foreman
Francisco Habon	Field Worker
Gael Ito	Experimentalist
Pacifico Padilla	Senior Field Worker
Domingo Vallecera	Field Worker

Kauai Substation

Fernando Garcia	Field Worker
Narciso Garcia	Field Worker

Students

Axel Lehrer	Bayreuth University, Germany
Xiaohui Qui	University of Hawaii

Sugar Company Production in 2000

Company	Acres Harvested	Tons Raw Sugar	Tons Sugar Per Acre
Amfac Sugar Kauai	9,402	39,018	4.15
Gay & Robinson, Inc.*	3,527	51,882	14.71
Hawaiian Commercial & Sugar Co.*	17,266	210,300	12.18
Totals all companies	30,195	301,200	

**HARC Members*

Albert. H and D.W. Ow (2000) Cre-lox directed integration of transgenes into the tobacco genome. In 'Plant Molecular Biology Manual'. (Eds S. B. Gelvin and R. A. Schilperoort) pp. N3 1-13. (Kluwer Academic Publishers: Dordrecht).

Day, C.D., E. Lee, J. Kobayashi, L.D. Holappa, H. Albert, and D.W. Ow (2000) Transgene integration into the same chromosome location can produce alleles that express at a predictable level, or alleles that are differentially silenced. Genes Dev 14: 2869-80.

Fitch, M., T. Leong, L. Akashi, S. Ferreira, and P. Moore (2000) Growth and yield of clonally propagated papayas compared to multiple-seedling transplants. In Vitro 36(3, II). 41-A.

Fitch, M., A.T. Lehrer, and P.H. Moore (2000) Production of susceptible sugarcane planting material free of ScYLV by a tissue culture technique. The 6th International Society of Sugarcane Technologists Pathology Workshop, 16-23 July, 2000. Thailand. p. 8.

Lehrer, A.T., F.C. Meinzer, P.H. Moore, and E. Komor. (2000) Movement of ScYLV and impact of its infection on performance and physiology of the sugarcane plant. The 6th International Society of Sugarcane Technologists Pathology Workshop, 16-23 July, 2000. Thailand. p. 6.

Ma, H., H. Albert, R. Paull, and P.H. Moore (2000) Metabolic engineering of invertase activities in different subcellular compartments affects sucrose accumulation in sugarcane cells. Aust. J. Plant Physiol. 27: 1021-1030.

Ming, R., C. Abbey, F. Zee, P. Moore, and A. Paterson (2000) A papaya BAC library as a foundation for molecular dissection of a tree-fruit genome. Plant and Animal Genome VIII. Fruit and Nuts workshop, Jan. 13-17, 2000. San Diego, CA, p. 23.

Nagai,C. (2000) Better Food through Biotech. Agriculture Hawaii July-September p.36

Paterson, A., J. Bowers, M. Burow, X. Draye, C. Elsik, C. Jiang, C. Kastsar, T. Lan, Y. Lin, R. Ming, and R. Wright (2000) Comparative organization and function of plant chromosomes. Plant Cell. 12:1523-1539.

Santo, L.T. and A.H. Teshima. (2000) Milestone herbicide in sugarcane, macadamia nut, pineapple and coffee. Proceedings of the 55th and 56th Annual Conference of the Hawaiian Sugar Technologist on October 21 and 22, 1999. p. 46.

Santo, L.T., S. Schenck, H. Chen, and R. V. Osgood. (2000). Crop profile for sugarcane in Hawaii. USDA OPMP and PIAP website.

Santo, L.T. (2000) Fertilization of eucalyptus for rapid canopy closure on the Hamakua Coast in Pa'auilo. Hawaii Agriculture Research Center Forestry Report 4 and technical supplement.

Santo, L.T. (2000) Evaluation of herbicides for preplant and post broadcast applications in Hawaiian pineapple. Hawaii Agriculture Research Center Tropical Fruit Report 2.

Santo, L.T., M.H. Nakahata, G.P. Ito, and V.P. Schell. (2000) Calcium and liming trials from 1994 to 1998 at HC&S. Hawaii Agriculture Research Center Agronomy Report 83 and technical supplement.

Santo, L.T., E. Pablo, and G.H. Wachi. (2000) The effect of planting method on uprooting of sugarcane in the Makaweli soil series. Hawaii Agriculture Research Center Agronomy Report 84 and technical supplement.

Santo, L.T., E. Pablo, G.H. Wachi and G.L. Pitz (2000) Pendimethalin in the Makaweli soil and its affects on sugarcane cultivar H77-4643. Hawaii Agriculture Research Center Weed Control Report 149.

Schenck, S. (2000) Asparagus production and variety yields. Hawaii Agriculture Research Center Vegetable Report 2.

Schenck, S. and A.T. Lehrer (2000) Factors affecting the transmission and spread of sugarcane yellow leaf virus. Plant Disease 84:1085-1088.

Schenck, S. and A.T. Lehrer (2000) Factors affecting the transmission and spread of sugarcane yellowleaf virus. 6th ISSCT Sugarcane Pathology Workshop. July 16-23, 2000. Thailand.

Wu, K.K., H. Deng, T. Wenslaff, and P.H. Moore (2000) Basic theory of selecting single-dose molecular markers as tools for QTL selection in sugarcane. Sugar Cane International Jan: 13-20. pp 13-20.

Zhu, Y.J., H.H. Albert, and P.H. Moore (2000) Differential expression of soluble acid invertase genes in the shoots of high-sucrose and low-sucrose species of Saccharum and their hybrids. Aust. J. Plant Physiol. 27:193-199.

Zhu, Y.J., M. Fitch, S. Ferreira, and P. Moore (2000) Chemically induced resistance of Carica papaya against Phytophthora palmivora. In Vitro Cell & Devel. Biol., 36 (3). 71A.

Zhu, Y.J., S. Ferreira, M. Fitch, and P. Moore (2000) Benzothiadiazole (BTH) activates systemic acquired resistance (SAR) responses in papaya to reduce disease symptoms of seedlings inoculated with Phytophthora palmivora. Int. Symp. Tropical and Subtropical Fruits, Cairns, Australia, November 2000, p. 52.

Zhu, Y. J., C.S. Tang, S. Ferreira, M. Fitch, and P. Moore (2000) Improving fungal resistance of papaya through transgenic approaches. 36th Annual Hawaii Papaya Industry Association Conference, Honolulu, September, 2000.

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