GUAM
AGRICULTURAL
EXPERIMENT
STATION

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AND LIFE SCIENCES

COLLEGE OF AGRICULTURE
UNIVERSITY OF GUAM

Contents

DIRECTOR'S REPORT

The faculty of the Guam Agricultural Experiment Station have been quite active in the local, regional and international arena. Some of the achievements include biological control of the mango tip moth, serpentine leaf miners, Siam weed, spiraling whitefly, leucaena mealy bug, mild strain protection of papaya ring spot virus, use of fertigators and irrigation controllers, and animal waste management. Faculty members have conducted numerous workshops for the general public on their current research programs as well as on general topics.

A number of articles based on the research findings have been published in local, national, regional and international journals. Equally, findings were also disseminated through local news media and extension outlets.

C.T. Lee, Ph.D.
Dean/Director

AGRICULTURAL ECONOMICS

Small Landholders on Guam

J.W. Brown

One of the primary marketing problems fac ing farmers on Guam is market risk (price drops) associated with gluts of locally produced fresh produce. When too many farmers plant and harvest the same crop at the same time, the limited local marketing channels can become saturated with the product and prices can fall below the level that farmers expected when they planted the crop. At times, farmers can have difficulty in finding an outlet to sell their produce.

One way to address this problem is to provide farmers and other participants in the market with information on current plantings and expected island-wide harvests for the most popular fruits and vegetables grown on island. The Guam Cooperative Extension (GCE) and the Guam Department of Agriculture have been providing this service on an intermittent basis for many years. We have initiated a joint project with the GCE to update its forecasting abilities and, in particular, to update the information on crop yields used as a basis of these forecasts. A small grant was obtained from the University of Guam's Research Council to measure actual farm yields on Guam and Saipan. Surveying has begun on Guam and the survey of farm yields will be initiated on Saipan soon.

In connection with the crop yield measurements, a project to estimate costs of production for some of the more popular crops on Guam has been started. Farmers are first contacted to solicit their participation, and then starting with the initial land preparation an individual planting is followed throughout its production cycle to determine all inputs used in producing the crop. This is done by giving the farmer a record sheet to record all of his or her activities associated with the crop. The sheets are collected every two weeks throughout the production cycle. As sufficient samples are collected for each crop, crop budgets will be prepared in the coming year.

AGRICULTURAL ENGINEERING

Optimizing Yield of Vegetable Crops and Minimizing Deep Seepage

P. Singh

Agriculture is perceived as a potential source of groundwater contamination on Guam. This is of big concern to the regulating agencies as well as the public in general. Adoption of microirrigation technology and development of irrigation and fertilizer management techniques specially suited to our soils, crops and environmental conditions has been the focus of experiments since 1990.

Irrigation Management

A microirrigation scheduling experiment was

conducted to develop water management criteria for optimum crop production. A fully automated microirrigation scheduling system with a controller, solenoid valves, switching tensiometers and a fertigator was used to evaluate water use efficiency at five irrigation treatments for growing cucumber. The experiment was conducted at Inarajan Experiment Station during January - May 1994. Cucumber (var. Soarer) was grown in a field with shallow (20-30 cm deep) Guam clay soil with a mean pH of 7.3. The P and K ranged 7.3 - 23.1 ppm and 77.5 - 150.0 ppm in the field. Phosphorous was banded preplant at the rate of 110 Kg/ha. Potassium (240 Kg/ha) and nitrogen (255 Kg/ha) was injected weekly in split applications. The five irrigation scheduling levels of 5, 10, 25, 45, and 65 Centibar (CB) were tested.

Although the cucumber yield were not significantly different among the first four treatments, there was a trend of gradual decline in the mean yield. The highest mean yield was 65,680 Kg/ha at 5 CB irrigation scheduling. The lowest yield of 47,500 Kg/ha was obtained at 65 CB irrigation scheduling. The water-use efficiency, the yield per mm of water used, was highest (170 Kg/mm) at 45 CB treatment. The yield at this treatment was 55,000 Kg/ha. A total of 177 mm rainfall occurred during the experiment.

One of the salient feature of the automated system, when using it for irrigation scheduling under switching tensiometer control, is that it cuts off irrigation when water reaches a predetermined depth in the soil profile. In a well designed and operated system, this ensures that water and nutrients are not leaching below the root zone of the crop.

Fertilizer Management

This experiment was designed to obtain information on optimum fertilizer dosages. The experiment was conducted during May - July 1994 in the same field as the irrigation experiment. The five levels of N tested were 0, 65, 135, 200, and 270 Kg/ha. The fertilizer was applied weekly in split applications. Irrigation was scheduled at 15 CB. The highest mean yield of 32,000 Kg/ha was obtained for the 200 Kg/ha N treatment. The lowest yield of 7,100 Kg/ha was for no N fertilizer treatment. The experiment was terminated early due to disease and insect problems. The highest yield obtained was about half the maximum yield obtained in the irrigation management experiment. It would seem more appropriate to recommend fertilizer application rate and yield reporting on a weekly basis. This would allow for a better comparison over different experiments.

Parameters for Microirrigation System Design

Experiments were conducted to obtain optimal wetted soil volume (OWV), a microirrigation system design parameter, for cucumber crop and Guam clay soil. Pots of 10 different sizes were used. The smallest pot contained 1.4 Kg of soil while largest pot had 47 Kg soil. Plant height, leaf area, fresh and dry weights of roots and shoots were measured. Based on the data analysis, optimal wetted volume was determined. It increased with the plant growth. This was used to infer the location of switching tensiometers for continuous automation from transplanting to apparent full cover.

Three locations (depths and lateral distances from a plant hill: 5x5 cm, 10x10 cm and 15x15 cm) for the switching tensiometer were identified and tested for irrigation scheduling. The 5x5 cm location was the irrigation control site for first two weeks after transplant. The 10 x 10 cm served as control site for next two weeks of plant growth when the control site was shifted to the third location at 15x15 cm. Thus, a bank of switching tensiometers located at these positions with respect to plant hill and drip line can be used for irrigation scheduling automation. The final optimal wetted volume is used for selecting emitter and drip line spacing in an microirrigation system design.

Effects of Nitrogen and Potassium Fertilizers on the Yields of Cucumber

J.A. Cruz

Two field experiments were conducted at the Yigo Experiment Station, one during the wet season (July-September) and one during the early dry season (November-January) to evaluate applied nitrogen and potassium levels through the drip irrigation system on the yields of cucumber. The field studies were conducted on the Yigo soil classified as clayey, gibbsitic, isohyperthermic, tropepitic, eutrustox which is very shallow, calcareous soil with limited moisture holding capacity. The initial soil test from these sites indicated the following chemical properties of the surface 15 centimeters: slightly alkaline pH 7.6, low concentrations of available phosphorous 4 ppm P, low concentrations of exchangeable soil potassium 37 ppm K, and soil organic matter levels of 6.40%.

The treatments consisted of ammonium nitrate to supply the nitrogen and potassium sulfate to supply the potassium applied at the rates of 0, 50, 100, and 150 Kg N & K/ha through drip irrigation system. The fertilizer injection system was calibrated at 1:100 ratio delivery rate to maintain the desired concentration levels of N & K. Each treatment was replicated four times in a randomized complete block design. The four nitrogen and potassium levels were factorially arranged with nitrogen treatments as main plot and potassium treatment as subplot. The 10-day-old cucumber seedlings were planted in 30-meter rows with 46 centimeter by 150 centimeter plant spacing. The triple superphosphate fertilizer at the rate of 200 Kg P/ha was banded between the double drip irrigation lines. The double drip lines were installed 30 centimeter apart in the rows under black plastic mulch. Dissolved ammonium nitrate as nitrogen fertilizer and potassium chloride as potassium fertilizer were applied through the drip irrigation system three times a week.

Two weeks after the final harvest soil, samples were taken to the depth of 15 centimeter for soil organic matter test. The soil test results indicated that the soil organic matter levels did not increased as the applied nitrogen levels were increased from 0 Kg N/ha to 150 Kg N/ha. Despite very low concentration of available exchangeable soil potassium, there was no significant response to potassium fertilizer applications. There was slight yield increase as the nitrogen levels increased from 0 Kg N/ha to 150 Kg N/ha. The combined effects of the injected nitrogen and potassium levels showed no significant response on the yields of marketable cucumber. The average yields of marketable cucumber for both field trials were below the appropriate yields due to damaging winds and excessive rainfall during early stages of plant growth and harvest period.

Soil Test Summary, 1984 - 1993

P.P. Motavalli, J.A. Cruz, J.L. Demeterio and R.Y. Marasigan

Soil testing promotes the efficient utilization of nutrients for optimal plant growth and productivity while minimizing environmental pollution. The Soil and Plant Testing Laboratory of the University of Guam's College of Agriculture and Life Sciences has been offering soil analytical services to the Guam community for more than 15 years. A summary of the soil-test results from soils submit-

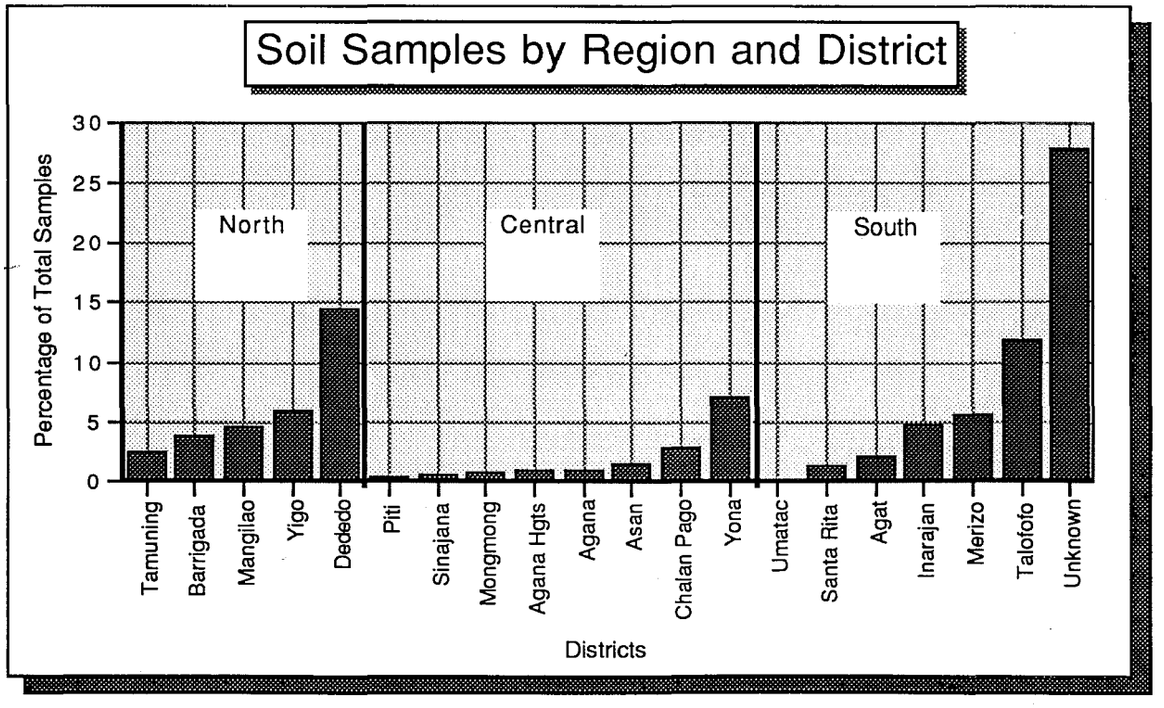
ted to the laboratory between 1984 to 1993 was prepared. This summary provides information on the laboratory's performance during that time and general trends in soil properties by source and geographic region on Guam.

From 1984 to 1993, the laboratory analyzed 2,926 soil samples. The lowest number of samples analyzed was 133 in 1988; the highest was 444 in 1984. More than 88% of all soil samples analyzed originated from Guam. Farmer samples comprised 32.5% of total samples. Other sources of samples included researchers (42.6%), off-island samples (11.5%), golf courses (9.7%), landscapers and nurseries (2.3%), government agencies (0.8%) and private companies (0.1%). Off-island samples came from several locations in Micronesia including Saipan (25.6%), Pohnpei (21.9%), Kosrae (12.5%) and Yap (11.0%).

Analysis of the geographic origin of soil samples submitted by farmers on Guam indicated a relatively larger representation of samples from Northern Guam (see below). In Northern Guam, the Dededo district submitted the largest number of samples. Yona in the central region and Talofofo in the south also had a relatively higher proportion of submitted samples. The geographic origin on Guam of more than 27% of all submitted farmer samples was not indicated on the submission sheet. The geographic distribution of submitted soil samples may be an indication of greater agricultural activity in a given district and also possibly a greater lack of awareness of the availability of soil testing in certain districts.

Analysis of soil test results indicated that the highest proportion of farmer soil samples tested 4-6% in soil organic matter, 7.0-8.0 in soil pH, 0-10 mg/kg P, 40-80 mg/kg K, 3600-4800 mg/kg Ca, 0-280 mg/kg Mg, 0-15 mg/kg Fe, 0-10 mg/kg Zn, 75-100 mg/kg Na, 0-50 mg/kg Mn, and 0-2 mg/kg Cu. These values suggested that a large proportion of farmers' fields may be experiencing deficiencies in P, K, Zn, and Mn. The large proportion of farmer soil samples with a relatively high pH indicated that problems related to high pH, such as low P, Fe, Zn, Mn, and Cu availability, may also be common. Soils submitted from northern districts generally had higher pH, organic matter and P content and lower K, Mg, Fe and Cu than soils submitted from the southern districts.

Further improvements in the services offered by the Soil and Plant Testing Laboratory may be necessary. These improvements include educational programs to increase public awareness of the need for soil testing and the development of reliable fertilizer recommendations. Informational programs, specifically targeted on managing deficiencies in P, K, Fe, Zn, Mn, and Cu for various crops, may also be required.



Effect of Fiber and Feed Restriction on Body Weight of Pullets

F.G. Abawi and O.H. Diambra

Feed restriction and fiber level were used to control body weight and sexual maturity of pullets raised in battery cages. Artificial light was increased from 14 hours at 16 weeks of age to 16 hours of light at 20 weeks of age. A total of 168 day-old chicks from a brown-egg strain of layers were started on a common pullet starter, and fed ad libitum. At eight weeks of age, pullets were randomly allocated into four treatments, consisting of seven replicates of six birds each. Two levels of calculated crude fiber (4% and 6%) and two feeding regimens (full vs. restricted) were prepared in a 2 x 2 factorial design.

Results indicated that restricting feed to four days a week was effective in controlling body weight and sexual maturity of pullets. Increasing crude fiber content from 4% to 6% of the diet did not affect feed consumption, sexual maturity or daily weight gain. The management of pullets for early or late maturity is dictated by economical factors, such as shortage of eggs and price difference between medium and large size eggs.

Enzyme and Amino Acid Supplemation of Tangantangan Leaf Meal-Based Diet For Broiler Chicks

F.G. Abawi and O.H. Diambra

A total of 336 broiler chicks were used in this study to evaluate the effects of feeding high levels of Tangantangan leaf meal (TLM) with or without cellulase enzyme and/or amino acids supplementation. Cellulase enzyme preparation from *Penicillium funiculosum* was used at a rate of 5g/100kg per diet. D-L methionine and L-lysine were added to increase the NRC (1984) requirements for these amino acids by 15%.

Data indicated a significant decrease ($P<0.05$) in daily feed intake when chicks were fed diets containing 10% TLM. Enzyme or amino acid supplementation did not improve feed intake. Daily weight gain was significantly lower ($P<0.05$) within groups fed unsupplemented TLM during the first three weeks. Enzyme or amino acid supplementation sustained growth during the first week but its effects disappeared thereafter. TLM diet supplemented with both enzyme and amino acids performed as well as the unsupplemented control diet.

Overall feed conversion was not affected by dietary treatment. As a consequence of the bulky nature of the high fiber diet, slower growth among chicks fed the TLM diet resulted from significantly lower ($P<0.05$) calorie and protein intake. However, feed, energy and proteins were utilized with the same efficiency whether or not TLM was used and/or supplemented with enzyme and amino acids.

Birds on Tangantangan diets had significantly longer intestinal tract and heavier gizzard weight compared to the control.

Effect of Varying Calorie and Protein Levels on Layers Fed High Levels of Tangantangan Under Tropical Conditions

F.G. Abawi and O.H. Diambra

Different calorie and protein concentrations were fed to 120 commercial layers (Rhode Island Red Cross) to evaluate laying performance with 10% leucaena in the diet. Three calorie levels (2600, 2800 and 3000 kcal/kg) and two protein levels (15 and 18%) were investigated in a 3 X 2 factorial arrangement of six treatments, with five replicates of four birds each. Daily feed intake, percent of hen-day production and average daily egg-weight were recorded. Feed conversion (feed mass/egg mass) was computed. Data were collected from the onset of egg production at 21 weeks of age to the fourth month of production.

Data indicated a significant effect ($p<0.05$) of calorie or protein level on feed intake. Feed intake decreased significantly ($p<0.05$) as calorie or protein level increased. Percent of hen-day production and egg weight were similar among all treatments. Layers on low-energy feeds were able to increase consumption despite high fiber and bulk contribution of leucaena leaf meal.

AQUACULTURE

Marine Shrimp and Mangrove Crab Culture in Guam

I. Silva-Krott, J. Brock, J. Brown, B. Barber, D. Crisostomo, and J. Tellock

Two projects sponsored by the Center for Tropical and Subtropical Aquaculture deal with culture of crustaceans in Guam. Local farmers raise specific-pathogen-free blue shrimp, *Penaeus stylirostris* in earthen bottomed, concrete ponds. Within six months, shrimp grow to market size and are harvested and sold to fish stores and restaurants.

Recently farmers noticed black discoloration of gills of market-size shrimp. These shrimp did not look appealing to customers. Our research included evaluation of shrimp during the growth period in the pond in order to identify possible causes of gill discoloration. Work entailed periodic measurement of water parameters, gross and histological examination of shrimp, and observation of harvesting procedures. Preliminary results after the first half of the project indicated water quality, such as salinity and water exchange of shrimp ponds, played a role in appearance of black gill discoloration.

The second ongoing project dealt with identification of species suitable for aquaculture in Guam. We targeted mangrove crabs as they do occur in Guam rivers and examined growth rates and pathogens in wild caught crabs. The study included the installation of a quarantine system to screen aquatic species. The quarantine system consisted of separately located tanks with purified fresh and salt water supply. All effluent water was purified by UV light to eliminate biologic contaminants prior to disposal. Mangrove crab will serve as a model for development of this quarantine system. An additional aspect of this project dealt with evaluation of the economic feasibility of mangrove crab production in Guam. Preliminary information indicated that addition of mangrove crabs to milkfish ponds always improves the profitability of the ponds. Research was carried out by Dr. Ilse Silva-Krott, Dr. John Brown (University of Guam), Dr. Jim Brock (Aquaculture Development Program, State of Hawaii), Bob Barber and Dave Crisostomo (University of Guam, Cooperative Extension).

Cabbage Insect Control

R. Muniappan and T.S. Lali

The insects *Hellula undalis, Crocidolomia pavonana, Halticus tibialis* and *Liphaphis erysimi* in the head cabbage fields are controlled by trap cropping with Indian mustard, radish cv. Minowase # 3 and Chinese cabbage cv. Tempest. Diamondback moth, *Plutella xylostella* is parasitized by the egg parasite, *Trichogramma chilonis* and larval parasite, *Cotesia plutellae*. Cutworm, *Spodoptera litura* is parasitized by the larval parasite, *Euplectrus xanthocephalus* during the wet season.

Biological Control of Bean Pests

D. Nafus

BEAN FLIES – Studies on the biological control of the complex of pests attacking beans continued. Current objectives continued to focus on identifying parasitoids already present on Guam before bringing in new species. No new parasitoids of bean fly, *Ophiomyia phaseoli* (Tryon) were collected in 1994, suggesting that the faunal survey is complete. To date, *Hemiptarsenus semialbiclavus, Chrysonotomyia formosa, Gronotoma micromorpha, Gronotoma guamensis, Ganaspidium utilis, Callitula sp.,* and *Sphegigaster ?rugosa* have been identified. With the exception of *Callitula sp.*, and *Sphegigaster ?rugosa*, all parasitoids also attack the leafminers *Liriomyza trifolii* and *L. sativae*, indicating that there is substantial overlap in the two communities. *G. micromorpha, G. guamensis*, and *G. utilis* were all rare and were not important components of the bean fly parasitoid guild. In the past, *G. micromorpha* and *G. guamensis* have been rare components of the leafminer guild, but *G. utilis* was the most abundant species. This suggests that it is more host specific for leafminers than the other parasitoids. *H. semialbiclavus* was the most abundant parasitoid attacking the bean fly, and was also very abundant on leafminers. *C. formosa* also commonly parasitized both species.

Two additional species, as yet unidentified, were commonly found attacking bean fly, and several more species were reared occasionally. None of these species have been reared from leafminers. *Opius importatus* and *Opius phaseoli*, imported from Hawaii in 1971 and 1972, failed to establish.

Aphids

In 1994, no parasitoids or mummies were found attacking either cotton aphid, *Aphis gossypii*, or the cowpea aphid *Aphis craccivora* Koch. *Menochilus sexmaculatus, Harmonia arcuata, Coelophora inaequalis,* and two small, unidentified lady beetles not previously reported from Guam were reared. *M. sexmaculatus* was again the most common coccinellid. Two species of predatory flies, *Ischiodon scutellaris* and an unidentified predacious drosphilid, were collected feeding on the aphids.

Parasitoids of Bean Pod Borer

An unidentified braconid parasitoid was reared from the larvae in 1993 and 1994. The parasitoid

prefers first to third instars. Only two of 48 field collected fourth instars and no fifth instars were parasitized. A few first instars were parasitized, but second and third instars were heavily attacked. Parasitization ranged up to 100% in some weeks, and over the entire crop cycle, 28% of the second and 40% of the third instars were parasitized. This parasitoid appears to be more effective than indicated last year.

IPM Programs and Natural Enemies of Cotton Aphid and Cowpea Aphid

A pilot IPM system for beans was tested against an untreated control to see if minimal pesticide use was compatible with natural enemies of cotton aphid and cowpea aphid. The program was developed primarily to conserve parasitoids attacking the leafminer *L. trifolii* , which is resistant to most insecticides but is readily controlled by parasitoids if insecticide usage is held to a minimum. Both IPM treatments and controls were replicated three times. Counts of significant bean pests were done weekly, and treatments for weeds, insects, or diseases were done within a day or two after surveys if economic thresholds were exceeded. Aphids, bean flies, weeds and powdery mildew triggered control measures. In a three-month period, four insecticide treatments were needed on the IPM fields. In the untreated plots, more than 50% of the sample sites were infested with aphids on all but the earliest sample dates. In IPM fields cowpea aphids infested about 20% of the sample sites on only two occasions. Colony size was less than one-tenth of the size of colonies in control fields. Natural enemies, predominantly coccinellids, were abundant in control fields, but were unable to check aphid population growth. Yields were 60% lower in untreated fields due to a combination of bean fly and aphid outbreaks. Aphid damage from feeding on pods directly reduced yields 10%, and the remainder of the loss was due to premature senescence and loss of vigor caused by a combination of aphid feeding and bean fly damage to vines. Populations of natural enemies were very low in IPM fields. Despite the relatively low number of insecticide treatments, on most sample dates, coccinellids, syrphids, and other predators were absent. It is not clear whether this was due to insecticide treatments, or to the unattractiveness of treated fields due to sparse aphid populations. Leafminer populations were low in both treatments, averaging less than two leafminers per leaflet. This is sufficiently low to have little or no effect on yield. Only about one-third of these emerged from the leaf to pupate. Emergence rates were slightly higher in the IPM fields, but overall population levels were slightly lower, indicating that the program was successfully conserving parasitoids.

Flame Tree Loopers

Poinciana trees were selected in four villages and monitored for outbreaks and damage from *Pericyma cruegeri*. A single outbreak was recorded in 1994 in November and extending into December in Northern Guam. Looper populations were less than 30 per 100 leaves. Trees were defoliated in Mangilao, Dededo, and Agana. Parasitoids were rare in 1994, and only one specimen, *Brachymeria lasus*, was reared from 1040 larvae and pupae collected. *Echthromorpha sp.* and *Exorista civiloides*, both found in a few pupae last year, were not reared.

At Mangilao, an experiment was set up to test the effectiveness of two types of *Bacillus thuringiensis*, Dipel and MPV. Three trees were treated with Dipel, three with MPV, and three were left untreated. All trees were monitored weekly to determine the density of the looper. Treatment with *B. thuringiensis* was to be initiated if were more than one per five leaves. Trees were treated twice during an outbreak in November. Both treatments were ineffective at preventing defoliation: control trees were 100% defoliated, and treatment trees 96% defoliated. There were two reasons for this. First, the threshold for initiating treatment was set too high, so treatment started too late to prevent some defoliation. Second, although populations of loopers on the Dipel and MPV trees were reduced, they were quickly replaced by loopers moving in from nearby untreated trees that had been defoliated. Additional treatments could not be made immediately due to restrictions by the cooperators on which days the trees could be treated. Thus, treatment with Dipel and MPV delayed, but did not stop defoliation.

Effectiveness of Floating Row Covers in Controlling Orange Pumpkin Beetles in Cantaloupe

I. Schreiner and D. Nafus

A test for the effectiveness of floating row covers in protecting cantaloupes was begun in May 10, 1994 with the planting of the variety Premium Hybrid (Twilley Seeds). Plots, consisting of two rows 25-feet long, were either covered until flowering or not. The covers were placed over the plots and held down with rebar. Unfortunately, they were stretched tight, and the weight of the rebar prevented the cover from floating. Black plastic mulch was used to prevent excessive weed growth. Drip irrigation was used. The plants were treated with *Bacillus thuringiensis* Jun. 9 to control melon worms at the time the row covers were removed. Thereafter, plants were treated weekly with dimethoate to prevent melon fly damage. The seedlings damaged by the tight row cover never fully recovered. The plants remained smaller throughout the growing season and the yield was significantly less in the covered plots. This occurred despite relatively high numbers of pumpkin beetles (*Aulacophora similis*) feeding in the uncovered plots. A month after the row covers were removed, there were slightly more beetle larvae around the roots of the uncovered plants, but the number was low and apparently not damaging to the crop.

Impact of Plastic Mulch and Floating Row Covers on Orange Pumpkin Beetles in Watermelon

I. Schreiner and D. Nafus

A test for the effectiveness of floating row covers and plastic mulch in protecting watermelons began January 10, 1994. The variety planted was Jubilation (Twilley Seeds). Plots consisted of two rows 20 feet long. There were three treatments. Floating row cover plots had black plastic mulch and floating row covers placed on plants on the planting date. Mulched plots had black plastic mulch only, and untreated plots had neither mulch nor row covers. The row covers were removed when the plants began flowering and were also beginning to escape from the sides of the row cover. The plants were treated with carbaryl as soon as the row covers were removed to control orange pumpkin beetles. Treatments continued weekly thereafter with dimethoate to prevent melon fly damage. A soil sample was taken a month after the row covers were removed to determine estimate beetle larvae numbers. There was a very high incidence of orange pumpkin beetles in the first week after planting, and adult beetles killed many plants in unmulched plots the week after emergence. Once they had consumed the plants in the unmulched plots, the beetles moved to the uncovered plants in the mulched plots and attacked them severely. However, as these plants were somewhat larger at the time of attack, the plants survived. Beetle larvae were most abundant in the mulched uncovered plots, as there were no plants in the unmulched plots, but the covered plots were protected until flowering. Yield was highest in the covered plots. However, yield was very low as the plants collapsed during a week of rainy weather at the end of March.

Relationship Between Irrigation and Orange Pumpkin Beetles in Watermelon

D. Nafus, I. Schreiner and P. Singh

An experiment to assess the impact of irrigation levels orange pumpkin beetles in watermelons began in June 1994 with the planting of the variety Top Yield. Delays in obtaining necessary parts resulted in the experiment being planted late in the dry season. Irrigation was provided by two drip lines in each row, spaced 12 inches apart, under black plastic mulch. All plots were evenly watered for about three weeks to allow the plants become established, and thereafter water rates were varied. Tensiometers, placed between the irrigation lines at a depth of six inches, were used to automatically control irrigation. The controllers were set at 10 centibars, 30 centibars and 50 centibars. All treatments were replicated four times. The weather was dry for the first five weeks of the experiment; then heavy rains began. There was no difference in the area covered by the plants during the growing period. The number of melons and their total weight decreased as water stress increased, although the difference was not quite significant at the 0.05 level. Beetle larvae were sampled in the soil before harvest and also counted under melons at harvest. There was no significant difference in the number of larvae found among the three water treatments, nor did the percent of melons damaged by beetle larvae differ.

Use of Chemical Lures to Attract Luffa Beetles to Traps

I. Schreiner and A. Dierking

A series of chemicals derived from the floral scents of pumpkins which had previously been tested on *Aulacophora similis* was tested on *Aulacophora quadrimaculata*, the beetle infesting luffa squash. The chemicals tested were *trans*-Cinnnamaldehyde; 1,2,4-Trimethoxybenzene; Indole, 4-methoxy-cinnamonitrile; Cinnamyl alcohol and a mixture of equal parts of *trans*-Cinnamaldehyde, Indole and Cynnamyl alcohol, referred to as TIC. Cotton dental wicks were soaked in mineral oil and then 90mg of the test chemical was applied. Liquid chemicals were applied directly and solid ones were dissolved in acetone first. The wicks were placed on the top of 12-ounce yellow plastic disposable cups. The cups were mounted on rebars about one foot long. Traps were placed at least five feet apart around large luffa vines at several different sites around Guam.

None of the chemicals tested were very effective at attracting *A. quadrimaculata*, and there was no difference among the chemicals.

Transgenic Cabbage

M. Sticklen, L.Y. Wen and R. Muniappan

Transgenic plants can be obtained when transformed cells are able to regenerate. Commonly, regenerated plants are induced from cells adjacent to the wounded surface of explants in the presence of particular growth hormones, mainly cytokinin and/or auxin, in a culture medium. This wounded surface also serves as an entry point for *Agrobacterium* to deliver T-DNA into plant cells. The regeneration ability of explants used for transformation system.

The first step of the project was to identify a plant material for plant transformation which should be highly responsive for *in vitro* shoot regeneration. Sixteen Head Cabbage varieties from Takii Seed Company, Japan, together with 10 cabbage varieties from Horticultural Research International, Kent, UK, were tested for *in vitro* shoot regeneration from their cotyledonary petioles, hypocotyl segments and root segments. Effects of various medium compositions and growth hormone compositions on the shoot differentiation were also investigated. On the most effective medium, nine varieties produced multiple shoots from 90-100% of their cotyledonary petiole explants; six varieties produced multiple shoots from 60-80% of their hypocotyl explants, and one variety produced multiple shoots from its root segments. Finally, two responsive varieties, i.e., Emerald Cross and Golden Cross, were selected for *Agrobacterium* medicated transformation using either their cotyledonary petioles or hypocotyl segments.

For the construction of the binary plasmid harboring the Bt gene, a DNA fragment consisting CaMV35S promoter and the Bt gene was excised from pCIB418 plasmid using the restriction enzymes *HindIII* and *EcoRI*. The excised DNA fragment was ligated into the T-DNA in vector of pBIN19. This T-DNA has carried a neomycin phosphotransferase (NPTII) gene as a plant transformation selectable marker. Construction of the binary plasmid harboring the chintinase gene has been accomplished by the laboratory at Michigan State University. The two binary plasmids were introduced into *Agrobacterium* (strain LBA4404) by triparental mating.

The two *Agrobacterium* Ti plasmid constructs were used to transform both *Brassica* cabbage and tobacco. The use of tobacco was to quickly check the effectiveness of the constructs for plant transformation, since tobacco has a well-established T-DNA transformation system. Two to three *Agrobacterium* colonies harboring either of the binary plasmid constructs were used to infect cabbage cotyledonary petioles and tobacco leaf discs. Several kanamycin resistant tobacco shoots were obtained from the use of either of the constructs, but no kanamycin resistant cabbage shoots were produced. With the confidence of the *Agrobacterium's* ability of delivering the T-DNA into tobacco plants, further efforts were made to transform cabbage varieties. These included the use of wounding product acetosyringone to enhance *Agrobacterium's* ability of delivering T-DNA, the use of hypocotyl segments as an alternative material for transformation, pre-incubation of explants on the cultural medium for 1-3 days before *Agrobacterium* infection. The use of hypocotyl segments, together with the use of acetosyringone and pre-incubation for one day has produced 4 kanamycin resistant shoots which might be transformed with the Bt gene. These shoots are too small to be analyzed now. However, even with the use of this optimized method, transformation efficiency was still very low. A large transformation experiment of hypocotyl segments was carried out recently in order to produce more kanamycin resistant shoots. In addition, experiment with dark treatment of plant materials before and during *Agrobacterium* infection has also been started. All the work is currently concentrated on producing transgenic cabbage plants.

Impact of Feral Ungulates on Survival of Seedling Trees in the Limestone Forest

I. Schreiner

Patches of tree seedlings of various species were found at several locations. Seedlings were tagged and monitored periodically for a year or more to determine survival, and where possible causes of mortality. The seedlings included: one patch of *Macaranga thompsonii* seedlings at Ritidian Point; three patches of *Tristiropsis acutangula* seedlings, at the Anao conservation Reserve within the animal exclusion fence area at Northwest airfield and at Bubulao; and one patch of *Heritiera longipetiolata* seedlings at the Mangilao cliff line. Within a 2-year period, all but four *Macaranga* seedlings had died or disappeared. Most were apparently eaten by ungulates, and a few died the first year of drought. About half of the *Tristiropsis* seedlings could still be found about a year later and were healthy. Only a small number of trees were chewed or uprooted. Half the *Heritiera* seedlings were alive after a year. A quarter had died either of drought or some other problem affecting the roots, and several could not be found. None showed signs of being eaten. Introduced feral ungulates may be a problem for regeneration of certain species of trees in certain locations, but the impact is not universal.

Micropropagation of Ifil and Flame Tree

Mari Marutani, Ernesto Rivera and Emilia Manalastas

Seeds of Ifit, *Intsia bijuga* (Colebr.) O. Kuntze were germinated asepticly in water-agar media and MS media and placed in a culture room with air temperature of about 25° C. Rate of seed germination was very low with less than 1% in both media. Germinated seedlings were further divided into parts as explants for callus induction in MS media with 30 g/liter of sucrose, 8 g/liter of agar, 1.5 mg/l of BA (6-benzylaminopurine) and 0.04 mg/l of NAA (naphthalene acetic acid). However, there were no sign of callus formation. Among three antioxidants examined, L-cysteine gave a better result to prevent browning tissues of ifil compared to PVPP (polyvinyl polypyrrolidone) and ascorbic acids.

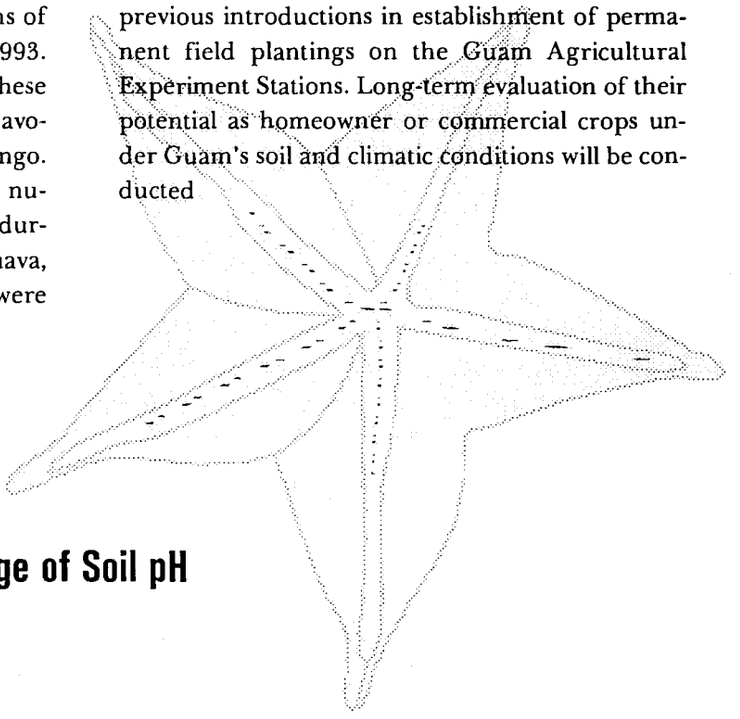
Callus of flame tree, *Delonix regia* (Boj.) Raf. multiplied faster in MS media with 10mg/l BA + 0.6 mg/l NAA than 4 mg/l BA + 0.8 mg/l NAA. These callus tissues are currently subjected to different combinations of growth regulator to induce roots and shoots.

Introduction of Woody Perennial Fruits to Guam

T.E. Marler

Numerous cultivars of avocado, carambola, and mango were introduced to the collections of the Agricultural Experiment Station during 1993. As a result, the introductions of cultivars of these species during 1994 were limited to four more avocados, two more carambolas, and one more mango. The focus of new introductions was shifted to numerous other woody perennial tropical species during 1994. Numerous selections of atis, chicle, guava, rambutan, longan, and other exotic species were added to the permanent collection.

These new introductions will be added to the previous introductions in establishment of permanent field plantings on the Guam Agricultural Experiment Stations. Long-term evaluation of their potential as homeowner or commercial crops under Guam's soil and climatic conditions will be conducted



Soursop is Well-Adapted to a Range of Soil pH

T.E. Marler and G.B. Palomo

One of the environmental stresses of fruit plants on Guam involves the chemical properties of the soils. Most of Guam's soils have a pH below or above the pH range in which most fruit trees best perform. One approach in managing crops on these soils is to use cultural inputs to either modify the pH of the soil or provide the minerals in a form of fertilizer that overrides the influence of the suboptimum pH. The most efficient and inexpensive manner of managing crops on these soils, however, is to determine those crops that can tolerate the high or low pH, and plant those crops.

Soursop (*Annona muricata*) is a popular fruit tree on Guam and throughout the lowland tropics. This fruit, known as laguana on Guam, can be found growing in a range of soil types. We studied the growth of soursop plants in sand culture, using nutrient solutions with pH ranging from 3 to 8, to determine the tolerance limits of this species.

Measurements of growth and photosynthesis confirmed the field observations that soursop is well-adapted to a range of soil pH conditions. This species should be easier to manage in soils with extremes of pH than many other species. The results indicate soursop trees can be planted in any of the soil types on Guam and should grow and produce well with typical cultural inputs such as fertilization and protection from wind and pests.

Papaya Leaves Respond to Rapid Changes in Light Caused by Clouds

T.E. Marler and H.S. Clemente

Plants growing on Guam are exposed to constantly changing light conditions. This is easy to visualize for plants growing beside a building, where the building shades the sunlight for a portion of the day, and the plant is exposed to full sunlight for a portion of the day. It is also easy to visualize for plants growing underneath large trees, where the majority of the day a leaf is shaded and that shade is periodically interrupted with high light in the form of sunflecks that last for several minutes each.

However, even plants that are growing in the open spaces of Guam experience fluctuations of light due to broken cloud cover. On average, only 18 days per year on Guam have cloud conditions classified as clear. The rest of the days are cloudy or partly cloudy, the cloudiness typically coming in the form of broken cumulus cloud cover. Under these conditions the light available to a leaf may change from full sunlight to less than 20% of sunlight in seconds. The change from low light back to full sunlight as the cloud passes by the solar beam also occurs in the order of seconds.

Light energy is used by the leaf in the process of making food, so whenever a cloud blocks a majority of sunlight this process declines in proportion to the amount of light that is available during cloud cover. The accompanying process of water loss by the leaf is not very dependent on the amount of sunlight, but is instead almost completely dependent on how open the stomata are.

Plants can be classified in two general groups with respect to the manner in which the stomata in their leaves respond to these rapid fluctuations in light. The leaves of some plants have stomata that are relatively insensitive to the rapid increases and decreases of light that occur as clouds pass by. In these plants, water loss remains high throughout the duration of cloud cover. Leaves of other plants, however, have stomata that are able to partially close fairly rapidly when light suddenly becomes low enough to limit food production by the leaf. In these plants, the loss of water declines substantially during cloud cover. These plants have a distinct competitive advantage during periods of limited water, such as during the dry season of Guam, in that they are more efficient in balancing water loss with food production each day.

We conducted a field experiment and a controlled experiment to determine the general manner in which papaya leaves respond to simulated sun-cloud transitions. The stomata of papaya leaves partially closed after about one minute of cloud cover, and continued to slowly decline until the return to full sunlight. Following this return to high light, several minutes were required for the stomata to fully re-open. As a result, water loss was partially restricted, but the process of making food was also restricted due to the partial stomatal closure. When papaya plants were under mild drought stress, this response was more rapid and the partial stomatal closure was of greater magnitude while the leaves were under cloud cover.

Development of Cultural Methods for Vandas and Dendrobiums in Guam

James McConnell

Vanda cultivars were transplanted into four-inch hanging wooden baskets. Dendrobiums were either transplanted into six-inch pots using 3/4-inch crushed limestone aggregate and grown on benches or kept in two-inch pots attached to fencing perpendicular to the ground. The fencing allows for more efficient use of space.

The orchids were irrigated daily with various types of mini-sprinklers to determine the most suitable for efficient fertigation. The nozzles have flow rates of ranging from 6 to 35 gph. The sprinklers have a variety of spreaders and spinners available to produce different watering patterns. By changing the type of spreader or spinner, it is possible to direct fertilizer solution onto the plants with less water missing the plants. The use of spreaders allowed for very accurate placement of water. The greater accuracy of water and fertilizer saves water and fertilizer. Spinners were more appropriate in situations desiring the greatest coverage. The sprinklers were installed into 4mm tubing, allowing easy placement of sprinklers in contrast to using PVC pipes or poly hose. The low volume sprinklers have the advantage of working at low water pressures while maintaining satisfactory coverage. Previously, spinning sprinklers were found to be too non-directional to allow the use of fertigation because of the amount of irrigation water not directed to plants. The operating pressures were also higher causing problems in times of low water pressure.

Turf Grass Fertilization in Guam

Mark Hamilton, Frank J. Cruz and James McConnell

The performance and leaching behavior of six nitrogen fertilizers applied to bermudagrass were studied under humid tropical conditions. The grass was established in 20 X 36 cm pots. The pots were filled with 8cm pea gravel and 28cm of silica sand. Ammonium nitrate (AN) was applied to the turf as NO_3-N between 0.25 and 6 lb./1000 ft²/mo. Performance was gauged by clipping dry weights, image analysis for greenness, and visual ratings. Leachates were checked for nitrate levels. A rate of 2 lbs./1000ft² was found to provide a quality of turf of acceptable quality while yielding a minimum of nitrate leaching. A rate of 6 and 4 lb./1000ft²/month resulted in the highest readings at 38.2 and 42.7ppm NO_3 respectively without a significant increase in turf quality. Rates of 2lb/1000ft² or less produced leachate nitrate less than 9ppm and turf of unacceptable quality.

Nutralene, Nitroform, sulfur coated urea, small and large granule IBDU, and AN were applied at a rate of 2 lb./1000ft² /month to the turf pots. The slow-release forms were applied as a three-month dose. Performance was determined as above and nitrate leaching was monitored by weekly collections. Nutralene, SCU and Nitroform yielded peak nitrate levels two weeks after application and IBDU treated turf yielded maximum nitrate levels after four weeks. IBDU, Nutralene, SCU and Nitroform treatments had nitrate levels of 40.6, 23.2, 17.0 and 7.5 ppm respectively during peak leaching periods. IBDU appeared to supply nitrate the longest. Turf quality began to diminish about six weeks after the experiment began. At six weeks the pots with weekly applications of AN had the highest quality.

Improvement of Plant Development and Yield of Solanaceous Crops in Guam

Mari Marutani and Emilia Manalastas

Adaptability of 14 germlines of eggplant (*Solanum melongena* L.) in the hot humid environment was examined in Guam cobbly clay soil with pH of 7.5 in the field of Yigo Experimental Farm starting Feb. 3, 1994. The population of carmine spider mite, *Tetranychus cinnabarinus* (Boisd.), was very high throughout the experiment. Five lines were tolerant to the mites, which included two local long green eggplants, 'Long Green Cruz' and 'Long Green Gabby,' and three long purple cultivars of 'Nitta hybrid No. 1' ('Nitta' x 'Molokai'), 'Nittahybrid No. 2' ('Nitta' x'Waimanalo'), and 'Nitta.' Nine susceptible cultivars were 'Black Shine,' 'Kokushu,' 'Kurume long purple,' 'Millionaire,' 'Money Maker No. 2,' 'Okitsu No. 1,' 'Pingtung Long,' 'Takii's Long Black,' and 'Waimanalo'. A cultivar 'Molokai' was originally included for this trial; however, because the germination rate was very poor (about 1%), this cultivar was removed from the study.

Response of a tomato cultivar (*Lycopersicon esculentum* Mill.), 'Solar Set,' to the amount of nitrogen fertilizer was examined in Pulantat soil in Barrigada during the 1993-1994 dry season. Four levels of fertilizers (50, 100, 200, and 400 N lb/A) were applied through fertigation systems as weekly application. The harvest yield increased as the amount of N fertilizer increased. The total marketable yield of five-week harvests was 14.2 lb·plant^{-1} for 50N treatment, 14.8 lb·plant^{-1} for 100N, 15.7 lb·plant^{-1} for 200N, and 17.0 lb·plant^{-1} for 400N. The concentration of N-nitrate in petiole sap recorded on the following date of fertilizer application maintained the highest level with 400 N treatment. The highest amount of nitrate-N content was recorded during the third week after flowering.

Evaluation of Tropical Legumes as Green Manure in Vegetable Production on Guam

Mari Marutani and Emilia Manalastas

The decomposition rate of *Crotalaria juncea* L. was examined in Guam cobbly clay, Pulantat, and Akina soils. Cut pieces of leaves and stems (150 g of fresh weight) in nylon fabric mesh bags were buried in the soil within the plow layer. Within two weeks, about 30% of plant tissues were decomposed at all three soils. On the twelfth week, over 60% were decomposed. The decomposition was slightly faster in Pulantat than the other two soils. The amount of total-N was lowest in Akina soil in the second week. On the twelfth week about 90% of the original N had been mineralized.

A total of 17 soil samples from seven locations were collected to estimate the population of indigenous rhizobia. A series of diluted solution of soil samples was made to inoculate seeds of *Macroptilium atropurpureum* (DC.) Urb. and *Leucaena leucocephala* (Lam.) de Wit as test plants in order to determine the population of *Bradyrhizobium* spp. and *Rhizobium* spp., respectively. Guam cobbly clay soil in Yigo had a greater population density of *Rhizobium* spp.

Crotalaria juncea is being evaluated as a green manure crop on vegetable crop production. A split plot design with four replications was used having an application of inorganic N fertilizers (200, 100, 50 and 0 lb/A N-urea) as a main plot at preplanting of vegetable crops and with or without a green manure crop as a sub-plot. Sunnhemp was grown for about two months before it was incorporated into the soil at the flowering stage. After the fertilizer treatment was applied, pai tsai, *Brassica napus* L. var. *chinensis* L. cv. Speedy 602 was grown from April 8 to May 19, 1994. The average yield of pet tsai was highest with application of 100 lb N fertilizer and with green manuring. Currently, the same experiment is being conducted to reveal the effect of green manuring and fertilizer treatment for the second season.

Evaluation of Pesticides Against Pests of Solanaceous Crops on Guam

Mari Marutani, Ernesto Rivera, Lee Yudin and Cody Flis

The efficacy of permethrin and carbaryl against flea beetle, *Epitrix hirtipennis* (Melshelmer), was evaluated on seedlings of eggplant, *Solanum melongena* L. cv. Nitta. Two rates of permethrin (Pounce WP25), 1.67 oz and 2.34 oz AI per 100 gallon, reduced the number of flea beetles and had residual effects for the longest time. In contrast, the effectiveness of carbaryl (Liquid Sevin 50 WP), with rates of 13.77 oz and 27.54 oz AI per 100 gallon, lasted only about a week.

The efficacy of insecticidal soap (Safer insecticide concentrate) and Sun spray oil were tested against whitefly, *Bemisia* sp., on tomato seedlings, *Lycopersicon esculentum* Mill. cv. N-52. Sun spray oil was more effective having less eggs laid after spray. *Bemisia* sp. was identified as *B. argentifolii* Bellow & Perring, n. sp. because of its wide range of host plants and induction of silverleaf and vein clearing on susceptible cultivar of zucchini, *Cucurbita pepo* L. cv. Ambassador. Two larval parasitoids were recovered from eggplant and tomato plants.

The effect of planting sunnhemp, *Crotalaria juncea* L., prior to tomato cultivation and the efficacy of nematicide, oxamyl (Vydate L), are being evaluated against root knot nematode, *Meloidogyne* spp. A susceptible cultivar 'Firebird' was planted in the entire experiment field to confirm presence of nematodes in the field. Sunnhemp was planted twice between July and December, 1994 with the rate of 50 lb/A. Oxamyl was applied in the soil after transplanting susceptible seedlings of tomato cultivar 'First' as an indicator plant. Currently, the degree of nematode infestation is being recorded.

Development of a Culturally Appropriate Diet-Assessment Instrument for Children on Guam

R.S. Pobocik

In order to accurately identify food consumption patterns of children living on Guam, food records were collected from 463 fifth grade students ages 9 through 13 during the dry season this year. Nine hundred fifty-four, or 55% of the total records collected (1,727 for both rainy and dry seasons), were entered into the Food Intake Analysis System© (FIAS) for nutrient analysis.

Analysis of these dietary data revealed many areas for improvement. The mean ± standard deviation (SD) energy intake was 1,706 ± 851 kcals which is 82.3 ± 41.5 % of the recommended intake. The distribution of energy did not meet dietary recommendations. Carbohydrate intake was low, 50.3 ± 11.8% of calories, relative to the recommendation of 55-60% of calories. Carbohydrates are the sugars and starches found primarily in grains, cereals, fruits, vegetables, and sweets. The protein content of the diet was high, 16.6 ± 5.1% of calories, rather than the recommended 10-15% of calories. When protein is expressed as a percentage of the Recommended Dietary Allowances (RDA), it was 223.8 ± 125.5%, or more than twice the required amount. The fat content, 33.1 ± 9.3% of calories, also exceeded the recommended intake of 30% or less. Although mean cholesterol intake, 263 ± 240 mg was lower that the recommended intake of 300 mg daily (or less), the large standard deviation indicates that many children are eating too much cholesterol. Dietary sodium, 3,034 ± 1714 mg, also exceeds the recommended intake of 2,000 mg per day. Mean fiber intake was low, only 9.3 ± 7.0 grams per day.

Mean Adequacy Ratio (mean nutrient intake divided by RDA times 100) ± SD for specific nutrients are as follows: vitamin A, 89.8 ± 104.0; vitamin C, 216.9 ± 337.0; thiamin, 123.9 ± 78.8; riboflavin, 112.7 ± 66.1; niacin, 137.3 ± 79.2; vitamin B_6, 96.9 ± 58.3; folate, 169.6 ± 187.8; vitamin B_{12}, 229.8 ± 250.6; vitamin E, 83.3 ± 112.7; calcium, 62.9 ± 44.7; phosphorus, 111.3 ± 59.6; magnesium, 99.5 ± 61.4; iron 100.0 ± 55.3; and zinc, 86.9 ± 52.2. Mean intake of the majority of these vitamins and minerals was adequate; however, calcium intake was very low. Most of the children, 72.2%, had less than 80% of the RDA for calcium.

Data base improvements include 92 traditional local recipes which have been identified and added to the FIAS and the identification of 27 regional food items not in the data base. For the second phase of this study, a questionnaire will be developed from the nutrient information that will be able to be used to determine dietary adequacy. This questionnaire will be specifically designed for children living on Guam.

The cooperation of Guam Public Schools is gratefully acknowledged for making this research possible.

Development and Evaluation of Effective Control Techniques for the Papaya Ringspot Disease on Guam

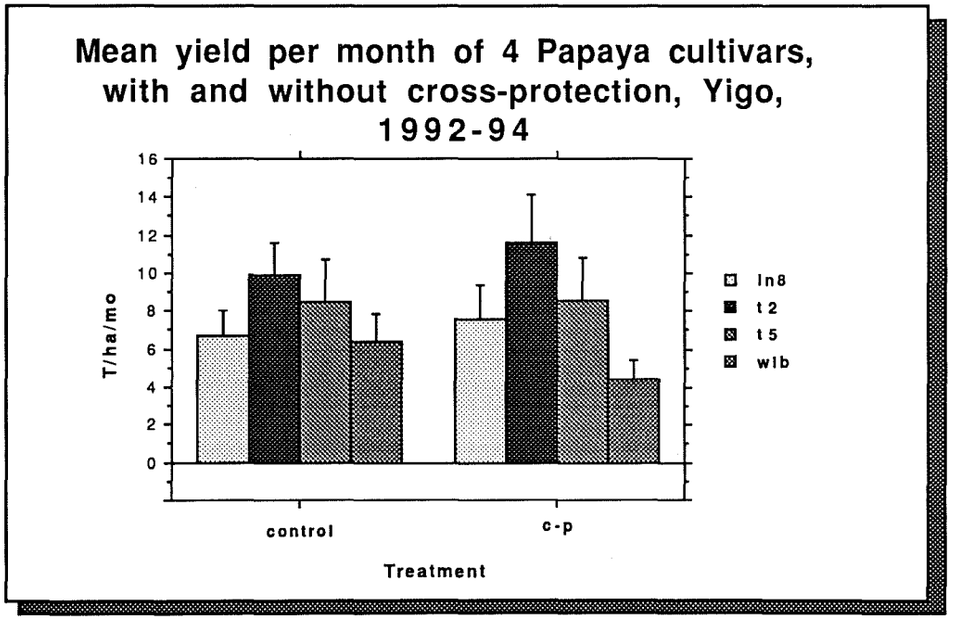
G.C. Wall, L.S. Yudin, S.A. Ferreira and D. Gonsalves

Four papaya cultivars were evaluated for yield over a nine-month harvesting period. Treatments included cultivars Waimanalo Low-Bearing (WLB), Line 8 (L8), Tainung #2 (T2) and Red Lady (RL). Untreated control plots were compared with cross-protected plots. The latter were inoculated at one month and again two weeks later with a mild strain of the Papaya Ringspot Virus (PRV). The test took place in Yigo Experiment Station. Planting was in December 1992. Harvesting started in August 1993 and continued until April 1994.

Virus infection was verified via NCM-ELISA. Sugar content was measured with a refractometer. Infection with the mild strain did not affect sugar content, and had no effect on yield, except for WLB, which showed some yield loss. WLB and L8 had the highest sugar content (10.8 and 10.0 Brix degrees, respectively). T2 outyielded all other cultivars, with and without cross-protection. Yields were 10.8, 8.5, 7.1, and 5.4 T/ha/month for T2, RL, L8 and WLB, respectively. Highest fruit weight was obtained with RL (1.73 kg).

Similar results were observed in another test at Inarajan Experiment Station. Our findings so far indicate that the test mild strain is a suitable candidate for use in cross-protection against our severe forms of PRV-p, and works well with cvs T2, RL, and L8.

Very recently, a different control technique for PRV has been researched, with mixed results.



Gonsalves and co-workers have developed and tested transgenic papaya plants into which a PRV gene coding for coat protein was inserted. The plants were found to express this trait, producing viral coat protein. When inoculated with the severe strain of PRV from Oahu, HI, very similar to the strain from which the viral gene was obtained, good resistance was observed to occur. However, when inoculated with the Guamanian PRV strain, resistance was not good.

So unless Guam develops its own transgenic papayas capable of producing viral coat protein like that of our PRV severe strain (an expensive undertaking), we will not be able to utilize those already developed in Cornell. Therefore, we must continue to consider cross-protection as our best tool in the control of PRV. Careful selection of cultivars, combined with cross-protection, elimination of inoculum reservoirs, and rogueing of early infected plants will have to be the strategy of choice for avoiding yield losses due to PRV on Guam, until other more effective control methods become available.

Biological Suppression of Soilborne Plant Pathogens

G.C. Wall

No additional biotypes of *Pseudomonas solanacearum* (P.s.) were found in 1994. Soil samples from different fields where bacterial wilt is known to occur were collected. Isolates of P.s. identified with the help of the Biolog bacterial identification system were used to look for bacteriophage specific to that species. Soil samples from fields where P.s. is known to exist were collected for bacteriophage enrichment and assay, following a modified technique of Crosse and Hingorani. All test results were negative during 1994, except for control assays using *E. coli.*

Soil samples from fields conducive to bacterial wilt were used in preparing the following soil combinations: 100% field soil, 1:1 mixture of field soil and river sand, 1:1 mixture of field soil and autoclaved field soil, 100% autoclaved soil, and 100% river sand. All of the above were submitted to the soils lab for analyses to determine the differences in organic matter content, nutrient content, soil structure, texture, etc. Data are being analyzed. This information will be useful in understanding the differences in wilt incidence on bell pepper observed previously in these soil treatments.

Control of Important Viral Diseases of Cucurbits in the American Pacific Islands

G.C. Wall, L.S. Yudin, and J.J. Cho

During the past year we have introduced a mild strain of Papaya Ringspot Virus-p (Cornell) and one of Zucchini Yellow Mosaic Virus (INRA, France) to Guam for testing; we are maintaining these isolates for further work, and have completed some preliminary work in order to proceed with cross-protection tests on cucurbits in the screenhouse. Later this year we should have completed cross-protection screenhouse tests with both mild strains, against local severe strains of PRV-w and ZYMV, respectively.

Work in Maui, HI, has led to the isolation of various mild strains of PRV-w. These were originally obtained from an infected zucchini plant on Maui, and maintained in the greenhouse on zucchini for several generations. Various isolates were obtained from axillary shoots with mild symptoms 2-3 weeks after inoculation onto various cucurbit hosts. They have been purified by the dilution-end-point technique, and are ready for greenhouse tests of cross-protection.

Epidemiology of Virus on Watermelon

G.C. Wall and J.W. Brown

Watermelon field tests (cv Top Yield) using crop covers, or floating row covers, and plastic mulch with drip irrigation gave excellent insect and virus control (Papaya Ringspot Virus-w). Two separate tests were completed in Radio Barrigada, with different planting dates, 3/93 and 4/93. Plants were inoculated with PRV-w at transplanting (tretment 1), at 25 cm vine length or 2 weeks later (treatment 2), at flowering (treatment 3), and control plots were not inoculated (treatment 4). Covers were removed after the first female flowers were seen. Compared with common local practice, insecticide use was greatly reduced, and virus incidence in uninoculated plots was low, despite the fact that plots remained uncovered after flowering. Yields were 32% higher than in PRV-inoculated plots.

Table 1. Mean yields obtained from watermelon plots inoculated at various growth stages with PRV-w in Radio Barrigada, Guam, 1993

Treatment	Yields (T/ha)[a]		
	Exp. 1	Exp. 2	1 + 2
1	41.86 bc	34.92 a	38.39 a
2	21.82 a	35.55 a	28.69 a
3	29.87 ab	42.94 a	36.41 a
control	43.48 bc	57.56 b	50.51 b

a: Different letters signify differences at .05 level (Fisher's LSD).

Table 2. Mean PRV-w incidence observed in watermelon plots inoculated at various growth stages in Radio Barrigada, Guam, 1993

Treatment	Incidence (%)[a]		
	Exp. 1	Exp. 2	1 + 2
One	88.6 bc9	4.3 a	91.45 a
Two	100.0 a	94.3 a	97.08 a
Three	94.3 ab	77.8 a	86.01 a
Control	72.0 bc	18.7 b	45.45 b

a: Different letters signify differences at .05 level (Fisher's LSD).

Table 3. Brief analysis of economic gains derived from the use of floating crop covers for watermelon production in Radio Barrigada, Guam, 1993.

	Per 100 ft. Row
COSTS	
Floating crop covers	- $19.50
Labor (handling covers @$7.00/hr)	- $ 3.50
GAINS	
No spraying material (what it would cost for the pesticides that were not applied)	+ $ 3.94
No spraying labor (labor cost for the applications that weren't needed)	+ $ 7.00
Net yield gain (difference between mean yields for control and for virus-inoculated plots)	+ $261.89
NET	$249.83 (=$13,603.24/acre) (=$33,600.00/ha)

Note:

This analysis assumes no crop loss due to other pests, (only that attributable to virus incidence), and seven pesticide applications without crop covers (versus three with covers, or a difference of four).

Pesticides not applied, which normally would be applied, include: dimethoate, malathion, carbaryl, mancozeb and spreader-sticker.

Identification of Economically Important Viral Diseases of Cucurbit Crops on Guam and Development of Strategies for their Control

G.C. Wall

A list of distributors of cucumber, melon and watermelon cultivars was put together, including available information on disease resistance. This list was distributed throughout the region by mailing it to all Extension services. Fruit blotch incidence on watermelon was still reported from several farms on island. Virus assays using NCM-ELISA techniques revealed that certain cucurbit weeds and wild plants are serving the role of virus reservoirs and sources of inoculum for our most prevalent cucurbit viruses on Guam, Papaya Ringspot Virus-weak (PRV-w) and Zucchini Yellow Mosaic Virus (ZYMV); previous work has already shown this, so only ZYMV and PRV polyclonal antibodies conjugated with alkaline phosphatase were used. Wild pumpkin *(Cucurbita pepo)* was often found infected with ZYMV. Wild patola or sponge gourd *(Luffa aegyptiaca)* was usually infected with ZYMV, although some samples also had PRV. Wild bittermelon *(Momordica charantia)* was found to harbor both as well. Dodder*(Cuscuta campestris)* parasitizing wild bittermelon, which can also attack cucurbit crop plants, was found to be infected with PRV-w.

Tropical Mushroom Production with Used Paper, Sewage Sludge and *Leucaena* Wood Chips

E.N. Imperio and G.C. Wall

The raw materials used for the production of oyster mushrooms have been analyzed for their C:N ratio. Table 1 shows the materials and their C:N ratios.

Table 1. C:N ration of various organic materials used for the growing of *Pleurotus* sp.

MATERIALS	*C:N RATIO*
Sewage Sludge	9.65 : 1
Leucaena sp. chips	33.75 : 1
Wood chips	61.92 : 1
Shredded newspaper	245.00 : 1
Unshredded newspaper	209.59 : 1
Shredded cardboard	276.81 : 1
Unshredded cardboard	146.50 : 1
Grass/newspaper combination	102.87 : 1

Table 2. Mycelial growth of *Pleurotus* sp. on different substrates.

SUBSTRATE	*AVERAGE WEEKLY GROWTH* (percentage)			
	1	2	3	4
Sewage sludge	0	0	0	3.3
Leucaena chips	0	1.5	18.3	18.3
Wood chips	6.6	13.3	51.6	76.6
Unshredded newspaper	31.6	38.3	76.6	97.3
Shredded newspaper	6.6	6.6	31.6	63.3
Shredded cardboard	1.6	1.6	13.3	30.3
Unshredded cardboard	24.3	40.0	61.6	70.0
Grass/newspaper combination	11.6	18.3	26.6	41.6

The said materials were mixed with 20% grain. These were soaked in water for 24 hours. After soaking, 1.5 kg of the materials were placed inside incubation spawn bags with microporous filter patch. These were sterilized in the pressure cooker for one hour at 15 psi. After cooling, the bags were inoculated with approximately 2% *Pleurotus* sp. spawn.

Mycelial growth was measured every week. Table 2 shows the differences in growth obtained from the different substrates.

The data on Table 2 indicate that the substrates that promoted the fastest mycelial growth were: unshredded newspaper (97.3%), wood chips (76.6%) and unshredded cardboard (70.0%). It is probable that these materials promoted faster mycelial growth due to the ease by which air can penetrate into the substrate. The shredded materials might have more surface area due to their relatively smaller size but this might have restricted the entry of air. Hence growth was not as prolific as in the case of the unshredded materials.

The following projects were in operation during the FY1994 at the Guam Agricultural Experiment Station.

Hatch Projects

General Administration of Federal Grants Funds Research – R. Muniappan

Use of Locally Available Feedstuffs and Potential Feed Sources on Guam for Poultry Feeding – F. Abawi

Small Land - Holders of Guam: Production Analysis and Risk-Avoiding Behaviors – J. Brown

Evaluating Alley Cropping for a Low Input Sustainable Head Cabbage Production on Guam – P. Motavalli

Development of Cultural Methods for Vandas and Dendrobiums in Guam – J. McConnell

Improvement of Plant Development and Yield of Solanaceous Crops on Guam –M. Marutani

Introduction and Evaluation of Cultivars and Rootstocks of Woody Perennial Fruits on Guam – T. Marler

Development of a Culturally Appropriate Diet Assessment Instrument for Children on Guam – R.S. Pobocik

Balanced N & K Fertilization Through Drip-Irrigation Systems on Cucumbers – J. Cruz

Biological Control of Beanfly and Pod Borer on Guam – D.M. Nafus

Cucurbit Pest Management for Guam –I. Schreiner

Study of Tinangaja, Black Leaf Streak and Papaya Ringspot of Guam – G.C. Wall

Development of Trap Cropping and Biological Control Methods for Crucifer Crop Pests on Guam – R. Muniappan

Management and Adaptation of Selected Warm Season Turfgrasses in the West Pacific Region – G. Wiecko

Regional Research Projects

Water Nutrient Management of Crops Under Micro-Irrigation – P. Singh

Biological Suppression of Soilborne Plant Pathogens – G.C. Wall

Biological Control in Pest Management Systems of Plants – D.M. Nafus

Regional Research Coordination

Regulation of Photosynthetic Processes – T. Marler

Chemistry and Bioavailability of Waste Constituents in Soils – P. Motavalli

Tropical and Subtropical Agricultural Research Projects

Evaluation of Tropical Legumes as Green Manures in Vegetable Production on Guam – M. Marutani

Evaluation of Processing Indigenous Feeds as Substitute for Imported Poultry Feed — F. Abawi

Dynamics of Root Growth, Water Uptake and Automation of Micro-Irrigation Scheduling – P. Singh

Control of Pumpkin Beetles, *Aulacophora similis*, by Techniques Using Little of No Insecticide – D.M. Nafus

Research on Tropical Mushroom Production with Used Paper, Sewage Sludge and *Leucaena* wood chips – E. Neri Imperio and G.C. Wall

Turfgrass Fertilization in Guam — J. McConnell & F.J. Cruz

Development of Diamondback Moth and Cutworm Management Program for Head Cabbage – R. Muniappan

The Papaya Root System: Characterizing for Optimum Cultural Management –T. Marler

Control of Important Viral Diseases of Cucurbits in the American Pacific Islands – G.C. Wall

McIntire-Stennis Projects

Causes of Failure of Regeneration of Native Trees in Limestone Forests of Guam –I. Schreiner

Control of the Poinciana Looper on Guam –D.M. Nafus

Nitrogen Fertilization of Ironwood and Mahogany Trees used as Windbreaks on Guam –T. Marler

Micropropagation of two Tropical Leguminous Trees in the Mariana Islands –M. Marutani

NAPIAP

Evaluation of Pesticides Against Pests of Solanaceous Crops on Guam –M. Marutani

Fungicides Tests for Control of Plumeria Rust – G.C. Wall

Aquaculture

Mangrove Crab as a Model for Development of a Quarantine System to Screen Species for Aquaculture in Guam – I. Silva-Krott

Gill Discoloration in *Penaeus stylirostris* – I. Silva-Krott

Other Projects

Schreiner, I., G.C. Wall, L. Yudin, D.M. Nafus, et al. Cucurbit Management for the Pacific Islands. 1994-1996. ADAP $29,200 (first year)

Ifit Tree - DOD Contract – T. Marler

College of Micronesia MOU – C.T. Lee/R. Muniappan

Dietary Guidelines – R.S. Pobocik, ADAP project.

Diet Assessment – R.S. Pobocik and J. Brown, ADAP project.

CONFERENCES & WORKSHOPS attended by AES Faculty

Name State/Country	Conference Date
Abawi, F.	83rd Annual Meeting of the Poultry Science Association Mississippi Aug. 7 - 12, 1994
Brown, J.	Annual Meeting of the World Aquaculture Society New Orleans, LA Jan. 12 - 18, 1994
Brown, J.	Technical Committee of the Center for Tropical and Sub-Tropical Aquaculture Honolulu, HI April 19 - 21, 1994
Brown, J.	Investigate the Production Economics of the Mangrove or Mud Crab Penang, Malaysia/Tungkang, Taiwan Aug. 13 - 28, 1994
Diambra, O.	83rd Annual Meeting of the Poultry Science Association Mississippi Aug. 7 - 12, 1994
Marler, T.	Establishing and Maintaining a Container Nursery Pohnpei, FSM Feb. 10, 1994
Marler, T.	Growing Tropical Fruits on Pacific Islands Pohnpei, FSM Feb. 11, 1994
Marler, T.	Fruit Production in Palau Palau March 10, 1994
Marler, T.	Tropical Fruits for Palau Palau March 11, 1994
Marler, T.	Teaching Botany in the Classroom Miami, FL June 20 - 29, 1994
Marler, T.	Annual Mtg. of the American Society of Plant Physiologists Portland, OR July 30 - Aug. 3, 1994
Marler, T.	Annual Meeting of American Society for Horticultural Science Corvallis, OR Aug. 7 - 10, 1994
Marutani, M.	91st Annual Meeting of the American Society for Horticultural Science Corvallis, OR Aug. 6 - 10, 1994
Marutani, M.	XXIV International Horticultural Congress Kyoto, Japan Aug. 21 - 27, 1994
McConnell, J.	Annual Meeting of the American Society for Horticultural Science Corvallis, OR Aug. 6 - 10, 1994
Motavalli, Peter	Agroecosystems in the Caribbean & Pacific Islands Orlando, FL Oct. 15 - 19, 1994
Muniappan, R.	Tropical and Subtropical Agricultural Research - Pacific Basin Administrative Group Meeting Hawaii April 5 - 9, 1994
Muniappan, R.	Compositae Conference London, England July 25 - Aug. 5, 1994

Pobocik , R.S.	ADAP Diet Assessment Training Chuuk, FSM Jan. 3 - 7,1994
Pobocik, R.S.	ADAP Diet Assessment Training Saipan, CNMI Jan. 19 - 21, 1994
Pobocik, R.S.	ADAP Nutrition Committee Meeting Honolulu, HI Feb. 6 - 8, 1994
Pobocik, R.S.	ADAP Diet Assessment Rep. of Belau July, 25 - Aug. 3, 1994
Singh, P.	Agroecosystems in the Caribbean & Pacific Islands Orlando, FL Oct. 15 - 19, 1994
Singh, P.	W-128 Western Regional Project Technical Committee Annual Meeting Kona, HI Oct. 24 - 28, 1994

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Marler, T.E. 20 March 1994. Wild Guava Plants Range All Over Guam. Islander Magazine, Pacific Daily News, Cover Photo and p. 8.

Marler, T.E. 24 April 1994. Those Crazy Fruits. Islander Magazine, Pacific Daily News, pp. 6-7.

Marler, T.E. 24 April 1994. How to Choose a Fruit Tree. Islander Magazine, Pacific Daily News, p. 7.

Marler, L. and T. Marler. 28 August 1994. Ivory Nuts. Islander Magazine, Pacific Daily News, Cover Photo, pp. 5-6.

Marler, T. 28 August 1994. Ivory from a Tree. Islander Magazine, Pacific Daily News, p. 7.

Marler, T. 28 August 1994. Kapingamarangi. Islander Magazine, Pacific Daily News, p. 6.

Marler, T. and B. Lawrence. 8 August 1994. Moving Grown Palms is not Really a Huge Job. Islander Magazine, Pacific Daily News, p. 12.

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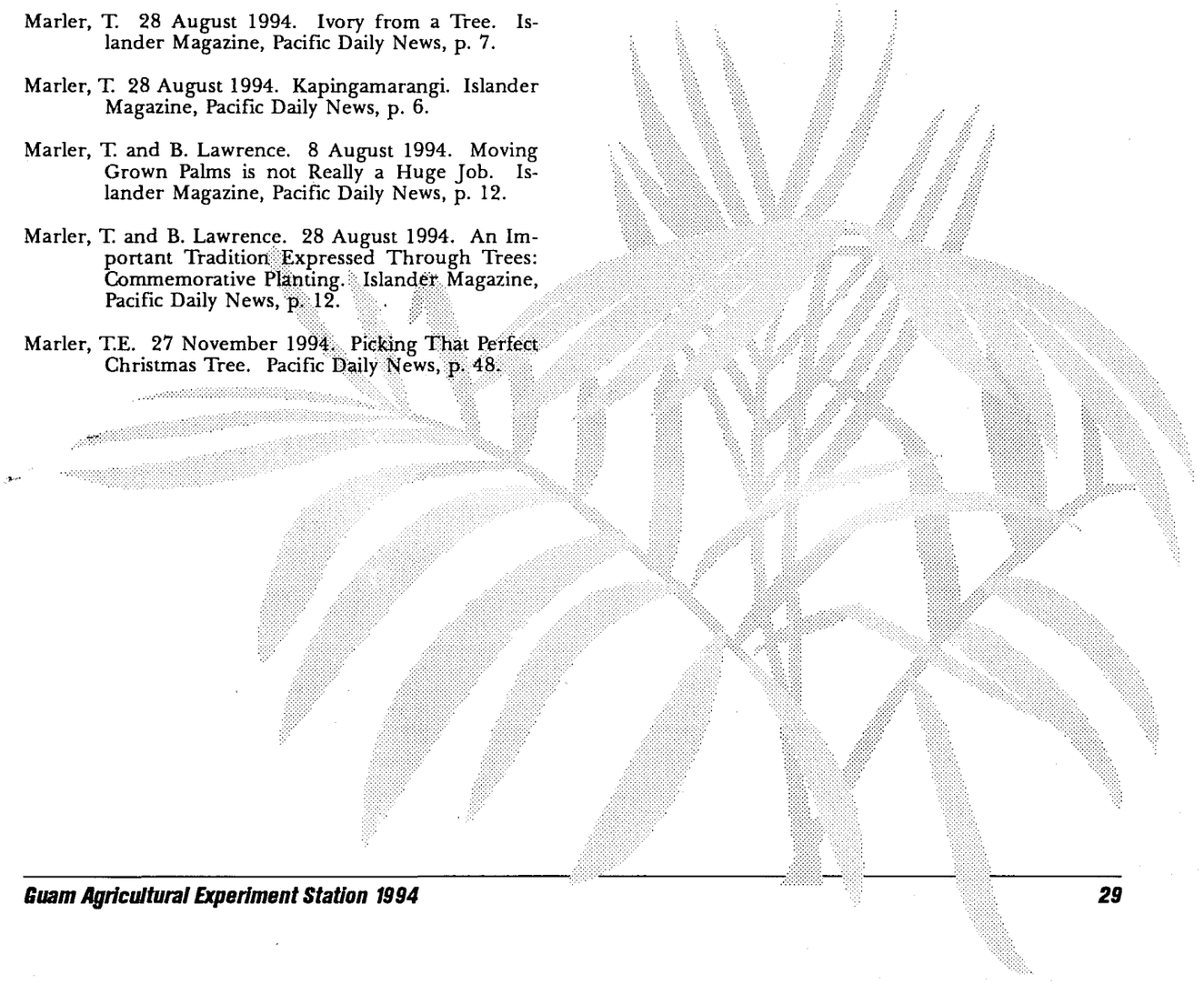

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