GUAM AGRICULTURAL EXPERIMENT STATION

University of Guam
Annual Report
1986

FROM THE DIRECTOR

In 1986, collaborative research programs with the International Research Sites Network for Agrotechnology Transfer (IBSNAT) and the International Potato center (CIP) were continued.

Research facilities for ornamentals were completed.

The stations has expanded its stations to Yigo and Barrigada in addition to Inarajan and Ija. The additional sites will provide opportunities to experiment in different soils of the Northern, Central and Southern parts of the island.

AES faculties were involved with FAO and UNDP with travels to the Maldives for biological control of the giant African snail survey of insects including training of local personnel to survey, recognize and collect insects, respectively.

Experiment station personnel were heavily involved in the College of Agriculture and Life Sciences' planning efforts. It is anticipated that research projects henceforth be much more integrated.

In 1986, Dr. Muniappan elected to do full time research. Dr. Demeterio was appointed in December as Associate Director for AES.

WILFRED P. LEON GUERRERO
DEAN/DIRECTOR

The cover designed by Cecilia A. Perez features several photographs depciting the work of the beneficial insect Pareuchaetes pseudoinsulata in controlling the pest weed Chromolaena odorata.
Photos by: Dr. R. Muniappan, Professor of Entomology

AGRICULTURAL EXPERIMENT STATION

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AGRICULTURAL ENGINEERING

Calvin A. Saruwatari and Chin-tian Lee

Introduction

Research continued in agricultural engineering to study the application of micro-irrigation to vegetable crops on Guam. Field trials were carried out to determine the water requirement under micro-irrigation for cucumber on a private farm field. Domestic water was used.

Description of Experiment

A continuous function design with five water treatments and three replications was initiated on cucumber (Market King). Treatments 1 to 5 were set at 1.0 hours, 1.5 hours, 2.0 hours, 2.5 hours, and 3 hours per day, respectively. The discharge rate of the RIS Biwall was approximately one gallon per minute (224 liters per hour) per 100-foot (30-meters) lateral with a 18-inch (46-centimeter) spacing. Rainfall was measured on site and totaled approximately 9.43 inches (23.9 centimeters). Preplant fertilizer was applied at a rate of 10 pounds per 100 feet (22 kg per 30 meters) of 10-30-10 fertilizer and a side dress was applied at the same rate of 21-0-0 fertilizer. Insects problems and plant diseases were noted and treated with Dibrom, Tribasic Copper Sulfate, Sevin, and Dithane M-22 as part of the general spraying program. The irrigation system was not turned on during weekends and on days following rainfall measuring more than 0.5 inches (13 millimeters).

Results and Discussions

Analysis of the data collected showed no significant difference in the number of fruits formed between the treatments. No significant difference was found between the treatments.

Conclusions

Based on the results of this experiment, irrigating at least one hour per day in the absence of rainfall is sufficient for growing cucumbers on this particular soil type (Guam variant). Since the total applied water in Treatment 1 of one gallon per minute (224 liters per hour) per 100 feet (30 meters) is equivalent to an application of 0.32 inches (0.85 centimeters), the irrigation system need not be turned on if the rainfall exceeds 0.5 inches (13 millimeters). Additional irrigation will not increase yield.

The recommended harvest length for this variety of cucumber (Market King) is about 8 to 9 inches (20 to 23 centimeters) in length and a one inch (2.5 centimeter) diameter with harvesting taking place just prior to seed formation in the cucumber. It was found that the local preference was for a cucumber of 10 to 12 inches (25 to 30 centimeters) in length and at least an inch and a quarter (3.2 centimeters) in diameter.

AQUACULTURE

Stephen G. Nelson

This year our studies focused primarily on the feeding biology of rabbitfishes (siganidae) and included work on assimilation efficiencies and food preferences of the fish.

Siganids are one of several groups of herbivorous fishes commonly found in tropical coral ref and mangrove habitats. They are among few such fishes with characteristics which render them suitable for aquaculture. A particularly desirable feature of the group in this regard is that, in nature, siganids feed almost exclusively on a variety of filamentous and fleshy macroalgae. The abilities of these fishes to utilize macroalgal diets has stimulated interest in the development of algal-based, siganid culture systems within the tropical Pacific.

We were particularly interested in Siganus argenteus, a common species which has been suggested for culture within the region. Examples of the results of our work with this species are shown in Tables 1, 2 and 3. Tables 1 and 2 display the results of the compositional analyses of diets and corresponding agesta for fish fed in the laboratory and fish which had been recently feeding in their natural environment. Table 3 compares the assimilation efficiencies of juvenile siganids which were either fed mono-algal diets or had been recently feeding on the naturally occurring alage of the reef-flats. An interesting point from this data was that the wild-caught fish had stomach contents which were higher in nitrogn content than found in any of the experimental algal diets. This suggests that the fish either supplemnet their diet with non-algal high-protein sources or that they can select high-protein thalli or portions thereof. We intend to further explore this issue. Studies of the feeding preferences of siganids were also intiated.

In addition to the work with siganids, analyses of the data concerning the physiology of agarophytes of the genus Gracilaria were completed. These seaweeds are often sold in fresh vegetable markets on Guam and may be usefully incorporated into brackfish or marine culture systems here.

Table 1. Organic and nitrogen contents (%) of algal diets and corresponding egesta of juvenile rabbitfish Siganus argenteus. The values represent means of three anlysis.

	Ingested		Egested	
Diet	Organic	Nitrogen	Organic	Nitrogen
Enteromorpha	81.62±0.88	2.72±0.36	66.84±0.23	1.06±0.05
Gracilaria	94.20±0.57	3.66±0.14	81.16±1.18	1.88±0.25
Hypnea	81.38±1.25	3.23±0.30	69.66±2.35	2.30±0.20
Sargassum	87.10±1.60	2.36±0.46	77.00±2.83	1.47±0.13

Table 2. The organic and nitrogen contents (%) of replicate samples of stomach and rectal contents of juvenile rabbitfish Siganus argenteus collected from the reef at of Pago Bay, Guam.

Sample	Organic Content	Nitrogen Content
Stomach	87.95	8.56
Somach	85.88	9.21
Rectal	78.32	6.23
Rectal	78.05	6.45

Table 3. The assimilation efficiencies for total organics and nitrogen of juvenile rabbitfish Siganus argentus.

	Assimilation Efficiency (%)	
Algal Diet	Organic	Nitrogen
Enteromorpha	54.63	72.67
Gracilaria	73.41	84.15
Hypnea	47.44	56.24
Sargassum	50.86	65.38
Natural	46.03	57.12

CROP MODELS

T.C. Tseng

Introduction

The rapid introduction of new agrotechnologies to Guam and the Micronesian islands in the past two decades requires a better understanding of the complex inter-relations among soil, weather, irrigation, fertilization, and the growth of crops for farm management. The limited technical manpower and the high costs of collecting reliable data make it difficult to carry out comprehensive field analyses of crop growth and crop production on Guam. Computer crop models have been used to alleviate some of the problems by simulating crop growth and crop yields under various environment conditions. The objective of this project is to develop integrated models for cash crops cassava, corn and papaya. The models are based on the general grain model CEREAL and the perennial crop model EPIC developed in the United States; and adapted to the weather and soil components of the Western Pacific tropical environment of Guam and the Micronesia islands. Interactive microcomputer version of the models with extensive prompts for options and input parameters makes them more portable and easier accessible to the general users.

Results

Impact to Date or Expected

Adaptation of the CEREAL model developed by C.A. Jones et al., of the USDA Agricultural Research Service, Temple, Texas to Guam's environment has basically completed. Major changes from the Texas model are the climatological equations. These equations were simplified from the general ones applicable to the four-season temperate zones, to those applicable only to the wet-dry periods of the tropical zones. In particular because of the relative stable patterns of weather in the Micronesian islands, a set of more detailed estimations on the seasonal variations of sunshine hours, solar radiation, heat unit, relative humidity and potential evapotranspiration rates were introduced into the model; and the snow and frost components were deleted. In addition, a microcomputer-base interactive version, again adapted from the Texas' micro-version, has also been completed in this phase of project. The adapted microcomputer version emphasizes user-friendliness by extensively employing menus and comments on computer screen to prompt users to enter the relevant cultivar-specific parameters from the keyboard. It also prompts the user to select weather, soil, and fertilizer data-set names. The adapted interactive model includes further two subroutines: a subroutine for conversion of units for the input data, and subroutine for interpolation of missing data that are needed by the model. Missing data are common in field measurements and large data sets that involve keeping records over long periods of time, such as those of weather, soil, and fertilizer components. The adapted model for Guam environment is now in the validation stage. Corn data gathered by Dr. Cope and Dr. Demeterio at the University of Guam's Inarajan Experiment Station in 1985 and 1986 respectively, were used for validation. Using the cultivar-specific parameters provided by Dr. Jones for his Texas model and the Inarajan field data, both the Texas and the Guam-adapted models predicted higher corn yields than those actually harvested. The difference between the prediction and the observation may be due to the tropical environment, which may affect the physiology of the cultivars that were developed in the temperate U.S. mainland but planted on Guam. A fine-tuning of the parameters for these cultivars with the Inarajan data by nonlinear steepest-descend method is now in progress.

DATABASE

K.L. Carriveau

Introduction

The Micronesian Area Tropical Agriculture Database Center began in 1982 as a cooperative venture of the College of Agriculture & Life Sciences and the Robert F. Kennedy Memorial Library. The goal of the project was to gather in one location all published and unpublished documents produced in or about Micronesia concerning tropical agriculture and related subjects, and to provide bibliographic information retrieval and document dissemination services. Although the federal funding will end in June of 1987, the University of Guam has committed resources to insure continuance of the life sciences database. In 1986, the Micronesian Area Research Center assumed responsibility for the project and for the ultimate expansion of the model into a topically comprehensive access tool.

Objectives and Accomplishments

One major problem facing researchers in Micronesia used to be the access to information about agricultural research on a timely basis. The problem has been largely resolved as a result of this project. Its objectives and accomplishments may be summarized as follows:

1) Identifying sources of materials being published and making arrangement for automatic deposit of such materials with the center.

The major producers of agricultural documents in the Micronesian region have been identified and memoranda of understanding for automatic deposit have been negotiated with and signed by the governors and/or ministries of the Commonwealth of the Northern Mariana Islands, the Federated States of Micronesia, the Republic of Belau, and the Republic of the Marshall Islands. Bibliographic databases such as AGRICOLA and BIOSIS are searched routinely for the identification of published materials about Micronesia as the basis for future acquisitions.

2) Identifying and providing bibliographic access to information currently available as sections of books, journals, reports etc.

Computerized access to bibliographic information is provided to agriculturists both in inquiry and batch modes. The center uses IBM's SQL/Data System as the bibliographic information management system. The system's Interactive Structured Query Language was specifically designed for people who have little or no knowledge of computers. The Micronesian Area Tropical Agriculture Database (MATADB) was designed to provide timely access to comprehensive bibliographic information, and is intended to supplement rather than supplant existing resources, e.g., AGRICOLA. Each record is composed of six columns, i.e., AUTHOR, TITLE, SOURCE, DOCNO (document number), CALLNO (call number) and KWI (key word index/abstract). The key word abstract is a composite of fixed language subject headings taken from the Thesaurus of Key Words and natural language key words abstracted from the text of the document itself. A user can request a bibliography of references by author, by words within a title, by source, or by subject. More sophisticated searches can be done by using Boolean logic search strategies.

3) Provide services to collect, abstract, index and store materials produced in or concerning the Micronesian area in fields related to tropical agriculture.

The acquisition of materials is done through purchases, site visitations and automatic deposits. Once acquired, each item is indexed and abstracted for entry into MATADB. Monographs and serials are cataloged and incorporate into either MARC's Pacific Collection or the main library's collection for storage. Offprints, reprints and unpublished materials are stored on specially designated shelves in the Micronesian Area Research Center.

4) Maintain profiles of scientist working in the Micronesian area in terms of ongoing projects and long-term interests.

A database called Agriculture Registry (AGREG) was developed to keep track of project participants. Its scope is similar to USDA's Current Research Information System (CRIS) and makes provision for the recording of a person's name, title, address, phone number, interests, and projects. The database is updated annually and serves as a reference for identifying potential publications and for identifying appropriate audiences for the Selective Dissemination of Information serivces.

5) Provide Selective Dissemination of Information Services

A user's guide to SDI Services was published and mailed to all project participants in order to facilitate the dissemination of information. The guide indicates how to formulate appropriate search strategies and provides the requisite forms for document photoduplication services. Once a search request is received, a "quick bibliography" is generated and is sent not only to the requester but also to project participants who have a similar interest profile registered in AGREG. Beginning this year, a "quick bibliography" of what has been published within the past year will be generated and will be sent to all participating agencies in Micronesia.

6) Provide reference service to scientists working in the field throughout Micronesia in terms of being able to produce bibliographies and photoreproductions of documents on demand.

Reference services are available. However, requests for such services have been few. As in previous years a mini-workshop was conducted in 1986 in order to advertise the center's service capabilities. The workshop was open ot the public and was presented as a Micronesian Area Research Center Seminar. Scientists have been guaranteed the tailor-made bibliographies can be produced within 24 hours for off-line search requests or instantaneously through on-line searching.

7) To be able to exchange bibliographic data and copies of publications with similar tropical agriculture centers in Hawaii, Fiji, and elsewhere.

The center is now able to exchange bibliographic data with similar institutions either on tape or in hard copy. Informal working relationships have been made with the University of Hawaii's Pacific Collection, the Pacific Basin Development Council, the Institute of Pacific Islands Forestry, the University of the South Pacific's Pacific Information Center and the South Pacific Commission to share bibliographic data and/or publications. More formal working relationships have been established through memoranda of understanding with the Ministry of Agriculture & Lands, Solomon Island Government, the Department Resources Development, Kiribati, and the Institute of Natural resources, University of South Pacific. Interest in this area would seem to indicate that a Pacific region bibliographic network is feasable, but actualization of such a network may take some time to accomplish.

Future Prospects

On the whole, the Micronesian Area Tropical Agriculture Database project has been very successful. The initial problems of identifying and appropriate application program and of hiring research assistants have been resolved. In short, the project's goal has been accomplished in large part, and the University of Guam has committed resources to continue the work even when the federal funding ends. The Micronesian Area Research Center recognizes the applicability of the model to other disciplines and has already committed funds to expand MATADB's scope to include all life sciences. Grant applications have been submitted to the National Endowment for the Humanities and to the National Institutes of Health in order to continue the database's expansion.

ENTOMOLOGY - Biological Control

Donald Nafus

In 1986, studies were concentrated on the following topics: the establishment and effectiveness of *Ganaspidium hunteri* on the leafminer, *Liriomyza trifolii*; an evaluation of significance and natural enemy complex associated with the wooly whitefly, *Aleurothrixus floccosus*; and the biology and biological control of the mango shoot caterpillar, *Penicillaria jocosatrix.*

Status of release of *Ganaspidium Hunteri*

The release of *Ganaspidium hunteri* has continued to be monitored. Although additional recoveries of *G. hunteri* have been made, the parasite is uncommon and has had little impact on *L. trifolii* populations to date.

Biological Control of the Wooly Whitefly, *Aleurothrixus Floccosus*

A) Parasite Survey

The wooly whitefly was first noticed on Guam in 1984 and was causing serious problems on guava and citrus. In 1986, a survey program was initiated to determine if there were any parasites attacking the whitefly and if parasites should be imported for release. In addition, the population levels of the whitefly were monitored on different types of citrus.

Methods

Survey sites were set up in five villages. Two tangerine trees in each village were sampled each month beginning in March. On each tree, ten mature leaves were randomly collected. The number of whitefly nymphs and pupae, eclosed adults and dead whiteflies with exit holes of parasites were counted. All leaves were held and emerged parasites were collected for identification.

Results

Wooly whitefly populations were high in March but declined rapidly thereafter (Figure 1). A parasite, *Eretmocerus* sp. was found parasitizing the whitefly. About 40% of the whiteflies were parasitized in the initial sample. This percentage increased to about 60% in subsequent samples and has remained relatively constant since then. Whitefly numbers are currently not causing economic damage.

B) Survey of parasites on different citrus types

Lemon, lime, pomelo, tangerine, and calamansi were checked to see if there were differences in the population levels of wooly whitefly and in the rates of parasitization.

Methods

The study was conducted in an orchard in Yigo. Five trees each of lemon, lime, pomelo, tangerine, and calamansi were sampled every 3 months. On each tree, ten mature leaves were randomly collected. The number of whitefly nymphs and pupae, eclosed adults, and dead whiteflies with exit holes of parasites were counted. All leaves were held for parasites and wooly whitefly emergence.

Results

Tangerine had the highest populations of wooly whitefly. Parasitization rates were similar on all types of citrus (Table 1).

Biological Control of the Mango Shoot Caterpillar, *P. Jocosatrix*

A) Impact of caterpillar on fruit and leaf production

Studies of the impact of *P. jocosatrix* on mango were conducted to assess the impact of the caterpillar on flower and fruit production.

Methods

The studies used the same methods as reported in 1985. Two sties were selected for study, Agat and Barrigada. At each sites, 8 trees were selected, 4 treated and 4 were left as an untreated check. On each tree, 20 buds were randomly selected and tagged. The number of caterpillars, flushing leaves, and flowers produced were recorded for each of these buds.

Results

Caterpillar populations were low in 1986 (Figures 2 and 3) and study trees sustained little damage compared to the trees studied in 1985. New shoots suffered little defoliation and both treated and untreated trees had one major flush and little flush thereafter. Flower and fruit production was similar on untreated and treated trees.

B) Basic biology of the caterpillar

The basic biology of the mango shoot caterpillar was studied to provide needed information for pest management and for initiation of biological control.

Methods

The studies were conducted under field conditions in Barrigada. Individual shoots on a mango tree were randomly selected as the buds began to break. All shoots on each branch were followed. Each day the shoots were searched for eggs and larvae. The location of the eggs were recorded. All larvae were marked with india ink on the head capsule. The location, head capsule size, body length were measured daily. A daily record of the size and age of the leaves on each shoot were kept.

Results

Eggs were laid on breaking buds and young leaves until about 11 days after budbreak. The eggs hatched in 2-3 days and the caterpillar went through 5 instars. Development was extremely rapid with the caterpillar going through an instar a day (Table 2). The feeding period lasted 5-6 days before the caterpillars left the leaves to search for pupation sites in cracks or crevices in the bark or in the soil at the base of the tree.

The larva fed only on the new growth. First instars feeding on leaves which were older than 10 days suffered high mortality. Older instars consumed leaves up to 13 days old, at which point the leaves changed from brown to green and became tougher. After this time the leaves were not suitable as a food source.

C) Natural enemy survey and release of biological control agents

Eggs, larvae, and pupae were surveyed for local parasitoids. No parasitoids were found attacking any of the life stages. Predatory wasps, 3 species of *Delta*, were observed removing the caterpillars from the trees. The impact of the predators is unknown at this point.

The wasp, *Aleoides* sp. near *circumscriptus*, is being released as a potential control agent for the caterpillar. It is a solitary larval parasite which attacks the first 3 instars. Shipments of about 150 Mummies have been found on the release trees the week after release, and in one case on an adjacent trees three weeks after release. Surveys are continuing.

Trichogramma platneri was released but has not been recovered from the mango shoot caterpillar to date.

Releases of other parasites will be made in 1987.

Table 1. Parasitization of the wooly whitefly on various types of citrus.

Host plant	% Parasitized wooly whiteflies	Number wooly whiteflies/10 leaves
Calamansi	46	8.0
Lemon	64	6.9
Lime	41	9.7
Pomelo	41	17.0
Tangerine	49	36.0

Table 2. Duration and sizes of life stages and instars of the mango shoot caterpillar.

Life stage	Instar	Duration (in Days)	Head capsule (mm)	Body length (mm)
Egg	1	2-3	0.2	2-4
Caterpillar	2	1	0.5	4-7
	3	1	1.0	8-11
	4	1	1.5	11-17
	5	2-3(1-2 feeding)	2.5	17-22
Pupa		11-12		

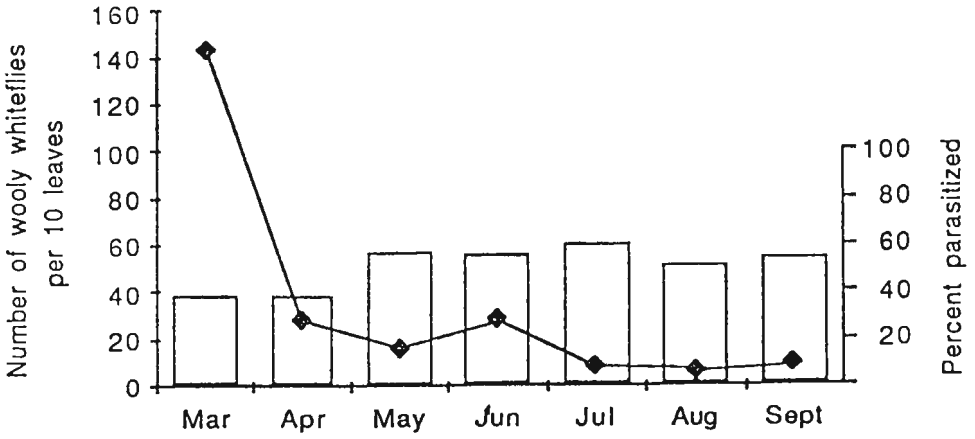


Figure 1. Changes in the population of wooly whiteflies in relation to the percent parasited

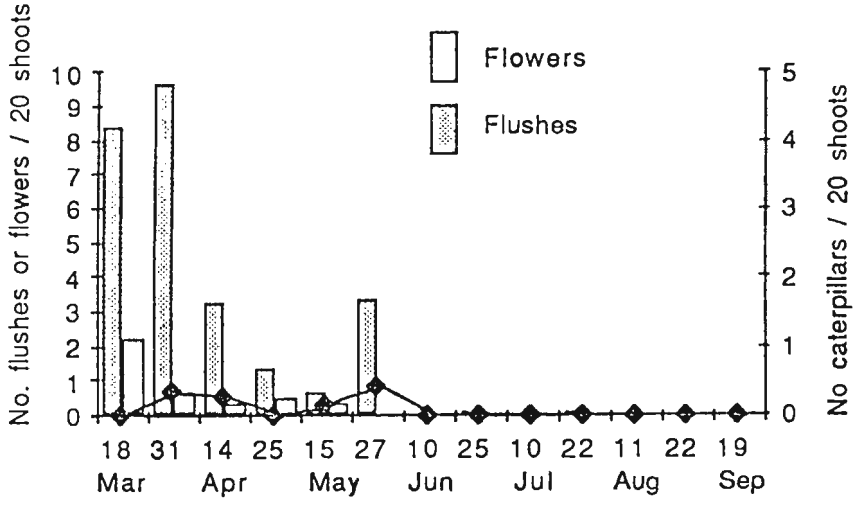


Figure 2. Number of flowers and flushes in relation to populations of the mango shoot caterpillar in 1986: untreated trees.

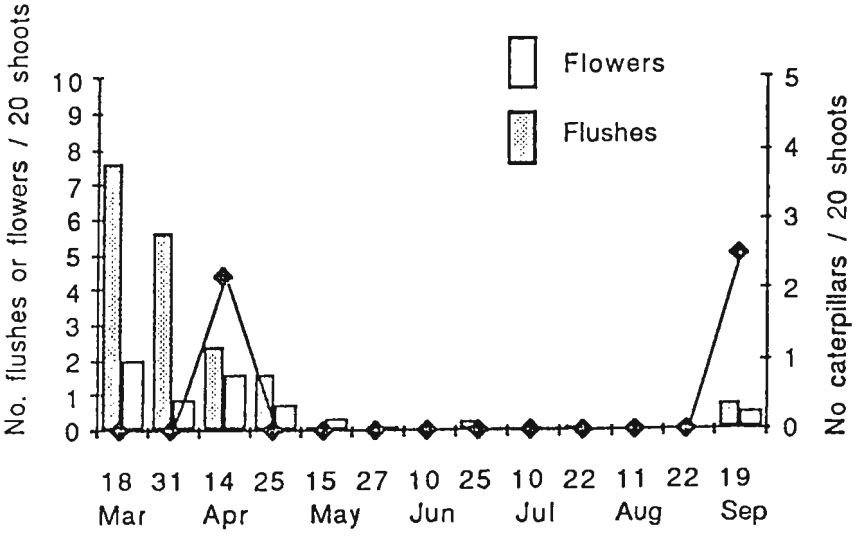


Figure 3. Number of flowers and flushes in relation to populations of the mango shoot caterpillar in 1986: treated trees.

ENTOMOLOGY - Biological Control of *Chromolaena odorata*

T.F. Seibert

Introduction

In 1985 *Pareuchaetes pseudoinsulata* established and was doing widespread defoliation of *Chromolaena odorata* on Guam. This year the project concentrated on follow-up information on the extent of the damage caused by *Pareuchaetes* and any effects a reduced population of the weed may have on the insect. Introductions to the Northern Mariana islands of Rota and Tinian were made. Additionally, an additional year of funding was obtained so that efforts to get *Mescinia* sp near *parvula* (Pyralidae) and *Melanagromyza eupatoriella* (Agromyzidae) from Trinidad could be made.

Pareuchaetes pseudoinsulata

Pareuchaetes pseudoinsulata introductions that have failed or succeeded in the past both lack follow-up studies to determine why they failed or what the impact was on the *Chromolaena* population. The follow-up needs to be continued for a number of years if establishment occurs so that the rate of impact can be evaluated and the dynamics of the decline or recovery can be understood.

Impact of Defoliation on *C. odorata* Density

Data on control through 1986 showed that *Pareuchaetes* can have a significant impact on the weed, however, the local *Chromolaena* population growth characteristics may influence the success of the insect. The best results by *Pareuchaetes* appear to be obtained in open fields that are heavily infested by the weed. Under these conditions movements by the insects are unrestricted and a continuum of the weed or local *Chromolaena* refuges from the original allows for maintenance of a local insect population despite reduced plant availability after the initial defoliation. Changes in field site plant density six months and one year following colonization by *Pareuchaetes* are shown in Fig.1 for three sites. It can be seen that heavy mortality was inflicted on the *Chromolaena* populations. The insects must maintain a population in the area to inflict the continuous damage necessary to cause plant mortality by resource drain. Roadside and patchily distributed populations of the weed appear to recover to a greater extent than field populations because of local extinctions of *Pareuchaetes* before refoliation from the root crown occurs and food availability is renewed. Despite this mortality and the significant reduction in seed weight and germination reported last year, some plants will eventually recover and new individuals will develop from seeds in the soil. Therefore it is important that further follow-up studies on the progress of *Chromolaena* recovery be conducted to determine what the ultimate impact *Pareuchaetes* has on the *Chromolaena* population.

Pareuchaetes Releases - Rota & Tinian

In February releases of *P. pseudoinsulata* were made on Rota, CNMI. The first release consisted of approximately 1000 adults, the second of approximately 500 adults, both field collected on Guam the night prior to their release. The first shipment was released approximately one half mile west of the airport, the second approximately one quarter mile east of the airport.

A follow-up survey conducted in November revealed the insects were widely defoliating at virtually all locations at lower elevations on the island. The local farmers apparently took a great interest in the work of the insects and transported truckloads of the caterpillars on uprooted *Chromolaena* at the front of the infestation to their farms. Only the east and west ends of the island and the fields on the central mountain appeared to not yet have the insect.

One shipment of approximately 500 insects was released in early October on Tinian approximately 2 miles north of the airport. No follow-up has yet been conducted.
Mescinia and *Melanagromyza.*

As mentioned above, long term control of *Chromolaena* by *Pareuchaetes* is still uncertain. Particular concern results from the poor colonization ability of *Pareuchaetes*. Because of this, efforts to import the stem borers *Mescinia* sp near *parvula* and *Melanagromyza eupatoriella* were initiated. These insects are hoped to be complimentary to the damage done by *Pareuchaetes* by stunting the elongating growth of the stems that overgrow native vegetation. This stem elongation is what I consider to be the most aggressive character of the plant in its takeover of adjacent vegetation. Additionally, *Melanagromyza* is an excellent colonizer of patches as I found on a visit to the native range of the weed in Trinidad. Virtually, every patch of the weed had some stems attacked by this agromyzid fly.

Permits were obtained for both species and the first shipments from the Commonwealth Institute of Biological were received in December. Unfortunately, these insects have not been successfully bred in captivity and thus those received were field released after screening for parasites in quarantine. The small number released in the field lessens the chances of establishment however currently there is no alternative. Only 21*Mescinia* adults emerged and were released, while only 26 *Melanagromyza* were released.

Conclusions

The damage done thus far by *Pareuchaetes* is very encouraging. *Chromolaena* numbers have been greatly reduce in field habitat and the weeds appear to have been largely replaced by other vegetation. Time will be necessary to determine whether the weed can recover from this significant damage. One consideration that must be made is whether the vegetation replacing the *Chromolaena* is more desirable than the weed itself. Both weedy and desirable species have been replacing *Chromolaena.* Some form of pasture management is going to be necessary both to prevent easy recolonization of overgrazed pastures by *Chromolaena* and to ensure that the species in the community replacing the weed are desirable.

Stem borers are an attractive addition to *Pareuchaetes* because of their damage and in the case of *Melanagromyza* because of its colonizing ability. The next year will concentrate on establishing stem borers and following the recovery of *Chromolaena,* if any.

ENTOMOLOGY - Pest Management

Ilse Schreiner

Eggplant

Eggplants (var.B-1) were transplanted July 9, 1986. Rows of twelve plants each, spaced 2 ft. apart were either mulched with black plastic, or left unmulched. The rows were 5 ft. apart. The insecticide tested was Sevin, applied at the rate of 2 tablespoons per gallon (2 lbs/ 100 gallons). The treatment was applied weekly throughout the growing cycle. The mulch and the insecticide treatments and the untreated control were each replicated 4 times. Counts of the insects present were done on three occasions. On the first occasion, the numbers of fleabeetles (*Epitrix hirtipennis*) and fleahoppers (*Halticus tibialis*) were estimated by counting the number of two leaves on each of 12 plants. More species of arthropods appeared later in the season. Leafhoppers (*Sundapterix* biguttula) and mealybugs (*Ferrisia virgata*) were estimated by counting the number of adults and nymphs on 4 leaves large leaves on each of 10 plants. The number of spider mites (*Tetranychus sp.*poss. *cinnabarinus*) and aphids (*Aphis gossypii*) were counted on the first fully expanded leaf on one shoot of each of ten plants.

Results

The insecticide treatment significantly reduced the numbers of most of the insect species (Table 1). However, the number of spider mites was significantly higher in the plots treated with Sevin. The yield was variable due to the heterogeneity of the field (which was on a slope) but a two way analysis of variance with position in the field and treatment as the two factors showed a significantly higher yield in the insecticide treated plots. Untreated plots appeared burned due to leafhopper damage by the later part of the growing cycle and most of the difference in yield can probably be attributed to control of the leafhopper. The mulched plots did not differ significantly in any way from the untreated plots.

Beans

A trial was run to compare several spray regimes for the leafminer, with no treatment for leafminer, but control of other pests. Beans were planted Feb 7, 1986. Plots consisted of two 6 m rows, 1.2 m apart. The rows were separated by rows of sweet corn to minimize insecticide drift. The treatments consisted of:

1) spraying once a week with Pydrin for the whole growing season;
2) spraying Pydrin weekly until the beans flowered and then spraying with Dibrom to control pod borers only;
3) spraying Cygon early for control of beanfly, and then spraying Pydrin weekly once flowering began; and
4) spraying Cygon for bean fly control and Dibrom for pod borers.

The number of leafminers per plot was estimated by counting the number of mines on 40 mature leaves in each plot. Yield was the total yield for both rows.

Results

The various spray regimes had no effect on leafminer numbers, and thus there were no differences in yield (Table 2). There was a slight but non-significant reduction in the percent pods damaged by borers if the Pydrin was used after flowering. Previous trials had shown Pydrin to be highly effective against leafminers and pod borers on beans. It is thought that the insecticide had become ineffective due to being stored for three years in a rather hot shed.

Cucumbers

Cucumbers (var.Slice Master) was planted Oct. 20, 1986. The plants were grown on trellises, in rows 5ft apart. Black plastic mulch was laid on all the rows, and they were fertilized with 16-16-16 at the rate of 100 lbs N/acre. To determine whether cucumber beetles (*Aulacophora similis*) could be controlled with insecticides applied in the soil, granular diazinon was applied to half the rows, whereas the other half were untreated. Each row was then split into three foliar treatment: either Sevin or Dipel applied weekly or no treatment. Cucumber beetles were collected from parts of Guam where they were abundant, and released into the fields on several occasions. *Diaphania indica* (melon worm) numbers were estimated by counting the number of caterpillars per leaf on each of 20 mature leaves per subplot. All yield was picked and weighed.

Results

Despite the attempts to colonize cucumber beetles, the number of beetles in the field remained very low and no damage due to them could be observed. The number of melon worms was significantly reduced in the subplots being sprayed with insecticides (Table 3). The number and total weight of cucubers was not affected by the soil treatment, but was significantly higher in the subplots treated with insecticides than in the control plot.

Mango

Control of Blotch Miner

To determine if Sevin, which is effective as a chemical to control mango shoot caterpillar was also effective in controlling the number of blotch mines on mango trees, the following experiment was set up. Each of four mango trees in Agat and Barrigada was sprayed weekly anytime that new leaves were observed on the trees. The trees were checked once a week to determine if new leaves were present. The same number of similar close-by trees served as control. When new leaves were present, they were sampled twice a week for blotch miners, by randomly choosing 20 shoots, and counting the number of blotch mines on one leaf of each shoot.

Results

The overall mean number of blotch mines per leaf was 6.1 ± 3.3 on the treated trees, and 6.0 ± 3.0 on the untreated trees. There was no significant difference in these two numbers ($t=0.093$; $P=0.928$). It is probable that checking the trees only once week resulted in spraying the trees to late, even supposing that Sevin might be effective. The blotch miners appear to attack only very young leaves. Once the blotch miners have attacked a leaf, the lesion remains whether or not the larva is killed by the insecticide. However, the mean number of mines per leaf was quite low, and it is unlikely that that number of blotch miners is damaging. Occasional susceptible trees may require control of the miner.

Populations of the Blotch Miner

The seasonal importance of blotch miner number was assessed in two separate samples. In the first sample, eight trees in Agat and eight trees in Barrigada were monitored. Twenty shoots were marked at the beginning of the year and every two weeks the marked shoots were observed to determine whether they had produced new leaves or flowers since the previous sample. At the same time, one leaf from each of 20 new shoots/tree (not necessarily those marked) were examined, and the number of blotch mines on the leaf was counted. If twenty shoots were not available, then the sample consisted of the number of leaves that were available at that time.

Because often the marked trees were lacking new leaves, so that sample sizes were small, a second monitoring program was begun. Once a month, four trees with many new leaves were examined in each of four villages (Merizo, Agat, Barrigada and Yigo). Numbers of blotch mines was recorded in a manner similar to the above.

Results

The population trends of the blotch miner in relation to the amount of the tree flushing can be seen in Figure 1. There does not appear to be a correlation between the amount of new leaves and the number of blotch miners. The population trend of the leafminers on heavily leafed trees in the four villages can be seen in Figure 2. Two full years of data will be required before it can be determined if there is a difference in seasonal incidence.

Table 1. Number of insects per sample and yield of eggplant.

Treatment	Fleabeetles July 23	*Halticus* July 23	Fleabeetles Sept. 4	*Halticus* Sept. 4	*Empoasca* Sept. 4	*Tetranychus* Sept. 4	*Aphis* Sept. 4
Sevin 4.4 lbs AI/acre	0.08a	0.7a	0.18a	0.3a	0.03a	22.7a	0.1a
Black plastic mulch	0.72b	2.5b	0.48a	1.0a	0.4a	0.4b	1.0b
Control	0.52b	1.9b	0.32a	1.1a	0.5a	0.4b	0.6ab

Treatment	*Empoasca* Oct. 28	*Mealybugs* Oct. 28	*Tetranychus* Oct. 28	*Aphis* Oct. 28	Number eggplants	Yield/row (kg)
Sevin	3.0a	0.1a	15.5a	0.0a	319	19.0
Black plastic mulch	20.8b	2.3a	0.2b	2.5b	139	11.4
Control	26.4b	2.2a	0.1b	1.4ab	169	9.8

Table 2. Effect of several spray regimes on leafminer numbers and yield in yard-long beans.

Treatment	Mean number leafminers/leaf	Yield/row Kg	Percent pod borer damage
Pydrin every week	16.6	14.1	2.9
Pydrin until flowering	15.2	11.3	4.3
Pydrin after flowering	17.4	12.3	3.7
No Pydrin	17.8	11.4	4.6

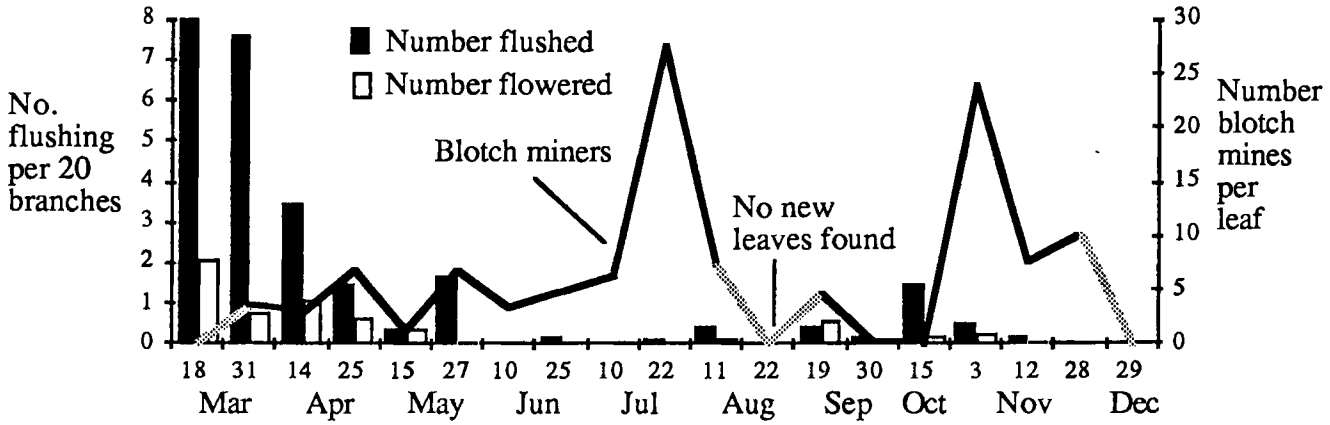


Figure 1. Number of branches flushing and flowering, and number of blotch miners per leaf on the continuous survey trees in Agat and Barrigada.

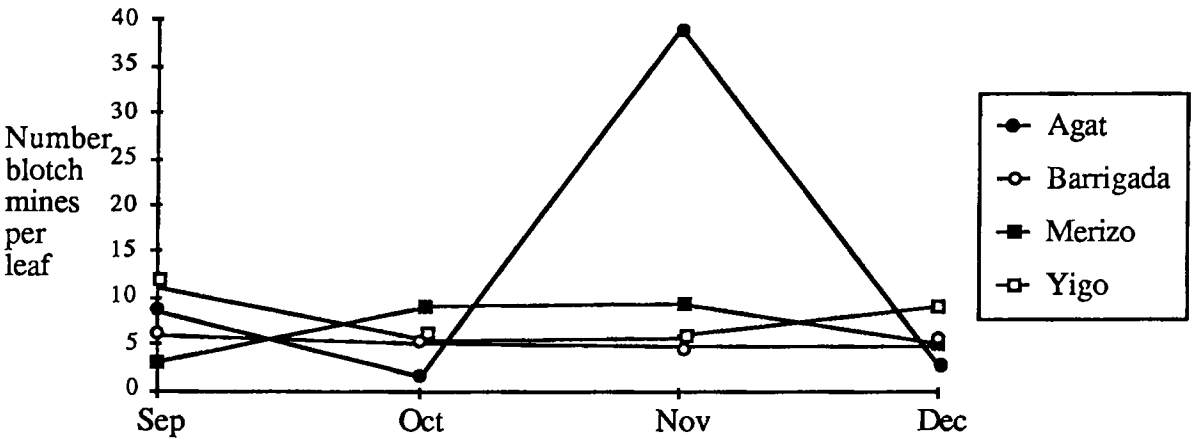


Figure 2. Number of blotch miners per leaf in the monthly survey of four villages.

Table 3. Effect of soil and foliar insecticides on *D. indica* numbers and cucumber yield.

Treatment and lbs AI acre	Number *D. indica* per leaf	Number cucumbers	Yield (kg)
Diazon 14G 41lbs Sevin 50WP 4.4 lbs	0.5	70	22.4
Diazinon 14G 4lbs+ Dipel 4.4 lbs	0.4	68	21.8
Diazinon 14G 4lbs	3.0	62	20.7
Sevin 50WP 4.4 lbs	0.9	77	26.9
Dipel 4.4 lbs	0.3	63	22.9
Control	2.2	59	19.4
Analysis of Variance			
Soil treatment F (and probability)	0.502(0.495)	0.01(0.92)	0.406(0.538)
Foliar treatment F (and probability)	27.654(0.0001)	4.35(0.027)	7.151(0.005)
Soil*Foliar Treatment F (and probability)	1.853(0.183)	1.77(0.195)	1.735(0.202)

ENTOMOLOGY - Pest Management and Biological Control

Ilse Schreiner and Donald Nafus

Corn

Two trials were set up to determine whether tillage methods affected the number of predators feeding on corn borers on sweet corn plants, and if this would affect yield. The first trial was planted April 25, 1986 with Hawaiians Supersweet #9 seed. The no-till plots were treated with Round-up (glyphosate)before planting and with 2,4 D (Weed-B-Gone) after planting. The tilled plots were tilled preplant, and hand-weeded and rototilled later. The plots were 4.5 m (15ft) wide and 18.3 m (60 ft) long, with corn rows planted 90 cm (3 ft) apart. The main plots were subdivided later in the season into 4 treatments, and treated with combinations of detasselling at the pollen-shed stage and/or weekly Dipel treatments. Ants were sampled with 4X10 cm index cards soaked in vegetable oil. Cards were either placed on the ground and sampled 20 minutes later to determine the number of ants of what species had been recruited, or clipped to the stalks of corn plants at about the level of the developing ear and sampled after 3 hours. Eight cards were used for each plot for each sample. The number of corn borers per plant was determined by dissecting 5 plants/subplot the week after detasselling. The yield was determined for the whole plot, and all ears were peeled to determine if they were damaged by corn borers.

For the second trial, the plots were made bigger, 17X17 m each. The same corn variety was used, planted on July 16, 1986. The main plots were subdivided into 6 treatments, which were treated with weekly with Lannate, Dipel or nothing and either detasselled at pollen shed or not. The various samples were done as above, except that because of the low number of corn borers present, 10 plants per subplot were dissected to determine the number of corn borers per plant. Yield was determined by randomly choosing 50 plants per subplot and collecting all yield from these plants.

Results

Pitfall traps set out during the first trial did not reveal any ground dwelling predators other than ants, which were more conveniently sampled with the-oil soaked cards than with pitfall traps. The tillage method had no effect on ant numbers in Trial 1 (Figure 1). Three species of ants recruited to oil-soaked cards on the ground, *Solenopsis geminata rufa* (F.), *Monomorium minutum* Mayr and *Tetramorium tonganum* Mayr (identifications tentative pending confirmation by a taxonomist). Two of these, *S. geminata* and *M. minutum*, recruited to oil-soaked cards placed on the stems of the corn plants and were occasionally observed feeding on corn borer egg masses. *S. geminata* was also frequently found in the stalk cavities made by older corn borer larvae, and appeared to be consuming pupae. The ant *Technomyrmex albipes* Fr. Smith was common on corn plants but could only be attracted to sugar bait. This ant was generally observed in association with the corn delphacid *Peregrinus maidis*, and was not observed to be a predator on corn borers.

The second trial took place during a period of extremely rainy weather, and ant activity was very low during the whole experiment. Despite the much larger plot size in the second trial, there was still no difference in ant activity in the till and no-till plots (Figure 2).

Given the lack of difference in predator activity between the tilled and untilled plots, if was not surprising to find no significant differences in the number of corn borers per plot between treatments in either the first or the second trial (Table 1). The yield of undamaged ears was also not significantly different between the two treatments in either trial.

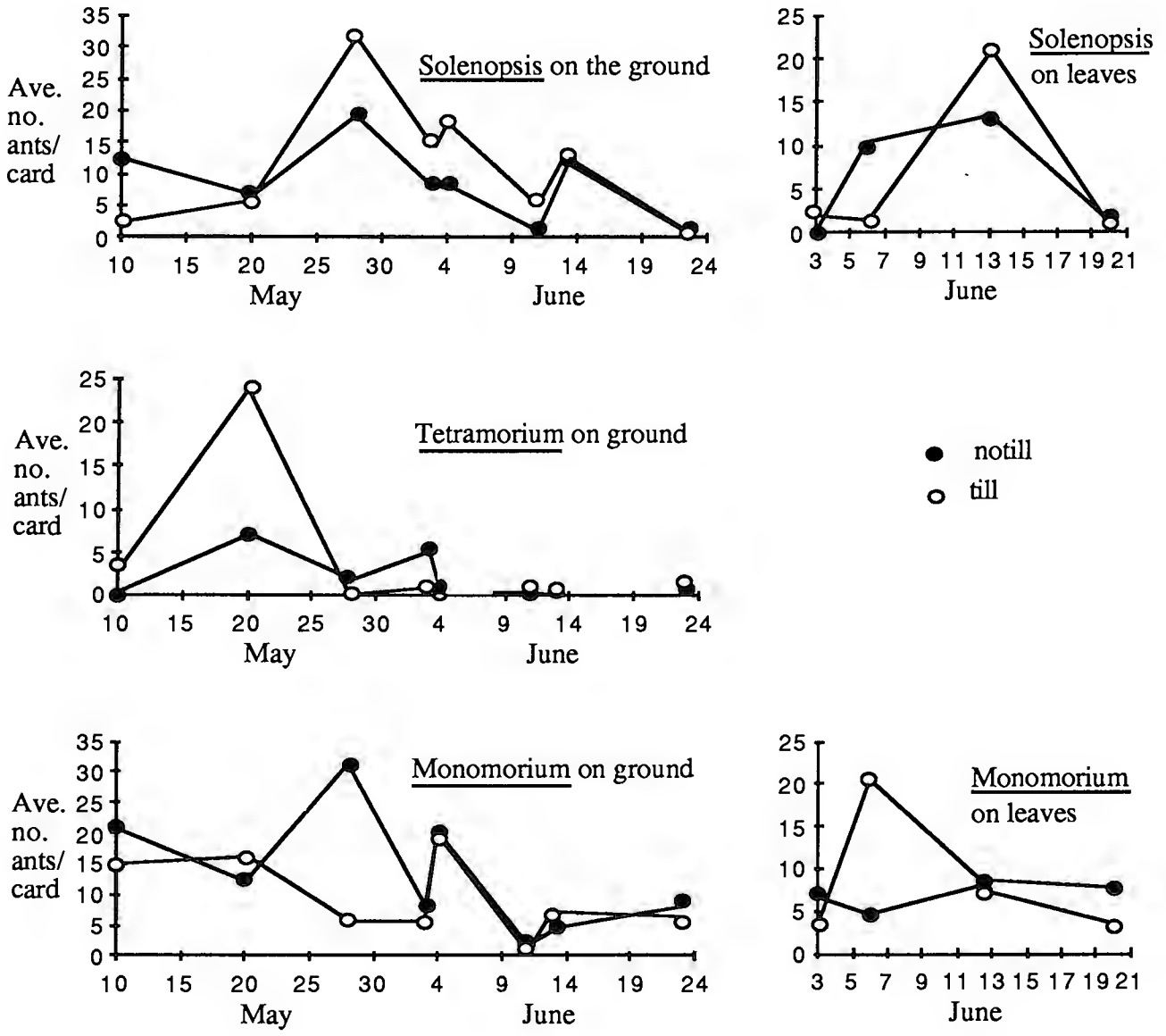


Figure 1. Number of ants attracted to oil-bait cards over the growing season in trial 1.

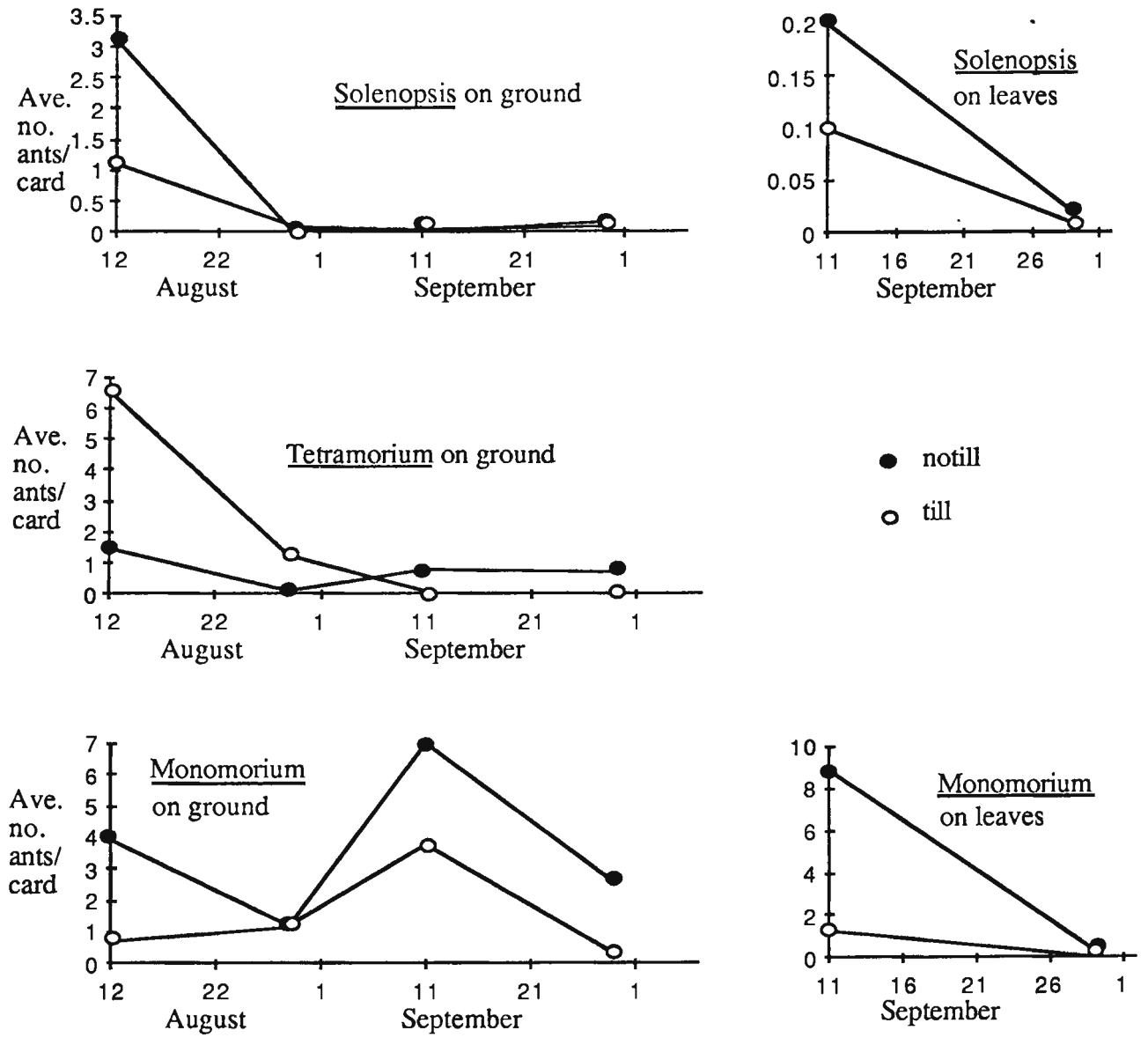


Figure 2. Number of ants attracted to oil-bait cards over the growing season in trial 2.

The number of corn borers was significantly reduced in the detasselled plots as compared to the plots which were not detasselled (Table 1). The insecticides had no effect on corn borer numbers. This may be because of the rainy weather which prevented scheduled sprays. Frequently, it also rained very soon after the fields were sprayed. In the first trial, neither the insecticide not the detasselling had any significant effect on yield. In the second trail, detasselling significantly increased yield. In both trials, the percent damaged ears was very high, despite the low numbers of corn borers found at the tasselling stage compared to previous trials.

New Insect Identifications

Beginning with 1985 all insect identified as being new on Guam or Micronesia are included in the annual report to provide an informal record. All insects identified in 1986 are listed in Table 2.

Biological Control Organisms Shipped Off-Island

In 1986, a parasite *Encarsia haitiensis* and a ladybeetle *Nephaspis amnicola* were shipped to Belau for control of the spiraling whitefly *Aleurodicus dispersus*. Casual observation in Belau late in 1986 showed that the beetle had apparently not established, but the parasite had controlled the problem in Koror as very few whiteflies could be found and those pupae seen had parasite exit holes. The whitefly was still a problem on some of the other islands of the group such as Malakal.

Table 1. Effectiveness of tillage method, detasselling and insecticide use on corn borer numbers.

	Number of corn borers per plant		Number of undamaged ears harvested (Percent damage in parenthesis)	
Treatment	Till	Notill	Till	Notill
Trial 1				
Dipel	7.7	6.1	39(46)	29(46)
Dipel + detasselled	4.7	3.7	54(37)	37(40)
Control	11.6	7.6	42(51)	34(40)
Control + detasselled	3.6	5.2	34(41)	37(43)
Trial 2				
Dipel	5.3	3.0	5(92)	22(61)
Dipel + detasselled	2.7	2.0	11(82)	16(72)
Lannate	3.7	4.3	13(78)	8(86)
Lannate + detasselled	2.5	2.4	15(75)	18(70)
Control	3.9	4.4	13(78)	16(74)
Control + detasselled	2.6	2.7	14(76)	22(63)

Analysis of Variance

Trial 1		
Tillage treatment F	0.01 (df=1,6;p=0.93)	1.4(df=1,6;P=0.28)
Plant treatment F	2.18 (df=3,18;P=0.13)	1.18 (df=3,18;P=0.34)
Interaction-plant*tillage f	1.53 (df=3,18;P=0.21)	0.87 (df=3,18;P=0.48)
Contrast-tassel vs. detassel F	8.65 (df=1,18;P=0.01)	0.93 (df=1,18;P=0.5)
Trial 2		
Tillage treatment F	0.12 (df=1,6;p=0.89)	3.13(df=1,6;P=0.12)
Plant treatment F	1.18 (df=5,26;P=0.35)	0.73 (df=5,26;P=0.61)
Interaction-plant*tillage f	0.59 (df=5,26;P=0.71)	1.55 (df=5,26;P=0.21)
Contrast-tassel vs. detassel F	7.70 (df=1,26;P=0.02)	6.82 (df=1,26;P=0.02)

Table 2. Insects identified in 1986 as being recent arrivals on Guam or other islands in Micronesia.

Species	Order	Comments
Guam		
Bemisia tabaci (Gennadius)	Homoptera	Previously recorded from Saipan, prob on Guam for many years
Delta circinalis (F.)	Hymenoptera	Similar to *Delta pyriforme* but darker. Present here since 1970s?
Delta campaniformis gracilis (Saussure)	Hymenoptera	Also on Tinian, Belau
Stenocatantops spendens (Thunberg)	Orthoptera	First collected in 1984-grasshopper pest of vegetables
Mecopoda elongata (L.)	Orthopetra	Present at least since 1970's
Genosula mundata zonocera (Navas)	Orthoptera	Present at least since 1970's
Batrachedra sp.	Lepidoptera	Webs betel nut flowers
Eretmocerus sp.	Hymenoptera	Parasitizing wooly whitefly
Hippotion celerio (L.)	Lepidoptera	Present for many years, post-war arrival
Praestochrysis lusca (F.)	Hymenoptera	Present for many years-parasite of cocooned moth pupae
Chrysis fuscipennis Brulle'	Hymenoptera	Present for many years-parasite of mud daubers
Kallitaxilia crini (Matsumara)	Homoptera	Present for many years common on many plants
Other areas of Micronesia		
Oxya japonica japonica (Thunberg)	Orthopera	Tinian and Saipan
Aleurodicus dispersus Russell	Aleyrodidae	Pohnpei
Thrips palmi Karny	Thripidae	Belau

HORTICULTURE - Fruit Crops

R. Rajendran

Fruit Crop Survey and Accession

The survey of fruit crops of Guam was continued in 1986. Seedlings and vegetatively propagated materials from identified single plants were raised for the fruit germplasm collection at the experiment station. In addition, the following were identified; *Cocos nucifera* variety javanica (dwarf coconut) with yellow, orange and green nuts, *Cocos nucifera* variety *spicata* dwarf and medium in height producing unbranched flowering spikes and yellow, orange and green fruits. *Cocos nucifera* variety *spicata* has not been previously identified as existing on Guam. All the cultivars were planted at the Ija Agricultural Experiment Station, for trials.

A plant of *Blighia sapida* Koenig (Syn. *Cupsnia sapida* Voight.; *Sapindus obvatus* W. & A.), English Akee, belonging to the family *Sapindaceae* introduced into Guam about eight years back, was located in the Dededo area. This plant flowered and produced fruits for the first time on Guam this year. A native to West Africa and West Indies it produces edible fruits, very attractive, reddish orange in colour, usually with three large black seeds and a fleshy capsule. The white fleshy aril attached to the seed is the edible portion. The seeds of this plant are poisonous. Seeds and seedlings have been collected for propagation.

Three new large fruit producing mango trees has been identified in Agat, Santa Rita and Harmon. One of these cultivars was found to be superior in protein as compared to the selected local cultivars and commercial varieties (Table 1, Fig. 1).

Table 1. Fruit characters of the selected Mango Cultivars

Name/Fruit Type	Average Fruit wt	Skin wt in Gms	Stone wt in Gms	% Edible Portion	Total soluble solids/ % sugar in flesh
Basilio (Local large)	1252	206	71	78	15
Quan (Carabao)	342	48	53	70	19
Babu (Chinese Mango)	452	33	58	41	14
Cruz (Local Large)	206	28	28	73	14
Santa Rita (Haden)	680	116	50	75	13

Banana

The analysis of the third leaf from the top in the banana cultivars Williams hybrid, Lacatan and the variety Valary were done and are presented in Table 2. Marked difference in the nitrogen, phosphorus and mineral contents in the leaf indicate variation in the fertilizer requirements of the cultivars. Further studies will be taken up to confirm the same.

Table 2. Banana Leaf Analysis

	%N	%P	%K	%Na	%Ca	%Mg	ppm Zn	ppm Fe	ppm Mn	ppm Cu
Williams	3.85	0.26	0.03	4.61	0.45	0.59	18	66.6	251.6	16.6
Lacatan	3.28	0.22	0.03	5.31	0.60	0.34	15	79.1	167.2	11.1
Valery	3.47	0.26	0.03	5.31	0.45	0.31	13	66.6	312.5	11.1

Mango

Potassium Nitrate at the rate of 10 g in a liter of distilled water was sprayed in the selected mango trees. Effect was more dramatic in the cultivar Carabao. In treatments on varieties where no results were observed the spray was repeated at 15 day intervals. Results are shown on Table 3. It was observed that the trees which received fertilizer and irrigation responded better to the spray. Studies with other nitrates are in progress.

Table 3. Induction of flowering mango using 10 g of potassium nitrate dissolved in a liter of distilled water.

Village	Variety	Result			Number of sprays at 15 day intervals
		Flower	Leaf	No effect	
Inarajan	Pico	xx		x	1
	Haden			x	1
				x	2
		x	x		3
	Pairi	x	x		1
	Carabao	xxx			1
	Local Seedling	xx			1
Yigo	Saipan Seedling	x	x		1
Govt. Hill	Haden	x	x		1
Barrigada	Haden			x	3
	Saipan Seedlings	xx			1
	Carabao	xxx			1
Anigua	Pico				2
	Carabao	xx	x		1
	Haden			x	2

xxx - Profuse 80% or more
xx - Over 50% of the shoots
x - 25 to 30% of the shoots

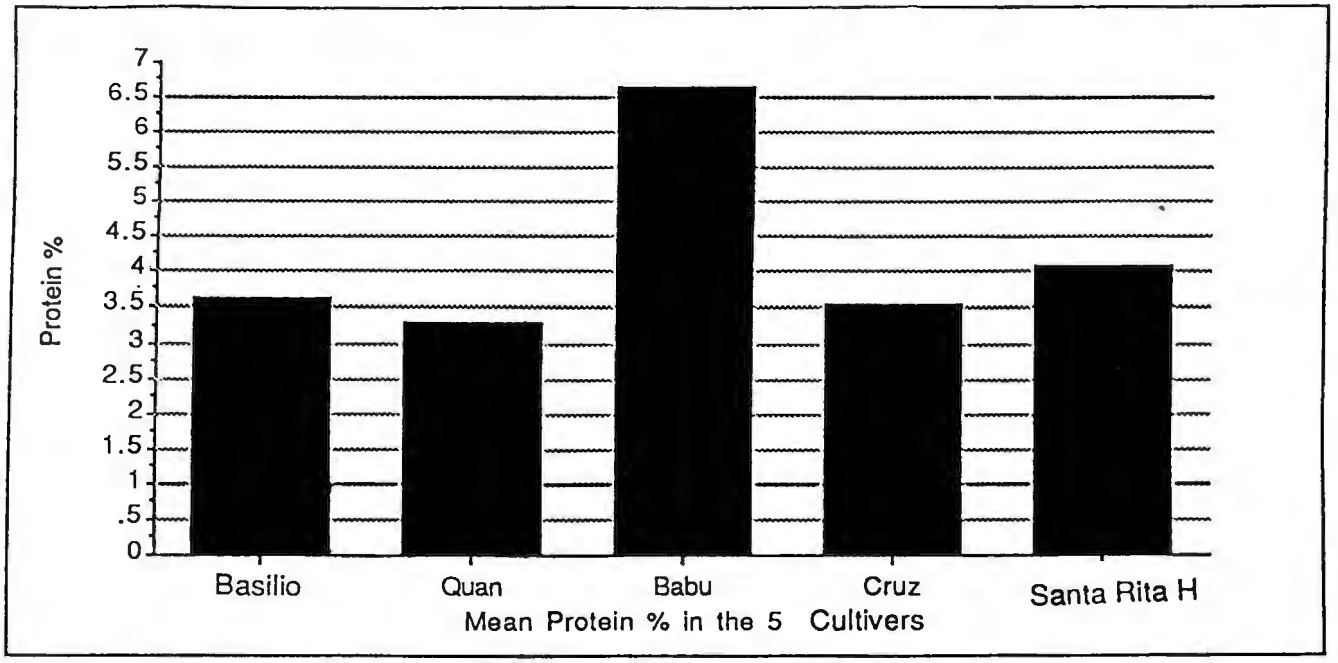


Figure 1. Bar chart of mean of nine replicated measures of protein in the five mango cultivars from Table 1.

Fertilizer Experiment

Fertilizer experiments on mango and guava seedlings are in progress at Ija, Agricultural Experiment Station.

Papaya Trials

Papaya yield trials in the clay soils of Southern Guam are in the second year of growth. In an experiment on total soluble solids, with four cultivars of papaya, it was observed that the total soluble solids (TSS) remained at 4% level up to 110 days from the flower opening. Between 110 to 125 days there was a steep increase in the TSS; after this the steep increase continued up to 140 days in the "Solo", and 145 days in the "UOG Dwarf" papaya, whereas in the cultivars "Local" and the "Truk" the rate of increase was slower. After 140 days in the "Solo", "Local", "Truk" cultivars and after 145 days in the "UOG Dwarf," there was a steep fall in the TSS of the fruit. The rate of fall in TSS was less in the UOG Dwarf as compared to the other cultivars tested as shown in Fig. 2.

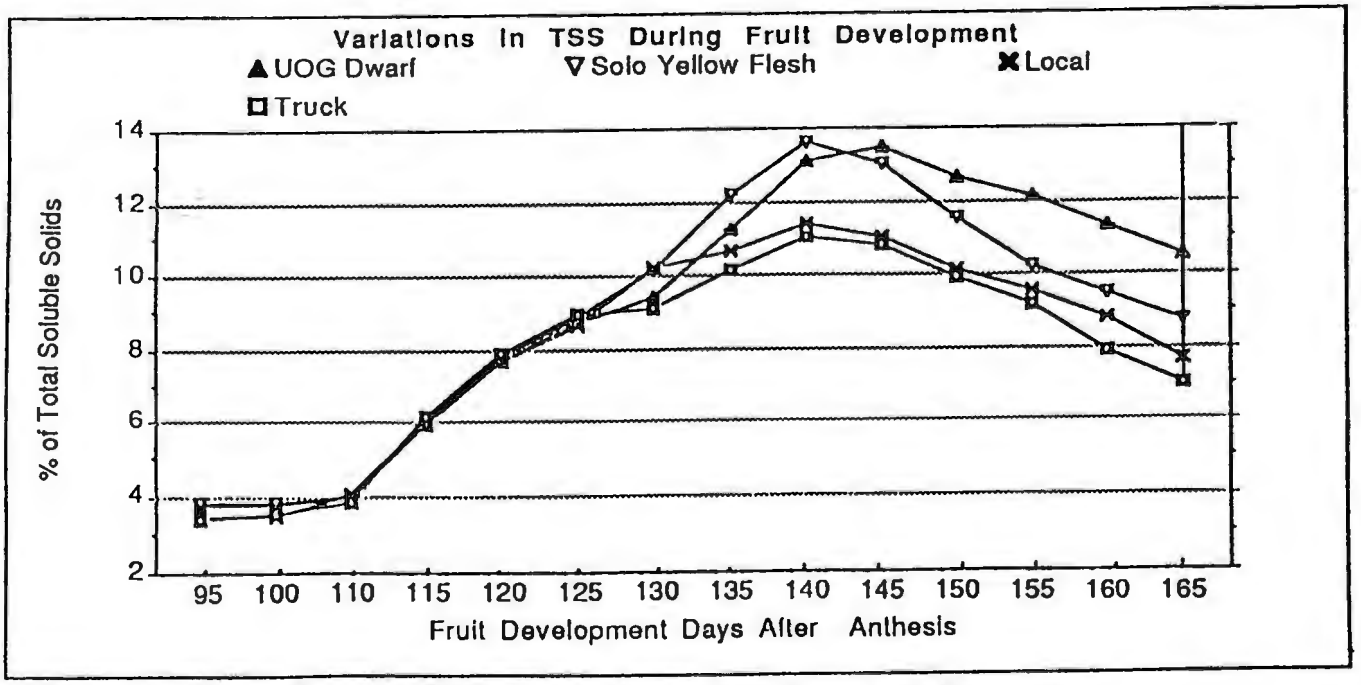


Figure 2. Change in sugar (TSS) content in the developing fruit of papaya

HORTICULTURE - Ornamental Crops

J. McConnell

The emphasis of the program has been to evaluate and select specific ornamental plants for their potential as commercial crops in Guam and to determine the cultural methods for optimum production in the tropics. Current research has concentrated on commercial cut flower production. The production aspects have been broken into tthree areas: cultivar evaluation, propagation, and crop management. Cultivars of orchid genera and anthuriums have been chosen for advance testing. Cultivars of other species that have been collected for further evaluation are bird of paradise, heliconias, gingers and ferns (for use as cut foliage).

In 1986, an ornamental research facility was constructed on the campus of University of Guam. Databases on ornamentals and on orchid literature were developed. The experiments conducted this year included media/fertilizer studies with vandas and dendrobiums, and a propagation experiment with anthuriums. Cultivar evaluations were continued on vandas, dendrobiums and anthuriums.

Construction of an Ornamental Research Facility

Much effort this year was devoted to the development and construction of a facility to do ornamental research. The facility was developed on the campus of the University of Guam. Several sturctures were constructed to make it possible to compare the culture of ornamentals under different conditions. A fiberglass-covered structure was constructed for propagation and acclimatizing orchid seedlings removed from flask. The solid covering was necessary to control the amount of water applied to the plant material. A shade house was constructed and covered with three different densities of shade cloth. This allows plants to be grown at four different light intensities: full sun, 70%, 40%, and 10%. The structure was designed to be constructed at low cost. The support structure is of pipes and ropes. The shade cloth is attached so that in the event of a severe storm the shade cloth can be removed. The pipes are attached together to allow for further expansion.

An automatic irrigation system was installed and is controlled by a solar powered time clock. A collected of different sprinklers were installed for further evaluation. The irrigation system was based on a design recommended by the Soil Conservation Service.

A tissue culture lab was constructed for the propagation of the plant material. The lab consists of three sections: a medium preparation area, an aseptic flasking room and an aseptic culture room.

Computerized Database of Ornamentals to Grow in Guam

A database of ornamental plants was entered into a computer. The program used was developed to allow the database to be accessed by individuals with little training in computers. Plants can be searched by scientific name, common name, growing habit, final height, and by their desired growing conditions. The database supplies information on culture and propagation.

A computerized database of orchid literature is under development. The database will include references of American Orchid Society Bulletins from 1946 to current. Searches are currently possible on genera, species, authors and keywords.

Vandas

Vandaceous Cultivars under evaluation

Seedlings of 15 vandaceous cultivars have been collected and are being grown to flowering for further evaluation. The cultivars are listed in Table 1. The cultivars will be evaluated for their potential as commercial cut flowers. The plants are beginning to flower and will be evaluated for the following characteristics: number of racemes per plant, number of flowers per raceme, percentage bud drop, quality of the flower (size, color, and substance), quality of the raceme (Upright, stiff raceme, distribution of the flowers), and the cut shelf life of the racemes and flowers.

Table 1. Vandaceous Hybrids and Cultivars

Aranda Wendy Scott x E. Sanderiana
Ascda. Medasand x Ascda. Inferno
Rhy. Gigantia x Rhy. Gigantia 'white'
Rhyn. Gigantea 'Red Giant'
V. Josephine x V. Jarungrak
V. Josephine x V. Kasem's Delight
V. Josephine x V. Pimsai
V. Keeree x (V. Gordon x V. Coerulea)
V. Nancy Rodillas x V. Sanderiana
V. Pimsai-Kasem's Delight x V. Jarungrak
V. Rasri Gold x V. Rasri Alba
V. Rasri x V. Kultana Gold
V. Rothschildiana
V. Ruby Prince x V. Rev. Masao Yamada
V. Woodlawn Glory x V. Nancy Rodilky

Vanda

Media-Fertilizer Study--tissue analysis

The objective of this study was to evaluate crushed coral aggregate and coconut husk as growing media for Vanda X Miss Joaquim and to obtain basic information on the effect of fertilizer on the nutrient levels in the vegetative portions of the plants. Coconut husk is commonly used in Guam as a medium for growing Vanda Miss Joaquim.

Coconut husk has several undesirable characteristics. It decomposes quickly, is quickly invaded by weeds, and is not available in large quantities. Crushed coral is available in abundant quantities at low cost, does not need to be replaced or replenished, and weeds do not establish readily.

Generally V. X Miss Joaquim is fertilized little in Guam. Two different forms of fertilizer were applied to see if there was any response to fertilizer application and whether the form of fertilizer made a difference. A slow release fertilizer applied at three month intervals was compared with weekly applications of a liquid fertilizer.

Material and Methods

The plants were established in a randomized complete block design consisting of two media treatments and three fertilizer treatments with three replications. The plants were grown in either coconut husk or crushed coral aggregate. The fertilizer treatments were Foliar 60 (applied weekly), Osmocote (applied monthly) and the control (no fertilizer application).

The plants were grown in full sun for one year with daily irrigation from February 1985 to February 1986. The stem and leaf portions were removed, dried, and ground for tissue analysis at the end of the experiment.

Tissue nutrient levels were found to be similar in coconut husk regardless of fertilizer application. Three nutrient elements, phosphorus, calcium, and magnesium, were present in lower levels in vandas grown in crushed limestone than those grown in coconut husk. The level of phosphorus was lowest (0.03%) for the unfertilized limestone treatment. The levels of calcium and magnesium and phosphorus were unaffected by the addition of either fertilizer to coconut husk. Calcium and magnesium were present in the Foliar 60 fertilizer but not in the Osmocote but this did not affect the levels in the plant tissues.

The crushed limestone is almost pure calcium carbonate and so it was expected that the levels of calcium would be higher in the plants grown in the crushed limestone. A possible reason for the lower levels of calcium and magnesium in the plants growing in limestone may be due to the water holding capacities of the media and the elvels of these nutrients in the irrigation water. The level of calcium in the water of northern Guam is about 170 ppm. The coconut husk held large quantities of ground water after each irrigation. This water is available to the vandas on a continuous basis whereas the water moved rapidly through the limestone medium. The levels of available water may have affected nutrient uptake and the growth of the plants. The vandas grown in limestone may have experienced water stress resulting in the lower values for the vegetative characters andless nutrient uptake.

Additional nutritional studies of V. X Miss Joaquim with higher rates of fertilizer application and the effect irrigation and water stress on plant growth and flowering of vandas is necessary to determine the optimal cultural practices for flower production.

Table 1. Vegetative characters of V. X Miss Joaquim grown in two different media and two different fertilizers.

Treatment (Medium/Fertilizer)	Number of leaves	Number of Nodes	Stem Length (cm)	Internode Length (cm)	Stem&Leaf Dry Weight (q)	Stem&Leaf Fresh Weight (q)	Percent Dry Weight %
Husk/No Fertilizer	20.8a[z]	23.9a	44.9a	1.5a	12.8a	60.9a	21bc
Husk/Foliar 60	20.4a	24.0a	46.4a	1.5a	12.5a	63.4a	20c
Husk/Osmocote	20.9a	23.6a	46.4a	1.5a	12.8a	64.5a	20c
Limestone/No Fertilizer	10.9b	15.3b	30.7b	1.4a	6.0b	21.0b	29a
Limestone/Foliar 60	14.6b	18.5b	35.0b	1.4a	8.1b	30.6b	26a
Limestone/Osmocote	14.3b	18.1b	35.3b	1.4a	7.9b	33.1b	24ab

[z]Mean values followed by different letters are different at alpha = 0.05 within columns using the Bonferroni procedure.

Table 2. Tissue analysis of V. X Miss Joaquim in two different media and two different fertilizers.

Treatment	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	Zn (ppm)	Fe (ppm)	Mn (ppm)	Cu (ppm)
Husk/No Fertilizer	0.44az	0.07ab	0.46a	3.57a	0.48az	25.6a	43.5a	22.1a	13.3a
Husk/Foliar 60	0.59a	0.09a	0.40a	3.16ab	0.45a	26.0a	48.6a	22.2a	11.4a
Husk/Osmocote	0.63a	0.08a	0.42a	4.40a	0.50a	27.8a	48.6a	21.9a	14.2a
Limestone/No Fertilizer	0.34a	0.03c	0.41a	175c	0.21b	23.4a	51.4a	20.8a	10.2a
Limestone/Foliar 60	0.45a	0.05bc	0.47a	2.31bc	0.28b	33.1a	55.4a	24.3a	10.8a
Limestone/Osmocote	0.41a	0.05bc	0.48a	2.16bc	0.22b	23.5a	47.2a	21.7a	13.9a

[z]Mean values followed by different letters are different at alpha = 0.05 within columns using the Bonferroni procedure.

Dendrobiums

Cultivar evaluation

A collection of dendrobium cultivars has been established for evaluation as commercial cut flowers or potted plants. The plants are beginning to flower and will be evaluated for the following characteristics:number of racemes per plant, number of flowers per raceme, percentage bud drop, quality of the flower (size, color, and substance), quality of the raceme (Upright, stiff raceme, distribution of the flowers), and the cut shelf life of the racemes and flowers. The cultivars that have been collected are listed in:

Table 4.Dendrobium cultivars currently under evaluation.

D. X Alice Noda
D. X Antenatum
D. X Autumn Lace
D. X biggibum
D. X Bobby Mesuia 'Hilo'
D. X Booncho Gold
D. canalictum
D. X Dahil Sayo
D. X Dream City
D. X Easter Bunny 'Brian'
D. X Florence Sucita x D. X Wendell Sucita
D. X Janet Moi 'Aoki'
D. X Kaneohe Beauty
D. X Lim Theong Hin 'Waipalm' AM/HOS
D. X Mae. Teramoto x D. X Mae Teramoto
D. X Macro big x D. biggibum
D. X Mini pearl 'Elaine Fuchigami'
D. X Momi Cummins 'Blue' x D. Jester
D. phal. 'Kangal' x (D. phal (Extra) x self)
D. X Robsam 'Waimea'
D. samoense
D. X Sanda Kusuon 'Larry'
D. X Satin Lace 'Alii'
D. X Snow Elf

D. X spectable
D. X Spellbound 'Superclone'
D. X Sri Siam
D. strebloceras (Taberium)
D. X Ted Takiguchi 'gouldii' X D. Cindy Stripe
D. X Tokiko Inaki
D. troucolacaum x D. X Formosum
D. X Tsuruyo x D. X Kamarots
D. X Waterest/D. Hickam 'Deb' AM AOS x D. X Kathy Sargaret
D. X Garnet Beauty 'Suzuki' x (D. X Betty Ho x D. X Stacee Ohashi)
D. X Bendum
D. X Kaneohe Beauty 'Kim'
D. X Mary Mak
D. X Troy Mitami 'Gilbert'
D. X Walter Omae

Banana Media Experiment

Dendrobium and vanda orchids seeds are generally germinated in aseptic conditions. The medium commonly used is Modified Vacin and Went. A modification to the medium is the addition of green William's Hybrid banana. In Guam it is difficult to grow William's Hybrid due the the disease bunchy top. Cooking bananas appear to be more tolerant of the disease and are available in Guam. This experiment was undertaken to evaluate whether a locally available cooking banana (Samma) is usable in germinating medium for orchids.

Material and Methods

Seedlings of D. Jaquelyn Thomas 'Uniwai Supreme' were transferred to sterilized Vacin and Went media containing either green Williams' Hybrid bananas or Samma cookings bananas. 30 seedlings were placed in each flask. The treatments were replicated three times. After the seedlings were approximately 2.5 cm, the 10 largest seedling from three different flasks of each treatment were removed and measured. The characters measured were shoot length, root length, number of roots, fresh weight, and dry weight.

Results and Discussion

The results are presented in Table 5. There was no significant difference between the treatments for shoot length, root length, and number of roots. The treatments did produce significant differences in fresh and dry weight. Cooking bananas generally do not have as high a sugar content as eating bananas and it is suspected that the differences noted could be due to different sugar levels available in the media. It was concluded that the type of banana can effect the growth of orchid seedlings and the cultivar of banana is a factor to consider when germinating orchid seedlings. Seedlings that were transplanted from the flask are still being evaluated to see if the type of banana affects the seedlings after they are removed from flask.

Table 5. Mean Values of vegetative characteristics of dendrobium seedling in banana media study

Banana	Leaf Length (cm)	Root Length (cm)	Number of Roots	Fresh Weight (g)	Dry Weight (g)
William's Hybrid	2.88[z]	2.43	4.0	1.00**	0.08
Samma Cooking	2.60	1.51	3.1	0.81	0.04

zMean values were compared in columns. * indicates significance at p=0.05, ** indicates significance at p=0.01.

Anthuriums - Anthurium cultivar evaluation

The anthurium cut flower cultivars listed in Table 6 were collected from Hawaii to be evaluated for their potential as cut flowers in Guam. The plants are established are yield data is being recorded. The flowers will also be evaluated for their color and cut shelf life.

Table 6. Anthurium Cultivars Collected

Calypso	Marian Seefurth
Deweese	Nitta
Diamond Jubilee	Nitta
Kaumana	Ozaki
Kozohara	Paradise Pink
Manoa Mist	Trinidad
Marian Seefurth	Asahi

Cutting Experiment

A common problem in developing a new crop is to have a sufficient supply of plant material for commercial production. This experiment was done to evaluate the feasibility of buying node cuttings from Hawaii for propagation in Guam. Node cuttings are sections of the anthurium stem with all leaves removed. The node cuttings are relatively inexpensive and readily survive in a box during the shipping to Guam. This form of cutting would also lessen the chance of introducing new pests that would normally be found on the leaves or flowers.

Material and Methods

The stem pieces were left intact and planted in a completely randomized design. The stem pieces were planted in mixture of peatmoss, fir bark and vermiculite (2:2:1) in open benches with screen to contain the medium. The benches were placed under a fiberglass house to shade and control the moisture. Eight months after planting sprouted seedling were removed from the stems and the seedlings were planted individually. The stem pieces were replanted for further propagation. The number of plants per cultivar was tabulated and the cost per seedling was calculated.

Results and Discussion

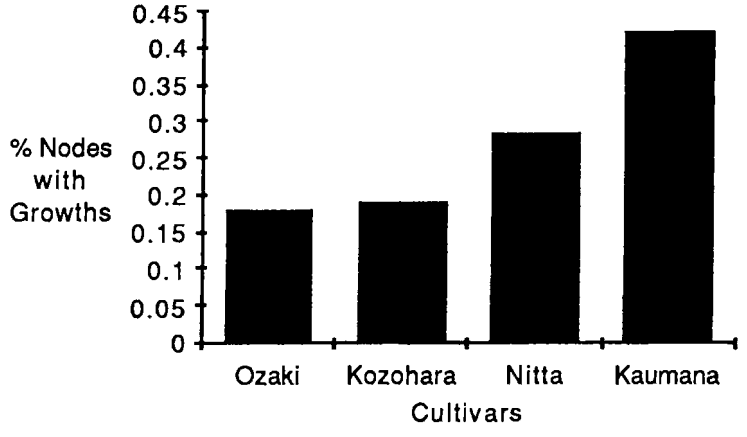
The results are presents in Table 7 and Figure 1. Stem pieces of Kaumana were the most productive with 42.5% of the nodes producing seedlings in 8 months. Ozaki and Kozohara produced the least number of seedlings. The estimated cost per Kaumana seedling was $1.18 and was $2.78 per seedling for Ozaki. Additional seedlings are being produced by the replanted stem pieces.

This method of propagation was a relatively slow method of acquiring plant material. cultivars vary in the number of seedlings produced.

Table 7. Percentage seedlings produced from node cuttings and estimated cost per seedling.

	Cultivars			
	Ozaki	**Kozohara**	**Nitta**	**Kaumana**
% Seedlings produced 1	8.0%	19.0%	28.5%	42.5%
Cost per Seedling	$2.78	$2.63	$1.75	$1.18

Figure 1. Comparison of seedling production by node cutting of four anthurium cultivars.



HORTICULTURE - Vegetable Crops (Potato)

M. Marutani

Introduction

Four field experiments were conducted during the 1985-1986 dry season at Barrigada, Guam which had the soil classified at Pulantat series, clayey, montmorillonitic, isohyperthermic, shallow Udic Haplustalf with pH of 6.75. In the first experiment, two cultivar trials were carried out to identify suitable potato varieties in Guam. In the second experiment field performance of locally stored seed tubers was tested. Tubers were stored for 8 months from March 1985 to November 1985 in three different storage methods; cold storage, air-conditioned room and a diffuse light structure. The third experiment, planting date experiment, was conducted by using three planting dates with an interval of four weeks (November 18, 1985, December 16, 1985 and January 13, 1986). Three varieties, Kennebec, Red Pontiac and Sequoia, were selected for this trial. The fourth experiment was conducted as a collaboration of IBSNAT program to observe phenological events of growing a cultivar 'Kennebec' under a white plastic mulch. A portable weather station was installed at the site of experiment to take climatological data. After harvesting tubers from the field, a similar storage experiment was repeated to confirm the result of previous experiment to identify the best storage methods of locally harvested tubers for a subsequent planting in a dry season. In-vitro culture of potato plantlets have been successfully maintained in a tissue culture lab by using a modified MS medium.

Weather Data

Weather data taken at the site of experiment from November 19, 1985 to April 24, 1986 is shown in Table 1. The average daily temperature was lowest during the third and fourth weeks of February. Air temperature, solar radiation, and relative humidity during the growing season averaged 26.6 C, 19.1 MJ/day, and 75.8%, respectively. Rainfall was lowest during the last two weeks of January recording 11.8 mm for this driest period and there was the longest dry period from March 16 to April 24, 1986. A total rainfall of the entire growing season was 585.2 mm.

Experiment I: Evaluation of Potato (Solanum spp.) Culivars on Guam During 1985-1986 Dry Season

Two varietal trials were done. In the first trial, a total of 10 cultivars were tested while in the second trial nine were evaluated for their field performance. Three cultivars, Kennebec, Red Pontiac and Sequoia were included in both trials, however because of a mechanical failure of storage facility seed tubers of the three cultivars were not at best condition at planting in the second trial.

Materials and Methods

The first trial was conducted from November 22, 1985 to February 13, 1986. Cultivars tested were Kennebec, Red Pontiac and Sequoia from Australia and 7 cultivars, MS35.22, DTO-28, BR112-113, 720088, Cosima, LT-2 and LT-5 from the International Potato Center in the Philippines. In the second trial, in addition to Kennebec, Red Pontiac and Sequoia, 6 cultivars, Norchip, Desiree, Katahdin, C14-343, C1-884, and LT-1 from Cornell University were examined from December 23, 1985 to March 24, 1986. A randomized complete block design with 4 replications was used in both trials. Tubers were planted at a spacing of 5 tubers/m in double lines within a single row. Twenty tubers per 4 m row and 15 tubers per 3 m row were planted as one replication of one variety in Trial 1 and 2, respectively. The distance between rows was 1 m in both trials. Before planting a complete fertilizer of 10-30-10 was applied at the rate of 1110 kg and was incorporated in soil. Additional N fertilizer (Urea; 46-0-0) was side-dressed or injected through irrigation system at the rate of 120 kg/ha at around 30 and 50 DAP (days after planting).

Several pesticides were used to control insect pests and disease problems. A drip system was used to irrigate the field.

Parameters to compare plant development were emergence date, the percentage of emergence, the number of stem per plant and canopy cover. At harvest, yield, the percentage of harvest, the number of tuber per plant, the average weight of tuber, specific gravity of tuber and tuber size distribution were examined. The emergence date was determined by the date when 50% of plant emerged. As leaf miner damage became apparent to some cultivars, the degree of leaf miner damage was estimated by measuring infected leaf area at 64 DAP in Trial 1.

Results

Trial 1

Table 2 shows the results of ten cultivars evaluating at harvest. Kennebec had the highest yield of 29.2 t/h. Red Pontiac and Sequoia followed closely with 27.1 t/h. MS35.22 and a CIP cultivar, DTO-28 produced 23.9 t/h and 21.4 t/h, respectively. Yield of other five cultivars ranged from 18.8 t/h to 10.5 t/h, LT-5 being the lowest yielder. US cultivars such as Kenenbec, Red Pontiac, Sequoia and MS 35.22 yielded high. The three highest yielders were grwon from larger seed tubers and about 85% of population was harvested. An Argentine clone, 720088, had the lowest survival rate (35% harvested). BR112.113 and Cosima were characterized by producing many small tubers, in contrast LT-5, LT-2 and 720088 had fewer number of tubers per plant than other cultivars. The average tuber weight was heaviest with 53.9 gram of Kennebec, followed by Sequoia with 53.7 gram. Red Pontiac, DTO-28 and LT-2 produced an average tuber of about 50 gram.

Table 3 presents data on emergence, leaf miner damage, canopy cover, number of stem and number of branch of main stem. LT-5 emerged extremely late (31 DAP), while Kennebec, Red Pontiac, MS35.22 and BR112.113 emerged in less than 11 days after planting. Canopy cover were measured at 62 DAP, 69 DAP and 76 DAP. DTO-28 retained more than 50% canopy cover even at 76 DAP. Leaf miner infestation was least with DTO-s28. The number of stem and the number of branch of the main stem was measured at 66 DAP. LT-5 was characterized having the lowest number of stem of 1.1. DTO-28 developed more branches than any other cultivars (average of 16.3).

Trial 2

The harvest result of Trial 2 is presented in Table 4. Norchip (produced the highest yield of 20.2 t/h, followed by Desiree, Katahdin, C14-343, Kennebec, C1-884, Red Pontiac, LT-1. Sequoia yielded the lowest at 9.9 t/h. The average weight of a tuber ranged from 55.9 g (Norchip) to 25.9 g (Red Pontiac). Unlike Trial 1, the overall yield in Trial 2 was very low. Especially Kennebec, Red Pontiac and Sequoia which yielded high in Trial 1 produced less than half of yield obtained from Trial 1. The poor performance of those three cultivars was mainly caused by planting physiologically old seed tubers and insufficient water. Application Sequoia survived least, having only 55% harvested.

Comparisons of plant development among 9 cultivars are shown in Table 5. Kennebec and Red Pontiac emerged in less than 10 days after planting while C1-884 and Sequoia took 14 days to emerge. The low emergence rate of Sequoia (66.5%) indicated that this cultivar had bad seed tubers and many tubers rotted before any stems emerged. Other cultivars had emergency rate of over 88%. Canopy cover was highest with 45% of Kennebec at 31 DAP which was much lower than the maximum canopy this cultivar could achieve. From 38 DAP to 80 DAP Norchip showed the highest canopy cover and did not have distinct increase or decrease during the growing period. In general, canopy cover dropped after 60 DAP. Poorer plant development in Trial 2 was probably due to under irrigation and heaver infestation of mealy bugs, mites and thrips than Trial 1.

Discussion

In spite of the high temperature which provided unfavorable condition for growing potatoes, the traditional varieties, Kennebec, Red Pontiac and Sequoia showed to have potential in Guam under proper cultural management. MS35.22, DTO-28 and Norchip produced relatively high yield. Among four CIP clones (DTO-28, LT-1, LT-2 and LT-5), DTO-28 was the best yielder while LT series did not perform well in the two trials. Norchip, Desiree, Katahdin and two neo-tuberosum types (C14-343 and C1-884) which were developed at Cornell University could have produced higher yield if irrigation and disease problems had been overcome in Trial 2. It is worth reevaluating these cultivars again.

Experiment 2: Influence of Storage Methods in Subsequent Field Performance of Three Potato Cultivars

Self-maintenance of local planting materials is important in order for farmers to have seed tubers readily available in production of potatotes on the island of Guam. In highland tropics, inexpensive diffuse light structures are used to store seed tubers between planting seasons. Seed tubers should be physiological young at planting time after a long storing period. In this experiment, locally harvested seed tubers were stored in three different methods for eight months and field performance of those tubers was tested in next dry season.

Materials and Methods

Three storage methods were used; cold storage, air-conditioned room, and diffuse light storage. The condition of three storage methods were described in AES Annual Report, 1985. All tubers remained from the storage experiment from March to November, 1985 were planted on December 13, 1985. Three cultivars, Kennebec, Sequoia and LT-2 were used and each cultivar was labeled separately by location of harvest. Treatments were replicated three times in a randomized complete design. The number of tubers planted varied from three to fifteen depending on cultivar and storage method. Data on emergenc, harvest and size distribution of tuber were expressed by percentage and yield was calculated by per plant. The number of stem was expressed by per hill. For data analysis each cultivar from two locations were pooled because there was no significant difference among locations.

Results

Table 6 shows the result of influence of storage methods on subsequent field performance. The percentage of emergence was poorest for three cultivars stored in diffuse light structure. In cold storage and air-conditioned room, LT-2 hadess emergence percentage (about 60%) than Kennebec and Sequoia (95-100%). At harvest, an influence of storage methods was more apparent where Kennebec and Sequoia in cold storage had 98% and 97% of harvest percentage, respectively while the same two cultivars in air-conditioned room had 87% of hills harvested and in diffuse light structure the harvest percentage were 36% for Kennebec and 27% for Sequoia. The harvest percentages of LT-2 from three three storage were 43 for cold storage, 56% for air-conditioned room and 16% for diffuse light structure. The yield was highest with 378 g/plant for Sequoia in cold storage and second with 300 g/plant for Kennebec in cold storage. LT-2 in diffuse light structure had the lowest yield of 85 g/plant. Seed tubers stored in cold storage produced more tubers than those from air-conditioned room and diffuse light structure. The number of tuber per hill was highest with 8.2 of Kennebec in cold storage and the lowest with 2.0 of LT-2 in diffuse light structure. The size distribution of tuber showed that Sequoia had more large tubers than two other cultivars.

Discussion

Cold storage was the best method to keep seed tubers physiologically young and to have better yield than storing in air-conditioned room or diffuse light structure. A cultivar, LT-2 was poorer than both Kennebec and Sequoia in all storage methods and it was especially poorest in diffuse light structure. Storing seed tubers for eight months at an ambient temperature in diffuse

structure made them physiologically very old and the percentage of emergency, plant development and harvest yield were very low. Although diffuse light structure is less expensive and it could be used as a short term storing place, it is not suitable for a long term storage. In the environment of lowland tropics, cold storage is the best method to keep seed tubers at the best condition for the subsequent field planting for eight months.

Experiment 3: Influence of Planting Dates and Storability of Seed Tubers in Field Performance of Three Cultivars

Studies on planting potatoes in lowland tropics from the Philippines have indicated that the best season for planting potatoes is cooler months of a year from November to January. Because of the shorter daylength during these months tuberization occurs early and so growing period is shortened. On Guam where it has similar climate as the lowland in the Philippines, potatoes are planted during these three months. It is, however, of interest which month is the best of all in production of potatoes. In this experiment three planting dates were chosen with the interval of four weeks and plant development was compared. Unfortunately because of lack of good facility to store seed tubers, the results of the experiment were affected not only by dates of planting (weather conditions) but also by the condition of seed tubers at planting. This experiment presents confounding effect of planting dates and storability of three cultivars before planting.

Materials and Methods

Kennebec, Red Pontiac and sequoia were planted at three planting dates of November 18, 1985, December 16, 1985 and January 13, 1986. Thirty tubers per row and three rows per plot were used. The distance between rows was 0.9 meter and the length of row was 9 meter. At each planting date, treatments (cultivars) were replicated three times and within each replication treatments were randomly arranged. The growing seasons were a little less than three months and harvest dates of three tirals were February 10, 1986, March 11, 1986, and April 8, 1987.

Until planting, seed tubers were stored in an air-conditioned room and in a case of power outage they were kept in diffuse light structure which was not the best method to maintain seed tubers at the best condition.

During growing season, application of pesticides such as fungicides and insecticides were done when necessary and additional N fertilizer was side-dressed two times during growing period. Various parameters on plant development and final yield were compared and analyzed.

Results and Discussion

Table 7 showed the result of Experiment 3. Although planting dates were the original main treatment in the experiment, the result was greatly affected by tuber conditions at planting. In general, the January planting performed poorest for all cultivars while yield of November planting was highest. Sequoia showed the poorer storability and faster degeneration of tubers than Kennebec and Red Pontiac before planting. There were no harvests of Sequoia from the January planting. Kennebec had the highest emergence percentage in all three planting date trials. Kennebec had better storability of tubers prior to planting and therefore the cultivar seemed to have an advantage to withstand drier conditions in March and April which was the period when plant and tuber development took place for January planting trial.

This experiment should be repeated by using seed tubers with similar physiological condition to test influence the planting as seen in the result of Experiment 2.

Experiment 4: Observation of Canopy Cover and Tuber Development of a Cultivar "Kennebec" During Dry Season.

As a collaborator of IBSNAT project at the University of Hawaii, the growth of a cultivar "Kennebec" was closely studied and important phenological stages were recorded.

Materials and Methods

One hundred sixty tubers were planted in a plot. A plot had 8 rows and 20 tubers were planted in each row. The distance between rows was 90 centimeter and the distance between plants in a row was 25 centimeter. A plot was repeated three times. Seed tubers were planted on January 31, 1986. Before planting, a complete fertilizer of 10-30-10 was applied and incorporated in soil. Additional N fertilizer (Urea, 46-0-0) was applied at 24 DAP, 40 DAP and 55 DAP through irrigation lines. Insecticides and fungicides were sprayed weekly to control pests. A white plastic mulch was placed to control weeds.

Canopy cover was measured weekly. At stages of T1 (date when tuber initiation was observed = 33 DAP) and T2 (T1+2 weeks = 47 DAP) and T3 (T1+4 weeks = 63 DAP), 8 plants were sampled to measure various parameters of plant development. On other sampling times such as 42 DAP, 54 DAP and 66 DAP four plants were studied. The total tuber weight, average weight of tuber, fresh leaf weight and stem were compared. All tubers were harvested on April 24, 1986 (83 DAP).

Result and Discussion

Emergence date was recorded on February 12, 1986 (12 DAP) when there were more than 50% of plants with some part visible at soil surface. Tuber initiation was observed at 33 days after planting seed tubers. Figure 1 shows changes in plant development of Kennebec from planting to harvest. Canopy cover reached a maximum of 79% at 47 DAP and declined afterward. The weight of fresh leaf was heaviest at 54 DAP. The length of main stem increased rapidly after emergence and the growth seemed to cease at around 60 DAP. At 63 DAP the length of main stem was 54.2 cm.

The increases in total tuber weight and the average weight of tuber during plant development were also shown in Figure 1. At harvest the total tuber yield per plant was 494.5 gram and the average tuber weight was 56.8 gram.

In addition to data mentioned above, the minimal data set indicated by IBSNAT was collected and was sent to Dr. L. Manrique in Hawaii to calculate the growth rate of Kennebec on Guam. Table 8 shows estimated growth rates at T2 and T3 stages. The partitioning coefficient (tuber growth rate/total growth rate) is very low which is in agreement with other experimental evidences indicating that partioning coefficient is low with high temperature. The negative value of tuber growth rate at T3 stage may be due to tuber respiration losses and losses of tuber caused by tuber rots. Tuber rots became a serious problem around 60 DAP and it affected the data set at especially late part of the growing period.

Table 1. Temperature, rainfall, solar radiation and relative humidity at the experimental field during the growing period.

Period	Temperature (C)			Rainfall	Solar Radiation (MJ/day)			Relative Humidity (%)		
	Min	Max	Average	(mm)	Min	Max	Average	Min	Max	Average
11/19 - 11/30	-	-	-	60.9	-	-	-	-	-	-
12/1 - 12/13	-	-	-	107.8	-	-	-	-	-	-
12/14 - 12/31	23.9	31.5	26.7	84.7	-	-	-	76.3	88.6	83.7
1/1 - 1/15/86	23.8	31.0	26.7	27.5	14.9	20.8	18.0	73.4	91.9	83.6
1/16 - 1/31	22.9	30.5	26.1	11.8	13.6	21.8	17.9	70.5	86.1	80.5
2/1 - 2/15	22.9	29.8	25.8	45.0	11.8	19.8	15.7	62.1	82.8	73.8
2/16 - 2/28	20.7	29.4	24.7	116.4	14.4	23.6	17.7	67.2	81.9	75.5
3/1 - 3/15	22.7	28.8	25.3	59.8	10.0	22.7	17.2	60.0	75.7	67.7
3/16 - 3/31	24.3	30.4	27.0	27.3	10.3	25.2	22.6	68.0	83.1	76.2
4/1 - 4/15	24.3	29.9	27.0	22.4	17.2	26.0	22.2	64.1	79.1	72.4
4/16/ - 4/24	23.6	30.2	26.6	21.6	12.6	26.0	21.6	62.2	75.8	69.1
Average	23.5	30.2	26.3		13.1	23.3	19.1	67.1	82.8	75.8
Total				585.2						

Table 2. Results of 10 cultivar evaluation in Trail 1 conducted from Nov. 22, 1985 to Feb. 13,1986 in Experiment 1.

Variety	Yield (g/plant)	Yield (t/h)	Harvested %	No. of tuber per hill	Ave. tuber wt. (gram)	Size distribution (by weight) % small (<3cm)	% medium (3cm-5cm)	% large (>5cm)	Specific gravity
Kennebec	584	29.2	84	11.1	53.9	4.5	54.8	40.8	1.058
R. Pontiac	542	27.1	85	10.9	50.1	4.3	55.0	41.0	1.053
Sequoia	542	27.1	84	10.3	53.7	2.5	42.8	54.0	1.063
MS35.22	477	23.9	65	12.0	39.8	6.5	78.8	15.0	1.056
DTO-28	428	21.4	76	8.4	50.7	4.0	46.8	49.0	1.061
LT-2	376	18.8	53	7.5	50.4	4.8	54.0	41.3	1.064
BR112.113	318	15.9	71	15.7	20.4	16.3	79.3	4.5	1.062
720088	313	15.6	35	7.4	41.0	7.3	65.5	27.5	1.065
Cosima	294	14.7	61	12.0	24.3	14.3	81.3	5.0	1.071
LT-5	210	10.5	81	5.1	40.7	4.5	73.3	22.0	1.073
Mean	408.3	20.4	69.5	10.0	42.5	6.9	63.1	30.0	1.063
CV (%)	20.2	20.2	10.7	17.3	15.6	34.5	18.2	38.2	0.7
LSD(0.05)	120	6.0	10.8	2.5	9.6	3.4	16.6	16.6	0.010

Table 3. Growth and development of 10 cultivars in Trial 1 conducted from Nov. 22, 1985 to Feb. 13, 1986 in Exp.1.

Variety	Emergence Date DAP*	Emergence %	Leaf miner damage (%) (at64DAP)	Canopy cover (%) 62 DAP	69 DAP	76 DAP	No. of stem /plant	No. of branch main stem
Kennebec	< 11	99	85	49	15	7	6.8	9.0
R. Pontiac	< 11	100	86	35	24	10	5.0	9.0
Sequoia	11	93	73	67	29	17	2.9	7.4
MS35.22	< 11	86	68	71	27	5	4.6	8.3
DTO-28	12	79	14	89	65	52	3.0	16.3
LT-2	18	69	50	24	23	19	2.0	5.4
BR112.113	< 11	83	85	14	17	11	4.6	8.1
720088	15	51	75	14	8	12	2.5	5.4
Cosima	12	71	78	50	25	8	5.0	7.8
LT-5	31	76	30	34	27	22	1.1	6.3
Mean		80.7	64.3	44.7	26.0	16.4	3.8	8.3
CV (%)		9.3	15.7	41.1	42.9	48.2	27.3	32.3
LSD(0.05)		11	15	27	16	11	1.5	3.9

* DAP = days after planting

Table 4. Results of 9 cultivar evaluation at harvest in Trial 2 conducted from Dec. 23, 1985 to March 24, 1986 in Exp. 1.

Variety	Yield (g/plant)	Yield (t/h)	Harvested %	No. of tuber per hill	Ave. wt. of tuber (g)	Size distribution (by weight) % Small (<3cm)	% Medium (3cm-5cm)	% Large (>5cm)	Specific gravity
Norchip	404	20.2	95	7.3	55.9	3.8	40.6	55.6	1.065
Desiree	358	17.9	88	9.9	36.3	9.5	62.0	28.5	1.051
Katahdin	334	16.7	93	6.6	51.1	5.2	46.4	48.4	1.064
C14-343	268	13.4	82	8.8	30.5	15.5	67.4	17.1	1.069
Kennebec	263	13.1	93	8.3	32.6	20.3	76.4	3.3	1.062
C1-884	252	12.6	85	8.7	29.9	13.6	71.0	15.4	1.070
R. Pontiac	223	11.1	90	8.7	25.8	11.9	78.9	9.2	1.057
LT-1	215	10.8	82	5.0	43.0	9.0	78.1	12.9	1.070
Sequioa	198	9.9	55	5.6	35.8	12.5	68.0	19.5	1.084
Mean	279.4	14.0	84.8	7.7	37.9	11.3	65.4	23.3	1.066
CV (%)	19.1	19.1	13.1	20.4	16.3	49.4	13.6	51.2	1.0
LSD(0.05)	78	3.9	16.2	2.3	9.0	14.7	13.0	17.4	0.016

Table 5. Plant development of 9 cultivars in Trial 2 conducted from Dec. 23, 1985 to March 24, 1986 in Exp.1.

Variety	Emerg. Date DAP*	Emergence %	No. of Stem per hill	Canopy Cover (%)						
				31 DAP*	38 DAP	45 DAP	59 DAP	66 DAP	72 DAP	80 DAP
Norchip	12	96.5	2.6	29	32	35	39	39	36	32
Desiree	12	91.5	2.7	30	29	30	34	32	24	32
Katahdin	11	98.3	2.6	29	22	28	33	29	17	13
C14-343	12	91.8	2.3	25	21	27	31	30	23	21
Kennebec	< 10	100.0	3.8	45	29	35	38	30	3	1
C1-884	14	88.3	2.1	20	14	20	24	22	19	16
R. Pontiac	< 10	100.0	2.8	38	26	32	30	29	14	12
LT-1	12	90.0	2.4	25	28	31	33	30	19	10
Sequioa	14	66.5	2.1	18	14	19	20	16	6	4
Mean		91.4	2.6	28.8	23.8	28.6	31.2	28.4	17.9	15.7
CV (%)		5.7	20.8	23.0	28.3	22.8	17.2	17.1	51.7	56.0
LSD(0.05)		7.6	0.8	9.7	9.8	9.5	7.8	7.1	13.5	12.8

*DAP = days after planting

Table 6. Influence of storage methods on subsequent field performance in Experiment 2.

Storage methods	Variety	Emergency %	Harvest %	Yield g/plant	No. of tuber per hill	Size distribution (%) Small (<3cm)	Medium (3-5cm)	Large (>5cm)
Cold storage (CS)	Kennebec	99	98	300	8.2	8	82	10
	Sequoia	100	97	378	8.0	4	57	39
	LT-2	61	43	212	7.8	14	76	0
Air-conditoned room (AC)	Kennebec	96	87	252	5.8	7	73	20
	Sequoia	95	87	248	4.5	4	46	50
	LT-2	62	56	198	5.8	15	62	23
Diffuse light structure (DLS)	Kennebec	51	36	184	4.8	18	73	9
	Sequoia	33	27	130	4.0	6	81	13
	LT-2	19	16	85	2.0	6	92	0
Storage mean	CS	86.7	79.3	296.7	8.0	8.7	71.7	16.3
	AC	84.3	76.7	232.7	5.4	8.7	60.3	31.0
	DLS	34.3	26.3	133.0	3.6	10.7	82.0	7.3
Cultivar mean	Kennebec	82.0	73.7	245.3	6.3	11.0	76.0	13.0
	Sequoia	76.0	70.3	252.0	5.5	4.7	61.3	34.0
	LT-2	47.3	38.3	165.0	5.2	12.3	76.7	7.6
CV(%)	Storage method	30.6	29.2	35.0	39.4	-	-	-
	Cultivar	27.1	30.7	28.0	30.3	-	-	-
LSD(5%)	Storage method	13.7	11.6	53.1	1.5	-	-	-
	Cultivar	11.2	11.2	38.9	1.1	-	-	-

Table 7. Influence of planting dates and storability of three cultivars on plant growth and yield in Experiment 3.

Planting date	Cultivar	Emergence Date (days from planting)	Emergence %	No. of stem per plant	Harvest %	Yield (g/plant)	No. of tuber per plant
Nov. 18, 1985	Kennebec	10	96	4.2	96	578	9.3
	Red Pontiac	12	94	5.2	88	420	7.0
	Sequoia	15	92	2.1	58	465	9.4
Dec. 16, 1985	Kennebec	10	96	3.9	88	350	6.5
	Red Pontiac	12	95	5.7	90	358	10.0
	Sequoia	12	54	1.6	58	242	5.2
Jan. 13, 1986	Kennebec	10	55	3.0	43	269	4.4
	Red Pontiac	11	20	2.8	7	160	2.7
	Sequoia	16	7	1.2	0	0	NA
Planting Date Mean							
	Nov. 18, 1985	12.3	94.0	3.8	80.7	487.7	8.6
	Dec. 16, 1985	11.3	81.7	3.7	78.7	316.7	7.4
	Jan. 13, 1986	12.3	27.3	2.3	16.7	143.0	-
Cultivar Mean							
	Kennebec	10.0	82.3	3.7	75.7	399.0	6.7
	Red Pontiac	11.7	69.7	4.6	61.7	312.7	6.6
	Sequoia	14.3	51.0	1.6	38.7	235.7	-
CV(%)	Planting date	-	4.0	11.0	1.8	47.3	15.8
	Cultivar	-	8.6	19.9	2.4	33.5	20.4
LSD (5%)	Planting date	-	3.0	0.5	7.6	195.5	1.3
	Cultivar	-	5.1	0.7	6.6	NS	1.3

Table 8. Estimated growth rates and partitioning coefficient for a cultivar, Kennebec, in Experiment 4.

Parameter	Growth Stage	
	T2	T3
Total growth rate	16.13	15.03
Tuber growth rate	9.59	-1.04
Partitioning coefficient*	0.59	---

*Calculated by tuber growth rate divided by total growth rate.

HORTICULTURE - Vegetable Crops (Winged Bean, Tomatoes)

C.T. Lee

Horticulture research work on vegetable crops in 1986 continued to study the effect of exogenous growth regulators on growth, yield and quality of solanaceous and cucurbit crops. The vegetable crops studied under this project were tomato and eggplant. A new project to study promoting flowing and drawfing of winged bean with plant growth regulators was conducted. Another project to study the response of trickle irrigation was in cooperation with agricultural engineering personnel.

I. Promote Flowering and Dwarfing of Winged Bean with Plant Growth Regulator

It has been shown that naturally occurring plant hormones play an important role in the process of flower bud induction and control of plant size. Synthetic plant growth regulators have been developed that will induce flowering at desired times and reduce plant size in many agricultural crops. No work has been reported on the application of plant growth regulators for the flower induction and dwarfing on winged bean.

The objectives of this project are: (a) to assess the possibility of year round production on winged bean through flower induction, and increasing of the number of flowers, and pod sets by the application of growth regulators; (b) to evaluate the use of plant growth regulators on dwarfing to reduce labor and material costs of staking in the production of winged bean; and (c) to study the effect of plant growth regulators on the quality of winged bean pods and seeds.

Materials and Methods

This experiment was conducted at the Guam Agricultural Experiment Station from May through December, 1986. The soil was clay, low in available nitrogen and phosphate and moderate in available potassium. The pH was 8.0.

Seeds of winged bean cultivar "Chimbu" were sown directly in the field. A randomized complete block design with three replications was used. Treatments consisted of seven growth regulators at the normal concentration plus the control, namely: 2,3,5 - triiodobenzoic acid (15 ppm), B-naphthoxy acetic acid (50 ppm), succinic acid -2-2-dimethyl hydrazine (100 ppm), 2,4-dichlorophenoxy acetic acid (100 ppm), 4-chlorophenoxy acetic acid (40 ppm), (2-chloroethyl) trimethyl ammonium choride (500 ppm) and spray-n-grow (2500 ppm). The growth regulators were applied at 3, 4, and 5-leaf stages.

Each experimental plot was three rows of 4.57 meters long. The spacing adopted was 1.22 meters between rows and 0.46 meters within rows. Side-dressing with a 10-20-20 fertilizer at 387 kg/ha was done four weeks after sowing the seed. A preventive spraying program was followed once weekly to reduce possible insect damage. Kelthane and Malathion 50 were used. A rotary tiller and garden hoe were used to control weeds. Sprinkles irrigation was utilized when watering was needed.

The plant was supported with a trellis constructed of tangantangan (leucaena) stakes and plastic nets. The data on plant height were collected on June 27, July 5, July 15, July 25, August 5, and August 12, 1986. Other collected data were pod weight, number of pods per plant, marketable pod yield and unmarketable pod yield.

Results and Discussions

Table 1 shows the effect of the seven selected growth regulators on plant height. There was a significant difference in plant height from the treatment of growth regulators especially in the early stage of vegetative growth. Treatment of 2, 4-dichlorophenoxy acetic acid and

4-chlorophenoxy acetic acid with an average plant height of 16.2 cm (measured on June 27, 1986) was significantly shorter than the rest of seven treatments. The application of succinic acid-2-2-dimethyl hydrazine and (2-chloroethyl) trimelhyl ammonium chloride were the next shortest in plant height. Treatment of spray-n-grow did not affect plant height. Treatment of 2, 4-dichlorophenoxy acetic acid and 4-chlorophenoxy acetic acid were the only two effective growth regulators in the control of plant height measured from July 5 through August 12, 1986.

Fresh pod weight with an average of 23.8g was not significantly affected by the application of growth regulators. There was also no significant difference in the unmarketable fresh pod yield between treated and untreated plants. Treatment of B-naphthoxy acetic acid, (2-chloroethyl) trimethyl ammonium chloride, and spray-n-grow with an average of 72.28 pods per plant was the highest in the number of pods produced per plant in comparison to the rest of the treatments. Treatment of B-naphtoxy acetic acid, (2-chloroethyl) trimethyl ammonium chloride, and spray-n-grow also produced the highest marketable fresh pod (with an average of 29.34 MT/ha). Next highest in the marketable fresh pod yield was 2,3,5-triidobenzoic acid. There was no significant difference from the treatment of succinic acid-2-2-dimethyl hydrazine, 2, 4-dichlorophenoxy acetic acid, and 4-chlorophenoxy acetic acid in the production of marketable fresh pod. The number of pods per plant is one of the major factors affecting the yield on winged bean.

Conclusions

The experiment was to study the effect of plant growth regulators on the flowering and growth of winged bean. Seven growth regulators, namely: 2, 3, 5-triiodobenzoic acid (15 ppm), B-naphthoxy acetic acid (50 ppm), succinic acid-2-2-dimethyl hydrazine (100 ppm), 2,4-dichlorophenoxy acetic acid (100 ppm), 4-chlorophenoxy acetic acid (40 ppm), (2-chloroethyl) trimethyl ammonium chloride (50 ppm) and spray-n-grow (2,500 ppm). The experiment was started on May 21, 1986. The growth regulators were applied at 3, 4, and 5-leaf stage.

The plant height was significantly reduced by the application of 2, 4-dichlorophenoxy acetic acid and 4-chlorophenoxy acetic acid. There was a significant difference in the number of fresh pods and yield of fresh pod from the treatment of 2, 3, 5-triidobenzoic acid, B-naphthoxy acetic acid, (2-chloroethyl) trimethyl ammonium chloride and spray-n-grow. There was no difference in fresh pod weight between treated and untreated plants.

II. Effect of Exogenous Growth Regulators on Growth, Yield and Quality of Solanaceous and Cucurbit Crops

IIa. The effect of the 4-Chlorophenoxy Acetic Acid on Eggplants

This experiment was to study the effect of 4-chlorophenoxy acetic acid on the growth and production of eggplants during both dry and wet seasons.

Materials and Methods

The eggplant cultivar "Millionaire" was used in this experiment. Seeds were sown in Jiffy-7 pellets and one-month old seedlings were transplanted to the field. Treatments consisted of six concentrations (0, 10, 20, 30, 40 and 50 ppm) of 4-chlorophenoxy acetic acid. The spray solution was applied at a ten-day interval to the flowering blooms. The experiment design was randomized complete block with three replications. Each experimental plot consisted of three rows of 5.03 meters long. A spacing of 1.22 meters between rows and 0.46 meters was adopted.

Fertilizer (10-20-20) at the rate of 448 kg/ha was broadcast and incorporated into the soil before transplanting. Side-dressing with the same fertilizer at the same rate was done four weeks after transplanting. A preventive spraying schedule was followed twice weekly to control possible insect and disease damage by using Malathion 50, Ethion, Diazinon Ag 500 EC, Dithane M-45 and Tribasic Coppers. Sprinklers were used for irrigation whenever watering was needed. A rotary tiller and garden hoe were used to control weeds.

Results and Discussion

a) During the Dry Season

The results of the effect of 4-chlorophenoxy acetic acid on some horticultural characteristics and production of eggplants during the wet season. There was no significant difference in fruit weight between treated and untreated plants during the wet season. All plants treated with 4-chlorophenoxy acetic acid at the concentration of 30, 40, and 50 ppm significantly increased the number of fruits per plant and marketable fruit yield. However, the only treatment increased unmarketable fruit yield was at 30 ppm.

IIb. The effect of the B-Naphthoxy Acetic Acid on Eggplant

This experiment was to study the effect of the B-naphthoxy acetic acid on the growth and production of eggplants during both dry and wet seasons.

Materials and Methods

The eggplant cultivas "Millionaire" was used again in this experiment. The planting method, pest and weed control, irrigation system and experiment design were the same as in experiment IIA except for the treatment. Treatments for this experiment consisted of five concentrations (0, 25, 50, 75, and 100 ppm) of B-naphthoxy acetic acid applied to eggplant flowers at a ten-day interval.

Results and Discussion

a) During the Dry Season

The results of the effect of B-naphthoxy acetic acid on some horticultural characteristics and production of eggplants during the dry season are shown in Table 5. The application of B-naphthoxy acetic acid did not affect fruit weight and unmarketable fruit yield. B-naphthoxy acetic acid at the concentration of 75 and 100 ppm gave a significant increase on the number of fruits per plant and marketable fruit yield.

b) During the Wet Season

Table 6 indicates the results of the effect of B-naphthoxy acetic acid on some horticultural characteristics and production of eggplants during the wet season. There was no significant difference in fruit weight and unmarketable fruit yield between the treated and untreated plant. The number of fruits per plant and marketable fruit yield were increased from the application of B-naphthoxy acetic acid at the concentration of 75 and 100 ppm.

Conclusion

Several experiments were conducted to study the effect of two growth regulators (4-chlorophenoxy acetic acid and B-naphthoxy acetic acid) on the growth and production of eggplants during the dry and wet seasons. The cultivag "Millionaire" was used for these experiments. Treatments were six concentrations (0, 10, 20, 30, 40, and 50 ppm) of B-naphthoxy acetic acid. The spray solution was applied at a 10-day interval to the flowering blooms. It was found that the spraying on the leaf and growing point should be avoided as much as possible otherwise would damage to the plant.

During the dry and wet seasons, 4-chlorophenoxy acetic acid at the concentration of 30, 40 and 50 ppm gave a significant increase in the number of fruits per plant and marketable yield on eggplants. Application of B-naphthoxy acetic acid at the concentration of 75 and 100 ppm; increase in the number of fruits per plant and yield on eggplants. However, there was no significant difference in fruit weight between treated and untreated plants from the application of these two growth regulators.

Table 1. The effect of different growth regulators on plant height of winged bean (planted on May 21, 1986).

Treatment	plant height (six months)					
	June 27 1986	July 5 1986	July 15 1986	July 25 1986	Aug. 5 1986	Aug. 12 1986
2,3,5-triiodobenzoic acid (15 ppm)	27.7c *	34.5b	47.1b	66.4b	101.0b	140.1b
B-naphthoxy acetic acid (50 ppm)	27.8c	28.1b	48.2b	65.9b	99.2b	143.9b
succinic acid-2-2 -dimethyl hydrazine (100 ppm)	25.5bc	36.4b	54.9b	70.7b	100.9b	146.2b
2,4-dichlorophenoxy acetic acid (100 ppm)	15.2a	21.9a	35.5a	50.1a	74.4a	110.4a
4-chlorophenoxy acetic acid (40 ppm)	17.1a	22.9a	32.8a	52.0a	75.3a	121.1a
(2-chloroethyl) trimethyl ammonium chloride (500 ppm)	22.3b	34.2b	46.5b	64.2b	93.7b	142.0b
Spray-N-grow (2,500 ppm)	33.6d	39.6b	48.8b	64.1b	101.8b	147.7b
Control	31.7d	37.8b	54.2b	73.3b	110.0b	155.5b

* Means followed by the same letter within same measurement in a column do not differ significantly at the five percent probability level using Ducan's Multiple Test.

Table 2. The effect of different growth regulators on some horticultural characteristics and production of winged bean (planted on May 21, 1986).

Treatment	Fresh pod weight (g)	Number of pods/plant	Unmarketable fresh pod yield (MT/ha)	Marketable fresh pod yield (MT/ha)
2,3,5-triiodobenzoic acid (15 ppm)	23.4a	66.91bc	1.52a	27.2 o bc
B-naphthoxy acetic acid (50 ppm)	24.7a	70.61c	1.43a	28.62c
Succinic acid-2-2 -dimethyl hydrazine (100 ppm)	24.2a	62.10ab	1.47a	25.17ab
4-dichlorophenoxy acetic acid (100 ppm)	23.0a	57.6o a	1.41a	23.51a
(2-chloroethyl) trimethyl ammonium chloride (500 ppm)	24.0a	72.3ba	1.48a	29.30c
Spray-N-grow (2,500 ppm)	24.1a	73.88c	1.60a	29.91c
Control	23.5a	59.07a	1.51a	24.05a

* Means followed by the same letter within same measurement in a column do not differ significantly at the five percent probability lelvel using Ducan's Multiple Test.

Table 3. The effect of 4-chlorophenoxy acetic acid on some horticultural characteristics and production of eggplant during the dry season.

Treatment	Fruit weight (g)	Number of fruits/plant	Unmarketable fruit yield (MT/ha)	Marketable fruit yield (MT/ha)
0 ppm	96.1a*	12.1a*	1.2a	18.5a
10 ppm	94.5a	12.9a	1.3a	19.9a
20 ppm	97.0a	14.9b	1.1a	22.9bc
30 ppm	96.8a	15.7b	1.2a	24.2c
40 ppm	99.1a	14.8b	1.1a	22.8b
50 ppm	98.2a	14.6b	1.2a	22.4b

*Means followed by the same letter within same measurement in a column do not differ significantly at the 5% probability level using Ducan's Multiple Range Test.

Table 4. The effect of 4-chlorophenoxy acetic acid on some horticultural characteristics and production of eggplant during the wet season.

Treatment	Fruit weight (g)	Number of fruits/plant	Unmarketable fruit yield (MT/ha)	Marketable fruit yield (MT/ha)
0 ppm	91.5a*	6.7a	0.7a	10.7a
10 ppm	90.2a	7.3ab	0.8ab	11.5a
20 ppm	89.5a	7.0a	0.8ab	11.1a
30 ppm	92.2a	8.3bc	0.9b	13.2b
40 ppm	90.5a	8.1b	0.7a	12.9b
50 ppm	91.1a	8.0b	0.8ab	13.0b

*Means followed by the same letter within same measurement in a column do not differ significantly at the 5% probability level using Ducan's Multiple Range Test.

Table 5. The effect of B-naphthoxy acetic acid on some horticultural characteristics and production of eggplants during the dry season.

Treatment	Fruit weight (g)	Number of fruits/plant	Unmarketable fruit yield (MT/ha)	Marketable fruit yield (MT/ha)
0 ppm	94.7a*	11.8a	1.1a	18.2a
25 ppm	95.2a	12.3a	1.2a	19.0a
50 ppm	96.1a	12.4a	1.2a	19.2a
75 ppm	94.3a	14.8b	1.1a	22.9b
100 ppm	97.8a	14.5b	1.1a	22.1b

*Means followed by the same letter within same measurement in a column do not differ significantly at the 5% probability level using Ducan's Multiple Range Test.

Table 6. The effect of B-naphthoxy acetic acid on some horticultural characteristics and production of eggplants during the wet season.

Treatment	Fruit weight (g)	Number of fruits/plant	Unmarketable fruit yield (MT/ha)	Marketable fruit yield (MT/ha)
0 ppm	90.1a*	6.5a	1.4a	10.3a
25 ppm	89.3a	6.9a	1.5a	11.0a
50 ppm	88.4a	6.8a	1.6a	10.8a
75 ppm	91.2a	8.0b	1.4a	12.8b
100 ppm	92.5a	7.7b	1.5a	12.3b

*Means followed by the same letter within same measurement in a column do not differ significantly at the 5% probability level using Ducan's Multiple Range Test.

PESTICIDES

C. Bjork

Impact of Insecticides on Yields of Head Cabbage

Research was conducted on head cababage, KK cross, August to December1985-1986 at the Agricultural Experiment Station in Inarajan, Guam. It was designed to test the effectiveness of two common insecticides and their combination in increasing yield by controlling the caterpillar pests of head cabbage.

I. Insecticide Trials 1985

Materials and Methods

A field trial using KK cross variety of head cabbage was conducted at Inarajan, Guam. The plants were grown in flats and transplanted as seedling into the experimental rows. Each plot consisted of three rows with individual plants planted one foot apart in the rows and one and a half feet apart between rows. Each row consisted of twelve plants or thirty-six plants/plot. The plots or pesticide treatments were replicated four times. The treatments were Control, Pounce at four ounces/acre, Dipel+ at one pound/acre and Pounce and Dipel+ combined at four ounces/acre Pounce and one pound/acre of Dipel+. The plots were sprayed twice a week. The insecticides were applied with a Solo Backpack sprayer-425 twice a week. Triton B-1956 was used as a sticker at the rate of one tablespoon/three gallons. The high amount of sticker was applied because of the high rainfall during the time of the experiment. Dithane M-22 and Tribasic Copper Sulfate was added to all treatments at the rate of one pound/acre of Dithane M-22 and three pounds of Tribasic Copper Sulfate. The insects of the first ten heads of the center rows of the three row group were counted in all plots. All heads were harvested, weighed, measured vertically and horizontally, assessed and rated as to insect damage and damage due to disease. There was a staggered yield with the heads being harvested when they were firm and mature. The fertilizer rate of eight pounds of 10:20:20/100 rows was applied preplant and tilled in. Each treatment was sidedressed twice during the season with 46:0:0 applied through the drip line at the rate of two pounds/100 feet of row.

Results and Discussion

In Table1 is shown the total weight harvested per plot. There were 78 pounds harvested in the Control plot, 107 pounds in the Dipel, 162 pounds in the Pounce plot and 148 pounds in the Pounce and Dipel plot. The Pounce plot yields twice as much weight as the Control plot, but if you look at the total marketable weight in Table1 you will see that ratios change with twice as much marketable weight as was produced in the Dipel plot than in the control plot, seven times more in the Pounce plot than in the control plots and almost seven times as much in the Pounce and Dipel plots than in the control plot. The use of Dipel did increase the marketable yield by two times as much, but was not nearly as effective as Pounce.

II. Insecticide Trials 1986

Materials and Methods

A field trial using KK cross variety of head cabbage was conducted at Inarajan, Guam, The plants were grown and transplanted from flats of seedling into the experimental rows. Each plot consisted of three rows with individual plants planted one foot apart in the rows and one and a half feet apart between rows. Each row consisted of twelve plants or thirty-six plants/plot. The plots or pesticide treatments were replicated four times. The treatments were Control, Pounce and

Dipel+ (combined at four ounces/acre Pounce and one pound/acre of Dipel+). Lannate + Dipel Plus combined at the rate of four pints Lannate one/acre + one pound/acre Dipel Plus. Dibrom + Dipel Plus combined at the rate of two pints Dibrom/acre + one pound of Dipel Plus/acre. The plots were sprayed twice a week. The insecticides were applied with a Solo Backpack sprayer-425 twice a week Triton B-1956 was used as a sticker at the rate of one tablespoon/three gallons. Dithane M-22 and Tribasic Copper Sulfate was added to all treatments at the rate of one pound/acre for Dithane M-22 and three pounds/acre for Tribasic Copper Sulfate. There was a staggered yield with the heads being harvested when the heads were firm and mature. The fertilizer rate of fifteen pounds of 16:16:16 /row was applied preplant and tilled in. This was almost twice the recommended dosage due to a miss calibration of a new backpack fertilizer spreader. This caused a burning of at least two of the outer leaves for the first two weeks. Each treatment was sidedressed twice during the season with 46:0:0 applied through the drip line at the rate of two pounds/100 feet of row and sprayed Foliar-60 once a week for the first six weeks at the rate of one tablespoon/gal.

Results

During 1986 the head cabbage had at least 30% less insects and a higher yield in both the Control and the Pounce plots than in 1985. In the northern part of Guam the major caterpillar pest of cabbage is the diamond- back moth, Plutella xylostella. This insect is rarely present in the experimental or farms in the southern part of Guam. The pests of cabbage in the northern part of Guam are mainly leaf eatters while the pests in the southern part of the island are more borers. The Control plots had a higher yield than in 1985 because with fewer insects, posssibly due to the fact that less corn was being grown at the experiment station and in the southern part of the island which had similar pests and using more fertilizer more of the heads made it to maturity whereas in 1985 several plots did not have one marketable head. The Pounce + Dipel Plus plots in 1987 averaged over 2700 more pounds of cabbage than during the 1985 experiment, thought to be largely due to the high fertilizer rate applied and the increased size of the head. Statistically there was not a significant difference between the Control plot and any of the spray plots. In practicality the Pounce + Dipel Plus plot would have produced over 18,000 more pounds of marketable head cabbage/acre than the Control plot.

Table 1

Treatment	Total Weight Harvested/ Treatment	Total Marketable Weight/Treatment	Marketable Weight/Acre*
Control	79 lbs.	22 lbs.	6,749 lbs.
Dipel	107 lbs.	40 lbs.	12,194 lbs.
Pounce	162 lbs.	142 lbs.	42,948 lbs.
Pounce & Dipel	148 lbs.	136 lbs.	41,253 lbs.

Table 2

Treatment	Total Heads Harvested/ Treatment	Total Marketable Heads/Treatment	Marketable Heads/Acre*
Control	136	20	13.2%
Dipel	129	31	21.5%
Pounce	137	116	80.5%
Pounce & Dipel	140	114	79.2%

Table 3

Treatment	Mean Total Marketable Weight/Treatment	Mean Total Marketable Heads/Treatment
Control	5.56a**	4.75c
Dipel	11.41a	7.75bc
Pounce	33.09b	30.0a
Pounce & Dipel	33.16b	27.75ab

*The treatment plots were 144 square feet or 1/302.5 part of an acre. To change total weight/treatment into weight/acre the total was multiplied by 302.5.

** Numbers followed by the same letter are not significantly different at the 5% level (LSD).

Table 4

Treatment	Total Weight Harvested/ Treatment	Total Marketable Weight/Treatment	Marketable Weight/Acre*
Control	124 lbs.	93 lbs.	28,072
Lannate + Dipel+	141 lbs.	126 lbs.	38,143
Pounce + Dipel+	157 lbs.	151 lbs.	45,678
Dibrom + Dipel+	140 lbs.	134 lbs.	40,535

Table 5

Treatment	Total Heads Harvested/ Treatment	Total Marketable Heads/Treatment	Percent Marketable Heads/Treatment
Control	111	78	54.2%
Lannate + Dipel +	141	125	86.8%
Pounce + Dipel+	134	125	86.8%
Dibrom + Dipel+	139	131	91.0%

Table 6

Treatment	Mean Total Marketable Weight Treatment	Mean Total Marketable Heads/Treatment
Control	23a**	19.25a
Lannate + Dipel +	31.75a	31.25a
Dibrom + Dipel+	33.5a	32.75a
Pounce + Dipel +	37.75	31.25a

**Numbers followed by the same letter are not significantly different at the 5% level(LSD).

SOIL SCIENCE

J.L. Demeterio

NPK Response Studies in Ponape

The response of field corn (San Miguel variety) to varied NPK levels was conducted in the Ponape Agricultural Experiment Station in collaboration with Dr. R.S. Dayrit. The field was located one hundred yards off the soil pit which was dug by the Soil Conservation Service in their Soil Survey of Ponape. The soils were the Umpump series with the taxonomic class - clayey, oxidic, isohyperthermica, shallow, Typic Arorthox. This particular field was a gravelly silty clay loam (35.6% clay, 25.32% silt, and 39.08% sand).

The soil test levels were as follows:

pH 5.90
6.8 ppm P
29.5 ppm K
1150.0 ppm Ca
85.0 ppm Mg
117.6 ppm Na
7.3% Organic Matter

Based on soil test test levels, a response to P and K application is expected. With a 7.5% organic level, addition of nitrogen which is based on crop known needs for N and organic matter content, the addition of 100 kgm N should be sufficient.

Individualized plot size was 4x4 meters replicated four times. The middle two rows were used to determine yields. Fertilizer was banded within the furrow, which was covered with 2-3" of soil and the seeds placed directly on top of the fertilizer band and covered with 1-2" of soil. Normal pesticide spraying was done and the corn was allowed to mature before harvesting. Field layout was a Randomized Complete Block Design.

Two croppings were made (January-March, 1986 and December 1986 - February 1987) while maintaining the sample plots for the same treatments. A rototiller and manual hoeing was done to preserve plot integrity.

Treatments and yield results are shown on Table 1. Treatment 1, 2, 3 and 4 tests the response to N fertilization; 5, 6, 7 and 3 for P; and 8, 9, 10, and 3 for K. The first field experiment was significant at the 1% probability level with a coefficient of variation of 18.68%. The second experiment was significant at the 5% level with a coefficient of variation of 25.35%. Although similar agronomic practices were followed in both experiments, the seeds for Experiment 2 were obtained from another source and the purity was questionable. In Experiment 1 yield ranged from 2308 kgm to 6899 kgms, and in Experiment 2 the range was from 2500 to 6034 kgm/ha. In both experiments the lowest yield was observed when no nitrogen was added.

The response to added nitrogen is shown in Table 2. The response trend in both experiments are similar with highest response obtained in the 100-300-100 treatment. The increased in yield in the first experiment ranged from 160.4 to 167.7%. Top yield increase in the second experiment was 141.4% over the control. It should be noted here that N application was done only once during planting.

The response to added phosphorus is shown in Table 3. Although yield was higher in the first experiment (average of 6286 to 4579 kgm/ha in the second experiment) the trend was the same. There was no significant increase due to phosphorus addition. The initial Olsen P level of 6.8 ppm is apparently adequate.

The response to potassium is shown in Table 4. In the first experiment yield increase ranged from 15.4 to 30.5%. The top yield of 6899 kgm at the 100-300-150 treatment is a yield increase of 1611 kgm which is just over the LSD.05 value of 1539. A more pronounced increase is observed at the 100-300-100 treatment of 66.2% (6034 as compared to 3630 kgm at the 100-300-0 treatment) in the second experiment. Although increase in yield due to K addition is observed in both experiment, there is no trend observed.

In summary, Umpump soils responded well to nitrogen addition while exibiting a moderate response to K. Umpump soils did not respond to phosphorus application.

Table 1. Corn grain yield (air-dried) at harvest in kilograms per hectare.

Treatment	Experiment 1 Yield **	Experiment 2 Yield*
0-300-100	2308	2500
50-300-100	6010	4543
100-300-100	6178	6034
150-300-100	5024	4423
100- 0-100	6226	4591
100- 75-100	6226	4495
100-150-100	6515	4808
100-300- 0	5288	3630
100-300- 50	6106	4351
100-300-150	6899	4639
C.V.	18.68%	25.35%
LSP.01	2079	2186
LSD.05	1539	1619

*Significant at the 1% probability level
**Significant at the 5% probability level

Table 2. Response to Nitrogen

	Experiment 1		Experiment 2	
Treatment	Yield kgm/ha	% of yield Response	Yield kgm/ha	% of Yield Response
0-300-100	2308		2500	
50-300-100	6010	160.4	4543	81.7
100-300-100	6178	167.7	6034	141.4
150-300-100	5024	117.7	4423	76.9

Table 3. Response to Phosphorus

Treatment	Experiment 1		Experiment 2	
	Yield kgm/ha	% of yield Response	Yield kgm/ha	% of Yield Response
100- 0-100	6226		4591	
100- 75-100	6226	0	4495	-2.1
100-150-100	6515	4.6	4808	4.9
100-300-100	6178	-7.7	4423	-3.7

Table 4. Response to Potassium

Treatment	Experiment 1		Experiment 2	
	Yield kgm/ha	% of yield Response	Yield kgm/ha	% of Yield Response
100- 30-100	5288		3630	
100-300- 50	6106	15.4	4351	19.9
100-300-100	6178	16.8	6034	66.2
100-300-150	6899	30.5	4639	27.8

Population Density Effect on Kernel Yield of Guam White Field Corn

This study was conducted in collaboration with IBSNAT's Patrick Ching who helped in designing and laying out of the experiment. A randomized complete block design tested 4 population densities. Nitrogen was blanket applied at 200 kgm N using urea. Individual plots were 4 x 15 meters. Normal pesticide spraying was done with water supplied by a drip irrigation system. The study was conducted at the Inarajan AES on Saipan soils.

Results of the experiment significant at the 5% probability level are shown in Table 1 and 2. Highest total kernel and biomass yield are observed in the 80,000 population density level. Kernel yield ranged from 1.478 to 2.525 tons/ha. Total biomass yield ranged from 4.346 - 8.094 metric tons/ha. If the target is silage corn, the 80,000 density level offers the maximum yield.

Table 1. Corn kernel yield (at 15.5% moisture) response of Guam white field corn in metric tons/ha as ofposted by population densities.

Population Densities plants/ha	Replications I	II	III	Mean
80,000	2.749	2.288	2.537	2.525
40,000	2.335	.935	2.607	2.292
20,000	2.231	1.932	1.889	2.017
10,000	1.240	1.137	2.057	1.478
			$LSD_{.01}$	.862

C.V. = 13.70%

Table 2. Total biomass yield (leaves, stalks, roots, husks, cobs, and kernels oven dried at 70°C) of Guam white field corn planted at different population densities, in metric tons/ha.

Population Densities plants/ha	Replications I	II	III	Mean
80,000	8.507	8.487	7.287	8.094
40,000	6.438	4.634	7.388	6.153
20,000	5.439	4.491	3.708	4.546
10,000	4.531	3.328	5.178	4.436
			$LSD_{.01}$	3.058

C.V. = 17.45%

Guam White Corn Yield Response to Varied Nitrogen Rates and Timing of Application

The response of Guam white corn yield to varying nitrogen rates and timing of application was carried out on Saipan soils, fine, oxidic, isohyperthermic Oxic Paleustalf at the Inarajan Agricultural Experiment Station. The experimental design was a split-plot with nitrogen rates as the main plot, with the sub-plot as timing of N application. Nitrogen was applied all at planting and one half at planting, the other half at onset of tasseling. Drip irrigation and normal pests control was practiced to maturity. Individual plot size was 5x4 meters with the middle 3 rows as the harvest rows.

Main plot results are shown in Table 1. The letters following the mean yield are Duncans multiple range t-test values. The 200 kgmN/ha treatment yielded the highest. Application of 400 kgm N actually reduced yield as compared to the 200 kgn N level. The response was a typical growth curve where addition of nitrogen increased yield up to a certain amount where yield starts to decrease.

Subplots results significant at the 5% probability level are shown in Table 2. A single aplication of Na yielded 3.544 in comparison to a lower yield response of 3.057 tons per hectare where nitrogen application was split. The results confirmed an earlier study (Annual Report 1985) where splitting N did not increase yield as compared to a single application.

Table 1. Corn kernel yield response in tons per two hectares of Guam white field corn to varying nitrogen rates.

Nitrogen Rates	Replications				
	I	II	III	IV	Mean
0	2.602	3.808	2.948	5.834	3.798C
50	3.680	6.480	6.779	4.947	5.472bc
100	4.795	5.524	6.994	7.258	6.143abc
200	9.489	10.213	7.831	10.147	9.420a
400	7.487	9.863	7.202	8.085	8.159ab

C.V. = 24.47
** Significant at the 1% probability level

Table 2. Guam white field corn response in tons/ha kernels to timing of N application.

Nitrogen Rates	All at Planting	Split Applied
0	2.195	1.603
50	3.228	2.243
100	3.582	2.561
200	4.804	4.617
400	3.913	4.261
Mean	3.544	3.057