

GUAM AGRICULTURAL EXPERIMENT STATION

RESEARCH REPORT III



UNIVERSITY OF GUAM
COLLEGE OF AGRICULTURE AND LIFE SCIENCES
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INTRODUCTION

We are proud to present the third Annual Report of the University Of Guam Agricultural Experiment Station. While we are still in the developmental stage, our farmers have recognized the value of our work and are now actively supporting the station.

Applied research still comprises the bulk of our efforts. However, we have increased the staff in the areas of Animal Science and plant pathology. Also, we have entered into some projects in co-operation with the Cooperative Extension Service of the College of Agriculture and Life Sciences. Finally, the section on "Land Use And The Guam Food Base" represents a needed supplement to literature in the field.

Through these activities we hope to satisfy our research goals in addition to some pressing community needs. It is our hope that within the next two years (1978-80) we will have a full staff capable of meeting the demands of increased agricultural productivity in Guam.

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HORTICULTURE (VEGETABLE CROPS)

Again, the emphasis in horticultural (vegetable) research work in 1977 was concentrated in screening and determining the adaptability of vegetable varieties which have economic potential and suitability for growth under the environmental conditions of Guam.

The current vegetable research Hatch projects are:

1. Studies on improvement of the watermelon and eggplant varieties grown on Guam; and
2. Varietal performance studies on major vegetable crops in Guam.

I. EGGPLANT VARIETAL SELECTION

1. Materials and Methods:

This experiment was conducted during the dry season of 1977 to evaluate the effect of environmental factors on the performance of eggplants. Nine varieties of eggplants were included in this trial. They were; Black Torpedo, Long Tom No. 4, Kitsuda Chunaga, Kisshin Improved, B-1, Black Diamond, Long Beauty, Okitsu No.2, and Ma Chih. Seeds were sown in jiffy-7 pellets and one month old seedlings were transplanted in the field. Jiffy-7 pellets reduced transplanting shock and setback problems to the seedlings. A randomized complete block design with three replications was used. Each experimental plot was a single row of 15.25 meters long. The spacing adopted was 1.52 meters between rows and 0.9 meters within rows. 15-15-15 fertilizer was broadcast before transplanting. Side-dressing with the fertilizer at the same rate was initiated immediately after the first harvest.

A twice weekly preventive spraying program was followed to reduce possible insect and disease damage by using Malathion 50, Dibrom 8E, Diazinon 500 EC, and Dithane M-45. Rotary tillers and garden hoes were used to control weeds. Sprinklers were used for irrigation.

Harvesting was started when the fruit had attained the desirable size, still glossy, and at the best edible stage. The Harvesting period lasted approximately two and one-half months from the time of first harvest.

Marketable yield was based on the fruit that was free of insect and disease damage. The unmarketable yield was the fruit spoiled by insects and diseases.

2. Marketable Fruit Yield:

Black Torpedo with a production of 46.36 metric tons of fruit per hectare significantly outyielded the rest of the eight varieties. Long Tom No. 4 was the next highest producer with 36.68 metric tons per hectare. There was no significant difference in yield among B-1, Ma Chih, Kisshin Improved, Kitsuda Chunaga, Okitsu No. 2, Black Diamond, and Long Beauty which ranged from 21.50 to 27.67 metric tons per hectare.

3. Unmarketable Fruit Yield:

The unmarketable fruit was mainly caused by insects and cottony rot disease, as a result of a soil inhabiting fungus, *Phytophthora paracitica*. This fungus was less prevalent in the dry season compared to the wet season.

B-1 and Black Torpedo were significantly less susceptible to fruit rot disease with 0.65 and 1.21 metric tons per hectare respectively of unmarketable fruit out of the total fruit production. The lower rate of fruit rot seemed to be attributed to the thicker skin and tougher flesh of the fruit. The varieties most susceptible to fruit rot disease were Long Tom No. 4 and Long Beauty, with 2.89 and 2.82 metric tons per hectare of unmarketable fruit respectively, during the dry season. The higher rate of fruit rot may be attributed to the thinner skin and more tender flesh of the fruit.

Fruit yield of different varieties of eggplant
during the dry season of 1977

Variety	Marketable Yield (MT/ha)	Unmarketable Yield (MT/ha)	Unmarketable Yield Percentage
Black Torpedo	46.36	1.21	2.54
Long Tom No. 4	36.68	2.89	7.30
Kitsuda Chunaga	22.49	1.77	7.30
Kisshin Improved	22.49	2.38	9.57
B-1	21.50	0.65	2.93
Black Diamond	25.81	1.95	7.02
Long Beauty	27.67	2.82	9.25
Okitsu No. 2	23.61	1.97	7.70
Ma Chih	21.50	2.60	10.79
L.S.D. at .05	6.30	0.74	

4. Shape of Fruit

Black Torpedo, Long Tom No. 4, B-1, Long Beauty, and Ma Chih have long, slim type fruit. Long slimmer types have more

flexibility in the kitchen. Their crosswise slices are preferable for baking, frying, casseroles and barbecuing. The round or half-long types are not generally preferred.

5. Conclusions:

Based on appearance, texture, and yield, Black Torpedo, Long Tom No. 4, B-1, and Long Beauty were the promising varieties as per the results of the experiment conducted during the dry season of 1977.

II. BELL PEPPER VARIETAL SELECTION

1. Materials and Methods:

This was the first year a bell pepper experiment was conducted during the wet season. The objective was to evaluate the climatic factors on the varietal performance. Seven varieties of bell peppers were included in the experiment. They were; Emerald Giant, Yolo Wonder, Twilley's Big Pack, Florida Giant, Midway, Keystone Giant, and World Beater. Seeds were sown in Jiffy-7 pellets and one month old seedlings were transplanted in the field. A randomized complete block design with three replications was used. Each experimental plot consisted of a single row of 15.24.



Varietal trial of bellpepper.

meters long. The spacing adopted was 1.22 meters between rows and 0.91 meters within rows. 10-20-20 fertilizer at the rate of 773 kg/ha was broadcasted and incorporated into the soil before transplanting. Side-dressing with the fertilizer at the same rate was initiated immediately after the first harvest.

A preventive spraying program was followed twice weekly to reduce possible insect, mite and disease damage. Kelthane, Dibrom 8E, Malathion 50, and Dithane M-45 were used. A rotary tiller and garden hoes were used to control weeds.

Little or no irrigation was needed during the wet season.

Harvesting was started when the fruit had attained the desirable size, but was still green, waxy and shiny. Good shape, thick flesh, good color, and fresh appearance were the criteria for initiating harvest. The harvest period lasted for about two months.

Marketable yield was based on the fruit which was free of insect and disease damage. The unmarketable yield was the fruit damaged by insects and diseases.

2. Marketable Fruit Yield:

World Beater with a production of 12.96 metric tons per hectare significantly out-yielded the rest of the six varieties. There was no significance in yield among Florida Giant, Twilley's Big Pack, and Keystone Giant which ranged from 10.13 to 11.10 metric tons per hectare.

3. Unmarketable Fruit Yield:

Keystone Giant and Florida Giant were significantly less damaged by insects and diseases with 0.36 and 0.34 metric tons per hectare of unmarketable fruit respectively. Midway was the highest unmarketable variety with 0.99 metric tons per hectare. The rest of the four varieties averaged 0.58 metric tons per hectare.

Fruit yield of different varieties of bell pepper during the wet season of 1977

Variety	Marketable Yield (MT/ha)	Unmarketable Yield (MT/ha)	Unmarketable Yield Percentage
Emerald Giant	9.64	0.49	4.84
Yolo Wonder	8.54	0.67	7.26
Twilley's Big Pack	10.90	0.70	6.03
Florida Giant	10.13	0.34	3.25
Midway	9.75	0.99	9.22
Keystone Giant	11.10	0.36	3.14
World Beater	12.96	0.47	3.50
L.S.D. at .05	1.16	0.28	

4. Size of Fruit

The fruit size of Florida Giant, Yolo Wonder and Keystone Giant averaged 85.3 grams in weight and were significantly larger than the rest of the four varieties. Midway and World Beater with 68.1 and 68.5 grams respectively were the smallest in fruit size.

5. Conclusions

Based on appearance, texture, size and yield, Keystone Giant, Twilley's Big Pack, Florida Giant, and World Beater were the promising varieties in the 1977 wet season experiments.

HORTICULTURE (FRUIT CROPS)

The need for research on fruit crops in Guam has been apparent since the establishment of the Agricultural Experiment Station in 1973.

A horticulturist with experience in fruit trees was recruited in 1977. During the later part of 1977 two research proposals, "GUA00020 - Improving the Status of Tropical Fruit Crops Through Selection, Introduction and Breeding" and "GUA00021 - Production of Short-Term Fruit Crops" were approved by the Cooperative Research, Science and Education Administration, U.S.D.A.

Work was initiated to conduct research on these two projects at Inarajan Station and other available sites. At Inarajan a propagation shed has been erected, propagation benches assembled, and orders placed for equipment not available locally. Sources of seed and vegetative plant material, specifically for papaya, pineapple, passion fruit and cape gooseberry, have been located and an import permit has been obtained from APHIS, USDA. Procedures are also being developed to survey and evaluate fruit trees growing on the island. The objective of these projects is towards the improvement of such existing crops as mango, avocado, guava, coconut, betel nut, papaya, etc. by the evaluation of local cultivars and cultural practices. Furthermore, cultivars from other countries will be imported and tested against local types for their suitability. New plant species will be tested for their usefulness as fruit crops in the island.



Seedling Nursery Construction



Greenhouse construction in progress

SOILS

I. East/West Center Project:

A nitrogen study conducted in association with the INPUTS (Increasing Production Under Tight Supply) project of the East/West Center was tied in with our on-going project in assessing the soil fertility status of Guam soils. Corn was used as the test crop. The nitrogen treatments were; 1) an inorganic source (ammonium sulfate at 75, 150, and 300 kgm N per hectare); 2) chicken manure with 3.01% N applied at rates double the nitrogen from the inorganic source; and 3) intercropping with legumes.

Four series of field experiments were done and ruined by the Asiatic corn borer (*Ostrinia furnacalis*) and corn earworm (*Heliothis* sp.). It was noted, however, that the corn stand was generally better in the intercropped treatments (mungo beans, peanuts, cowpea, and soybeans).



Intercropping corn with legumes

II. Water Resources Project.

Another completed nitrogen-related study was a joint project with the Guam Water Resources Center entitled, "Quality of Percolate Below the Root Zone of Selected Vegetables Grown in Northern Guam". The water source that services 75 percent of the Island's potable, industrial, and agricultural water needs is contained in a vast underground fresh water lens that exists in northern Guam. Renewed agricultural activities on top of the fresh water lens have drawn much concern from environmentalists about possible contamination.

A study was conducted to determine the type and amount of agricultural chemicals being used, to characterize the percolate quality below the root zone of selected vegetables, and to determine the possibility of contamination of ground water quality due to renewed agricultural activities in northern Guam.

An inventory of pesticide usage by farmers in northern Guam was conducted. Bench scale lysimeter studies were run to determine the quality of percolate below the root zone of tomato, bellpepper, eggplant, Chinese cabbage, and head cabbage. The effects of various nitrogen carrying materials were evaluated.

It is believed that with less than 0.2% of the land area in northern Guam devoted to full-time farming operations, the contamination of the fresh water lens cannot be attributed to farming activities. The data gathered also suggests that increased activity in agriculture in northern Guam will not contaminate the underground fresh water lens.

III. Soil Analysis and Soil Fertility

A total of 110 soil samples from farmers' fields were processed and analyzed in 1978. Phosphorus extracted with 0.5 M NaHCO_3 at pH 8.5 tended to range from not detectable to under 2 ppm in unfertilized soils. Phosphorus build-up was detected in fertilized soils with values ranging from 20-80 ppm. P. Acidic soils from the south exhibited lower exchangeable P than soils from the north. The fixation mechanism in acid volcanic soils tends to be stronger than the fixation mechanism in alkaline soils developed on top of limestone formations. A phosphorus study with levels ranging from 0-600 kgm P per hectare was conducted in the north using tomato. This follow-up study confirmed the need to add as much as 300 kgm nitrogen per hectare to overcome the P-fixing ability of alkaline Guam soils.

Plant tissue testing was initiated as another way of assessing the fertility of Guam soils. The optimum levels of total nitrogen, phosphorus, potassium, calcium, magnesium, iron, manganese, copper and zinc have not as yet been determined.

Agricultural Experiment Station Soils Research and Testing Laboratory received PPQ, APHIS, USDA permission to handle untreated off-island soils. With this the Experiment Station is now in a position to accept the responsibility of being the hub of soils related activities in this part of the world (Micronesia).

ENTOMOLOGY

The Entomology research at the University of Guam Agricultural Experiment Station continued to focus on integrated control methods. These methods are biological control, host plant resistance, sampling techniques, and the proper use of insecticides. They will be utilized together to lower the cost of inputs to farming and to increase crop production while holding environmental contamination to a minimum.

Current entomology research projects are:

1. Insect Pests of Cruciferous Vegetables on Guam (Hatch)

2. Studies on the Biology, Host Preference and Natural Enemies of the Philippine Lady Beetle (Hatch)
3. Environmental Improvement through Biological Control and Pest Management, Regional Research Project, W-84.

The station is also engaged in an informal project with Dr. V.E. Gracen, Cornell University; Dr. W.D. Guthrie, Iowa State University; and W.R. Wiseman, Southern Grain Insects Research Laboratory, Tifton, GA., in which promising corn lines are screened for resistance to the Asiatic corn borer, *Ostrinia furnacalis*, and also the corn earworm, *Heliothis* sp.

Other miscellaneous work includes insecticide testing, the development of sequential sampling plans for pest management use, and general biological control work. Also, the Institute of Biological Control in the Pacific has been created by The Board of Regents to serve the needs of islands in Micronesia and the South Pacific.

I. PESTS OF CRUCIFEROUS CROPS

1. Host Resistance Trials.

Field trials to detect cabbage variety resistance to *Heliothis* sp, *Crociodomia binotalis*, *Hellula undalis*, *Chrysodiexis chalcites*, *Plutella xylostella*, and *Spodoptera litura* were conducted. The cabbage varieties tested were Ruby Ball, KK Cross, OS Cross, CO Cross, KY Cross, Copenhagen Market, AS Cross, Golden Acre, Velocity Cross, Yoshni Summer, NS Cross, BA Cross, RI Cross, CG Cross, SD Cross, and Express Cross. Two separate trials were conducted in different time periods. Each trial had 4 replications and each trial was assessed for insect presence three times. Preliminary data examination indicates that Ruby Ball was not preferred by the whole insect complex.

2. Pest Management Decisions

The spatial distributions (on a per head basis) of the insect species are being examined to see if a common sequential sampling plan will be useful in pest management decisions.

3. Biological Control

Experiment Station staff members are working with three parasitoids of the cutworm, *Spodoptera litura*. One is the external parasite, *Meteorus* sp. (Braconidae), another is *Apanteles marginiventris* (Braconidae) and the third is *Trichogramma* sp. The external parasite also parasitizes *Heliothis* sp. on both cabbage and corn. However, population studies of these insects on cabbage do not indicate control but rather erratic populations of the parasites. Some work on the life history and the biological potential of *Crociodomia binotalis* was also performed.

II. PHILIPPINE LADY BEETLE STUDIES

The Philippine lady beetle, (PLB). *Epilachna philippinensis*, is a serious pest of tomatoes and eggplants. The larvae and adults feed on the foliage. The PLB develops also on the weeds, *Solanum nigrum* and *S. guamense*. The PLB has one imported parasite active on Guam; *Pleurotropis epilachnae*. It is a pupal parasite and can be recovered anywhere the immature host is found. Rearing studies of *P. epilachnae* and *E. philippinensis* are being continued to determine the potential control exerted by the pupal parasite. A larval parasite, *Pediobius foveolatus*, is being obtained through the Maryland Department of Agriculture and will be evaluated in the field and laboratory.

III. ENVIRONMENTAL IMPROVEMENT THROUGH BIOLOGICAL CONTROL AND PEST MANAGEMENT

1. Predatory mites

A predatory mite, *Phytoseiulus macropolis*, was collected on Guam. The rearing techniques for the imported predaceous mites, *P. persimulus* and *Metaseiulus occidentalis* were evaluated.

2. The Poinciana Looper

The poinciana looper, *Pericyma cruegeri*, a pest of the ornamental flame tree, *Delonix regia*, appears to be controlled by Dipel, a commercial insecticide consisting of *Bacillus thuringiensis*. Thirty-six flame trees were used. Eighteen trees were sprayed with 1 lb/50 gal. (0.454 kg/188 liters) of Dipel with one tablespoon of sticker. Eighteen trees were not sprayed. Counts of looper larvae were made on four limbs (three foot lengths counted from tip inward) per tree. At the end of the experiment, 9 control trees were sprayed with water and 9 were not. Data was then collected to determine if simply spraying water on flame trees controls the poinciana looper.

Preliminary data comparison of control vs. sprayed trees indicated Dipel effectively controls the poinciana looper but does not harm natural enemies of the poinciana looper. For example, the natural enemies include a chalcid pupal parasite, *Brachymeria albotibialis*; a tachinid pupal parasite, *Exorista civiloides*; the praying mantid, *Hierodula patallifera* and the mud dauber wasp, *Delta* sp.

Research information we are collecting on the population of



Field trial for biological control of Poinciana looper

local predators and the flame tree loopers as imported parasites indicates that we should:

- a. Use only Dipel as an insecticide to control the looper on a short term basis (only Thuricide is a possible substitute for Dipel).
- b. Import more natural enemies to augment those enemies already here, which will be our long term control factor. Necessary steps to import the predators are presently being undertaken.

It was interesting to note that some factors triggered a swift population reduction of the poinciana looper in 1977. This reduction likely could have been due to either the 56° F temperatures recorded in early 1977 and/or to a lack of leaves serving as food on the flame trees.

3. Miscellaneous

- a. The banana leaf roller, *Erionota thrax*, has four imported parasites on Guam, *Apanteles erionotae*, *Brachymeria albobialis*, *B. obscurata* and *Ooencyrtus erionotae*. The larval parasite, *A. erionotae*, is re-establishing itself well after almost disappearing as a result of typhoon Pamala in 1976. The egg parasite, *O. erionotae*, is also re-establishing itself well.
- b. The coconut beetle, *Brontispa palauensis*, has one imported parasite on Guam, *Tetrastichus brontispae*.

Population studies on the parasite and host indicate some control of the host by the parasite. A predatory earwig is also being studied to determine if it is an important factor in localized control.

c. An unidentified bagworm (Psychidae) is a new ornamental problem on lawns and home walls. Its life history has been determined along with the local parasites in order to determine what further steps should be taken for control of this insect.

d. The insect virus, SAN 240 I (SANDOZ), is presently being field tested for control of *Heliothis* sp. on tomatoes. Earlier preliminary tests this year did not appear promising for *Heliothis* sp. control on corn.

e. The station is also presently evaluating the results of recent releases of *Macrocentrus gifuensis*, parasite of the Asiatic corn borer received from Dr. H.C. Chiang, CSRS-SAES Liaison Scientist, University of Minnesota.

IV. INFORMAL CORN WORK

The Soils and Entomology sections of the College of Agriculture shared a corn experiment. The entomology section initiated a corn pest management program (main target, the Asiatic corn borer (ACB), *Ostrinia furnacalis*). Data was collected about:



Corn borer rearing



Field collected corn borer larvae.

- 1) The distribution of ACB egg masses per plant. This data and supplementary data will be used to calculate the k value to be used in a sequential sampling scheme used to make spray decisions.
- 2) Percent lodging of corn stalks and percent broken tassels per plot.
- 3) The effect of pesticide application per plot as measured by the number of ACB and *Heliothis* sp. per ear, and damage to the ear itself (data collected at harvest).

The five insecticides applied (on a management basis with 2 egg masses per 20 plants as a threshold) in this experiment were Dipel, Diazinon-G (down the whorl of the plant), Sevin, Penncap-m, and Orthene. There were 18 plots (3 plots per insecticide including control). Preliminary examination of data indicates that Orthene, Penncap-m and Dipel as applied show the greatest promise for future testing on Guam. The number of ears fit to be sold at harvest were; Orthene - 69%, Penncap-m - 66%, and Dipel - 64%. This is very promising, considering the 2 egg masses per 20 plants threshold necessary before insecticide application. The station anticipates continuation of this type of work, using other insecticides along with the three mentioned, and a different threshold (ie; 1 egg mass per 20 plants or even less).

V. ORIENTAL FRUIT FLY SURVEY

Entomology personnel conducted a survey to detect the presence of the Oriental fruit fly, *Dacus dorsalis* on Guam. The survey lasted from late April until early August, 1977. Twenty five standard traps obtained from Fruit Fly Investigation, ARS, USDA, Hawaii, and APHIS, USDA, Hawaii, and baited with methyl eugenol, were used and checked weekly throughout Guam. No oriental fruit flies were recovered. Guam has been declared as a zone that is free of the oriental fruit fly by APHIS, USDA, and FAO Rome.

Land Use and the Guam Food Base

Geographical research at the University of Guam Agricultural Experiment Station involves the spatial assessment of Guam's agricultural food and resource base. This type of regional investigation focuses on the interrelationships of the identification, control, and utilization of the island's land resources, especially those directly related to agriculture. To promote accurate planning for Guam's future, analysis will continue using the following methodology:

- 1) Search of primary and secondary local data sources;
- 2) Maps, both aerial and ground, and photographic use (mapping includes population and farm distribution; land tenure according to federal, territorial, and private categories, and others);
- 3) Field work in Guam, including surveys of farm operators and their existing farm operational resources and individual development.

Current geographical research projects are:

- 1) Construction of distribution maps locating farms;
- 2) Analysis of agricultural resources by tri-regions;
- 3) Compilations of data showing changing utilization, production, and distribution characteristics of surveyed farm operations.

Field Study

The locational assessment and inventory of existing agricultural operations utilizes a field questionnaire administered to practicing farmers.

The questionnaire utilized in the interviews covers fifteen separate categories of farm resources. The following headings define those categories:

1. Personal and social background
2. Location of farms by fields and residence
3. Size of the landholding(s)
4. Tenure of farm operator
5. Value of the agricultural land
6. Physiography of the farm
7. Land use by individual farm
8. Crops and animals by farm
9. Diet of farm household
10. Agricultural labor
11. Investment of capital in equipment and facilities
12. Annual Farm expenditures
13. Improvements to the agricultural land
14. Credit extension
15. Role of government

Economic and political parameters

It has been found that most food, manufactured items and investment capital are imported. For Guam to achieve a reversal and move toward achieving a balanced economy and a stabilized population depends on local land control, and a willingness for its people to accept a less conspicuous mass consumption of many goods and services presently available, such as the private automobile.

The ground level agricultural inventory carried out so far during this review period reveals that a greater food supply potential exists. The agricultural sector of the 1970s offers a potential food supply if properly developed. This potential food supply is thwarted by the interaction of the American political economy and traditional Chamorro land tenure and practices.

Further, this work shows that land resources are dominated and controlled by non-local sources; that twentieth century development resulted from a massive United States military establishment which transformed the entrenched subsistence system into a predominantly civil service society; that Federal and local Government employment and Federal subsidies now sustain the economy with tourism and private business developing very slowly.

Preliminary Findings

The actual number of active farmers, and the size and enumeration of operative fields were found to be small. Less than one percent of Guam's civilian work force farmed; just over one percent of the island's dry land was agriculturally utilized. Half of the farmers lived on their "ranches" revealing a major locational change from past patterns; 80 percent were Chamorro by birth. They own their fields and have little indebtedness, receive significant proportions of their annual income from non-farm sources, and they consume major portions of their crop production.

Alternatives

Future options translate as change, and difficult changes they are. Without Guam as a major military bastion, redistribution of substantial amounts of American public funds logically terminates. Therefore, a balanced development paradigm is requisite; a model entailing internal supports and reliance on island resource utilization is recommended. With restoration of local land control, it will augment the reliance upon imports in a positive way and prepare the population for a future less dependent on artificial economic structures.

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