Don

Guam Agricultural Experiment Station Annual Report 1981

1981 ANNUAL REPORT
GUAM AGRICULTURAL EXPERIMENT STATION

In 1981, the Agricultural Experiment Station initiated research projects supported by Section 406 Tropical Agriculture funds. These projects were designed not only to benefit Guam, but also our neighbors, the Commonwealth of the Northern Marianas and the rest of Micronesia. A contract was signed to assist the College of Micronesia in developing its new Land-Grand Program.

For the First time, our staff were able to participate in the Scientific and Technical Exchange Program of OICD, USDA and the USDA Summer Research Apprenticeship Program.

Programs in soils, vegetables, ornamentals, entomology, plant pathology, agricultural engineering, animal nutrition and aquaculture continued to progress. Agricultural marketing and pomology programs are to be strengthened in 1982.

WILFRED P. LEON GUERRERO
Dean/Director

CONTENTS

UNIVERSITY OF GUAM
ROSA ROBERTO CARTER, Ph.D
President

UNIVERSITY OF GUAM
BOARD OF REGENTS

EDWARD G. PEREZ
Chairman

EARL C. CONWAY
Treasurer

LEONILA L.G. HERRERO
Member

GLORIA R. MORTERA
Member

JUNE S. PEREZ
Member

JESUS S. QUINATA*
Member

ANTHONY A. LEON GUERRERO *
Member

* Appointed in 1982

SOILS

J.L. Demeterio

Soil Fertility

Field trials to assess nitrogen, phosphorus and potassium response of selected vegetables were conducted in Inarajan, Merizo, Santa Rita, and Dededo.

I. Assessing Alternate Sources for Fertilizer Nitrogen

The objective of this study is to promote minimum dependence on commercial inorganic nitrogen fertilizer. The on-going nitrogen source study (randomized complete block design, 8 treatments, 3 replications, with 4x4 m plots) at the Agricultural Experiment Station in Inarajan was modified. In keeping with the project's aim, the 200 kgm N/ha treatment was dropped in favor of in-row applications of tangantangan *(Leucaena Leucocephala)* leaves and stems. Relay cropping was also initiated. To date, the nitrogen sources evaluated in these long term field trials are legumes (intercropping with tangantangan and peanuts), chicken manure, ammonium sulfate, and fresh tangantangan leaves with green stems.

In previous years, the field was plowed prior to the start of the residual study. In the 1981 study, okra seeds were planted between hills of bellpepper plants towards the end of the growing period for the latter crop. This allowed for a smooth transition to the residual study while maintaining plot integrity and precluding the need for tilling under the bellpepper plants.

Blanket fertilizer addition prior to initial cropping was 0-300-138 kgm per hectare. Such additions were adjusted for PK content of the source material. The 12 tons of tangantangan leaves and stems were calculated to contain 322 kgms N, 12 kgm P_2O_5, and 113 kgm K_2O per hectare. The chicken manure and tangantangan leaves were allowed 4 to 6 weeks to decompose in place (within the farrow) prior to transplanting of bellpepper seedlings.

The vegetable yields in tons per hectare from the long term nitrogen source plots in 1981 are shown in Table 1. Bellpepper responded to fertilizer-nitrogen additions doubling yields from the control plots where no nitrogen was added. The chicken manure treatments surpassed all other yields. The data indicates that addition of 6 tons of chicken manure is sufficient. The legume intercrops, as in previous years, showed a depressed yield in the main crop (bellpepper). The addition of tangantangan leaves produced yield comparable to chicken manure, and was higher than the ammonium sulfate treatments. With the over-abundance of tangantangan in Guam, its use as a fertilizer-nitrogen source for vegetable crops shows good promise.

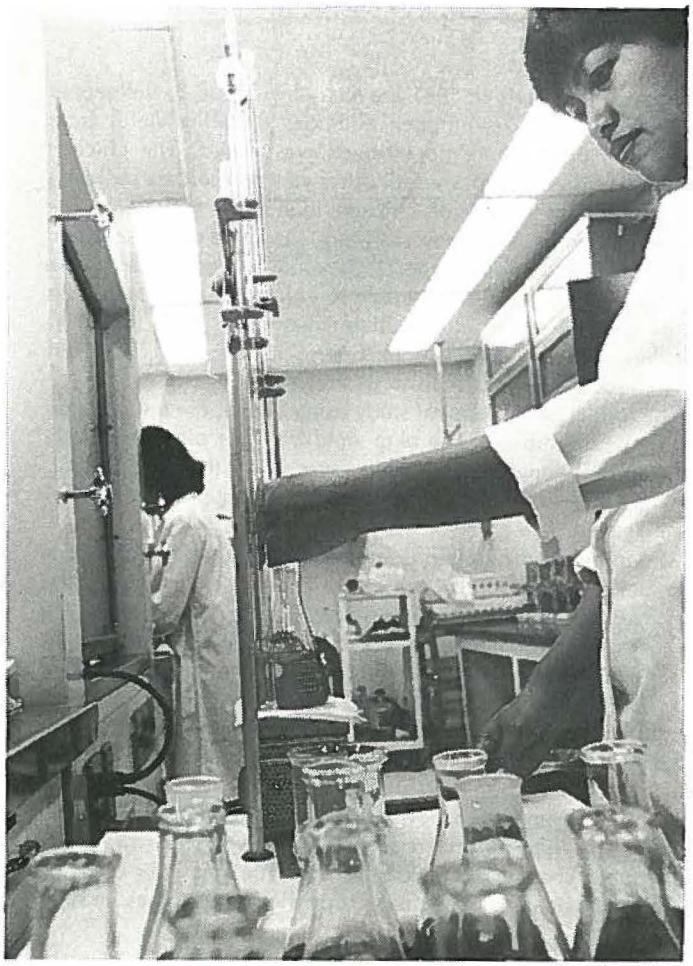
The results of the residual study using okra as the test crop are also shown in Table 1. The okra yield from the plots previously fertilized with tangantangan leaves was lower than the control. This indicates rapid minerlization of the nitrogen from tangan-tangan leaves.

The minerlized nitrogen is subject to uptake by the previous crop (bellpepper) and also subject to leaching lossess during the rainy season. Apparent depletion of nigrogen is reflected in the low okra yields on the plots previously fertilized with tangan-tangan leaves. The yield in the 12 ton chicken manure treatment was twice that of the control yield. The movement of nitrogen in the soil is strongly affected by the presence of organic matter. Apparently chicken manure (at 12 tons per hectare) does not mineralize fast as compared to tangantangan leaves and can continue supplying nitrogen beyond the first cropping. The peanut leaves, stems, and roots were plowed in-between the rows of the bellpepper. The yield of okra from the peanut inter-crop exemplifies the benefits of the next crop following legumes. In summary, the 1981 results of the long term nitrogen study, showed that:

1. Tangantangan leaves and green stems could substitute for in-organic fertilizer such 21-0-0 for bellpepper.
2. Including legumes in crop rotation and the use of chicken manure as an alternate source of fertilizer could lessen dependence on inorganic nitrogen fertilizer.

Table 1. Vegetable yield in tons per hectare from the long term nitrogen source plots in 1981.

Treatments	Bellpepper	Okra Residual study (June-October)
1. Control (no nitrogen)	11.33	7.63
2. Tangantangan intercrop	7.20	9.81
3. Peanut intercrop	3.25	14.05
4. Chicken manure, 6 tons/ha	25.64	9.37
5. Ammonium salfate, 100 kgm N/ha	19.99	9.07
6. Ammonium sulfate, 100 kgm N/ha plus 3 tons chicken manure	22.03	10.47
7. Tangan-tangan leaves 12 tons fresh weight/ha	23.39	6.25
8. Chicken manure, 12 tons/ha	25.04	14.77
$LSD_{.05}$	10.02	4.61



II. Nitrogen Application Timing

All fertilizer inputs in Guam are geared towards optimizing yields, while minimizing adverse environmental side effects. The phosphorus fixing ability of tropical soils precludes phosphorus movement in the soil profile. Potassium is a cation. This minimizes its leachability in the soil. Under tropical conditions on Guam, which includes high rainfall and temperature, organic matter mineralization and subsequent nitrification in the soil is accelerated. The NO3 formed could be taken up by plants or lost through leaching. Our lysimeter studies of 1978 have shown no percolation of NO3-N when plants were vigorously growing. Hence, we have been encouraging pin-point application of fertilizer 4 to 6 inches directly below the seedling during transplanting to facilitate uptake of nitrogen. This study was undertaken to examine timing of nitrogen application with the dual aim of optimizing yield while minimizing leaching losses.

A field experiment in the AES fields in Inarajan was conducted to determine the rate and timing of nitrogen addition on the yield of cherry tomatoes. A randomized complete block design, with 6 treatments, 3 replications, and 4x3m plots, was used. Ammonium sulfate (21-0-0) was banded within the furrow which was then hilled up prior to transplanting. The study was conducted in the dry season (March-June) with a sprinkler system supplementing rain. Normal preventive pesticide applications were used to control incidence of pests and diseases.

The yield of cherry tomatoes as affected by the nitrogen rate and timing of application is shown in Table 2. The yield ranged from 13.70 tons in the control plots to 21.85 tons of marketable tomatoes in the plots where 50 kgm N was added during transplanting, followed by another 50 kgm N side-dressed at flowering. Highest yield at 21.09 tons was attained in the single application of 50 kgm N. The field used was cropped for the first time. Inherent native nitrogen in the soils could account for the generally high yields.

Our nitrogen fertilizer recommendations have been based on organic matter level, the crop to be grown and previous cultural practices, i.e., legumes, manures, etc. It has also been standard practice to split the dosage, one at planting time and the second at the onset of flowering. The data gathered negates splitting of nitrogen application concept. The implications are that a second side-dress of nitrogen fertilizer may not be necessary.

The soils at the Agricultural Experiment Station is Guam clay, a *Lithic Ustropepts.* Year round farming is possible in this soil. Guam clay accounts for 35.4% of the landmass and blankets most

Table 2. Yield of cherry tomatoes in tons per hectare as affected by timing of nitrogen application.

Rate and Frequency of Nitrogen Applications	Marketable Yield
0	13.70
50*	21.09
25/25	17.24
100	19.16
50/50**	21.85
25/25/25/25	17.15
$LSD_{.05}$	4.75

* Kilograms per hectare nitrogen using 21-0-0. All initial nitrogen applications and a blanket treatment of 300 kgm P_2O_5 and 100 kgm K_2O per hectare were bonded with the furrow prior to transplanting of tomatoe seedlings.

** The second fertilizer split application was side-dressed during flowering. Subsequent nitrogen application in the 25/25/25/25 treatment was every 3 weeks after on set of flowering.

of the northern half of the island. This same experiment will be repeated in 1982, using the same plots. Sweet corn was planted in the field during the rainy season to lower, if not exhaust, native soil nitrogen.

III. Phosphorus and Potassium Studies.

A field Study in Santa Rita to determine crop yield response to varying levels of phosphorus and potassium using cherry tomatoes as the test crop was conducted during the dry season. The field was located on a hillside. The area was delineated according to slope. Two distinctly dissimilar areas were established with reddish soil (probably of the Agat-Attate association) in the upper area and a blackish soil in the lower area. A 6m zone separated the areas. This situation wherein two different soils lay side by side is not uncommon in Guam. In fact, this is more the rule rather than the exception.

A completely randomized block design with 3 replications was used. Individual plots were 3x4m with rows one meter apart. Distance between single tomato plants was 0.4 meters. Drip irrigation was used and a preventive pesticide application schedule was followed. Fertilizer was banded within the row prior to transplanting. Nitrogen was split applied and banded with phosphorus and potassium prior to transplanting and then side-dressed at the onset of flowering.

Initial soil tests results, treatments used and yield are shown in Table 3. Initial soil test indicated available phosphorus at 1.6ppm and 1.3ppm. This low level is consistent with most of Guam's agricultural soils. Other than this, all soil test values were within normal levels.

The yield responses in the phosphorus study in the red soils showed tremendous variability and had a top yield of 6.15 tons (Table 3). Statistical analysis of the data showed yield differences were insignificant. No trend could be detected.

Yield differences in the potassium study was insignificant. The initial soil test for potassium showed 75 ppm available potassium. This non-response to added potassium was similar to the non-response (Demeterio, 1980, AES Annual Report) by corn in soil testing over 70 ppm available K.

IV. Peanut Studies

A. Hill spacing-

The use of legumes as an alternate source of nitrogen was evaluated during our association with the East-West Center INPUTS (Increasing Productivity Under Tight Supplies) project from 1976-1979. Four legumes (mungbeans, soybeans, cowpeas, and peanuts) were grown as an intercrop. It has been established that intercroping with legumes depresses the yield of the companion crop. It was observed that of the legumes studied, only peanuts had profuse nodulation without inoculating the seeds prior to planting. Our long-term nitrogen source study has shown that the beneficial effects of legumes is felt in the follow crop. It is towards this end that a preliminary peanut population density study was made in 1981. The objectives were to achieve optimal yields in seeds and forage.

The experiments were conducted during the rainy season at the Experiment Station in Inarajan and in Dededo. The fields used had prior normal fertilizer application and were previously grown to corn. No further fertilizer additions were made for the peanut study. All rows were maintained at one meter apart, 20 meters long at Inarajan and 8 meters at Dededo. Four planting schemes were devised as follows:

1. 15.24 centimeters between hills/row
2. 30.48 centimeters between hills/row
3. Two rows 30.48 centimeters apart within the row with hills 15.24 centimeters apart.
4. Two rows 30.48 centimeters apart within the row with hills 30.48 centimeters apart.

The last two planting schemes are referred to as the "double row" treatments. The planting scheme amounts to a field stand of 65,616, 32,808, 131,230, and 32,808 hills per hectare, respectively. Seeds at the rate of 3 per hill were planted 2-3 inches deep. The planting scheme was tested using 5 rows. Two rows were sampled at Inarajan, while 3 rows were sampled at Dededo for yield data. There just was not enough field space to do a good statistical layout for this particular preliminary study.

Our previous study with peanuts indicated no serious pest and disease problems. The experiment at Inarajan proceeded to completion with minimal pesticide application. The rains during the growing period resulted in vigorous stands. The Dededo peanut field exhibited varied stands. This could be attributed to the variable field depth (0-30 cm) with the preponderance of limestone fragments in shallow soils underlain with pure limestone. Two weeks prior to harvesting, the field was devastated overnight. At first it was suspected to be herbicide damage. A closer look by our plant pathologist revealed it to be cercospora leaf spot and rust. The peanut plants, nevertheless, were harvested and the yield presented in Table 4.

Seed and forage yield are lower in Dededo as compared to Inarajan. This difference could be attributed to soil depth. Forage yield tended to be higher in the double row. There was no statistical difference among yield. It appears that the seed and forage yield were optimal at 30.48 cm spacing, single row. Fresh peanut seed yield ranged from 2.78-3.26 tons per hectare. These yields are comparable to U.S. mainland yields. A population density study will be carried out next year.

B. Peanut Yield Response to Residual Fertilizer in the Soil

The Experiment I (Table 3) in Santa Rita was continued during the rainy season to determine effects of residual fertilizer on the seed and forage yields of peanut. The soils in this study could be termed "problem" soils where yield was low at all fertilizer combinations. A legume in the rotation of crops is advisable for such soils. The individual plots were maintained undisturbed by using relay cropping. Peanut seeds at the rate of 3 per hill were planted between the tomato plants towards the end of the growing period for tomatoes. A spacing of .2M between peanut hills was attempted.

The yield in tons per hectare of peanut seeds and fresh forage is shown in Table 5. The fertilizer treated plots had seed and forage yield twice as much as the untreated plots. The data if anything else reinforces the belief that although legumes can use atmospheric nitrogen, other essential elements like phosphorus and potassium should be present to insure a vigorous plant.

The potassium response study in Santa Rita was grown to sweet corn to determine residual fertilizer effects. Heavy rains however resulted in extremely variable field stand.

V. Other Fertilizer Studies Conducted in 1982.

A phosphorus/potassium response study in Merizo (shioya soils) using sweet corn was nullified by heavy rains in August and September. Although the crop was grown to completion the yield exhibited a tremendous variation that statistical analysis of the data was impossible.

A production type study was conducted in Dededo during the dry season in a 20x20 meter plot. Yield was already affected by erratic supply of water during the growing period.

Table 3. Initial Soil Test results, treatments, and yield of cherry tomatoes in the phosphorus and potassium response study in Santa Rita.

pH 7.21		pH. 6.95	
phosphorus, 1.6 ppm		phosphorus, 1.3 ppm	
potassium, 250 ppm		potassium, 75 ppm	
organic matter, 1.80%		organic matter, 2.50%	
calcium, 5800 ppm		calcium, 4400 ppm	
magnesium, 120 ppm		magnesium, 1100 ppm	
zinc, 25 ppm		zinc, 6.4 ppm	
iron, 97 ppm		iron, 451 ppm	
manganese, 125 ppm		manganese, 200 ppm	
copper, 21 ppm		copper, 7 ppm	
texture, clay		texture, clay	
Treatments			
	Yield		Yield
0-0-0*	2.44 Tons/ha	0-0-0	1.42
100-0-100	4.25	100-150-0	14.62
100-25-100	3.10	100-150-25	14.16
100-50-100	5.41	100-150-50	20.20
100-100-100	6.15	100-150-100	16.20
100-200-100	5.96	100-150-200	12.66

Kilograms per hectare of N, $P_2 0_5$, and $K_2 0$

Table 4. Yield in Tons Per Hectare of Peanuts Under Varying Spacing at Two Locations.

		Location			
		Inarajan		Dededo	
Hill Spacing		Seeds	Forage	Seeds	Forage
Single Row,	12.24 cm	2.87	20.15	.42	2.65
	30.48	3.26	23.95	.91	9.65
Double Row,	12.24	2.78	34.11	.60	8.70
	30.48	2.96	26.56	.47	5.30

Table 5. Yield in Tons per Hectare of Peanut Seeds and Fresh Forage as Affected by Residual Fertilizer in the Soil.

Priro Treatment*	Seeds (Tons/ha)	Forage (Tons/ha)
0-0-0	.69	5.30
100-0-100	1.13	9.08
100-25-100	1.22	9.83
100-50-100	1.45	9.84
100-100-100	1.08	9.83
100-200-100	1.36	11.73

* Kilograms per hectare of N, $P_2 0_5$, and $K_2 0$

HORTICULTURE-VEGETABLE CROPS

CHIN-TIAN LEE

Horticultural (vegetable) research work in 1981 continued to focus on screening and determining the adaptability of vegetable varieties which have economical potential and suitability for growth under the environmental conditions of Guam. The vegetable varieties studied were Chinese cabbage, watermelon and winged bean. The response of trickle irrigation in the screenhouse was studied in cooperation with agricultural engineering personnel.

I. VARIETAL PERFORMANCE STUDIES ON CHINESE CABBAGE:

1. MATERIALS AND METHODS:

The Agricultural Experiment Station is cooperating with Asian Vegetable Research and Development Center (AVRDC) for Chinese cabbage research. Eleven entries of Chinese cabbage were tested during the dry season to evaluate the varietal performance in relation to climatic conditions. They were 77M(3)26, 77M(3)27, 77M(3)33, 77M(3)35, 77M(3)38, 77M(3)43, 77M(3)44, 77M(3)46, Accession no. 58, Accession no. 62 and B189C_1.

Seeds of Chinese cabbage were sown directly in the field. A randomized complet block design with four replications was used. Each experimental plot consisted of four 4.8m long rows. The spacing adopted was 1.5m between plots, 0.5m between rows and 0.4m between hills. A 15-15-15 fertilizer at the rate of 897 kg/ha was broadcast and incorporated into the soil before sowing the seed. Side-dresssing with the same fertilizer at the same rate was done three to four weeks after sowing the seed. The cabbage was treated twice weekly to prevent possible insect and disease damage. Dibrom 8 E.C., Malathion E.C., Dipel, Dithane M-45 and Tribasic Coppers were used. A rotary tiller and garden hoes were used for weed control. Sprinklers were used for irrigation.

Harvesting started when the heads were fully developed. Marketable yield was based on the head which was free of burst, insect, and disease. The unmarketable table yield was the head damaged by burst, insect or disease.

2. RESULTS AND DISCUSSIONS:

FORMING HEAD AND HEAD WEIGHT

Environmental factors, especially high night temperatures, can limit Chinese cabbage production by causing bolting, and/or by not forming compact heads. If the plant bolted or formed non-compact heads, the plant was considered heat sensitive.

All entries formed compact heads. The head weight ranged from 0.28 to 0.44 kg. 77M(3)43, 77M(3)46, Accession no. 58, 77M(3)26, 77M(3)27, and Accession no. 62 had the heaviest heads with an average of 0.41 kg per head. The lightest heads were B189C_1, 77M(3)33 and 77M(3)38 which ranged from 0.28 to 0.35 kg per head (Table 1).

MARKETABLE HEAD YIELD

77M(3)44, 77M(3)26 and Accession no. 58 produced the highest yield with an average of 11.93MT/ha., while 77M(3)33 and B189C_1, were the lowest with an average of 6.5 MT/ha. There was no significant difference in yield among 77M(3)38, 77M(3)35, 77M(3)27 and 77M(3)6. The yield ranged from 8.74 to 9.26 MT/ha (Table 1).

UNMARKETABLE HEAD YIELD

The unmarketable heads were mostly attributed to bacterial soft rot disease. All the entries had 50 to 65% bacterial soft rot disease. Accession no. 58 and 77M(3)33 with 1.78MT/ha had the lowest unmarketable head yield. 77M(3)26, 77M(3)46, 77M(3)46, 77M(3)43, and 77M(3)44 yielded 3.02 to 3.34 MT/ha and showed the highest unmarketable head yield (Table 1).

2. CONCLUSIONS

Based on appearance, texture, head size, and yield, 77M(3)44, 77M(3)26, and Accession no. 58 were the most promising varieties based on the dry season experiment.

II. VARIETAL PERFORMANCE STUDIES ON WATERMELON:

1. MATERIALS AND METHODS:

The watemelon experiment was conducted during the dry season. The objective was to evaluate the climatic factors on the varietal performance. The ten varieties of watermelon included in this trial were Crimson Sweet, Ice Box Midget, Black Diamond, Charleston Grey, Sugar Baby, Sweet Ibuki, Midget Cream, Dixelee, Florida 77-2, and Prince Charles.

Seeds were directly sown in the field. A randomized complete block design with three replications was used. Each experimental plot consisted of two rows 7.31 m long. The spacing adopted was 1.83 m between rows and 1.52 m within rows. Localized application of 10-20-20 fertilizer at the rate of 987 kg/ha was applied in a planting hole 15 cm deep and 30 cm wide, which was covered with 10 cm of soil before sowing seeds. This method of application prevented burning from the fertilizer of the seed or young plant. Side-dressing with the same fertilizer at the same rate was done five to six weeks after sowing the seeds.

A preventive disease and insect control program was followed twice weekly to reduce possible insect control program. Lannate L, Cygon E.C., Malathion E.C., Dithane M-45, and Tribasic Coppers were used. A rotary and garden hoe were used for weed control. The sprinklers were used for irrigation.

The watermelon fruits were harvested at the full mature stage.

2. RESULTS AND DISCUSSIONS:

The average fruit weight of each of the ten varieties ranged from 2.05 to 10.00 kg (Table II). The fruit weight of Charleston Grey with 10.00 kg was the highest among the ten varieties, and Crimson Sweet was the next highest at 9.77 kg. Midget Cream and Prince Charles were the smallest in fruit size and had an average weight of 2.13 kg. The rest of the six varieties ranged from 2.73 to 6.36 kg.

Charleston Grey with a fruit production of 50.35 MT/ha significantly outyielded the other nine varieties. Sweet Ibuki and Crimson Sweet were the highest with an average of 37.60 MT/ha; Florida 77-2 was the lowest in fruit production. The rest of the five varieties; Ice Box Midget, Black Diamond, Midget Cream, Prince Charles, and Dixelee had fruit yield ranging from 14.24 to 30.90 MT/ha (Table II).

UNMARKETABLE FRUIT YIELD

The unmarketable fruits were mainly due to belly rot disease on fruit and to fruit cracking. The percentage of belly rot disease and fruit cracking ranged from 9.1 to 33.7 (Table II). Black Diamond and Sugar Baby were the least susceptible to belly rot and

to fruit cracking.

SUGAR CONTENT OF FRUIT:

Sugar content in the fruit is one of the most important factors in determining the quality of watermelon. A refractometer was used for the measurement of sugar content in the fruit. Dixelee with a sugar content of 11.9% was significantly higher than the rest of nine varieties. Ice Box Midget and Midget Cream with 10.5% were the next highest in sugar content, while Black Diamond and Sugar Baby with 7.65% had the lowest content of sugar (Table II).

CONCLUSIONS:

Based on appearance, texture, size and yield, Charleston Grey; Crimson Sweet; Sweet Ibuki and Dixelee were the most promising varieties from the results of the experiment conducted during the dry season of 1981.

III. STUDIES ON THE POTENTIAL OF WINGED BEAN AS A CROP FOR GUAM

Winged bean is a tropical crop commonly found in backyards on Guam. Almost the entire winged bean plant can be utilized for food. Its greed pods, seeds, and leaves are rich in protein and vitamins. The tubers contain a high level of protein and carbohydrates, and are superior in protein content to taro and cassava. The seed has a high polyunsaturated oil content. Although the winged bean has exceptional potential scientific research on the crop is still limited.

1. MATERIALS AND METHODS:

Seeds of eighteen exotic varieties were collected from Puerto Rico, Indonesia, Guam and other countries. The eighteen varieties were planted in May, July, September, November, 1981 at the Guam Agricultural Experiment Station and in Talofofo to evaluate characteristics of priority interest. The varieties were planted at bimonthly intervals so that differences in photoperiod, moisture, temperature, etc., could be evaluated. A randomized complete block design with three replications was used. Each experimental plot was a single row 4.57m long. The spacing adopted was 1.22m between rows and 0.46m within rows. Sidedressing with a 10-20-20 fertilizer at the rate of 387 kg/ha was done four weeks after sowing the seed. A preventive spraying program was followed once weekly to reduce possible insect damage. Cygon E.C. and Malathion E.C. were used. A rotary tiller and garden hoes were used to control weeds. Sprinkers were used as needed for irrigation.

The plant was supported with a trellis made with tangantangan stakes and plastic cucumber nets. The mature pods were allowed to stay on the plant in the field until they were dry, and then the seeds were collected. All the seeds were kept for use in the next planting.

2. RESULTS AND DISCUSSIONS:

The results of the effect of different planting dates on some horticultural characteristics of winged bean are presented in Table III. The response of the winged bean varieties with respect to flowering and pod formation was affected by different planting dates. The three Guam varieties, C_1, and C_5 flowered and formed pods only in the September planting. Ten out of eighteen tested varieties were not affected by planting dates in their response to the initiation of flowering and pod development. These ten varieties were Mariposa, Mixed, Lunita, Chimbu, Ribbon, Siempre, Tinge, Dual, Toana, and Bogor. Therefore, some winged bean varieties are sensitive to photoperiod. Long days (over 12 hours of photoperiod) are inhibitory to flower initiation.

Table I. Performance of AVRDC's Chinese Cabbage Breeding Lines During Dry Season of 1981.

AVRD Selection	Forming Head	Head Weight (Kg.)	Marketable Head Yield (MT/ha.)	Unmarketable Head Yield (MT/ha.)	Bacterial Soft Rot (%)
77M(3)26	Yes	0.40	12.07	3.02	50.0
77M(3)27	Yes	0.39	9.05	2.90	65.0
77M(3)33	Yes	0.29	6.98	1.95	55.0
77M(3)35	Yes	0.38	8.95	2.42	55.0
77M(3)38	Yes	0.35	8.74	2.71	62.5
77M(3)43	Yes	0.44	9.26	3.15	50.0
77M(3)44	Yes	0.36	12.38	3.34	52.5
77M(3)46	Yes	0.41	9.10	3.09	65.5
Accession #58	Yes	0.41	11.34	2.95	50.0
Accession #62	Yes	0.39	8.11	2.43	60.0
B 189C_1	Yes	0.28	5.93	1.60	52.5
$LSD_{0.05}$		0.05	1.11	0.35	7.9

Table II. Performance of Commercial Varieties of Watermelon During Dry Season, 1981

Commercial Variety	Fruit Weight (Kg.)	Brix (Sugar Content) (%)	Marketable Fruit Yield (MT/ha.)	Unmarketable Fruit Yield (MT/ha.)	Fruit Belly Rot and Cracking-Fruit (%)
Crimson Sweet	9.77	9.8	36.47	6.74	15.6
Ice Box Midget	2.73	10.5	14.24	4.36	23.4
Black Diamond	6.36	7.7	14.31	1.43	9.1
Charleston Grey	10.00	9.5	50.35	7.50	13.0
Sugar Baby	2.77	7.6	11.63	2.82	19.5
Sweet Ibuki	5.45	9.9	38.66	4.10	9.6
Midget Cream	2.05	10.5	16.00	8.14	33.7
Dixielee	3.64	11.9	30.90	4.54	12.8
Florida 77-2	3.90	9.7	8.73	2.18	20.0
Prince Charles	2.20.	8.2	23.14	4.74	17.0
$LSD_{0.05}$	0.42	0.5	2.91	0.56	3.1

Table III. Effect of Different Planting Dates on Some Horticultural Characteristics of Winged Bean

	Planting in May		Planting in July		Planting in September	
Variety Name	Flowering in Two to Three Months After Planting	Forming Pod in Two to Three Months After Planting	Flowering in Two to Three Months After Planting	Forming Pod in Two to Three Months After Planting	Flowering in Two to Three Months After Planting	Forming Pod in Two to three Months After Planting
MITA 1018-Mariposa	Yes	Yes	Yes	Yes	Yes	Yes
MITA 969-Mixed	Yes	Yes	Yes	Yes	Yes	Yes
MITA 960-Lunita	Yes	Yes	Yes	Yes	Yes	Yes
MITA 943-Chimbu	Yes	Yes	Yes	Yes	Yes	Yes
MITA 951-Ribbon	Yes	Yes	Yes	Yes	Yes	Yes
MITA 953-Siempre	Yes	Yes	Yes	Yes	Yes	Yes
MITA 964-Tinge	Yes	Yes	Yes	Yes	Yes	Yes
MITA 958-Dual	Yes	Yes	Yes	Yes	Yes	Yes
MITA 961-Toano	Yes	Yes	Yes	Yes	Yes	Yes
MITA 942-Bogor	Yes	Yes	Yes	Yes	Yes	Yes
C1	Yes	No	Yes	No	Yes	Yes
C_3	Yes	Yes	Yes	Yes	Yes	No
C_5	No	No	No	No	Yes	Yes
Guam Long 01	Yes	No	Yes	No	No	No
Guam Short 02	Yes	No	Yes	No	Yes	No
Guam Medium 03	No	No	No	No	Yes	Yes
Guam Long 04	No	No	No	No	Yes	Yes
Guam Short 05	Yes	No	Yes	Yes	Yes	Yes

ORNAMENTAL HORTICULTURE

Syamal K. Sengupta

Research in ornamental horticulture was continued with growth retardants and cultural practices.

I. Several tubers rose *(Polianthes tuberosa)* collected and planted at the Agricultural Experiment Station in beds composed of peat moss, Hortipearl, and topsoil (3:3:1). Flowering was observed from October through December.

II. Gladiolus corms of assorted colors were obtained from a U.S. mainland nursery. The corms were refrigerated to break their dormancy. These corms were planted at the Agricultural Experiment Station on July 3, 1981, and flowers were observed on August 26, 1981. Flower diameters and spike Length are given in Table 1.

Table 1.

Color of Glads	Flower Diameter (cm)	Spike Length (cm)
purple	8.00	30
yellow	9.00	26
pink and yellow	9.00	26
pink and red	8.00	25

III. Kalanchoe varieties Sonata (orange), Sensation (deep pink) and Seranade (red) were tested with growth retardant, B-9, at two concentrations. Observations are shown in Table 2.

Table 2.

B-9 concentrate	Sonata	Sensation	Seranade
0	69.00	39.00	68.0
2500 ppm	44.50	35.0	60.5
5000 ppm	33.50	31.0	45.0

The height of treated plants were shorter than non-treated plants. However, the plants treated with 5000 ppm of B-9 were significantly shorter than those treated with 2500 ppm of B-9.

Chrysanthemum varieties, Intrepid Gold, Dazzler; Royal Trophy; Yellow Mandlay and Loyalty were grown in 8-inch plastic pots. The media consisted of peat-moss, hortipearl, sand and local topsoil (3:1:1:1) with 'Perk' micronutrient. Four rooted cuttings were planted in each pot. Short day treatment started after three weeks of planting. Bud initiation took place in 11 weeks. All plants were sprayed with A-Rest (.5/.25 mg) and B-9 at 2500 ppm concentrations.

Poinsettia varieties, GV-10; GV-14; Eckespoint C-1 Red; Annette Hegg Hot Pink and Annette Hegg White were given photoperiodic treatments by black cloth. GV-10 and GV-14 bloomed in 12 weeks; Eckespoint C-1 Red, Annette Hegg Pot Pink and Annette Hegg Dark Red bloomed in 13 weeks; Annette Heg White bloomed in 15 weeks.

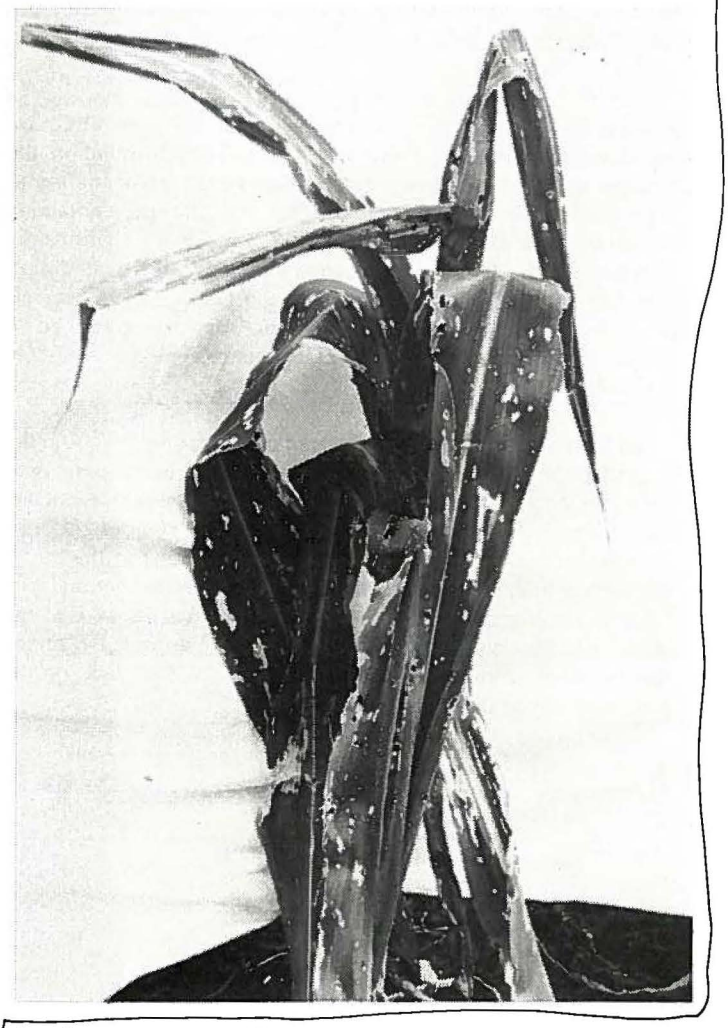
The ornamental horticulture experiment showed that black cloth treatment could be used for commercial flower production of Kalanchoe, Chrysanthemum and Poinsettia in Guam. Some varieties of Kalanchoe can be grown in outside gardens without using black cloth treatment.

ENTOMOLOGY

A. Pest Management

D. NAFUS AND I. SCHREINER

The development of Integrated Pest Management (IPM) programs for crops grown on Guam was targeted as a priority for the entomology section. Currently, no IPM programs exist and baseline information for the development of these programs is lacking. In 1981, efforts were concentrated on collecting basic information for two crops, pole beans and corn.



I. Corn

Don

Maize, *Zea mays,* is attacked by several species of insects on Guam, but only one, the Asiatic corn borer, *Ostrinia furnacalis,* causes severe and widespread damage. Since biological control can be an integral part of an IPM program, we are looking for ways to augment populations of natural enemies and to integrate them into a pest management program. On maize, *O. furnacalis* does not begin to lay eggs until the late whorl stage, about one month after planting. Population densities of the moth are high year round, probably due to breeding on an alternate host plant, which has not been identified at the time of this writing. Thus, to adequately control *O. furnacalis,* natural enemy populations must be high at the onset of *O. furnacalis* oviposition. On Guam the principal natural enemy of *O. furnacalis* is *Trichogramma chilonis,* an egg parasite which also attacks the sweet potato hornworm. We attempted to augment *T. chilonis* populations by intercropping corn and sweet potatoes. Eggs of the sweet potato hornworm, *Agrius convolvuli,* are deposited beginning 1 to 2 weeks after planting, giving *T. chilonis* 2 to 3 weeks to build up their population before the onset of *O. furnacalis* oviposition.

Methods: Four experimental treatments were set up; one monoculture each of sweet potatoes (MSP) and corn (MC), and two intercrops of sweet potatoes and corn at different spacings. The plots were 7 m wide by 15 m long with rows planted 1 meter apart. In one intercropped plot (I7), there were 7 rows of corn between the sweet potatoes (sweet potato at rows 1, 8, 15); and in the other (I3), 3 rows of corn between the sweet potatoes (sweet potato at rows 4, 8 and 12). All treatments were replicated twice in a block pattern.

Sweet corn, Hawaiian Super Sweet #9, was planted at a spacing of 2 seeds per 0.25 m and thinned to 1 plant per hill at 2 weeks. Sweet potatoes, Kaneohe Red, were planted as 8" cuttings with 2 tip leaves at a density of 3 plants/m. Fertilizer was applied at a rate of 100-300-100 kg/ha, as 10-30-10 NPK in furrows. All rows were hilled to prevent waterlogging of roots. Both corn and sweet potatoes were planted on May 20, 1981.

In each row of corn, two plants; one in the outside 2 m and one in the interior, were randomly selected and visual counts of all insects on them were made weekly. On 3 additional plants, all corn borer eggs were counted and checked for parasitism. Five masses of eggs which appeared newly laid and unparasitized, and five masses of parasitized eggs, were removed from each treatment and held in the laboratory to determine the number of eggs and the percentage of parasitism within an egg mass.

For sweet potatoes, weekly counts of all insects on 40 leaves in each row were made for 3 rows in each treatment. To determine parasitism rates, ten hornworm eggs per plot were sampled and examined for parasites.

At the harvest stage, all ears and 4 stalks per row, 2 from the outside 2 m and 2 inside, were removed and dissected. Numbers of corn borer holes, larvae, and pupae were counted. All pupae were held for parasite emergence.

Results: Eggs of the sweet potato hornworm did not reach peak densities until June 25, by which time *O. furnacalis* had already begun oviposition (Table 1). Parasite numbers on hornworm eggs reached peak numbers during the week of June 18 in I3, June 25 in I7, and July 1 in MSP (Table 1). Eggs of *O. furnacalis* were found at very low numbers on June 18 and increased rapidly. By June 25, average egg mass densities in the different treatments ranged from 0.29 to 0.50 masses per plant (Table 1). A continuous increase over the season was found until the maize began to dry around mid-July. No evidence of a distinct first and second generation was found.

On June 25, the first parasitized egg masses of *O. furnacalis* were found. Over the season, the number of parasitized egg masses increased three-fold, from about .07 masses/plant on June 25 to 0.23 masses/plant on July 9, although the percentage of parasitism changed very little over the season. On June 25, 37% of the egg masses were parasitized, while on July 9, 40% were parasitized. The intercropped plots showed a slight increase in parasitism, while the corn monoculture showed a slight decline (Table 1). The percentage of parasitized egg masses was highest in the I3 plots (42.4%), intermediate in the I7 plots (33.9%), and lowest in the CM plots (28.4%), although the difference was not significant (AOV).

Only rarely were all eggs within an individual egg mass of *O. furnacalis* parasitized. Approximately 28% of the individual eggs within a mass were parasitized, with the highest rates of parasitism in the intercropped plots (30.7% in I3; 31.1% in I7, and 23.5% in MC). Overall, 13.0% of the eggs from I3, 10.5% from

17, and 6.9% from MC were parasitized. No significant difference in the number of larvae per ear or per stalk was found between the intercrops and the monoculture (Table 2).

Of the other insect species monitored, most were too rare to show trends. Among the more common species associated with corn, *Chrysodeixis chalcites* and spiders were significantly more abundant in the intercrop. No significant trends were observed with any other species (Table 3). In the sweet potatoes, *C. chalcites* were more abundant in the intercrop than in the monoculture, as were 3 species of Orthoptera and a Collembola species. In the sweet potato monoculture, leafhoppers were more abundant than in the intercropped sweet potatoes. Only the leafhopper data was statistically significant (Table 3).

II. Pole Beans

Ilse ↓

Agromyzid leafminers (*Liriomyza* sp.) are a serious problem on pole beans on Guam. The most commonly used insecticides against this pest on Guam are diazinon and dimethoate, but farmers have reported that these materials do not always successfully control the leafminers. This experiment tested the effectiveness of these two insecticides at two different spray schedules and evaluated their effect on parasites of the leafminer.

Method: The experiment was conducted at the Guam Agricultural Experiment Station. Kentucky Wonder Beans (variety Takii Flat Pod) were planted August 19, 1981. A randomized complete block design with 4 replications was used. Each plot consisted of 2 rows, 3.60 m long. Rows were spaced 0.90 m apart. Plots were separated from each other by a barrier row of the same variety of beans to diminish insecticide drift from one plot to the next. Beans were planted individually about 15 cm apart in the row and were trained on nets. Fertilizer was applied at the rate of 10-300-100 kg/ha NPK. The treatments consisted of diazinon applied twice weekly or once every 2 weeks, dimethoate twice weekly or once every 2 weeks, and an untreated check. Diazinon (25% AI) was applied at the rate of .3 kg(AI) per ha and dimethoate (30.5% AI) at the rate of .3 kg(AI) per ha. The number of mines per leaf was estimated by randomly selecting 10 plants per plot and counting the number of mines on each leaf. Parasite numbers and the number of active mines per leaf were estimated by sampling 10 leaves per plot. Five leaves were examined and live miners and external larval parasites were counted. The other 5 leaves were held until the leafminer pupae emerged, and the pupae saved until both the flies and parasites had emerged. Three leaflets from this sample were used to estimate the area of the leaf mined. This was done by measuring the total leaf area with a Lambda Instruments leaf area meter, cutting the mines out with a razor, and measuring the leaf area again. The difference was the total area mined.

Results: The insecticides tested appeared to have no effect on leafminer populations. There was no difference found in the number of mines between treatments and the size of the mines were also similar (Tables 4 and 5). The ratio of mines containing live miners to the total number of mines was also not significantly different (Table 6). The average yield of beans in the treated plots was 2 to 3 times greater than that of the check plot. However, plant death due probably to *Rhizoctonia* root rot introduced so much variability that no significant differences could be detected (Table 4).

At least 3 species of hymenopteran parasites emerged from the *Liriomyza* mines and pupae. One species found was *Hemiptarsenus semialbiclavus*. The other species have not yet been identified; however, one appears to be a cynipid and may be a hyperparasite. The number of parasites found in the mines was not significantly affected by the insecticide treatments (Table 7). The number of parasites emerging from the pupae was too small to permit comparisons. The percent of miners parasitized was not high, and ranged from an average of 5 to 26% on the various sampling dates.

Table 1. Number of eggs and parasitized eggs of *Agrius convolvuli* on sweet potatoes and *Ostrinia furnacalis* on corn.

Date	June 5				June 11				June 18				June 25			
Plot	MSP	MC	I7	I3	MSP	MC	I7	I3	MSP	MC	I7	I3	MSP	MC	I7	I3
Number of egg *A. convolvuli*	3	--	2	1	2	--	4	3	21	--	17	22	20	--	21*	25
Number parasited egg *A. convolvuli*	2	--	0	0	0	--	0	0	3	--	5	12	7	--	11	16
% Parasitism	66	--	0	0	0	--	0	0	14	--	29	55	35	--	55	64
A. convolvuli eggs/ ten leaves	0.18	--	0.19	0.09	.08	--	0.21	0.13	0.08	--	0.21	0.25	0.50	--	0.25	0.50
Number of *O. furnacalis* egg masses	--	0	0	0	--	0	0	0	--	0	3	0	--	14	24	17
Number of parasitized egg masses	--	0	0	0	--	0	0	0	--	0	0	0	--	8	6	6
% parasitism	--	0	0	0	--	0	0	0	--	0	0	0	--	57	25	35
Number of egg masses/ Plant	--	0	0	0	--	0	0	0	--	0	0.06	0	--	0.29	0.50	0.35

Date	July 1				July 9				July 16				July 23			
Plot	MSP	MC	I7	I3	MSP	MC	I7	I3	MSP	MC	I7	I3	MSP	MC	I7	I3
Number of egg *A. convolvuli*	20	--	22	20	20	--	20	20	21	--	20	20	20	--	22	27
Number parasited egg *A. convolvuli*	11	--	14	13	14	--	12	8	11	--	7	5	13	--	14	13
% Parasitism	55	--	64	65	70	--	60	40	53	--	35	25	65	--	64	48
A. convolvuli egg/ ten leaves	0.46	--	0.42	0.21	0.33	--	0.21	0.25	0.54	--	0.29	0.58	0.62	--	0.17	0.46
Number of *O. furnacalis* egg masses	--	45	93	63	--	82	98	74	--	73	86	122	--	11	7	14
Number of parasitized egg masses	--	12	19	21	--	20	49	33	--	20	23	52	--	4	6	11
% Parasitism	--	27	20	33	--	24	50	45	--	27	27	43	--	36	86	79
Number egg masses/ plant	--	0.38	0.78	0.53	--	0.68	0.82	0.62	--	0.61	0.72	1.02	--	0.23	0.15	0.29

Table 2. Number of and damage caused by *O. furnacalis* on corn in monoculture and intercrops. No differences are significant (AOV; F-test)

Plot type	Number of larvae and pupae per ear	Number holes per ear	% of ear eaten (When ear produced)	Number larvae & pupae per stk	Number holes per stk
MC	3.38	5.78	30.3	7.57	10.3
I7	4.49	7.12	24.6	12.35	18.2
I3	3.21	5.04	20.6	8.31	13.4

Table 3. Seasonal averages of common ARTHROPODS on corn and sweet potatoes.

	Corn		
	Mean number of insects/plant/sample		
ARTHROPOD SPECIES	MC	I 7	I 3
Chrysodeixis chalcites (Esper)	0.40	0.90*	1.13*
Marasmia trapezalis (Guenee)	0.16	0.17	0.18
Peregrinus maidis (Ashmead)	4.55	3.98	4.44
Spodoptera sp.	0.02	0.06	0.04
Carophilus dimidiatus (Fabricius)	0.38	0.38	0.37
Spiders	0.08	0.17*	0.13
Rhopalosiphum maidis (Fitch)	0.19	0.11	0.20

	Sweet Potatoes		
	Mean number insects/10 leaves/sample		
Halticus tibialis Reuter	4.94	6.09	5.03
C. chalcites (Esper)	0.38	1.21	0.75
Orthoptera	0.625	1.67	1.13
Heteroptera	0.50	0.26*	0.31
Heteroptera (Whitefly)	0.56	1.59	0.71
Collembola	1.80	2.30	4.08

* Significantly different from control (AOV F test) at 0.05 level.

Table 4. Effect of insecticide treatments on bean yield and number of mines per leaf.

		Average number of mines/leaf				
Chemical	Spray Interval	Sept. 2	Sept. 8	Sept. 30	Oct. 26	Bean Yield (g)
dimethoate	3 days	3.3	6.4	6.1	11.1	364
dimethoate	14 days	3.5	6.1	7.8	13.5	320
diazinon	3 days	3.8	7.3	7.8	12.7	249
diazinon	14 days	3.4	5.5	8.3	16.3	405
check	--	3.1	5.8	8.2	11.8	107
F.		0.16	1.20	0.59	0.25	0.648
LSD (.05)		1.9	3.5	11.8		439

Table 5. Effect of insecticide treatments on the size of individual mines.

Chemical	Spray Interval	Average area of one mine (cm^2) Oct. 5	Oct. 18	Nov. 2
dimethoate	3 days	0.98	0.41	0.28
dimethoate	14 days	1.43	0.46	0.23
diazinon	3 days	1.16	0.52	0.26
diazinon	14 days	1.35	0.53	0.71
Check	--	1.20	0.65	0.28
F		1.07	0.76	1.13
LSD(0.5)		0.51	0.31	0.57

Table 6. Effect of insecticide treatments on the number of live miners present.

Chemical	Spray Interval	Active mines/total mines (%) Sept. 21	Oct. 5	Oct. 18
dimethoate	3 days	26	33	34
dimethoate	14 days	34	32	23
diazinon	3 days	33	43	23
diazinon	14 days	35	37	23
Check	--	23	44	23
F(Arcsin $\sqrt{P}$)		0.86	0.32	0.37

Table 7. Effect of insecticide treatments on number of leafminer parasites per 5 leaf sample.

Chemical	Spray Interval	Average number of parasites/sample Sept. 21	Oct. 5	Oct. 18	Nov. 2
dimethoate	3 days	2	1.5	4.2	4.5
dimethoate	14 days	7.5	4.2	4	5.8
diazinon	3 days	5	1.8	1.2	10.0
diazinon	14 days	8	2.2	3.5	5.2
Check	--	5.5	3	2	5.0
F		1.35	0.82	0.65	0.35
LSD(0.5)		4.3	3.7	4.9	6.9

B. Biological Control

JAMES R. NECHOLS

The research during 1981 focused on (1) evaluating beneficial species associated with the spherical mealybug; (2) establishing natural enemies of the spiraling whitefly; and (3) monitoring population fluctuations of the flame tree looper.

Spherical mealybug

The mealybug, *Nipaecoccus vastator* (Mask.), was a serious pest on the legume, *Leucaena leucocephala* (Lam.), and on other important plants during the dry seasons from 1977 to 1980. Since then, this pest has been under control with populations remaining at low levels. Surveys on Guam and Saipan reveal the presence of a number of natural enemies of *N. vastator,* among these, a newly-discovered gregarious encyrtid parasite, *Anagyrus* sp., which appears to be widely distributed. To help elucidate the role that *Anagyrus* plays in suppressing mealybug populations, and to determine its abundance relative to the other biological control agents, both field and laboratory studies were initiated.

I. Distribution and relative abundance--

Methods and materials: To determine the distribution and relative abundance of *Nipaecoccus* and its natural enemies, *Leucaena* was sampled extensively on Guam and Saipan. All the vegetation on each of 10 adjacent trees was examined at 56 sites on Guam (2-mile intervals) and at 30 sites on Saipan (1-mile intervals) along roadsides. At each site, the degree of mealybug infestation per tree was ranked visually (see Table 1). Mealybugs were also collected from trees at each infested site and held in the laboratory. The numbers and species of natural enemies emerging were recorded.

Results: The results (Table 1) show that mealybug population densities were very low during the rainy season, and were more frequently distributed on Guam than on Saipan. In Guam, mealybugs were found at almost half of the sample sites; whereas only 20 percent of the Saipan sites were infested. Infestation levels per site ranged between 10 and 100 percent ($\bar{X}$=30%) on Guam; on Saipan, 10 to 40 percent of the trees contained mealybugs at infested sites ($\bar{X}$=22%). The average population levels on individual trees were low on both islands (Table 1).

Table 2 shows the relative abundance of the spherical mealybug's natural enemies. The parasite, *Anagyrus* sp., was the most abundant beneficial species; it composed ca. 95 percent of all natural enemies on both islands. The predacious fly, *Kalodiplosis* sp. (Cecidomyiidae) accounted for 3 and 6% of the natural enemies recovered from Guam and Saipan, respectively. The drosophilid fly, *?Gitonides* sp., and the coccinellid beetle, *Diomus* sp., occurred infrequently in the Guam samples. Neither of these predacious species was found on *N. vastator* in Saipan during the sample period.

Anagyrus was recovered from 21 of 25 sites (84%) on Guam and from 100% of the Saipan sites. The average rate of parasitism was 77 and 70 percent on Guam and Saipan, respectively (Table 2). There was no apparent correlation between the degree of mealybug infestation and the percentage parasitism by *Anagyrus* sp.

Discussion: The results (Table 1) show that the distribution of *Anagyrus* sp. is nearly coincident with its host, *N. vastator,* both in Guam and in Saipan. Thus, despite very low and scattered mealybug densities, *Anagyrus* is capable of finding hosts. This is indicative of the parasite's good searching behavior.

The relative abundance of *Anagyrus,* and the high level of mealybug mortality attributable to this parasite, suggest its importance in the natural control of *N. vastator.* However, experimental evidence (e.g., exclusion experiments) is needed. For example, although apparently much less abundant, the beetle and fly predators may play an important role in regulating *N. vastator* populations because they are able to attack the mealybug's egg stage.

The low densities may be responsible for failure to find coccinellids or drosophilids in Saipan; both of these predators are commonly found in the cottony masses associated with adult mealybug aggregations.

II. Host susceptibility

Methods and materials: Mealybugs were cultured in the laboratory on greenhouse-grown plants *(Jatropha integerrima).* The parasite, *Anagyrus* sp., was reared from *N. vastator* on plants that were held outdoors in screened, frame cages.

To establish the stages of *N. vastator's* life cycle susceptible to attack (oviposition) by *Anagyrus* females, 12 mealybugs of each instar were confined in a dixie cup on an excised *Jatropha* leaf. Each group was then exposed separately to a mated, fed, parasite female for ca. 24 hours. Subsequently, each mealybug was dissected and the number of *Anagyrus* eggs (if present) were counted.

Results: The preliminary results (Table 3) indicate that *Anagyrus* females prefer to oviposit in the larger stages of *N. vastator.* The percentage parasitism in 1st, 2nd, 3rd, and adult instar mealybugs was 8.2,8.2, 12.4, and 22.6%, respectively. The mean

total number of eggs laid per female and the mean number of parasite eggs deposited in each host also varied in direct proportion to host size (age) (Table 3). The data were not analyzed statistically because of small sample sizes. Additional replications are in progress.

Discussion: The preliminary data suggest that *Anagyrus* females prefer the largest (i.e. most mature) mealybugs for oviposition. The oviposition rate was much greater in 3rd instar nymphal and adult mealybugs than in 1st or 2nd instar mealybugs. Both the frequency of hosts attacked (% parasitism) and the average number of eggs laid per host increased directly with host size.

Because *Anagyrus* is a gregarious parasite (i.e., more than one parasite survives in a given host), the ecological implications of these results are two-fold: (1) larger hosts provide a larger food source and, thus, allow a higher reproductive output for the parasite; and (2) survival of parasite progeny may be enhanced by maternal selection of large mealybugs, because premature (preadult) host mortality is avoided. On the other hand, the ability to accept all host stages suggests that asynchrony may not be a severe problem for *Anagyrus*. Knowledge of *Anagyrus'* stage specificity has been used for efficiently rearing this parasite in laboratory cultures.

Because preference behavior can change when female parasites are given a choice of host stages, multiple-stage exposure experiments are now in progress. In addition, the suitability of different mealybug stages for *Anagyrus* survival is currently under examination.

Spiraling whitefly

The spiraling whitefly, *Aleurodicus dispersus* Russell, is a newly-introduced pest on Guam. In May, populations were first seen on plumeria, coconut, mango, and guava trees near commercial plant nurseries in the villages of Mongmong and Barrigada. Beginning in June, we sampled 20 leaves from each of 4 plumeria trees in each village. Adult whiteflies were counted in the field; the egg and nymphal stages were counted on 10 of the leaves in the laboratory.

These calculations showed that whitefly densities were very high (ca. 300-500/leaf). In addition, surveys indicated that the population was dispersing rapidly to other parts of the island and becoming increasingly abundant. To control this pest, a predacious ladybeetle, *Nephaspis amnicola* Wingo, and a parasitic wasp, *Encarsia ?haitiensis* Dozier, were imported through the cooperation of the Hawaii Department of Agriculture. Beetle releases (ca. 5,000 adults) were made at a total of 7 infested sites in July, November, and December. Periodic samples (Barrigada and Mongmong) reveal that beetle numbers are increasing, and the species appears to have become established.

In November, ca. 150 *Encarsia* adults were released at one site in Mongmong. The status of this parasite is still uncertain pending additional sampling.

Flame tree looper

An island-wide survey was conducted in 1981 to establish seasonal patterns of abundance of the flame tree looper, *Pericyma cruegeri* (Butl.). A total of 28 flame trees were selected for the study; sample sites comprised almost every village on Guam.

Each month, the first 10 fully expanded leaves behind the growing tip were examined on each of 15 branches per tree. The total number of preadult (egg-pupal) loopers was counted. Beginning in June, the percentage of defoliation was also recorded.

The results (Fig. 1) show that loopers are present on flame trees throughout the year. Peak populations occurred in November with minor peaks occurring in February and May. In November, peak looper populations correlated with high rates of defoliation. That is, almost half of the trees were 90 to 100% defoliated. In April, and from June to August, looper populations were very low. During these months, loopers were found on only 20-30% of the sample trees.

Because the established pupal parasites, *Brachymeria albotibialis,* and *Exorista civiloides,* continue to be extremely rare (and are therefore ineffective in controlling looper populations), new natural enemies are being sought for importation from other countries, e.g., Papua New Guinea and Australia. Based on the present data, natural enemies should be imported for field release during mid-to late autumn (i.e., Oct. to Nov.).

The effective environmental factors regulating looper population dynamics are, as yet, unknown. Therefore, subsequent analyses will include correlations of climatic parameters (e.g., rainfall, relative humidity) for present and future population data. In addition, planned experimental investigations should provide information useful for the continuous culture of the looper. This is important because the peak activity of the looper on Guam appears to be out of phase with looper populations in countries from which additional beneficial species may be imported.

Table 1. Relative abundance of the spherical mealybug, *Nipaecoccus vastator,* during the rainy season, 1981.

	Guam[1]	Saipan[2]
Percentage of sites infested (n/N):	47 (26/56)	20 (6/30)
Mean ± S.D. (N) % of trees infested/infested sites:	30 ± 24 (26)	22 ± 12 (6)
Mean ± S.E. (N) degree of infestation/infested tree:[3]	1.1 ± 0.35 (26)	1.0 ± 0.1 (6)

[1]Sample dates: 9/14 to 10/7

[2]Sample dates: 10/8 to 10/9

[3]Ranking system: "0" uninfested; "1" = low, "2" medium, and "3" = "high" infestation

Table 2. Relative abundance of spherical mealybug natural enemies during the rainy season, 1981.

Natural enemy	Constancy+ (n/N)%		Dominance++ $\bar{X}$ ± S.E. % (N)		Percentage Parasitism $\bar{X}$ ± S.E. (N)	
	Guam	Saipan	Guam	Saipan	Guam	Saipan
Anagyrus	84 (21/25)[1]	100 (6/6)	96 ± 12 (21)	94 ± 14 (6)	77 ± 28 (11)[2]	70 ± 34 (6)
Cecidomyiid	16 (4/25)	16 (1/6	3.2 ± 11.2 (21)	6 ± 14 (6)	--	--
Coccinellid	16 (4/25)	0 (0/6)	0.5 ± 1.4 (21)	0 (6)	--	--
Drosophilid	8 (2/25)	0 (0/6)	0.5 ± 1.7 (21)	0 (6)	--	--

\+ Percentages shown are the number of mealybug-infested sites containing a given natural enemy (n)/the total number of mealybug-infested sites (N) x 100.

++ Percentages shown are the mean of the mean percentages computed from the number of each natural enemy emerging/total number of all natural enemies emerging per site x 100.

[1] All 4 sites where *Anagyrus* absent contained only 1 or 2 hosts

[2] Only includes sample sites containing 10 or more mealybugs.

Table 3. Relative susceptibility of *Nipaecoccus vastator* instars to ovipositional attack by its parasite, *Anagyrus* sp. Exposure period = 24 hours. Temp. = 27 ± 2° C.; L:D = 14:10

	Preference criteria for *Anagyrus* adult female:		
Mealybug instar	Percentage Parasitization ($\bar{x}$ ± S.D., N)	Total number of eggs/female ($\bar{x}$ ± S.D., N)	Number of eggs/ parasitized host ($\bar{x}$ ± S.E., N)
1st nymphal	8.2 ± 13.1 (13)	3.25 ± 1.3 (4)	1.1 ± 0.12 (4)
2nd nymphal	8.2 ± 13.3 (11)	3.0 ± 1.1 (4)	1.25 ± 0.5 (4)
3rd nymphal	12.4 ± 14.3 (9)	7.4 ± 5.6 (5)	1.97 ± 0.7 (5)
Adult female	22.6 ± 19.2 (16)	8.4 ± 4.6 (12)	3.2 ± 1.0 (12)

Table 4. Effect of insecticide treatments on the size of individual mines.

Chemical	Spray Interval	Average area of one mine (cm^2) Oct. 5	Oct. 18	Nov. 2
dimethoate	3 days	0.98	0.41	0.28
dimethoate	14 days	1.43	0.46	0.23
diazinon	3 days	1.16	0.52	0.26
diazinon	14 days	1.35	0.53	0.71
Check	--	1.20	0.65	0.28
F		1.07	0.76	1.13
LSD(0.5)		0.51	0.31	0.57

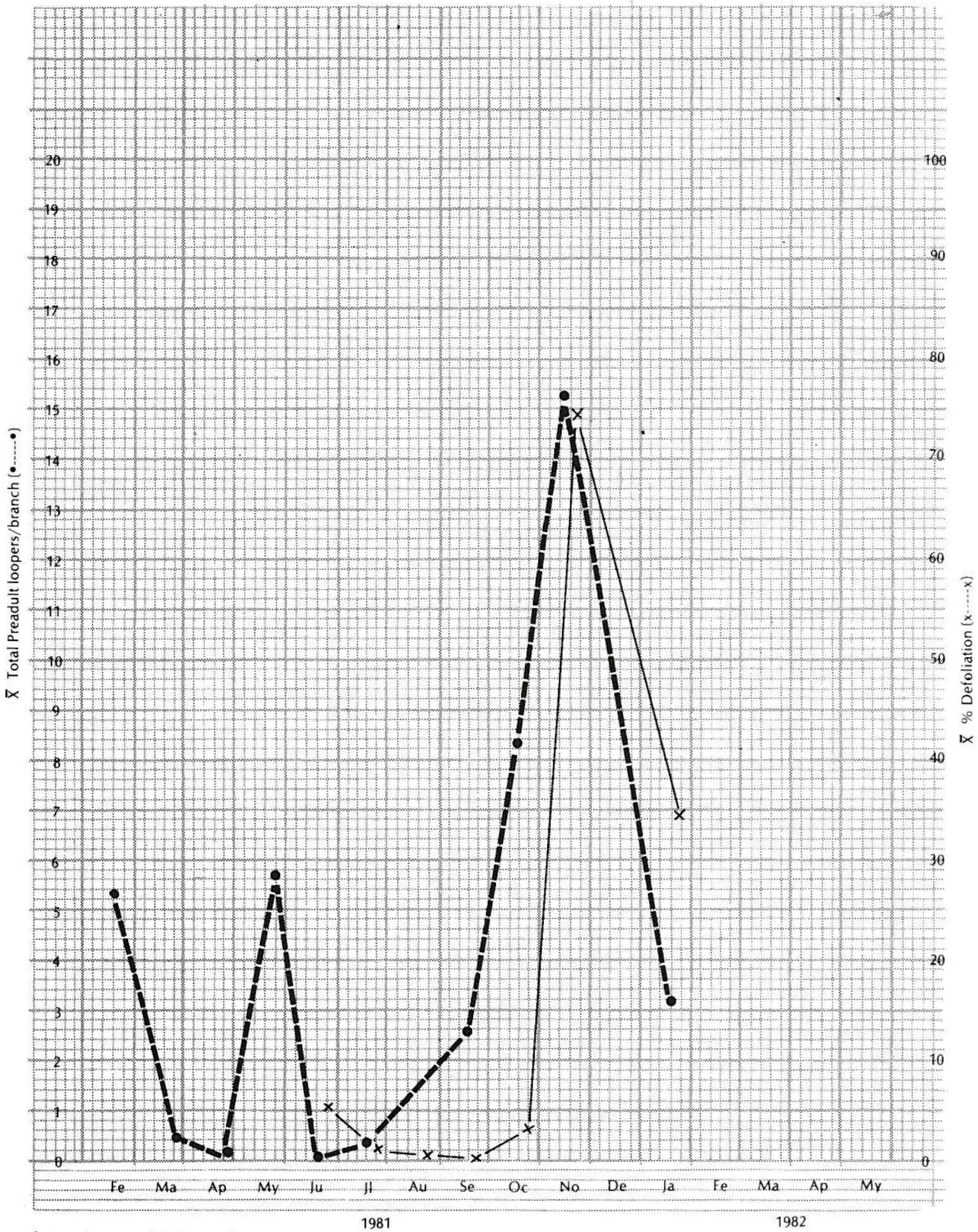
Table 5. Effect of insecticide treatments on the number of live miners present.

Chemical	Spray Interval	Active mines/total mines (%) Sept. 21	Oct. 5	Oct. 18
dimethoate	3 days	26	33	34
dimethoate	14 days	34	32	23
diazinon	3 days	33	43	23
diazinon	14 days	35	37	23
check	--	25	44	23
F(Arcsin P)		0.86	0.32	0.37

Table 6. Effect of insecticide treatments on number of leafminer parasites per 5 leaf sample.

Chemical	Spray Interval	Average number of parasites/sample Sept. 21	Oct. 5	Oct. 18	Nov. 2
dimethoate	3 days	2	1.5	4.2	4.5
dimethoate	14 days	7.5	4.2	4	5.8
diazinon	3 days	5	1.8	1.2	10.0
diazinon	14 days	8	2.2	3.5	5.2
Check	--	5.5	3	2	5.0
F		1.35	0.82	0.65	0.35
LSD (0.5)		4.3	3.7	4.9	6.9

Figure 1. Relationship between population densities of *Pericyma cruegeri* and percentage defoliation of flame trees at monthly intervals on Guam (1981)[1]



[1] Sample not made in December

PLANT PATHOLOGY

R. GARY BEAVER

I. Identification of Plant Diseases

Research in plant pathology has continued with an identification of plant diseases. During the past year. the search for plant diseases has been extended to include ornamental, grass and weed hosts, in addition to the regularly cultivated fruit and vegetable crops.

New reports of diseases records in 1981 are shown in Table 1.

II. Panama Wilt in Banana

Panama Wilt causing *Fusarium oxysporum* is continuing to spread slowly on Guam. During the past year, one new location for the disease was identified in Ipan, Talofofo.

III. Biological Control of Soilborne Plant Pathogens W-147

Guam soils are being investigated to determine the presence or absence of suppressive factor(s) that can be utilized to suppress or control *Fusarium* and *Rhizoctonia* diseases on beans, tomatoes and melons.

Physical properties of soils from selected sites (Table 2, Figure 1) have been determined. These soils are being screened for suppressive activity. Activities of soils from sites C and H are given in Figure 2. Soils from site H were planted successively to 5 cropping of Early Scarlet Globe Radish. Disease incidence and disease progression are shown in Figure 3.

This data suggests that within some Guam soils there are organisms or physical factors that can suppress diseases from *Rhizoctonia*.

Isolations from suppressive soils revealed the presence of three species of *Trichoderma*.

The study is not conclusive at the time, and will require further investigation to determine the nature and extent of suppressive soils in Guam.

Table 1

Fruits

A. Avocado *Persea americana*	
1) Phomopsis Leaf Spot	*Phomopsis* sp.
B. Breadfruit *Artocarpus altilis*	
1) Pingelap Disease	Unknown
2) Leaf Spot	Unknown bacterium
3) Algal Leaf Spot	*Cephaleuros virescens*
C. Citrus sp.	
1) Greasy Spot	*Cercospora citri-grisea*
2) Sooty Mold	*Capnodium* sp.
3) Algal Leaf Spot	*Cephaleuros virescens*
D. Fig *Ficus carica*	
1) Rust	*Cerotelium fici*
E. Guava *Psidium guajava*	
1) Algal Leaf Spot	*Cephaleuros virescens*
*2) Leaf Spot	*Phyllosticta eriobotryae*
3) Anthracnose	*Colletotrichum gloeosporioides*
F. Iba *Phyllanthus acidus*	
1) Rust	*Phakopsora phyllanthi*
G. Jack Fruit *Artocarpus heterophyllas*	
1) Fruit Rot	*Rhizopus arctocarpi*
H. Mango *Mangifera indica*	
1) Leaf Spot	*Pestilotia mangiferae*
2) Stem Swelling	Unidentified
I. Papaya *Carica papaya*	
1) Leaf Spot	Unidentified bacterium
*2) Leaf Spot	*Corynespora cassiicola*
J. Spanish Plum *Spondias purpurea*	
1) Gumosis	*Phytophthora* sp.

Vegetable

A. Bean, Bush *Phaseolus vulgaris*	
1) Root Rot	*Rhizoctonia solani*
B. Bean, K.W. Pole *Phaseolus vulgaris*	
*1) Leaf Spot	*Ascochyta phaseolorum*
C. Bean, Yardlong *Vigna sinensis*	
1) Root Rot	*Fusarium solani*
D. Cantaloupe *Cucumis melo*	
1) Leaf Blight	Unidentified bacterium
E. Chinese Parsley *Coriandrum sativum*	
1) Damping-off	*Pythium* sp.
F. Corn *Zea mays*	
1) Maize Stripe	Virus
G. Egg Plant *Solanum melongena*	
1) Leaf Spot	*Gloeosporium* sp.
H. Okra *Hibiscus esculentus*	
1) Root Knot	*Meloidogyne* sp.
I. Pepper, Bell *Capsicum annum*	
1) Leaf Spot	*Colletotrichum gloeosporioides*
J. Pepper, Hot *Capsicum fructensis*	
1) Leaf Spot	*Colletotrichum gloeosporioides*
*2) Leaf Spot	*Cercospora capsici*
K. Tomato *Lycopersicon esculentum*	
1) Leaf Blight	*Septoria lycopersici*
2) Leaf Spot	*Colletotrichum gloeosporioides*
3) Tobacco Mosaic	T.M.V.
L. Zucchini *Cucurbita pepo*	
1) Cucumber Mosaic	C.M.V.
2) Root Knot	*Meloidogyne* sp.

Ornamentals and Turf

A. *Aralia cordata*	
1) Leaf Spot	*Cercospora araliae*
2) Leaf Spot	*Phyllostictina* sp.
**3) Anthracnose	*Colletotrichum gloeosporioides*
B. *Bixa orellana*	
1) Leaf	*Phyllosticta bixina*
C. *Caladium* sp.	
1) Leaf Spot	*Pringsheimia* sp.
2) Leaf Spot	*Phyllosticta* sp.
D. Chinese Evergreen *Aglaonema commutatum*	
1) Leaf Spot	*Colletotrichum dematium*
E. Chinese Fan Palm *Livistona chinensis*	
1) Tip Dieback	Unidentified fungus
F. *Chrysanthemum morifolium*	
1) Root Rot	*Phytophthora* sp.
G. Crapemyrtle *Lagerstroemia indica*	
1) Sooty Mold	*Capnodium* sp.

H. Croton *Codiaeum variegatum*
1) Leaf Spot — *Phyllosticta codiaei*

I. *Dieffenbachia picta*
1) Leaf Spot — *Phyllosticta colocasiae*
2) Leaf Spot — *Colletotrichum glocosporioides*

J. *Dracena fragrans*
1) Leaf Spot — *Cercospora* sp.
**2) Anthracnose — *Colletotrichum gloeosporiodes*

K. *Eucalyptus cinerea*
1) Anthracnose — *Colletotrichum gloeosporiodes*

L. *Ficus elastica*
1) Leaf Spot — *Colletotrichum gloeosporioides*
2) Leaf Spot — *Diplodia theobromae*

M. Guinea Grass *Panicum maximum*
*1) Leaf Spot — *Cercospora fusimaculans*

N. Orchid *Dendrobium* sp.
1) Leaf Spot — *Phyllosticta* sp.
2) Leaf Spot — *Phyllostictinia pyriformis*

O. *Philodendron* sp.
1) Leaf Spot — Unidentified bacteria

P. *Plumeria rubra*
**1) Anthracnose — *Colletotrichum gloeosporioides*

Q. Poinsettia *Euphorbia pulecherrima*
*1) Bacterial Leaf Spot — *Corynebacterium poinsettiae*
2) Root Rot — *Phytophthora* sp.

R. *Rheo discolor*
**1) Anthracnose — *Colletotrichum gloeosporioides*
*2) Leaf Spot — *Pestilotia breviseta*
3) Leaf Spot — *Curvularia* sp.

S. Rose *Rosa* sp.
1) Leaf Spot — *Diplocarpon rosae*
2) Leaf Spot — *Pestilotia* sp.

T. Spider Lilly *Pancratium littorale*
1) Southern Blight — *Sclerotium rolfsii*

U. tube Rose *Polianthes tuberosa*
1) Southern Blight — *Sclerotium rolfsii*

Root Crops

A. Cassava *Manihot esculenta*
*1) Leaf Spot — *Cercosporidium henningsii*

B. Peanut *Arachis hypogea*
1) Leaf Spot — *Cercospora personata*
2) Rust — *Puccinia arachidis*

C. Red Yam *Dioscorea alata*
1) Rust — *Goplana dioscoreae*

Other

A. *Aglaonema commutatum*
1) Leaf Spot — *Colletotrichum dermatium*

B. *Alocasia macrorrhiza*	
1) Leaf Spot	*Mycosphaerella alocasiae*
C. *Barringtonia asiatica*	
*1) Leaf Spot	*Mycosphaerella* sp.
*2) Leaf Spot	*Cercospora barringtoniae*
D. *Bidens pilosa*	
*1) Leaf Spot	*Cercospora bidentis*
*2) Rust	*Uromyces bidenticola*
E. *Clerodendron inerme*	
1) Rust	*Uredo clerodendricola*
F. *Crinum asiatica*	
*1) Leaf Spot	*Mycoshaerella* sp.
G. Guam Cherry *Muntingia calabura*	
*1) Leaf Spot	*Cercospora muntingiae*
H. *Hibicus tiliaceus*	
1) Leaf Spot	*Phyllachora minuta*
I. *Ipomoea aquatica*	
1) White Rust	*Albugo ipomoeae-dunduratae*
2) Leaf Spot	*Cercospora ipomoeae*
J. *Ipomoea pes-caprae*	
*1) Leaf Spot	*Cercospora ipomoeae*
K. *Jatropha multifida*	
**1) Anthracnose	*Colletotrichum gloeosporioids*
L. *Morinda citrifolia*	
1) Leaf Spot	*Physalospora morindae*
M. Passion Fruit *Passiflora foetida*	
1) Leaf Spot	*Cercospora fusco-virens*
N. *Pithelellobium dulse*	
1) Leaf Spot	*Colletotrichum trancatum*
O. *Scaevola taccada*	
1) Sooty Mold	*Capnodium* sp.
P. *Stachyarpheta urticaefolia*	
*1) Mildew	*Oidium* sp.
Q. Sugar Cane *Saccharum officinarum*	
1) Leaf Spot	*Colletotrichum falcatum*
R. *Triphasia tridolia*	
**1) Anthracnose	*Colletotrichum gloeosporioides*
S. Wild Piper *Piper guahamense*	
1) Leaf Spot	*Colletotrichum dermatium*

* New Guam Record
** New Host Record

PESTICIDE RESIDUE

J.L. Demeterio

I. Fate of Added Malathion in Guam

The widespread use of the insecticide malathion can be attributed to its remarkably useful pattern of selective toxicity. It is extremely toxic to most insects and is less toxic to mammals. Malathion belongs to the group of insecticides known as organophosphates, whose suceptibility to degradation is well documented. While all prior work has been done in temperate regions, little work has been done on malathion degradation in the tropics.

Malathion is known to degrade by both chemical and microbial pathways. This study endeavors to follow the total dissappearance of the active ingredient.

The three basic phases in pesticide residue methodology are as follows: a) sample preparation b) extraction and cleanup, and c) detection and quantitation. Since this study is our first attempt, a detailed accounting of the analytical procedures is presented.

The work done is outlined as follows:

1. Initial trials runs to determine recovery and getting acquianted with procedures and instrumentation.
2. Following dissappearance of malathion using filter paper both in the field and in a growth chamber.
3. Following malathion dissappearance on tomatoes and citrus leaves.

Initial Trial Runs

A Perkin Elmer gas chromatograph Model 3920B equipped with a flame photometric detector and a 6 ft., ¼ in in. O.D. glass column packed with 3% OV on gas chrom WHP 80/100 mesh was used. The flow rates were N_2 30 ml/min., H_2 51 ml/min., air 107 ml/min. The air and H_2 flow rates were calibrated beforehand. The temperatures used were: column-180°C, detector-200°C, injector-160°C.

The gas chromatograph was tested for linearity. It was linear at attenuations 8 and 16 for 16-64 ng malathion. The standards used were obtained from the US EPA at Research Triangle Park, North Carolina.

Solvents, detergents, distilled water, and filter paper was tested for any peaks that might interfere with the analysis. The solvents tested were reagent and pesticide grade acetone, reagent and pesticide grade hexane, A.C.S. grade methylene chloride, 99% mol. pure iso-octane, and pesticide grade acetonitrile.

One hundred ml of each solvent, except acetonitrile (200 ml), was evaporated on a rotary evaporator until about 3-5 ml, then 5 ul was injected into the gas chromatograph. Twenty-five ml each of deionized distilled water and distilled water was extracted with 100 ml hexane. Fifty mg of powdered detergent was added to 25 ml of deionized distilled water in a 250 ml separating funnel. One hundred ml hexane was then added and agitated for two minutes. The igneous layer was drawn off, then anhydrous Na_2SO_4 added to the hexane extract and agitated for one minute.

The same procedure was followed for liquid detergent, except one drop detergent was used. Twenty grams of Na_2SO_4 were added to 100 ml 15% methylene chloride/hexane in a 250 ml Erlenmeyer flask and agitated for one minute. Whatman filter paper #4 and #1 were washed with 100 ml acetone. All the extracts and washings were evaporated to 3-5 ml in a rotary evaporator and 5 ul injected into the gas chromatograph.

The gas chromatograph was allowed to run for 30 minutes for each sample tested. No interfering peaks were found in any of the materials.

For malathion recovery testings, six circles of Whatman filter paper #1, 11.0 cm diameter were fortified with 80 ng malathion in a wide mouth reagent bottle. The caps were lined with aluminum pre-washed with acetone. Fifty ml pesticide grade acetone was then added. One set was allowed to soak for one hour while another set was agitated mechanically for 10 minutes. The acetone extract was transferred quantitatively to a 500 ml evaporating flask and evaporated to a few ml in a rotary evaporator, made up to 10 ml in a volumetric flask and 5 ul injected into the gas chromatograph. The peak heights in mm and percent recovery are shown in Table 1. While soaking and shaking both gave adequate recovery of added malathion, the latter (shaking) were used in subsequent assays.

Table 1. Recovery of Added Malathion as Affected by Soaking and by Shaking of Filter Paper Fortified with Malathion.

	Peak Heights				
	Standard	Sample			
No		Shake 10 min.	Soak 1 hr.	% recovery	Average
1.	112.2	114.2		101.8	
2.	105.8	109.8		103.8	
3.	105.8	109.5		103.8	103.0
4.	106.0		114.0	107.5	
5.	111.5		113.0	101.3	
6.	104.0		114.0	109.6	106.1

Malathion Degradation on Filter Paper Under Field and Growth Chamber Conditions.

The disappearance of added malathion under field condition was studied. Three rows of wire strung on tangantangan poles were set-up outside the laboratory building. The rows were one meter apart with the wire five feet off the ground. The location allowed for maximum sunlight and prevailing wind patterns. Malathion was added drop-wise on filter papers and then hung with a plastic clip on the wires. Three randomly selected filter papers were collected at various times in an effort to follow the degradation of malathion.

Individual filter papers were placed in wide-mouth amber bottles (recycled reagent bottles). Fifty ml pesticide grade acetone was added and the bottles were agitated for 10 minutes in a rotary shaker. The solutions were evaporated to dryness on a rotary evaporator. Dilutions were made with acetone and injected into the gas chromatograph.

The results of three field trials are presented in Tables 2, 3, and 4.

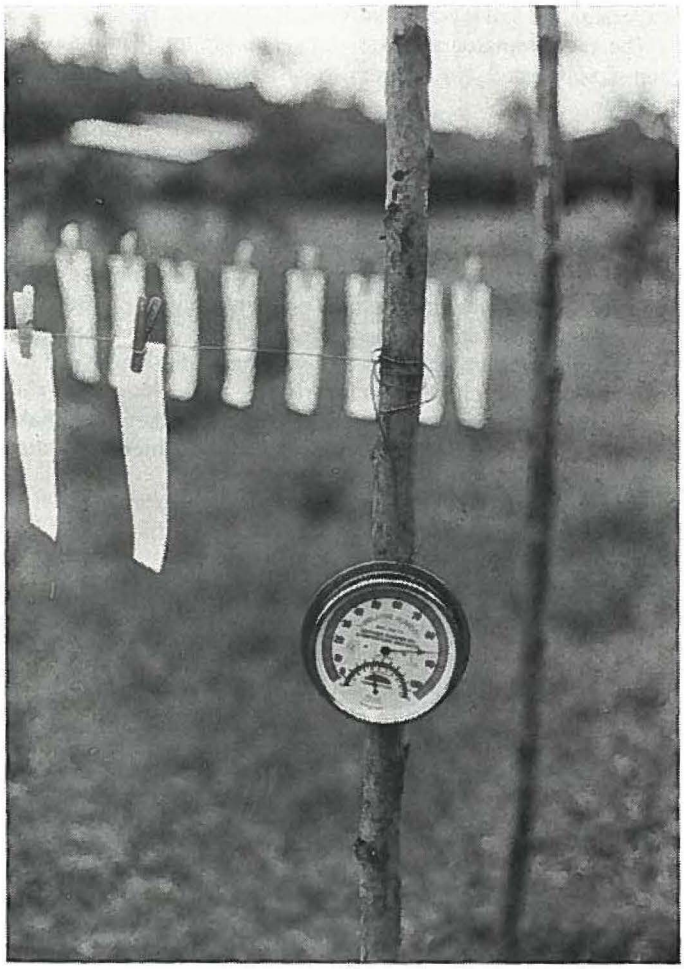


Table 2. Recovery of Added Malathion Under Field Conditions as Affected by Time (Trial 1).

Elasped time after malation addition	ug malation/filter paper	
	Replicates	Mean
0	240.0	247.5
	265.2	
	237.2	
1 hour	206.6	212.9
	212.0	
	220.2	
2 hours	209.0	210.8
	235.0	
	188.4	
4 hours	196.8	187.9
	185.6	
	181.2	
6 hours	187.2	172.93
	174.4	
	157.6	
1 day	1.72	1.69
	3.20	
	0.16	
2 days	0.12	0.19
	0.10	
	0.36	
3 days	n.d*	0.02
	0.04	
6 days	n.d	
	n.d	

* n.d. -- not detectable

A light drizzle preceded the 1, 2, 3 and 6 days sampling. It was generally sunny and partly cloudy for the 1, 2, 3 and 6 hour samplings. It should be noted that although it rained, the filter papers were still intact. It was noted that after 24 hours only 0.65% of added malathion was present.

The same trial was repeated three weeks later and the results are shown in Table 3.

Table 3. Recovery of Added Malathion Under Field Conditions as Affected by time (Trial 2)

Elasped time after malathion additon	ug malathion/filter paper	
	Replicates	Mean
0	204.4	203.6
	204.6	
	201.8	
2 hours	280.2	188.5
	198.4	
	187.0	
4 hours	199.2	196.4
	199.4	
	190.6	
6 hours	199.2	196.4
	199.4	
	190.6	
1 day	116.8	119.7
	113.0	
	129.2	
2 days	2.60	1.25
	0.10	
	1.04	
3 days	0.06	0.03
	0.04	
	n.d	

Alternating sun and rain occurred during the first day of sampling. Rain preceded the 2nd and 3rd day of sampling as in the first trial which brought down most of the filter paper. Humidity in both sampling periods was in excess of 90% R.H. Malathion residue after 2 days was noted to be 0.61% of malathion originally added.

A third trial was attempted where air temperature and relative humidity were monitored at sampling time. The results are presented in Table 4.

Table 4. Recovery of Added Malathion Under Field Conditions as Affected by Time (Trial 3).

Elasped time after malathion addition	Air temperature	Relative humidity	ug malathion/ filter paper	
			Replicates	Mean
0	98°F	67.5%	196.8	197.7
			194.6	
			202.6	
5½ hours	86	78	177.4	168.5
			168.4	
			159.6	
8½ hours	80	87	169.6	185.1
			197.8	
			187.8	
12½ hurs	77	99	144.4	151.8
			164.6	
			146.6	
15½ hours	74	100	2.23	1.89
			1.75	
			1.69	
24 hours			0.04	0.01
			n.d	
			n.d	

It was noted that temperature was 98°F at 9 o'clock in the morning. The temperatures dropped to 74° at midnight, at which time heavy rain fell immediately after the 15½ hour samples were collected. The relative humidity at this time was 100%. Analysis of the 15½ hour samples showed 0.95% of added malathion was present. The data strongly suggest that hydrolysis of malathion occurs as relative humidity increases.

Field conditions are not controllable, hence only results based on particular conditions at the time of the experiment can be stated. For more controllable conditions the growth chamber at the plant pathology laboratory was used employing the same techniques. Again, three rows of wire were strung across the growth chamber and filter paper strips (5x23 cm) were hung using plastic clips. Three strips were collected at random during sampling and placed inside jars where 50 ml acetone was added. The samples were stored in the freezer compartment of the refrigerator pending analysis which was within 15 hours of sampling time.

The relative humidity was around 70% during the 12 hour light period, and dropped to around 60% during the dark period. The temperature control worked well. The rate of dissappearance of malathion as indicated in Table 4 was much slower.

Table 5. Recovery of Added Malathion under controlled Conditions in a Growth Chamber.

Elapsed time after addition of malathion	ug malathion/ filter paper		Amount lost
0	206		0
	189.0	196.5	
	193.6		
4 hours	185.8		9.31%
	171.6	178.2	
	177.2		
8 hours	172.2		14.45
	166.4	168.1	
	165.8		
12 hours	160		16.79
	165.8	163.5	
	164.8		
18 hours	163.2		18.83
	160.4	159.5	
	154.8		
1 day	161.2		12.93
	173.2	171.1	
	178.8		
2 days	148		26.62
	141.8	144.2	
	142.8		
3 days	128.2		34.61
	128.8	128.5	
1 week	97.6		53.33
	85.8	91.7	
2 weeks	61.4		70.33
	55.5	58.3	
3 weeks	13.7		93.03
4 weeks	11.3		94.25

III. Malathion Degradation on Okra and Citrus Leaves

Malathion degradation in two distinctly different plant leaves were carried out at the Experiment Station in Inarajan. Citrus trees and okra plants were used. Citrus leaves are waxy, while okra leaves are pubescent and spiny. Recovery testing using known amounts of standards was carried out in order to establish a procedure for further testing.

(a) Recovery tests for malathion in Okra leaves

Individual okra leaves were cut and then fortified with 0.2 ml each of approximately 800 ppm solution of malathion. The method of Corley & Beroza was used in the extraction. Fifty ml. acetonitrile was added and the leaves were blended for 3 minutes at high speed, then filtered by suction through Whatman no. 4 filter paper. The solution was evaporated to several milliliters on a rotary evaporator. The residue was transferred with 50 ml of 4:1 acetonitrile: water to a 250 ml. separatory funnel and extracted 3 times with 50 ml portions of isooctane which was discarded. Fifty ml methylene chloride was added to the acetonitrile-water mixture, mixed gently and the layers allowed to separate. The lower layer was filtered through 50 g, Na_2SO_4 and rinsed with 50 ml. methylene chloride. The methylene chloride was evaporated to dryness and ethyl acetate added to make a final volume of 10 ml. Injections were then made on the gas chromatograph. The results are shown in Table 6.

Table 6. Recovery of Added Malathion on Okra Leaves Using Acetonitrile

Sample	Weight	Peak Height (mm) Sample	Control	% Recovery	
1.	3.42	64	77	83.1)	
2.	5.03	63	86.5	72.8)	74.1
3.	2.79	57.5	86.5	66.6)	

It was noted that the leaves were not macerated well when using 50 ml acetonitrile in the blender. So, 100 and 75 ml amounts of acetonitrile were tried. However, there was considerable leakage at the top of the blender at the time of blending. This loss could not be avoided.

Another extraction procedure was tried to avoid leakage that resulted from blending. The individual cut leaves were extracted by shaking overnight in half-gallon bottles with 50 ml acetonitrile. They were filtered through fluted filtered paper (VWR Grade 515) then the previous method was followed. The results are shown in Table 7.

Table 7. Recovery of Added Malathion Extracted with Acetonitrile and Shaken Overnight.

		Peak Height (mm)			
Sample	Weight	Sample	Control	% Recovery	
1.	2.95	51.5	80.5	64.0)	
2.	2.74	65.5	80.5	81.4)	80.3
3.	1.80	71.5	74.8	95.6)	

The recovery appeared to have improved, but the replication was not satisfactory. A simpler approach following the procedure of Zweig and Sherma was used substituting acetonitrile for chloroform. After shaking the cut leaves overnight with 50 ml acetonitrile and filtering, 10 g. Na_2SO_4 was added, and then the mixture was swirled vigorously and allowed to stand 10 minutes. A 25 ml portion was evaporated to dryness and taken up with ethyl acetate to a final volume of 5 ml. The results are shown in Table 8.

Table 8. Recovery of Added Malathion Using the Modified Procedure of Zweig and Sharma.

		Peak Height (mm)			
Sample	Weight	Sample	Control	Recovery	
1.	4.13	92	82.5	111.5)	
2.	3.72	89	75.5	117.9)	115
3.	2.74	84	75.5	111.3)	
4.	2.38	80.5	67.5	119.3)	

Since residue analysis will require a considerably larger sample size, the last method was used on 30g sample of okra leaves. The leaves were first chopped in the blender then malathion was added followed by 200 ml acetonitrile and the mixture agitated overnight. The mixture was filtered through fluted filter paper, 50g, Na_2SO_4 added, swirled vigorously and allowed to stand 10 minutes. One hundred ml was evaporated to dryness on a rotary evaporator and made up to 5 ml with ethyl acetate. Injections were made on the gas chromatograph.

The results are shown in Table 9.

Table 9. Recovery of Added Malathion Using the Modified Zweig and Sharma Procedure With Overnight Shaking.

	Peak Height (mm)			
Sample	Sample	Control	% Recovery	
1.	57.8	56.8	101.8)	
2.	53.5	55.5	96.4)	98.1
3.	47	48.2	96.7)	

The same method was followed substituting soaking for shaking overnight. The results are shown in Table 10.

Table 10. Recovery of Added Malathion Using the Modified Zweig and Sharma Procedure with Overnight Soaking.

	Peak Height (mm)			
Sample	Sample	Control	% Recovery	
1.	64	82.5	77.6)	
2.	20	25.5	78.4)	78.8
3.	20.5	25.5	80.4)	

For subsequent tests, the Zweig and Sharma method was followed, using cropped leaves agitated overnight with acetonitrile.

(b) Malathion degradation in citrus and okra leaves.

The disappearance of malathion sprayed on citrus and okra leaves in the field was studied. For the first spraying, 30 ml malathion /3 gallons water without sticker was used. The malathion reagent contained 5 lb. malathion/gallon. Initial sampling of leaves was made one hour after spraying. The next samples were taken 1, 2, and 8 days after spraying for okra and 1 and 2 days after spraying for citrus.

The leaves were chopped in a blender then weighed (5-25g) into halfgallon bottles. Two hundred milliliters acetonitrile was added and the bottles were agitated overnight (except for the 2-day samples which were agitated for 5 hours). The solution was filtered through fluted filter paper, 10-30 g. Na_2SO_4 added and then swirled vigorously. It was allowed to stand 10 minutes and then filtered through glass wool. One hundred ml was transferred to an evaporating flask and evoporated to dryness on a rotary evaporator. Suitable dilutions were made with ethyl acetate and then ejected into the gas chromatograph. The results are shown in Table 11.

Table 11. Malathion residue in okra and citrus leaves as affected by time.

Time after Spraying	ppm malathion		Time after Spraying	ppm malathion	
1 hr.	41.6)		1 hr.	46.0)	
	48.4	41.3		56.7)	47.1
	34.0			38.5)	
1 day	3.4)		1 day	3.3)	
	4.6			3.8)	3.7
	1.6)			4.0)	
2 days	0.16)		2 days	0.95)	
	n.d)	0.19		1.06)	0.94
8 days	0.06)				
	n.d)	0.02			
	n.d)				

Filter paper strips (5x23cm) strung on wire held by tangantangan poles were also sprayed with malathion at the same time as the okra and citrus plants. The filter paper strips were sampled one hour and one day after spraying. No further sampling was made, because heavy rain brought down the strips.

The strips were placed in wide-mouth reagent bottles and 50 ml acetonitrile added. They were agitated for 10 minutes and the solution evaporated to dryness on a rotary evaporator. Ethyl acetate was then added and injections were made into the gas chromatograph. The results are shown in Table 12.

Table 12. Malathion Residue from Filter Paper Strips.

Time after	ppm malathion Spraying	
1 hr.	358)	
	333.7)	352.9
	366.9)	
1 day	191.2)	
	149.0)	163.6
	150.5)	

It was generally sunny for the 1-hour and 1-day sampling, but rain preceded the 2-day sampling. It was mostly sunny before the 8-day sampling.

The spraying was repeated on okra leaves, this time using a sticker. The same anlytical procedure was followed. The concentration of the spraying mixtures were 1678 and 1968 ppm. Malathion could not be detected one day after spraying. This sampling was preceeded by rain in the afternoon and night. The amounts of malathion one hour after spraying were 79.6, 81.7, and 82.4 ppm, in the three samples analysed.

Summary

The dissipation of applied malathion was studied. Analytical procedures were evaluated for maximum recovery of known amounts of malathion. Laboratory and field samplings were carried out.

It appears that malathion dissipation is affected more by relative humidity than temperature. Malathion degrades fast (usually within two days) under Guam conditions.

AGRICULTURAL ENGINEERING

Chin-Tian Lee

Research in agricultural engineering continued in cooperation with horticulture (vegetable crops) to study trickle irrigation. An experiment, conducted by the horticulturist to determine the tomato response to trickle irrigation quantity and irrigation frequency in the greenhouse to explore the possibility of production all year-around, was initiated in December, 1980.

DESCRIPTION OF EXPERIMENT

The experiment was conducted in a screenhouse located at the Agricultural Experiment Station, Inarajan. Four-week old tomato seedlings (cultivar N-69) were transplanted into a 30 cm (19 liters) pot which contained a mixture of 67% soil, 33% peat moss, and 30 g of 10-20-20 fertilizer. The drip line was placed about 5 cm away from the plant with one emitter per plant. A randomized complete block design with 3 replications was used. Each replication consisted of ten pots. The three irrigation treatments were:

Treatment	Irrigation Quantity (Gallons/CU ration)	Irrigation Frequency (Days)
Trickle	40 gal/1.00	3
Trickle	30 gal/0.75	3
Trickle	20 gal/0.50	3

A pressure regulator was used for the trickle irrigation system to provide a discharge of approximately 1.9 liters per hour. Tap water was used for irrigation. For soil moisture observations, tensiometers were installed in each replication at a depth of 15 cm. A side-dressing of 30 g of 10-20-20 fertilizer per plant was applied 3 times during the growing period. Foliar fertilizer with major and trace elements was applied 3 times as nutrient deficiency symptoms developed.

Leafminers and fungal and bacterial diseases were noted in all plants. Cygon E.C., Dithane M-22 and Tribasic Copper Sulfate were used for control of insects and diseases.

DATA AND DISCUSSION

The results of different irrigation quantities on the characteristics and yield of tomatoes are presented in Table 1. The results indicate that the highest quantity of trickle irrigation (1.00 CU) produced the highest marketable fruit yield (5.9 kg/10 plants), the highest number of marketable fruit (133 fruits/10 plants), and the heaviest fruit weight (42.3 g). There was no significant difference between the trickle treatment of 0.75 and 0.50 CU in marketable fruit yields or number of marketable fruit. The highest unmarketable fruit yield (0.408 kg/10 plants) and highest number of unmarketable fruit (31.3 fruits/10 plants) was found with the lowest quantity of irrigation (0.50 CU).

CONCLUSIONS

The water quantity significantly affected fruit weight, number of fruit, and yields of tomato. Based on the results of this experiment, the trickle irrigation of 1.00 CU produced the heaviest fruit weight, highest number of fruit, and highest marketable fruit yield.

Table 1. Effect of different irrigation quantities of trickle system on the characteristics and yield of tomato in screenhouse druing wet season, 1981.

Irrigation Treatment	Fruit Weight (g)	Number of Marketable Fruit of 10 Plants	Number of Unmarketable Fruit of 10 Plants	Marketable Yield (kg/10 Plants)	Unmarketable Yield (kg/10 Plants)
Trickle (1.00 CU) (40 gal)	42.3	133.0	17.0	5.915	0.191
Trickle (0.75 CU) (30 gal)	41.6	120.0	18.3	4.992	0.250
Trickle (0.50 CU) (20 gal)	34.8	125.0	31.3	4.358	0.408
$LSD_{0.05}$	4.0	10.0	8.9	0.758	0.077

ANIMAL SCIENCE

A.L. PALAFOX

Studies were continued to determine the supplementary value of locally produced and/or available feedstuffs in swine rations.

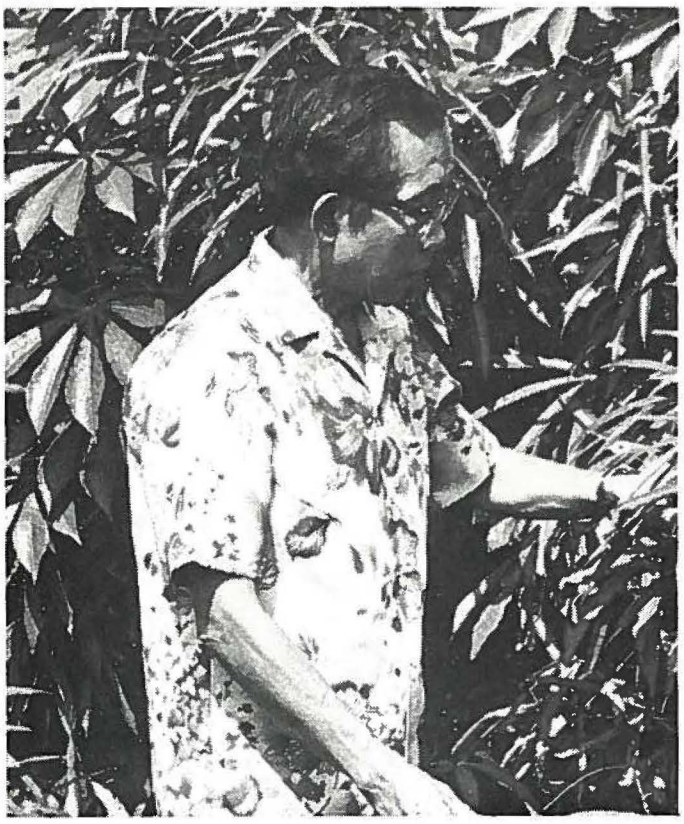
I. Experiment 2-1

The objective of this study was to determine the supplementary value of coconut meal (CM) compared with cottonseed meal (CSM). CM was obtained from Palau, whereas CSM was imported from the mainland United States.

Methods: Twenty-four weanling swine were used. There were 12 males and 12 females. They were weighed and randomized into four pens, six pigs each (three males and three females). They were fed 16 percent protein rations containing CM and/or CSM as the main source of protein. The diets were fed at random. Feed and water were provided ad libitum. Feed and body weight were obtained weekly for a period of five weeks.

Results: Table 1 shows the performance of the starting pigs fed with the starter diets. Two parts CM supplemented one part CSM on a weight for weight basis (w/w). Average final weights ranged from 15.05 to 19.12 kg. Pigs fed 10 percent CM plus 5 percent CSM weighed the most, whereas those fed 20 percent CM without CSM weighed the least.

Daily gain in weight averaged 0.18 to 0.28 kg. Pigs fed with 10 percent CM plus 5 percent CSM gained most, whereas those fed 20 percent CM without CSM gained least at the end of the experiment. Feed consumption was significantly affected by the amount of CM in the diets. Swine fed ten percent CM consumed the most feed, whereas those fed 20 percent CM consumed the least. Pigs fed diet 10 consumed significantly less than those fed diet 12.



Feed conversion ranged from 2.93 to 4.44 kg. Swine fed 10 percent CM plus 5 percent CSM were significantly more efficient than those fed 20 percent CSM.

Summary: Starting swine fed 16 percent protein rations containing CM and/or CSM showed that those fed 10 percent CM plus 5 percent CSM gained the most weight and consumed the least feed per unit of gain compared with the control and other test diets. Results obtained in this study showed that as much as 20 percent CM in the swine diet may supplement 10 percent CSM without significantly affecting swine performance.

II. Experiment 2-2

The objective of the second experiment was to determine the effect of 16 percent protein rations containing coconut meal (CM) as a replacement for cottonseed meal (CSM) on a 2:1 (CM:CSM) weight for weight (w/w) basis on performance of growing swine.

Methods: Twenty-four growing swine were weighed and then randomized into four pens of three males and three females each. They were fed 0, 10, 15 and 20 percent CM in combination with 10, 5, 2.5 and 0 percent CSM, respectively. Feed and water were provided ad libitum. Body weight and feed consumption were obtained weekly for 5 weeks.

Results: Table 2 showed the performance of the growing swine. Their initial weights averaged from 18.34 to 19.23 kg. Final body weight averaged from 25.45 to 30.67 kg. As the concentration of CM in the diet increased, final body weight decreased. It was probably due to the decreasing energy concentration as CM level in the diet decreased. All diets were isonitrogenous. The diets were calculated to contain 16 percent protein.

Average daily gain was from 0.18 to 0.34 kg. The control diet fed pigs gained the most weight, whereas those fed the 20 percent CM gained the least. Average daily feed consumption was significantly affected by the CM concentration in the diet. Pigs fed 0, 10, and 15 percent CM consumed similar amounts of feed. They consumed significantly more feed than pigs fed the 20 percent CM. This observation probably reflects the desirability of feeding growing swine at not more than 15 percent CM in the diet. Average feed conversion was lowest for the control diet (3.53 kg) and highest for those fed the 20 percent CM (5.84 kg). The amount of feed consumed per unit of gain tended to increase with increasing CM in the diet.

Summary: The data showed that as much as 15 percent CM in combination with 2.5 percent CSM may be fed growing swine without significantly affecting overall performance. The preceding data also show that there is a need for continuing studies on the desirability of determining if dietary energy concentration is involved in the decreasing feed efficiency with increase on concentration of CM in the diet.

III. Experiment 2-3

The objective of this study was to determine the feeding value of fresh cassava roots on the performance of growing swine.

Methods: Twenty-four growing swine, 12 males and 12 females were weighed and then randomized into two pens. There were 6 males and 6 females in each pen. A diet containing 10 percent CM plus 5 percent CSM calculated to contain 16 percent protein was fed ad libitum to each pen. Treatment 1 pigs were fed the growing mash diet only, whereas treatment 2 pigs were fed the growing mash plus an average of 0.59 fresh cassava roots daily.

Water was provided ad libitum. Body weight and feed consumption were obtained weekly for three weeks.

Results: Table 3 shows the performance of the growing swine. Initial average weights ranged from 27.50 to 28.41. Average final weight was 36.63 kg for the control, whereas it was 38.26 kg for pigs fed the fresh cassava roots. Average daily feed was 0.52 kg for the control and 0.45 kg for the test group of pigs. This data indicates that less growing mash is consumed by pigs fed fresh cassava roots daily. The feed conversion ratio of pigs fed the growing mash only (control) was 1.22 kg of grower mash per unit of gain, whereas it was 0.95 kg of mash for pigs fed cassava roots only consumed 78 percent as much feed per unit of gain compared with the control pigs.

Summary: Feeding fresh cassava roots to growing pigs with an average control weight of 27.50 kg can reduce the feed bill as much as 22 percent. This is specially true when cassava roots are produced within the farm enterprise. The data also showed that pigs fed grower mash plus cassava roots gained more weight daily than those fed grower mash alone.

Table 1. Performance of starting swine fed coconut plus cottonseed meal, experiment 2-1

Diet	9	10	11	12
Coconut Meal, %	0	10	15	20
Cottonseed meal %	10	5	2.5	0
Av. initial wt., kg	9.20	8.99	8.67	9.28
Av. final wt., kg	16.28	19.12	15.07	15.51
Av. daily gain, kg	0.20	0.29	0.18	0.18
Av. daily feed, kg	0.76 ab	0.85 b	0.72 ab	0.70 a
Feed/gain ratio, kg	3.80 ab	2.93 a	4.00 ab	4.44 b

1. Means within the same category bearing different letters are significantly different (P 0.05).

Table 2. Performance of growing swine fed coconut meal plus cottonseed meal, experiment 2-2

Diets	9	10	11	12
Coconut meal	0	10	15	20
Cottonseed meal	10	5	2.5	0
Av. initial wt., kg	18.74	19.08	18.34	119.23
Av. final wt., kg	30.67	28.33	27.34	25.45
Av. daily gain, kg	0.34	0.26	0.26	0.18
Av. daily feed, kg	1.20 b	1.20 b	1.17 b	1.05 a
Feed/gain ratio, kg	3.53	4.62	4.50	5.84

1. Treatments means within the same category bearing different letters are significantly different (P 0.05).

Table 3. Performance of growing swine fed fresh cassava roots, experiment 2-3

Treatment 1	1	2
Coconut meal, %	10	10
Cottonseed meal, %	5	5
Fresh cassava roots, kg	0	0.59[2]
Av. initial wt., kg	27.50	28.41
Av. final wt., kg	36.63	38.26
Av. daily gain, kg	0.43	0.47
Av. daily feed, kg	0.52	0.45[1]
Feed/gain ratio, kg	1.22	0.95[1]

1. Includes grower mash only.

AQUACULTURE

Genetic Assessment of *Macrobrachium* on Guam
Daniel B. Matlock

Selective plant and animal breeding has contributed greatly to agricultural productivity over the millenia. Aguaculture, however, is a relatively new endeavor, except for the culture of certain species in South East Asia, and has not yet benefited from genetic manipulation of stocks. This project represents an attempt to assess the genetic potential of the native Guam prawn, *Macrobrachium lar. Macrobrachium* culture on Guam is presently restricted to *M. rosenbergii,* a Malaysian prawn. *M. lar* is harvested from the wild and is not normally cultured in ponds. Selective breeding of this local species, or hybridization with the Malaysian prawn, might result in a variety with superior characteristics and aquaculture potential.

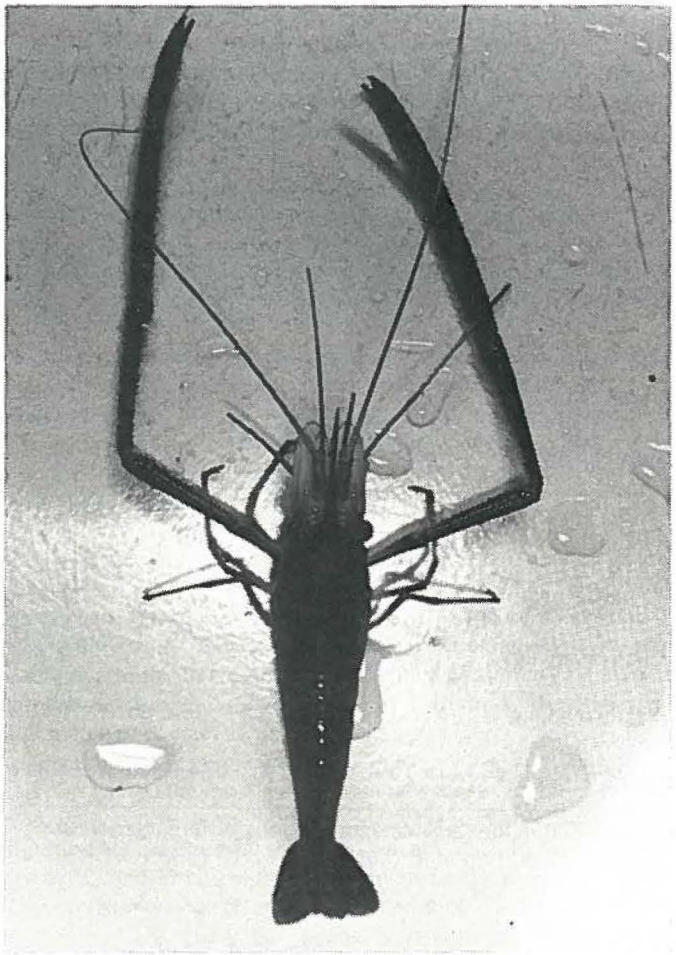
II. The first step in our genetic assessment of *M. lar* was to develop a series of enzymes from the prawns to be used as genetic markers. A total of thirty markers have been determined by lengthy trial-and-error experimentation. These include one or more isozymes of: esterase, carbonic anhydrase, isocitrate dehydrogenase, malate dehydrogenase, indophenol oxidase, amylase, succinate dehydrogenase, lactate dehydrogenase, phosphoglucomutase, leucine aminopeptidase, acid phosphatase, mannose phosphate isomerase, glutamic oxalotransferase, and glucose-6-phosphate dehydrogenase.

The enzyme markers are obtained by electrophoresis of tail muscle extracts. Prawn tails are frozen in liquid nitrogen, pulverized in buffer, sonicated to break up cellular membranes, and centrifuged. The clear supernatant is stored in 0.5 ml ampules at - 60°C until analyzed. A population is screened for one enzyme system at a time by applying forty individual samples to a single polyacrylamide gel, separating the proteins by electrophoresis, and staining for a particular enzyme. Differences in the electrophoretic mobility of a protein reflect differences in the genetic sequences that codes for the protein.

The markers are being used to determine the degree of genetic variability in *M. lar.* There are two important questions to be answered. 1) Are the prawns on Guam all part of one interbreeding population, or are they separated into genetically distinct populations in each river? 2) Is there sufficient variability to make selective breeding worthwhile?

To answer the first question, prawns were trapped on the Bubulao and Atantano Rivers. These were chosen because they are on opposite sides of the island so their populations would be more likely to show differences than those in adjacent rivers. Samples from the Bubulao River have been screened for every marker. Samples from the Atantano River are still being screened, so a complete quantitative analysis is not yet possible. Nevertheless, it appears that the two populations are identical at most loci, but show characteristic differences at a few of them. This means that there is at least some reproductive isolation between the two populations.

The answer to the second question must also wait for the completion of the electgrophoretic screening of the Atantano River prawns. For now, however, the Bubulao prawns have a very low level of variability; the population seems to be fixed at all but two of the genetic loci. These initial results indicate that selective breeding among prawns from the same location would be fruitless because there is so little genetic difference between inidviduals. However, if the prawn populations in various rivers are sufficiently different from one another, then hybridizing prawns from different locations might be useful. The results from the Antantano River samples will help to provide the answer. In addition, prawns have been collected from the Cetti and Sella Rivers and are being analyzed by UOG graduate student Gretchen Grimm. Prawns are also being collected from the Misa River on Saipan, with the assistance of Mr. Joaquin Villagomez, Mr. Ben Sablan, and Mr. Frank Aldan of the Department of Natural Resources, Commonwealth of the Northern Mariana Islands.



NUTRITIONAL STUDIES OF FRESHWATER SHRIMP
Stephen G. Nelson

One of the major activities this past year has been the study of assimilation of organic matter and nitrogen by freshwater prawns *(Macrobrachium lar)* fed a variety of diets. This data provides information on which types of diets the prawns can most effectively use. The diets tested ranged from 89 to 97% organic matter and from 2 to 14% nitrogen on a dry weight basis. Net assimilation efficiencies of total organics and nitrogen were calculated using the Conover ash-ratio method in accordance with equations 1 and 2 with the symbols as shown in Table 1:

$$U' = (F' - E')(100)/(1 - E')(F') \qquad (1)$$

$$U'_N = r_i - r_N\,(1 - U'/100)(100)/r_i \qquad (2)$$

A summary of our results is shown in Table 2. The net assimilation efficiencies of organic matter ranged from 78.6 to 97.1% and those for nitrogen ranged from 97.5 to 99.3% The prawns were extremely efficient at assimilating nitrogen from all the experimental diets.

It was previously shown that the rates of ammonia excretion by the prawns are influenced by the diet, but this influence was not correlated with the percentage of nitrogen in the diet. Ammonia is the principal nitrogenous excretory product of crustaceans, and thus, represents the principal non-growth use of

assimilated nitrogen. With the data on nitrogen assimilation and excretion taken together, it may be possible to estimate the retention of nitrogen by prawns fed specific diets.

The research hatchery has been producing post-larval *Macrobrachium rosenbergii* with the surplus production sold to local farmers for a nominal fee. In exchange for this service, the farmers provide ovigerous female prawns to keep the hatchery in operation.

Publications

Donaldson, T.J. 1981. Agonistic behavior of the freshwater prawn *Macrobrachium lar* in relation to size and sex. M.S. Thesis in Biology, University of Guam. 30P.

Table 1. List of symbols.[+]

Symbol	Explanation
E'	Ratio of organic weight to dry weight of feces
F'	Ratio of organic weight to dry weight of food
r_i	Ratio of organic nitrogen to total organic weight of food
r_n	Ratio of organic nitrogen to total organic weight of feces
U'	Percent assimilation efficiency of total organic weight
U'_N	Percent assimilation efficiency of organic nitrogen

[+] For further explanation see Condrey et al. (1972) "Comparision of the assimilation of different diets by *Penaeus setiferus* and *P. aztecus*" Fisheries Bulletin 70(4):1281-1296.

Table 2 Data describing the general net assimilation efficiency (U') and net assimilation efficiency of organic nitrogen (U'_N) by *Macrobrachium lar*. For symbol explanation see Table 1.

DIET	F'(%)	E'(%)	U'	r_i(%)	r_n(%)	U'_N
Fish *(Scolopsis cancellatus)*	90.43	29.37	95.60	14.42	23.5	99.28
Shrimp *(Macrobrachium lar)*	94.18	55.815	92.19	11.24	1.06	99.26
Freshwater Algae (*Microspora* sp.)	97.03	48.365	97.13	1.47	0.87	98.30
Seaweed *(Gracilaria edulis)*	31.6	50.89	-	0.85	1.49	-
Pig Feed (pellets)	96.14	84.22	78.57	7.55	0.29	99.18
Chicken Feed (pellets)	89.64	49.7	88.58	2.98	0.66	97.47

AES STAFF

Wilfred P. Leon Guerrero, Ed.D	Dean/Director
R. Muniappan, Ph.D	Associate Director
Edith R. Blankenfled, M.Ed	Assistant Director
R. Gary Beaver, Ph.D*	Associate Professor, Plant Pathology
Jefren L. Demeterio, Ph.D	Associate Professor, Soils
Thao Khamoui, Ph.D**	Assistant Professor, Agricultural Economics & Marketing
Chin-Tian Lee, Ph.D	Associate Professor, Horticulture
Donald M. Nafus, Ph.D	Assistant Professor, Entomology
James R. Nechols, Ph.D	Assistant Professor, Entomology
Anastacio L. Palafox, Ph.D	Professor, Animal Sciences
Vincent M. Russo***Ph.D	Assistant Professor, Plant Pathology
Ilse Schreiner, Ph.D	Assistant Professor, Entomology
Calvin A. Saruwatari, M.S	Instructor, Agricultural Engineering
Syamal K. Sengupta, Ph.D	Assistant Professor, Ornamental Horticulture
Silas Ed Gould, M.A	Assistant Professor, Media
Daniel Matlock, Ph.D*	Assistant Professor, Biology
Stephen G. Nelson, Ph.D	Associate Professor, Marine Biology
Joan Perry, MA, MAPA	Resource Conservationist SCS, USDA
William Null, Ph.D	Forester, Guam Department of Agriculture (Research Affiliate)
Marshall Kirby, M.S	Entomologist, USDA, APHIS, International Programs, Regional Office (Research Affiliate)
Herbert Rubin, M.S	Plant Pathologist, USDA, APHIS, International Programs, Regional Office, (Research Affiliate)
Rosalie Kikuchi, B.S	Biologist
Marilou Baccay, B.S	Chemist
Diana Ventura, B.S	Chemist
Edna Eclavea	Secretary

* Left in 1981
** Joined in 1981
*** Joined in 1982