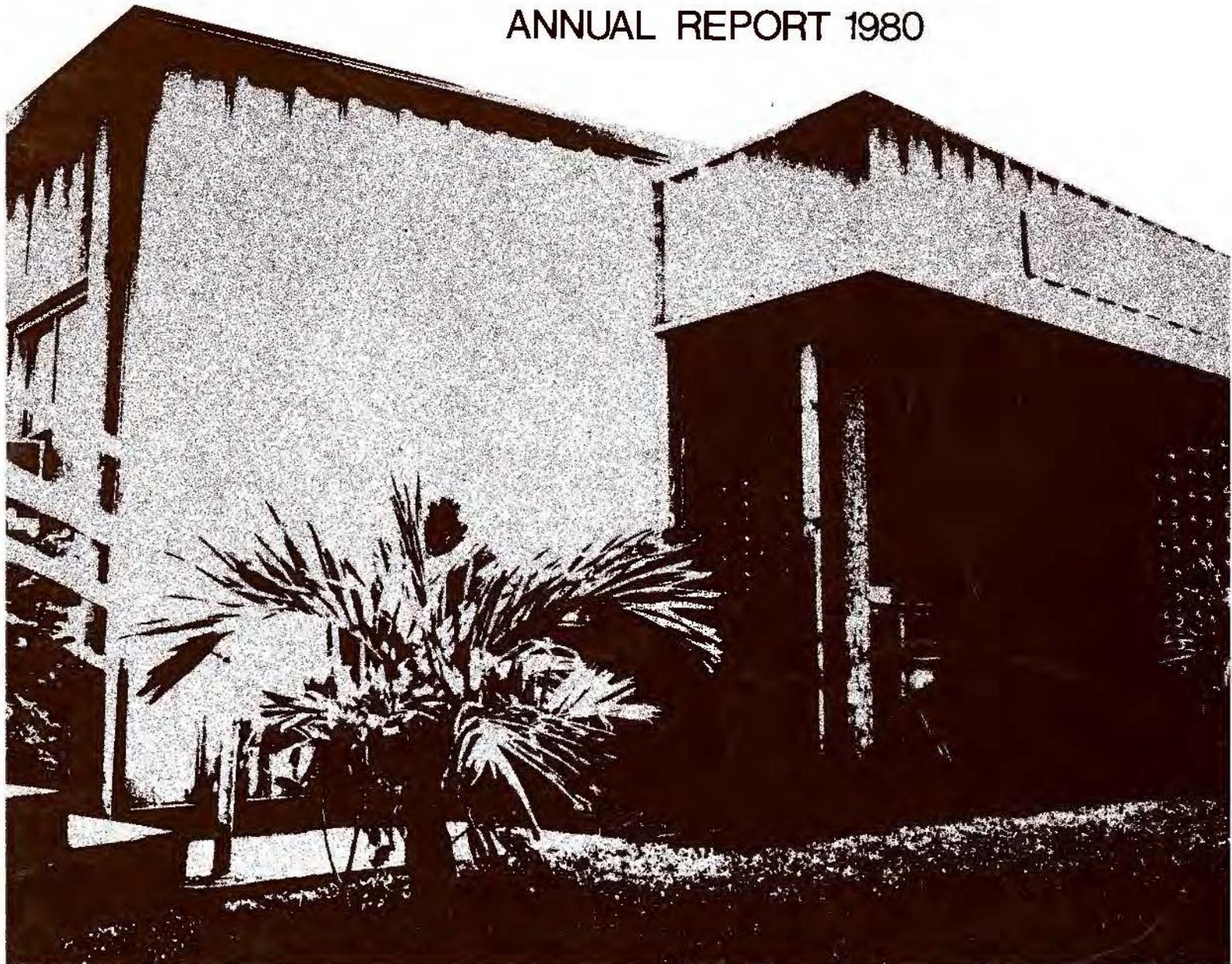


COLLEGE OF AGRICULTURE
AND LIFE SCIENCES

UNIVERSITY
OF GUAM

Guam Agricultural Experiment Station

ANNUAL REPORT 1980



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CONTENTS

| | |
|---|----|
| 1980 Annual Report Guam Agriculture Experiment Station. | ix |
| Soil Fertility | 1 |
| Horticulture (Vegetables) | 3 |
| Ornamental Horticulture. | 8 |
| Insect Cytology. | 9 |
| Plant Pathology. | 11 |
| Agriculture Engineering. | 14 |
| Aquaculture | 16 |
| Animal Science | 18 |
| Agricultural Economics. | 22 |

1980 ANNUAL REPORT
GUAM AGRICULTURAL EXPERIMENT STATION

The Guam Agricultural Experiment Station has been primarily focusing upon establishing and strengthening its core research programs on Guam. However, in 1980, efforts in developing contacts and cooperation with regional, national and international institutes and organizations started to materialize and became very visible.

The participation of the Guam Agricultural Experiment Station in Section 406, the International Council for the Development of Underutilized Crops, the South Pacific Commission, the Asian Vegetable Research and Development Center, the International Potato Center and other organizations prove our desire and progress in terms of involvement in international tropical agriculture.

Our future plans are to continue to strengthen the core research areas that are most useful for the agricultural development of Guam, to assist the countries and the territories of the Western Pacific in their agricultural development and to actively participate in international tropical agriculture programs.



WILFRED P. LEON GUERRERO
Dean/Director

Soil Fertility

J. L. Demeterio

Field experiments in 1980 involved potassium and nitrogen trials. Potassium levels in the experiment were 0, 50, 100, 200 and 400 kgm K₂O per hectare. A completely randomized block design was used. There were four replications with each treatment in 4 X 5 meter plots with four rows, each row one meter apart. The experiment was conducted in a field which tested 81 ppm exchangeable potassium using normal, neutral ammonium acetate extracting solution. Native white corn was used as a test crop with a drip irrigation system. *Heliothis* sp. was controlled successfully using Lannate L. The corn crop reached maturity with insignificant yield reduction from pests. The corn yield ranged from 3.59 to 4.40 tons shelled corn per hectare. The yield, however, was statistically insignificant. This lack of response to added potassium strongly indicates that soils testing 81 ppm exchangeable potassium may not need potassium fertilization.

The nitrogen studies in Dededo involved varying levels of nitrogen as supplied by ammonium sulfate and air-dried chicken manure. Native white field corn was used and the same agronomic practices as the preceding potassium study were followed. Yield response of corn to different levels

of nitrogen from ammonium sulfate are shown in Table 1.

TABLE 1. Effect of nitrogen from ammonium sulfate on corn yield in tons/hectare.

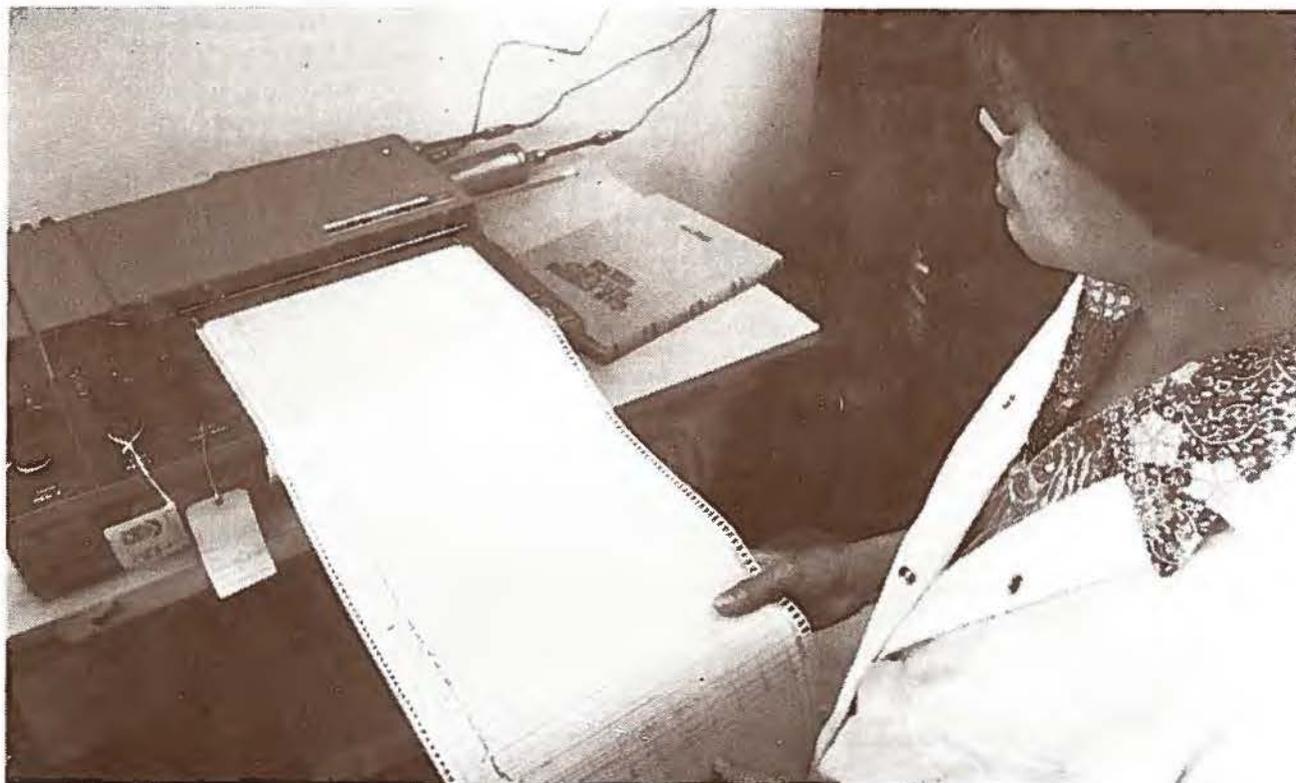
| Treatments | Shelled Corn Yield* |
|-------------------|---------------------|
| Control | 2.57 |
| 75 kgm N/hectare | 3.28 |
| 150 kgm N/hectare | 4.21 |
| 300 kgm N/hectare | 5.17 |
| | LSD .05 |
| | 1.39 |

*Significant at the .05 probability level

All nitrogen treatments were split applied, half at seeding and half at tasseling. The data shows that significant yield occurred at 150 kg N/hectare. Nitrogen recommendation in Guam, however, is not based on a soil test. The basis for nitrogen recommendation depends on the crop being grown, previous agronomic practices (addition of farm manure, growing of leguminous plants, etc.), soil type, and organic matter content. Previous studies (Demeterio, 1979 AES Annual Report) have shown the superiority of splitting nitrogen applications.

The effect of varying levels of air-dried chicken manure on corn yields are shown in Table 2.

The manure was applied in bands within a furrow 15 - 20 centimeters deep, and hilled up to form the row. The manure was previously dried and allowed to decompose 4-6 weeks prior to application. Chicken manure is available in abundance in Guam. Chicken manure has only 3% nitrogen but has a high concentration of micro-elements (Demeterio, 1979 AES Annual Report). Yield was highly significant at 3 tons chicken manure per hectare treatment. A one and one-half ton pick-up load of chicken manure costs \$10.00.



P₂O₅ and K₂O were blanket applied at 300 kgm per hectare in the ammonium sulfate experiment and adjusted accordingly in the chicken manure study. A subsequent residual study on all three field experiments during the rainy season, July through November, was wiped out by Typhoon Betty with 95 mph winds in October.

The on-going nitrogen source study in Inajaran (1979 - 1980) was summarized and the results presented in the Annual Meetings of the American Society of Agronomy in Detroit, Michigan November 30 - December 5, 1980. With the spiraling costs of petroleum based fertilizers, the use of less expensive sources has to be explored. Three-hundred kilograms per hectare of P₂O₅ and K₂O were blanket applied and corrected for any addition from chicken manure. The on-going study compares the use of 21-0-0, a petroleum process by-product; locally abundant chicken manure; and symbiotically fixed nitrogen by legumes. The experimental plots are at the Agricultural Experiment Station where sprinkler type irrigation is available. Guam has a distinct dry season, January through May, and a wet season from July through November with June and December as transitory months. There are 7 treatments replicated 3 times with 4 X 5 meter plots in a randomized complete

TABLE 2. Corn yield in tons per hectare as affected by varying levels of air-dried chicken manure.

| Treatments | Shelled Corn Yield* |
|--------------------|---------------------|
| Control | 2.57 |
| 3 tons per hectare | 4.31 |
| 6 tons per hectare | 3.95 |
| 9 tons per hectare | 5.27 |
| | LSD .05 |
| | 0.89 |

*Highly significant at the .01 probability level

block design. Two crops are grown within the year, the first one is in the dry season where all treatments are applied. The wet season experiment is a residual study. The dry season yield of head cabbage and the wet season yield of okra are shown in Table 3.

The head cabbage data is highly significant at the .01 probability level with an LSD of 4.8 tons per hectare. The data shows a low yield of 15.9 tons per hectare in the *Leucaena leucocephala* intercrop, and a high of 31.6 tons per hectare in the chicken manure treatment. The data implies that native nitrogen was sufficient. The high cabbage yield in the chicken manure treatment could be attributed to the microelements it carried (Demeterio, 1979 AES Annual Report). The *L. leucocephala* intercrop apparently competes with the vegetable crop causing low yields.

The residual study used okra as the test crop. The data as shown in Table 3 is significant at the .05 probability level. It should be pointed out that the calculated F value was 4.81 and the tabular F-value was 4.82 at the .01 probability level. The *L. leucocephala* intercrop again showed the lowest yield. The plots treated with 21-0-0 showed lower yields than the control. The chicken manure and *Arachis hypogea* intercrop had higher yields than 5.0 tons per hectare. For the month of September

alone, 54 centimeters of rain fell. It is apparent that the slow release of N by organic matter is beneficial during the rainy season. The carry-over value of legumes is dramatically illustrated in plots where peanuts were previously grown. It is now apparent that the use of *L. leucocephala* as an intercrop depresses the yield of the main vegetable. Trimming the hedge to an inch will be tried next year. The objective here is to slow the growth of *Leucaena*, while the main vegetable crop establishes itself. The 200 kgm N from 21-0-0 treatment will be discarded in favor of incorporating fresh green *L. leucocephala* leaves and stems banded in furrows, hilled up, and allowed to decompose 4 to 6 weeks prior to transplanting.

TABLE 3. Head cabbage and okra yields in tons per hectare during the 1980 growing season.

| Treatment | Head Cabbage** | Okra* |
|--|----------------|---------------|
| 1. Zero nitrogen | 24.7 | 3.8 |
| 2. <i>Leucaena leucocephala</i> intercrop | 15.9 | 2.6 |
| 3. <i>Arachis hypogea</i> intercrop | 20.2 | 5.8 |
| 4. 6 tons per hectare chicken manure | 31.6 | 5.1 |
| 5. 100 kgm N/ha from 21-0-0 | 25.5 | 4.1 |
| 6. 100 kgm N/ha from 21-0-0 plus 3 tons chicken manure | 24.4 | 3.5 |
| 7. 200 kgm N/ha from 21-0-0 | 22.5 | 2.9 |
| | LSD (.05) 4.8 | LSD (.05) 1.6 |

**Highly significant at .01 probability level.

*Significant at the .05 probability level.

PESTICIDE RESIDUE RESEARCH

A new Hatch Project, on "Fate of Added Pesticides on Guam" was approved and commenced on July 1, 1980. Preliminary work has been directed towards familiarization of a Perkin Elmer Gas Chromatograph Model 3920B equipped with an FID, FPD, and ECD detectors. The pesticide residue research laboratory was virtually started from scratch. Glassware, pesticide grade reagents, TLC equipment, and other paraphernalia needed for pesticide analysis were ordered. Initial study will be oriented towards more popularly used pesticides on Guam. Analytical procedures for two organophosphates (Diazinon and Malthion) and one carbamate (Sevin) are being evaluated. Decay patterns under field and controlled conditions will be stored as soon as the initial phase of getting the laboratory ready is accomplished. The chemist (Ms. Diana D. Ventura) assigned to the laboratory has undergone an intensive month long session with an EPA consultant from California on Pesticide residue analysis.

Horticulture (Vegetables)

Chin-Tian Lee

Horticultural (vegetable crops) research work in 1980 continued to concentrate on screening and determining and adaptability of major vegetable varieties which have economic potential and suitability for growth under the environmental conditions of Guam. The vegetable varieties studied

in 1980 were watermelon and tomato. The status of Sevin as a control of *Heliothis* sp. on tomatoes was studied with entomology personnel. The response of trickle irrigation on tomato and bell pepper was studied in cooperation with agricultural engineering personnel.

I. VARIETAL PERFORMANCE STUDIES ON TOMATOES

1. Materials and Methods:

This experiment was conducted during both the dry and wet seasons. The objective was to evaluate the climatic factors on varietal performance. Ten varieties of large-sized tomatoes, namely: N-11, N-52, N-63, N-65, N-69, Kosei 51, Pink Saturn, UH-BWN-21, Spring Giant, and UH 8248 were included in this experiment.

Seeds were sown in Jiffy-7 pellets and one-month-old seedlings were transplanted to the field. The experimental design used was a randomized complete block with four replications. Each experimental plot was two rows of 5.49 meters. A spacing of 1.22 meters between rows and 0.46 meters within rows was adopted. Fertilizer (10-20-20) at the rate of 448 kg/ha was broadcast and incorporated into the soil before transplanting. Sidedressing with fertilizer was immediately applied at the same rate. A preventive spraying schedule was followed twice weekly to control the possible insect, mite, and disease damage by Malathion 50, Diazinon Ag 500 EC, Lannate L, Kelthane, Dithane M-45, and tribasic croppers. Weed control was accomplished by a rotary tiller and garden hoe. Sprinkler irrigation was utilized whenever watering was needed.



The fruits were harvested once a week at the ripe or red ripe stage and the harvest period lasted for about two months.

2. Results and Discussion

Growth Habit, Fruit Setting and Fruit Cracking: Growth habit was rated as determinate or indeterminate. The determinate types are those that produce several flower clusters with the stem ending in a flower cluster. Indeterminate tomatoes keep growing because the terminal bud produces leaves, stems, and flowers. UH BWN-21, Spring Giant, and UH 8248 were determinate types, while the rest of the other breeding lines were indeterminate types (Table I). Higher levels of fruit setting and less cracking of fruit were obtained in the dry season as compared to the wet season for the same breeding line or variety (Tables I and II). In the wet season, all the breeding lines or varieties showed very poor fruit set and heavy fruit cracking. In the dry season, N-11, Spring Giant, and UH 8248 were medium in fruit set; and UH 8248 demonstrated moderate fruit cracking.

Size of Fruit: The fruit of N-69 and Spring Giant averaged 163.5 grams in weight, and were significantly larger than the rest of the eight breeding lines or varieties. Pink Saturn with 82 grams was the smallest in fruit size (Tables I and II).

Number of Fruit Per plant: The number of fruit per plant is affected by fruit setting. Poor fruit setting will result in a lower number of fruit. In the wet season, all the breeding lines or varieties had approximately one fruit per plant (Table II). During the dry season, the number of fruit per plant of the same breeding line or variety increased 8 to 13 times in comparison with the wet season (Tables I and II).

Marketable Fruit Yield: The marketable fruit yield of the same breeding line in the dry season was about 32 to 51 times that of the wet season. This was due to better fruit setting and an increase in fruit number per plant (Tables I and II). In the wet season, marketable fruit yield was low, ranging from 0.39 to 0.96 metric tons per hectare (MT/ha). In the dry season, marketable fruit production ranged from 13.15 to 48.76 metric tons per hectare. Spring Giant, with a production of 48.76 MT/ha significantly out yielded the other nine entries. The next highest in fruit yield were UH BWN-21, N-11, and N-69 with an average of 28.52 MT/ha. Kosei 51, Pink Saturn and N-52 were the lowest in marketable fruit production.

Unmarketable Fruit Yield: Unmarketable fruit was attributed to cracking or damage from insect and disease. In the dry season, unmarketable fruit ranged from 2.50 to 21.33 MT/ha. During the wet season, 1.53 to 3.39 MT/ha of unmarketable fruit was obtained.

3. Conclusions: Large-sized tomatoes were impossible to grow during the wet season based on the results of the experiment. Spring Giant, UH BWN-21, N-11, and N-69 were the promising selections for growing during the dry season.

II. VARIETAL PERFORMANCE STUDIES ON WATERMELON

1. Materials and Methods:

This experiment was conducted during the dry season to evaluate the effect of environmental factors on the performance of watermelon. The nine varieties of watermelon included in this trial were Asahi Miyako, Triumph, Glory, Striped Sugar, Cream Suika, Festival Queen, Sugar Suika, Sweet Carnival, and Green Fuken.

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 meters long. The spacing adopted was 1.83 meters between rows and 1.52 meters within rows. Localized application of 10-20-20 fertilizer at the rate of 897 kg/ha was applied to a planting hole 15 centimeters deep and 30 centimeters wide, then covered with 10 centimeters of soil over the fertilizer before sowing the seed. This method of application was to avoid the burning effect on the seed or young plant. Side-dressing with fertilizer at the same rate was initiated five to six weeks after sowing.

A preventive program was followed twice weekly to reduce possible insect and disease damage. Lannate L, Diazinon Ag 500 EC, Malathion 50, Dithane M-45, and tribasic coppers were used. A rotary tiller and garden hoe were used to control weeds. Sprinklers were used for irrigation.

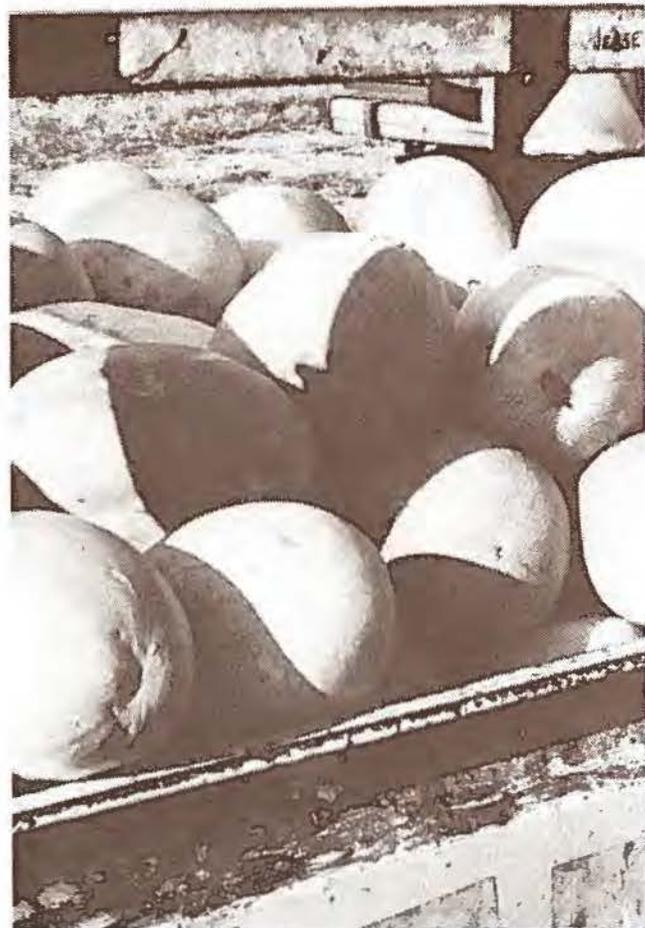


TABLE 1. Performance of Tomato Breeding Lines or Commercial Varieties of Tomatoes During Dry Season of 1980.

| Breeding Line or Commercial Variety | Growth habit | Fruit* Setting | Fruit** Cracking | Fruit Weight (gram) | No. of Fruit Per plant | Marketable Fruit Yield (MT/ha) | Unmarketable Fruit Yield (MT/ha) |
|-------------------------------------|---------------|----------------|------------------|---------------------|------------------------|--------------------------------|----------------------------------|
| N-11 | Indeterminate | 3.2 | 1.1 | 125 | 9.2 | 28.40 | 2.60 |
| N-52 | Indeterminate | 2.0 | 1.8 | 127 | 6.0 | 15.27 | 5.15 |
| N-63 | Indeterminate | 2.1 | 1.6 | 150 | 6.7 | 20.74 | 6.33 |
| N-65 | Indeterminate | 2.2 | 1.4 | 138 | 7.4 | 21.84 | 5.49 |
| N-69 | Indeterminate | 2.3 | 1.5 | 160 | 7.9 | 27.50 | 6.39 |
| Kosei 51 | Indeterminate | 2.0 | 1.6 | 111 | 5.7 | 13.15 | 3.86 |
| Pink Saturn | Determinate | 2.3 | 1.4 | 82 | 7.8 | 14.71 | 2.50 |
| UH BWN-21 | Determinate | 2.5 | 1.2 | 128 | 9.5 | 29.65 | 3.15 |
| Spring Giant | Determinate | 2.8 | 1.8 | 167 | 14.5 | 48.76 | 16.21 |
| UH 8248 | Determinate | 2.7 | 3.6 | 128 | 12.2 | 20.64 | 21.33 |
| LSD 0.05 | | | | 6 | 2.6 | 2.25 | 0.51 |

*Fruit Setting: 1 = No fruit to light setting
 2 = Light to medium setting
 3 = Medium setting
 4 = Medium to heavy setting
 5 = Heavy setting

**Fruit Cracking: 1 = None to light cracking
 2 = Light to moderate cracking
 3 = Moderate cracking
 4 = Moderate to heavy cracking
 5 = Heavy cracking

The watermelons were harvested at the fully mature stage. The maturity of the fruit was determined by a change in the color of the rind from white to light yellow on the part of the fruit in contact with the ground.

2. Results and Discussions:

Fruit Weight: The fruit weight of the nine varieties were small to medium size, ranging from 2.88 to 5.07 kilograms (Table III). Fruit weight of Glory, Cream Suika, and Festival Queen were heaviest with an average of 4.92 kilograms. Asahi Miyako and Sweet Carnival with 2.91 kilograms were the lightest in fruit weight.

Sugar Content of Fruit: Sugar content in the fruit is one of the most important factors in determining the quality of watermelons. A refractometer was used for the measurement of sugar content in the fruit. Cream Suika and Asahi Miyako with a sugar content of 10.6 and 10.5%, respectively, were significantly higher than the other seven entries. Sweet Carnival, Glory, and Striped Sugar were the next highest in sugar content (Table II). Triumph with 8.6% was the lowest in sugar content.

Marketable Fruit Yield: Glory, with a production of 43.48 MT/ha, significantly outyielded the rest of eight varieties. Cream Suika with 35.26 MT/ha was the next highest. There was no significant difference in fruit production among Festival Queen, Sugar Suika, and Sweet Carnival. Striped Sugar with only 12.10 MT/ha was the lowest in fruit yield (Table III).

CONCLUSION

Based upon quality and yield, Cream Suika and Glory were the most promising varieties.

III. STUDIES ON THE STATUS OF SEVIN AS A CONTROL OF HELIOTHIS SP. ON TOMATOES

Heliothis sp. is one of the most serious pests of tomatoes on Guam. A major concern in tomato production is the insect damage, rendering the fruits unsalable. The pesticide that is most commonly used on Guam for control is sevin. The objective of this experiment was to evaluate the efficacy of Sevin for the control of *Heliothis* sp. on tomatoes under tropical conditions and to determine if Sevin is the most effective insecticide to utilize for increased yields of undamaged fruit.

1. Materials and Methods:

The field experiment was conducted at the Guam Agricultural Experiment Station. One-month-old seedlings of N-65 tomato variety were transplanted in the field on March 3, 1980. A randomized complete block design with four replications was used. Each plot consisted of two rows, 6.10 meters long. Rows were spaced 1.22 meters apart. Each row consisted of ten plants. Insecticides evaluated were Lannate, Sevin, and Orthene. Treatments began on April 1, 1980, and continued every four days until June 6, 1980. Data on the number of fruits and weights of damaged and undamaged fruit by fruitworms were assessed by examining all ripening and ripe fruits on the plants on April 24; May 1, 8, 16, 22, and 30; and June 6 and 12, 1980.

2. Results and Discussion

TABLE II. Performance of Tomato Breeding Lines or Commercial Varieties of Tomatoes During Wet Season of 1980.

| Breeding Line or Commercial Variety | Fruit* Setting | Fruit** Cracking | Fruit Weight (gram) | No. of Fruit Per Plant | Marketable Fruit Yield (MT/ha) | Unmarketable Fruit Yield (MT/ha) |
|-------------------------------------|----------------|------------------|---------------------|------------------------|--------------------------------|----------------------------------|
| N-11 | 1.4 | 4.3 | 113 | 1.1 | 0.70 | 2.51 |
| N-52 | 1.2 | 4.7 | 114 | 0.8 | 0.39 | 2.16 |
| N-63 | 1.0 | 4.6 | 134 | 0.7 | 0.44 | 2.06 |
| N-65 | 1.1 | 4.5 | 123 | 0.8 | 0.48 | 1.99 |
| N-69 | 1.0 | 4.3 | 143 | 0.7 | 0.57 | 2.10 |
| Kossi 51 | 1.1 | 4.4 | 100 | 0.7 | 0.40 | 1.57 |
| Pink Saturn | 1.4 | 4.4 | 71 | 1.0 | 0.41 | 1.53 |
| UH BWN-21 | 1.3 | 4.1 | 115 | 0.9 | 0.72 | 1.99 |
| Spring Giant | 1.5 | 4.3 | 150 | 1.1 | 0.96 | 3.39 |
| UH 8248 | 1.0 | 4.6 | 114 | 0.7 | 0.39 | 1.77 |
| LSD 0.05 | | | 6 | 0.1 | 0.07 | 0.13 |

*Fruit Setting: 1 = No fruit to light setting
 2 = Light to medium setting
 3 = Medium setting
 4 = Medium to heavy setting
 5 = Heavy setting

**Fruit Cracking: 1 = None to light cracking
 2 = Light to moderate cracking
 3 = Moderate cracking
 4 = Moderate to heavy cracking
 5 = Heavy cracking

TABLE III. Performance of Commercial Varieties of Watermelon During Dry Season of 1980.

| Commercial Variety | Fruit Weight (kg) | Brix (Sugar Content) (%) | Marketable Fruit Yield (MT/ha) |
|--------------------|-------------------|--------------------------|--------------------------------|
| Asahi Miyako | 2.93 | 10.6 | 9.37 |
| Triumph | 4.43 | 8.6 | 17.40 |
| Glory | 5.07 | 10.1 | 43.48 |
| Striped Sugar | 4.07 | 9.6 | 12.10 |
| Cream Suika | 4.91 | 10.6 | 35.26 |
| Festival Queen | 4.78 | 10.0 | 27.19 |
| Sugar Suika | 3.66 | 9.2 | 27.04 |
| Sweet Carnival | 2.88 | 10.1 | 26.00 |
| Green Fuken | 3.61 | 9.5 | 17.78 |
| LSD 0.05 | | 0.29 | 3.40 |

Tomato was very susceptible to *Heliothis* sp. damage as indicated in the control treatment with 67.98% of damaged fruits and production of only 3.88 kg/plot of undamaged fruits (Table IV). The application of Lannate at 0.504 kgs.ai/ha was the most effective insecticidal treatment for the control of *Heliothis* sp. Lannate treatment with 151.75 undamaged fruits per plot was significantly higher than the rest of the three treatments; Orthene,

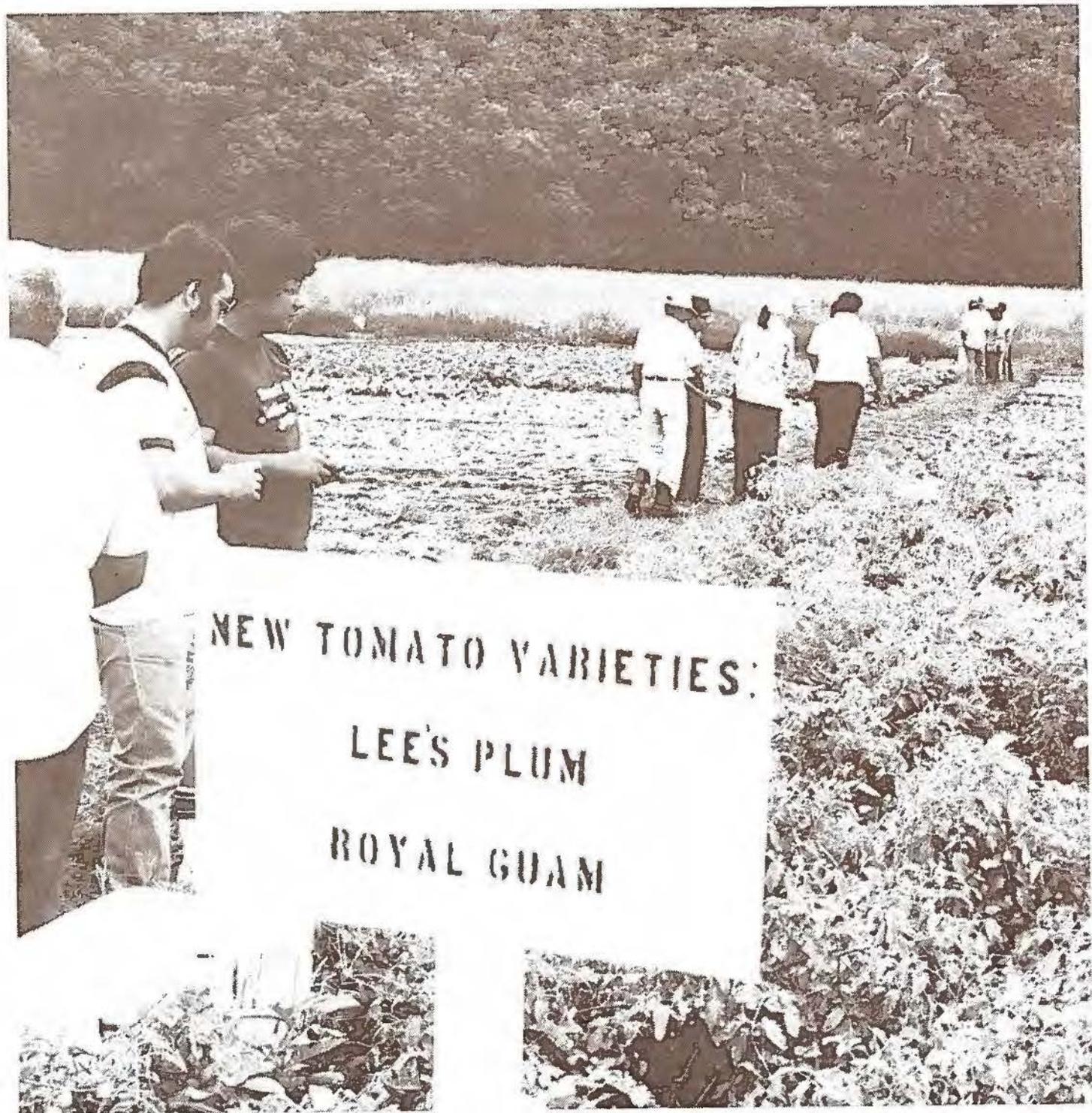
Sevin, and control with 138.00, 93.75, and 34.00, respectively, in undamaged number of fruits.

3. Conclusion

Based on the results of this experiment, Sevin proved to be unsatisfactory for the control of *Heliothis* sp. Lannate was the best insecticide and Orthene also showed high efficacy for insect control.

TABLE IV. Efficacy of Insecticidal Sprays for the Control of *Heliothis* sp. on Tomatoes.

| Treatment | Dosage kgs. ai/ha | Percentage of number of damaged fruit | Number of damaged fruit per plot | Percentage of number of undamaged fruit | Number of undamaged fruit per plot | Damaged fruit kg/plot | Undamaged fruit kg/plot |
|---------------------|----------------------|---|--|---|--|-----------------------------|-------------------------------|
| Lannate 1.8L | 0.504 | 12.55 | 21.75 | 87.45 | 151.75 | 2.40 | 17.11 |
| Sevin L | 1.121 | 32.43 | 43.75 | 67.57 | 93.75 | 4.89 | 10.50 |
| Orthene | | 17.86 | 30.00 | 82.14 | 138.00 | 3.29 | 15.33 |
| Control | 0 | 67.98 | 73.25 | 32.03 | 34.80 | 8.16 | 3.88 |
| LSD _{0.05} | | 3.44 | 5.38 | 3.51 | 9.69 | 0.59 | 1.01 |



Ornamental Horticulture

Syamal K. Sengupta



An ornamental horticulture research project was initiated in 1980 to evaluate the performance and marketability of different flowering and foliage plants on Guam.

Initial research work involved propagation of different ornamental plants such as Bougainvillea, Christmas cactus, croton, Dieffenbachia, Hibiscus, Ixora, etc. Tip cuttings were found to root earlier than 'hard' stem cuttings. 'Rootone F', a chemical root initiator with fungicide, was helpful for root initiation.

Commercial firms from the U. S. mainland and local nurseries donated stock or rooted plants to start the experiments. Nine rooted plants each of six varieties of poinsettias were sent by Paul Ecke, Inc., of California. These varieties were: Gutbier V-14, Gutbier V-10 Amy, Annette Hegg Dark Red, Annette Hegg White, Annette Hegg Hot Pink, and Eckespoint C-1 Red. These were used as stock plants. New cuttings were used to study retardant chemicals such as Cycocel and A-Rest. Black cloth photoperiodic treatment induced flower bracts on these plants. Short day (SD) treatment was started in the last week of September, 1980. Gutbier V-14 and Gutbier V-10 initiated flower bracts on December 15, 1980. Eckespoint C-1 Red, Annette Hegg Hot Pink and Dark Red flowered in January, 1981; and Annette Hegg White flowered in early February, 1981.

Yoder Brothers, Inc., of Ohio sent five varieties of potted chrysanthemums with fifty rooted plants of each variety. The varieties were: Dazzler — Orange Bronze, Intrepid Gold — Dark Yellow, Intrepid White — Ivory White, Pinktive — Dark Pink, and Wild Honey — Golden Yellow.

SD treatment was started on September 8,

1980. Flowers showed on the second week of December, 1980. Yoder Brothers catalogue mentioned that the chrysanthemums would flower nine to eleven weeks after SD treatment. However, in this experiment, the flowers opened thirteen weeks after SD treatment. This could be attributed to heat delay.

Mikkelsen, Inc., of Ohio sent five varieties of Kalanchoe with twenty rooted plants of each variety. The varieties were: Sonata — Orange, Serenade — Red, Sensation — Deep Pink, Nugget — Orange, and Firefly — Yellow.

These plants received six weeks of SD treatment for flower induction. Two weeks after SD treatment, all Kalanchoe foliage was sprayed with B-nine, 50% receiving a treatment of 5000 ppm and the remaining 50% receiving 2500 ppm. Growth retardant treatment showed that the plants were dwarfed and healthy. Even though all varieties received six weeks of SD treatment and were kept in natural day length afterward, flowering occurred in Sonata at the end of SD treatment; in Sensation after one week of natural day length; in Serenade after two weeks of natural day length; in Nugget after four weeks of natural day length; and in Firefly after six weeks of natural day length. The flowering lasted for two months under indoor conditions.

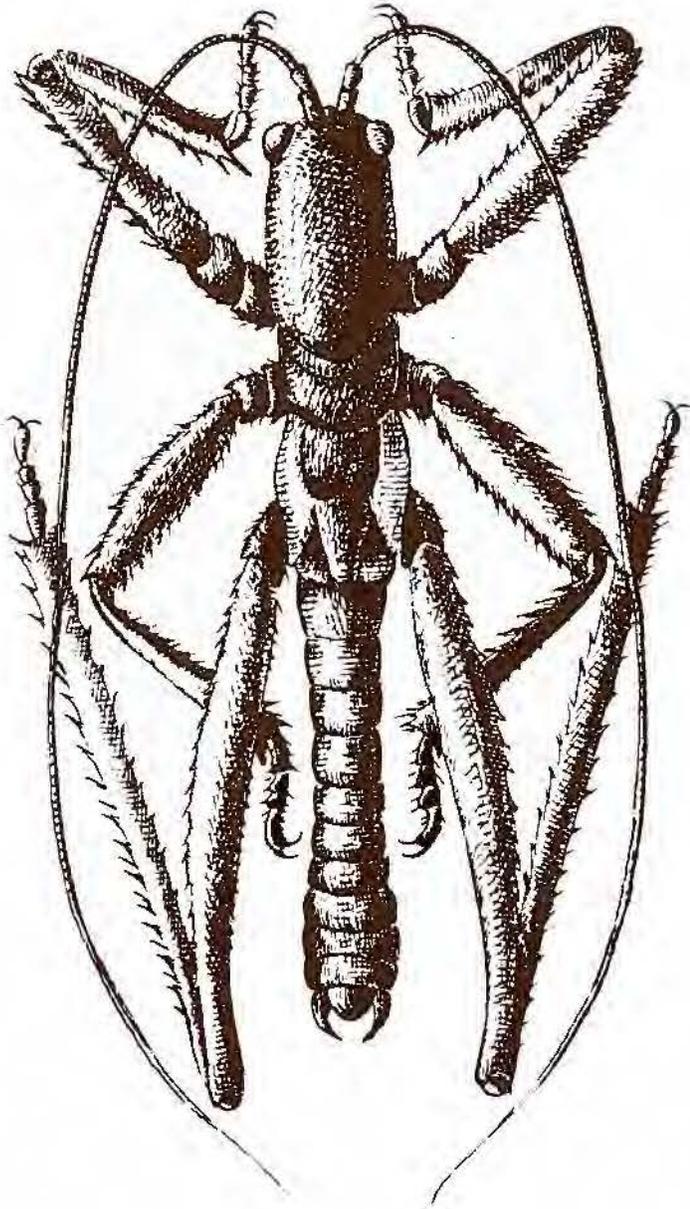
From this preliminary work, it is clear that in short day plants, flowers could be induced by manipulation of photoperiod using black cloth shading when desired.

Research is continuing on ornamental plants with cultural practices, growth retardants and flower induction.



Insect Cytology

Akey C. F. Hung



INSECT CYTOLOGY AND GENETICS

I. *Cylas formicarius*

Karyotype and sex-determining system of *Cylas formicarius* from Guam was determined as 10AA+XX in female, and 10AA+X_{yp} or 10AA+X_{yy} in male. However, culture from Louisiana has 10AA+XX in female and 10AA+XY in male. Further studies showed that culture from Hawaii has only X_{yp} males and that from Taiwan has both X_{yy} and X_{yp} males as in the Guam population. Therefore, at least three sex chromosome systems exist in *Cylas formicarius*, i.e., 10AA+XX

for females in all cultures with male either 10AA+XY or 10AA+X_{yy} or 10AA+X_{yp}. Further analyses of karyotype showed that the 10 autosomes consist of 3 metacentrics and 7 acrocentrics. The Y-chromosome in Louisiana culture is acrocentric and the y-chromosome in other cultures is a dot (either acrocentric or telocentric). It is assumed that the acrocentric Y gave rise to the dot y through misdivision.

Isozyme studies also showed that the Louisiana culture is different from the other cultures in at least two enzyme systems.

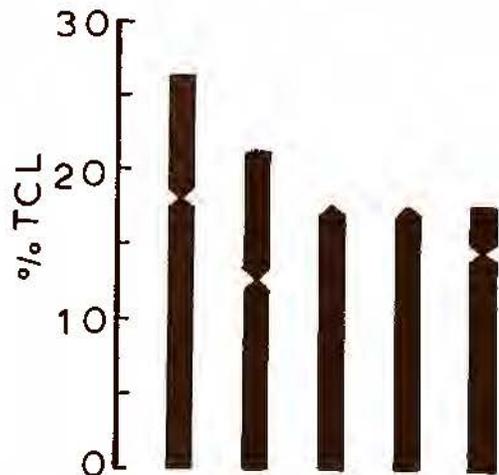
The reproductive incompatibility between cultures has also been investigated. Preliminary studies showed that male progeny of crosses between Hawaii and Taiwan cultures are fertile. The crosses between Louisiana and Guam cultures are still in progress.

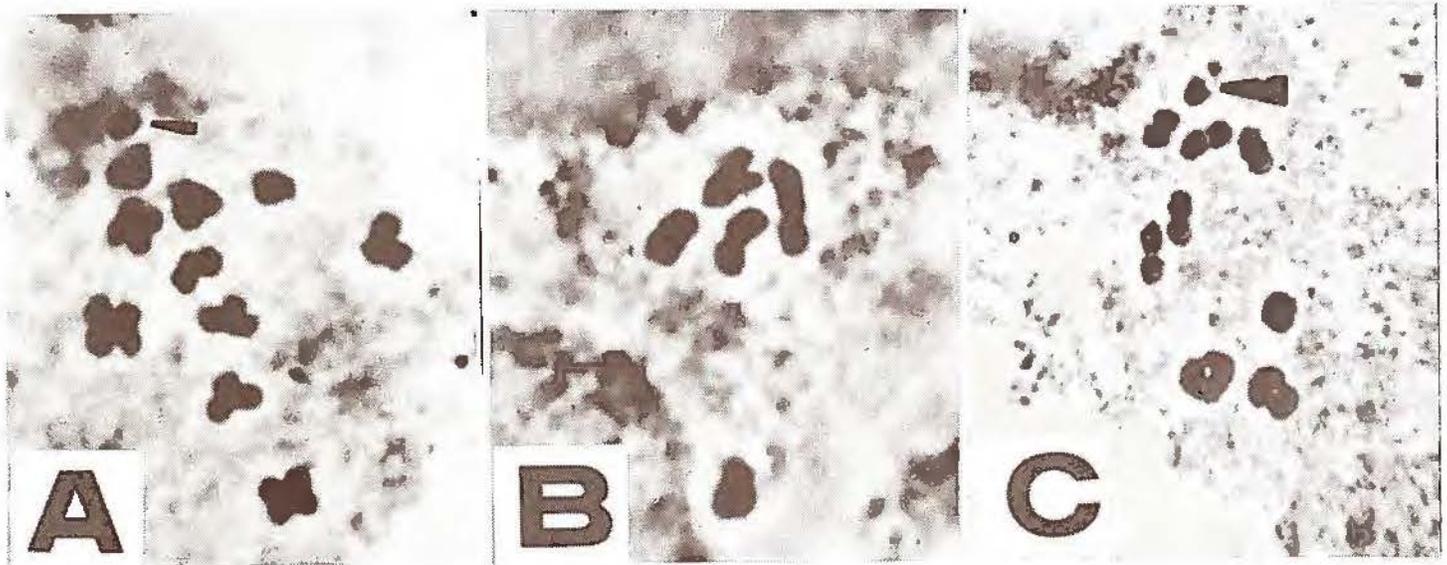
II. *Trichogramma* spp.

Karyotype and isozyme analyses have been carried out in *T. chilonis*, *T. evanescens*, *T. nubilale*, and *T. pretiosum*. So far, no significant differences have been detected among karyotypes of these 4 species as they all have $n=2SM+2T+1A$. However, these species can be readily distinguished on zymograms of tetrazolium oxidase and esterase.

III. *Epilachna philippinensis*

Karyotype and sex-determining system of Guam population have been established. The males have 8AA+X_{yp} and the females have 8AA+XX. The autosomes consist of 2 pairs of metacentrics, one pair of submetacentrics, and 5 pairs of acrocentrics. X-chromosome is acrocentric and y-chromosome is telocentric. The two metacentric and the one submetacentric pairs form ring-bivalent at diakinesis.





BIOLOGICAL CONTROL

James R. Nechols

MEALYBUGS ON TANGANTANGAN

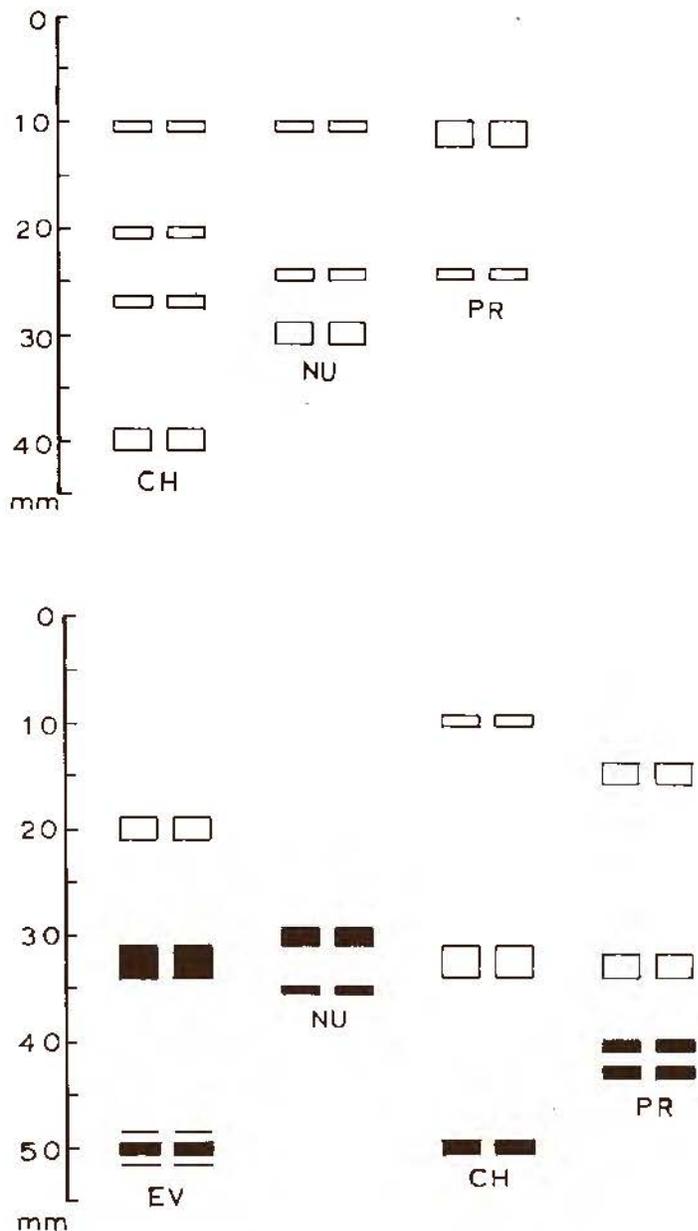
In Addition to a eulophid parasite (*Entedoninae*), and various coccinellid beetle species — all natural enemies of the mealybug, *Nipaecoccus vastator* (Maskell) — a new encyrtid parasite, *Anagyrus* appears to have become established on Guam. Preliminary results show that this parasitic wasp is present in northern (Yigo), central (Mangilao), and southern (Inajaran-Merizo) Guam where up to 90% of the mealybugs were found to be parasitized. The observed range for *Anagyrus* suggests that it may be distributed island-wide. Studies are presently underway to more completely define the distribution and impact of this parasite on mealybug populations.

Predaceous flies from the families Cecidomyiidae and Drosophilidae have also been recovered from *N. vastator* for the first time on Guam. Specimens are being forwarded for identification.

FLAME TREE LOOPER

The Poinciana looper, *Pericyma cruegeri* (Butl.), continues to be the major insect pest on the flame tree, *Delonix regia*. With the onset of the 1980 dry season (December), looper populations had declined to low levels. However, the pupal parasites, *Brachymeria albotibialis* (Ashmead) (Chalcididae) and *Exorista civiloides* (Bar.) (Tachinidae) have remained at consistently low densities during both the wet and dry seasons. Because these established parasites are not effectively controlling looper populations, attempts are being made to import additional parasite species from Australia through the cooperation of Dr. J. W. Turner, Entomology Branch, Department of Primary Industries, Queensland.

Currently, we are monitoring looper populations in various localities ranging from Yigo to Inarajan.



Plant Pathology

R. Gary Beaver

Research in plant pathology focused on several areas that involved the identification and control of diseases of crop plants important to the culture and economy of Guam.



Areas of research currently underway include the following:

I. IDENTIFICATION OF PLANT DISEASES VEGETABLES

- A. Eggplant - *Solanum melongena*
 - 1) Bacterial wilt - *Pseudomonas solanacearum*
 - 2) Fruit rot - *Phomopsis vexans*
 - 3) Damping-off - *Rhizoctonia solani*
 - 4) Root knot - *Meloidogyne incognita*
 - 5) Southern blight - *Sclerotium rolfsii*
- B. Melon - *Citrullus* sp. and *Cucumis melo*
 - 1) Anthracnose - *Colletotrichum lagenarium*
 - 2) Bacterial soft rot - *Erwinia carotovora*
 - 3) Belly rot - *Phytophthora* sp., *Sclerotinia sclerotiorum*
 - 4) Damping-off - *Rhizoctonia solani*
 - 5) Gummy stem blight - *Mycosphaerella citrullina*
 - 6) Virus-Cucumber mosaic
 - 7) Powdery mildew - *Oidium* sp.
 - 8) Wilt - *Fusarium oxysporum*
 - 9) Root knot - *Meloidogyne* sp.
- C. Okra - *Hibiscus esculentus*
 - 1) Southern blight - *Sclerotium rolfsii*
 - 2) Verticillium wilt - *Verticillium albo-atrum*
- D. Onion - *Allium* sp.
 - 1) Purple blotch - *Alternaria porri*
 - 2) Rust - *Puccinia allii*
 - 3) Southern blight - *Sclerotium rolfsii*
- E. Peanut - *Arachis hypogaea*
 - 1) Leaf spot - *Alternaria* sp.
 - 2) Rust - *Puccinia arachidis*
 - 3) Scab - *Sphaceloma arachidis*
- F. Pepper - *Capsicum* sp.
 - 1) Anthracnose - *Glomerella cingulata*
 - 2) Bacterial leaf spot - *Pseudomonas syringae*
 - 3) Bacterial spot - *Xanthomonas vesicatoria*
 - 4) Bacterial wilt - *Pseudomonas solanacearum*
 - 5) Damping-off - *Rhizoctonia* sp., *Pythium* sp.
 - 6) Southern blight - *Sclerotium rolfsii*
 - 7) Virus - Spotted wilt
 - 8) Virus - Potato Y
 - 9) Virus - Tobacco mosaic
- G. Radish - *Raphanus* sp.
 - 1) Black rot - *Xanthomonas campestris*
 - 2) Bacterial soft rot - *Erwinia carotovora*
 - 3) Damping-off - *Rhizoctonia solani*
 - 4) Crown rot - *Sclerotinia sclerotiorum*
 - 5) White rust - *Albugo candida*
- H. Sweet potato - *Ipomoea batatas*
 - 1) Anthracnose - *Elsinoe batatas*
 - 2) Soil stain - *Monilochaetes infuscans*
 - 3) Soil rot - *Streptomyces ipomoea*

- 4) Southern blight - *Sclerotium rolfsii*
- 5) Grey mold - *Botrytis cinerea*
- 6) Stem wilt - *Fusarium oxysporum*

I. Taro - *Colocasia* sp. and *Xanthosoma* sp.

- 1) Corm rot - Unknown
- 2) Viral - Dasheen mosaic virus
- 3) Leaf blight - *Phytophthora colocasiae*
- 4) Southern blight - *Sclerotium rolfsii*

J. Tomato - *Lycopersicon esculentum*

- 1) Bacterial canker - *Corynebacterium michiganense*
- 2) Bacterial soft rot - *Erwinia carotovora*
- 3) Bacterial wilt - *Pseudomonas solanacearum*
- 4) Damping-off - *Rhizoctonia* sp., *Fythium* sp.
- 5) Early blight - *Alternaria solani*
- 6) Late blight - *Phytophthora infestans*
- 7) Root knot - *Meloidogyne* sp.
- 8) Southern blight - *Sclerotium rolfsii*
- 9) Wilt - *Fusarium oxysporum*
- 10) Wilt - *Verticillium albo-atrum*

K. Yams - *Dioscorea batatas*

- 1) Leaf rust - Unknown

FRUITS

A. *Annona muricata*

- 1) Fruit rot - Unidentified fungus

B. *Annona squamosa*

- 1) Anthracnose - Unidentified fungus

C. *Cocos nucifera*

- 1) Cadang-cadang (Tinangaja) - Viroid
- 2) Bristle top - Unknown

II. COOPERATION IN BUNCHY TOP ERADICATION

Cooperation was extended to the Guam Department of Agriculture for a pilot program to eliminate Bunchy Top disease of banana from the Umatac area. The area provides a suitable test site isolated from other banana growing areas. An eradication team is canvassing the entire area once a month, systematically killing all bananas showing bunchy top symptoms with the herbicide K-pin (Picloram). The number of diseased bananas in the area has been reduced by approximately 85 percent within a two-month period.

III. DASHEEN MOSAIC VIRUS IN TARO

A program is currently underway to develop virus free taro planting stock which will be used to compare yield and quality of disease free taro with taro infested with Dasheen Mosaic Virus.

IV. PANAMA WILT OF BANANA

Panama wilt was recorded in one new location on Guam. The source of inoculum was traced to planting material brought into the plantation from another infested plantation. Isolates of *Fusarium oxysporum* f. sp. *cubense* taken from infected plants were associated with a species of bacteria tentatively identified as a *Corynebacterium* species. The bacteria does not appear to be pathogenic, but is capable of surviving within banana tissue into which it was inoculated. Further tests are being conducted to determine the role played by this organism in the wilt syndrome.

V. CADANG-CADANG OF *Cocos nucifera*

The symptomologies of Tinangaja and Bristle top, two disorders afflicting coconut palms on Guam, have been compared with the cadang-cadang disease of coconut from the Philippines. Samples of leaf tissue from healthy and Tinangaja diseased palms were extracted and examined by gel electrophoresis.

Comparative analysis revealed the presence of two viroid-like RNA's with mobilities similar to those extracted from the Philippines. Subsequent nucleotide sequence analysis by molecular hybridization showed that the tinangaja-related RNA's have nucleotide sequences equivalent to the RNA's from cadang-cadang diseased palms in the Philippines. Tinangaja is therefore considered to have the same etiology as cadang-cadang, a disease thus far believed to be restricted to the Philippines.

Nucleic acid extracts from Bristle top affected palms did not contain such viroid-like RNA's.

VI. A project is currently being set up under the W-147 Regional Research program to investigate methods for biological control of *Fusarium* and *Rhizoctonia* diseases of tomato, cantaloupe, and bean. The project will include a study of all agricultural soils on Guam.

Agricultural Engineering

Stefan Buzdugan
Chin-Tian Lee

Agricultural engineering continued in cooperation with horticulture (vegetable crops) to study trickle irrigation. Two experiments conducted in 1980 were: (1) to determine the response of bell pepper to a trickle irrigation schedule and irrigation water use efficiency; and (2) to determine the response of tomato to trickle irrigation schedule and irrigation water use efficiency.

I. BELL PEPPER EXPERIMENT

A. Description of Experiment

A Field experiment of 0.15 hectares with 12 plots, each plot with 3 rows, each row with 24 plants, and a spacing of 0.45 m X 1.22 m was used. This experiment was started by planting 4-week-old seedlings of a bell pepper variety, Yan Kwang from Taiwan, on January 30, 1980. The four irrigation treatments were:

| Treatment | Irrigation Quantity CU ratio | Irrigation Frequency Days |
|-----------|---------------------------------|------------------------------|
| Trickle | 1.0 | 3 |
| Trickle | 1.0 | 2 |
| Sprinkler | 1.0 | 3 |
| Sprinkler | 1.0 | 2 |

These treatments were randomly distributed in 3 replications. Bi-wall tubing with a water distribution orifice spacing of 0.45 m with discharge of approximately 1.5 liter/hour/orifice at 0.7 atm was used for this trickle irrigation system. The laterals were buried at 8 cm near the rows of bell pepper. The system included a pressure regulator and a 100 mesh screen filter.

For the sprinkler irrigation system, a full coverage sprinkler was used to wet a circle of 11 m in diameter with a flow of about 0.1 l/s at 1.5 atm. The government water distribution system was used since a separate irrigation water network does not exist in Guam. All plots received an equal amount of fertilizer throughout the experiment.

B. Data and Discussion

The field was plowed at a depth of about 20 cm. A quantity of 2 pails (40 liters) of chicken manure per row and 1, 016.4 Kg/ha of 10-20-20 fertilizer was incorporated before transplanting.

Tensiometers were installed in each plot at a depth of 30 cm for soil moisture observations. The irrigation water was applied in equal quantities for all the plots until 3 weeks after transplanting. Irrigation frequency was influenced by intensive rains during the growing season. Foliar fertilizer with major and trace elements was applied twice as nutrient deficiency symptoms developed.

Mosaic virus severely damaged all plots. *Sclerotium rolfsii* causing Southern blight, was noted after heavy rains. Other diseases caused by bacteria and fungi were noted in a few plants.

LSD 0.05

%

10-20-20

016.4

8.3

Dithane M-22, copper sulfate and Captan were applied for control of diseases. A few infestations of aphid, flea beetles, corn borers and spider mites were controlled with applications of Malathion, Dibrom and Kelthane. Weeds were controlled by periodic manual and mechanical cultivation. Bell pepper was harvested weekly from March 27 to June 19, 1980.

Frequent trickle irrigation (2 days interval) has produced the highest marketable yields, but no significant differences among treatments were found. Also, it has had the highest irrigation water use efficiency.

C. Conclusions

In 1980 experiments, trickle irrigation provided up to 53% increase in yield (Table 1), and up to 54% irrigation water efficiency (Table II) over sprinkler irrigation. However, it was not significant at the 0.05 level. With the frequent sprinkler treatment, the number of fruit per plant was less, but they were larger in size.

It was noted that the sprinkler gave nonuniform water application due to wind velocity. No clogging problems were observed in the trickle irrigation system.

Extensive mosaic virus damage was recorded in all plots. Other pests and diseases, except Southern blight, were found in low intensities.

II. TOMATO EXPERIMENT

A. Description of Experiment

A field experiment of 0.06 hectares with 9 plots, each plot with 3 rows, each row with 24 plants spaced at 0.04 m X 1.22 m were planted with N-65 tomato on February 7, 1980. The three irrigation treatments were:

| Treatment | Irrigation Quantity CU ratio | Irrigation Frequency Days |
|-----------|---------------------------------|------------------------------|
| Trickle | 1.0 | 2 |
| Trickle | 0.75 | 2 |
| Trickle | 0.5 | 2 |

Treatments were randomly distributed in 3 replications. A trickle irrigation system consisting of 8 ml twin-wall tubing with discharge of approximately 252 liters/hour 100 m line was used. The laterals were buried at 8 cm beneath the tomato rows. The system included a pressure regulator and a 100 mesh screen filter.

The government water was again used for irrigation. All plots received equal amounts of fertilizer at transplanting and during the growing season.

B. Data and Discussions

The field was plowed at a depth of about 30 cm. 1,016.4 Kg/ha of 10-20-20 fertilizer was

incorporated before transplanting. No organic manure was applied.

Tensionmeters were installed in each plot at a depth of 30 cm for soil moisture observations. The irrigation water was applied in equal quantities for 2 weeks after transplanting. Frequency of irrigation was influenced by intensive rains during the transitional season.

Side-dressing with 0.680 Kg of 10-20-20 fertilizer per row was applied 3 times during the growing season.

Leafminers, fungus, and bacterial diseases seriously affected all the plots. Surface cracking of fruit was observed after heavy rainfalls in the transitional season.

Dithane M-22, copper sulfate, Diazinon AG 500 EC, and Lannate L were used for control of diseases and insects. Weeds were controlled by periodic manual and mechanical cultivation. Tomato was harvested twice weekly from April 24 to June 30, 1980.

Marketable yields were up to 30% higher (Table III) with significant difference in fruit size in the trickle irrigation receiving the highest amount of water (1.0 CU). There were no significant differences in the number of fruit and yield per plant among the 3 treatments.

C. Conclusions

Up to 30% higher yields with significant differences in fruit size were observed in the trickle irrigation treatment receiving the highest amount of water (1.0 CU). No clogging problems occurred in the trickle irrigation system.



TABLE I. Effect of Different Irrigation Techniques on the Characteristics and Yield Components of Bell Pepper in 1980.

| Treatment | Crop Height (cm) | Fruit Size (g) | No. of Fruit Per Plant | Yield per Plant (kg) | Marketable Yield MT/ha | Unmarketable MT/ha | % of Total Yield |
|------------------------|------------------|----------------|------------------------|----------------------|------------------------|--------------------|------------------|
| Trickle (Infrequent) | 38.1 | 47 | 7.4 | 0.368 | 6.672 | 0.168 | 2.4 |
| Trickle (Frequent) | 45.8 | 45 | 8.6 | 0.399 | 7.220 | 0.239 | 3.2 |
| Sprinkler (Infrequent) | 37.8 | 44 | 6.0 | 0.268 | 4.860 | 0.366 | 7.0 |
| Sprinkler (Frequent) | 40.3 | 44 | 5.6 | 0.259 | 4.690 | 0.238 | 4.8 |
| LSD _{0.05} | 14.1 | 8.8 | 3.5 | 0.189 | 3.582 | 0.189 | |

TABLE II. Irrigation Water Use Efficiency on Marketable Yield of Bell Pepper in 1980.

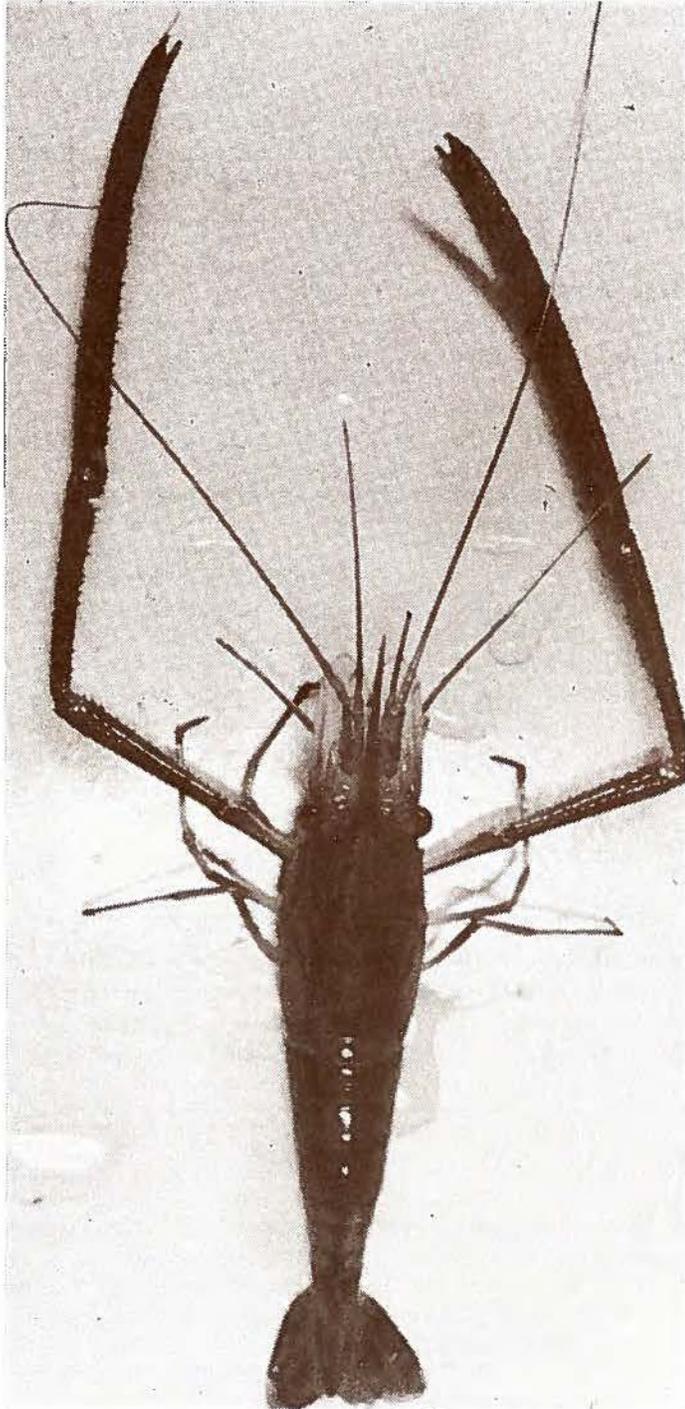
| Treatment | Irrigation I mm | Marketable Yield Y Kg/ha | Irrigation Water Use Efficiency Y/I Kg/ha ⁻¹ mm ⁻¹ |
|------------------------|-----------------|--------------------------|--|
| Trickle (Infrequent) | 6.672 | 228 | 29.2 |
| Trickle (Frequent) | 7.220 | 228 | 31.6 |
| Sprinkler (Infrequent) | 4.680 | 228 | 21.3 |
| Sprinkler (Frequent) | 4.690 | 228 | 20.15 |
| LSD _{0.05} | 3.582 | | 15.7 |

TABLE III. Effect of Different Scheduling of Irrigation System on the Characteristics and Yield Components of Tomato in 1980.

| Treatment | Fruit Size (g) | No. of Fruit Per Plant | Yield Per Plant (kg) | Marketable Yield MT/ha | Unmarketable Yield MT/ha | % of total yield |
|---------------------|----------------|------------------------|----------------------|------------------------|--------------------------|------------------|
| Trickle (1.0 CU) | 83.7 | 3.3 | 0.283 | 5.138 | 0.759 | 12.8 |
| Trickle (0.75) | 74.8 | 2.8 | 0.217 | 3.935 | 0.986 | 20.0 |
| Trickle (0.50 CU) | 74.2 | 2.9 | 0.223 | 4.036 | 0.992 | 19.7 |
| LSD _{0.05} | 8.3 | 0.8 | 0.071 | 1.54 | 1.594 | 0.344 |

Aquaculture

Stephen Nelson



This past year's research effort was directed toward two major projects which involved the freshwater prawn *Macrobrachium lar*. One of these studies concerned ammonia excretion by the prawns in relation to diet and the other was analysis of agonistic behavior of the prawns.

Ammonia Excretion

The rate of ammonia excretion by individual prawns was related to weight according to equation 1,

$$M/W = aW^{b-1} \quad (1)$$

where M = ammonia excretion rate is $\text{mg of NH}_4^+-\text{N}\cdot\text{g}^{-1}\cdot\text{h}^{-1}$

and W = dry weight in g.

Fig. 1 shows a typical plot of ammonia excretion rate on dry weight for *M. lar*. Log-transformation of this equation results in the linear relation expressed as

$$\text{Log } (M/W) = \text{Log } a + (b-1) \text{Log } W \quad (2)$$

In this case, the term $(b-1)$ becomes the slope of the line of best fit.

Table 1 shows statistics which describe the regressions of log of the ammonia excretion rates on the log of dry weight for each of the 6 experimental groups. Table 2 shows the nitrogen content of each diet as determined by microkjeldahl analysis. The diets ranged from 1.5 to 14.2% N. The rates of ammonia excretion were in general, higher for shrimp which were fed. The value of b , however, was not correlated with the % N of the diet.

Behavior

A detailed analysis of agonistic behavior of the prawn was conducted via examination of dyadic encounters. The prawns were found to have a diverse repertoire of aggressive and submissive behavioral units.

An interesting result of the analysis was that the behavior expressed during agonistic encounters was not influenced by size differences between the opponents. This was true for male-male, female-female and male-female matches and indicates that either (1) physiological or genetic factors which determine the level of aggressiveness are sufficiently variable to mask any size effect or (2) the prawns simply can't determine their own size in relation to that of an opponent.

Also, the sex of the individuals had no significant effect on the frequency of either aggressive or submissive acts as shown in Table 3. Therefore it would seem that the levels of aggression are independent of the sexual hormones.

Technical Reports

Nelson, S. G. and R. K. Kropp. 1981. Ammonia excretion by the freshwater prawn *Macrobrachium lar* in relation to diet. Technical Report 18 of the Agricultural Experiment Station, College of Agriculture and Life Sciences, University of Guam, 12 pp.

TABLE 1. Statistics describing the regression of the excretion rate ($\text{mg NH}_4\text{-N}\cdot\text{g}^{-1}\cdot\text{h}^{-1}$) on log of dry weight (g) for groups of *Macrobrachium* lar according to the equation $\log M/W = \log a + (b-1) \log W$.

| Diet | Correlation Coefficient | (b-1) | Log a | N |
|--------------|-------------------------|--------|--------|----|
| Fish | -0.722 | -0.679 | -1.131 | 26 |
| Shrimp | -0.414 | -0.655 | -0.867 | 30 |
| Algae | -0.625 | -0.692 | -1.329 | 32 |
| Pig Feed | -0.595 | -0.317 | -1.062 | 25 |
| Chicken Feed | -0.524 | -0.688 | -0.985 | 23 |
| Mollusc | -0.652 | -0.812 | -0.974 | 20 |
| Starved | -0.458 | -0.518 | -1.541 | 27 |

TABLE 2. Mean nitrogen content of replicate samples of each experimental diet.

| Diet | Mean % N | Standard Deviation | N |
|--------------|----------|--------------------|---|
| Fish | 14.4 | 0.64 | 3 |
| Shrimp | 12.3 | 0.52 | 6 |
| Algae | 1.5 | 0.18 | 6 |
| Pig Feed | 7.6 | 0.00 | 2 |
| Chicken Feed | 3.0 | 0.41 | 3 |
| Mollusc | 14.2 | 0.81 | 3 |

TABLE 3. Mean values and standard deviations of aggressive and submissive acts per 10 minute match. Sample size was 50 in each case

| Class of Act | Male-Male | Male-Female/ Female/Male | Female-Female |
|--------------|-------------------|-----------------------------|-------------------|
| Aggressive | 11.40 \pm 10.85 | 17.40 \pm 16.65 | 16.44 \pm 18.95 |
| Submissive | 2.32 \pm 4.44 | 3.90 \pm 4.72 | 4.44 \pm 5.13 |

Animal Science

Anastacio Palafox

During the year, studies have been conducted on the use of locally produced and available feed-stuffs for growing and finishing swine on Guam.

I. The first experiment was conducted on the use of copra meal as a source of protein for growing pigs. Copra meal was obtained from the island of Palau.

Forty pigs weighing approximately 53.0 to 58.0 pounds were randomized by weight, sex, and breed into eight pens, four pens of males and four pens of females. Table 1 shows the composition of diets. The diets contained 0, 15, 25 and 35 percent copra meal. Each of four treatments were fed to two pens of swine, one pen of five males, and one pen of five females. The tests were conducted for a period of 32 days. Feed and body weight were obtained weekly.

Average initial weights ranged from 55.0 to 57.00 pounds (Table 2). Variance analysis of the data showed that the average initial weights were similar. Average final weights ranged from 80.00 to 92.40 pounds. Although final weights were not significantly different, it was noteworthy that the pigs fed 35.00 percent copra meal weighed only 86.58 percent as much as the control. Average daily gain of the groups fed 35 percent copra meal (4-D) was only 58.39 percent as much as the control.

Average daily feed consumption of the pigs fed 35.00 percent copra meal consumed only 2.85 pounds of feed daily compared to 3.55, 3.53, and 3.62, respectively, for those fed 0, 15, and 25





percent copra meal. Those fed 35 percent copra meal consumed significantly less feed than those fed 0, 15, and 25 percent copra meal. Feed per pound of daily gain ranged from 2.47 to 3.38. Although there were no significant differences in the amount of feed per pound of gain, swine fed the control diet (0 percent copra meal) consumed 32.79 percent to 36.84 percent less feed per unit of gain than those fed copra meal.

CONCLUSION:

The data suggests that as much as 25.00 percent copra meal may be incorporated in the diet of growing swine without significantly affecting body weight gain and feed efficiency.

II. Another experiment was conducted on the use of cassava and copra meals on performance of finishing swine. Locally produced cassava roots were washed, chipped, sun-dried, and then ground in a hammer mill before mixing in the diet. Copra meal was obtained from the island of Palau.

Forty pigs ranging in weight from 75.00 to 94.50 pounds were used. The pigs were distributed at random by weight, sex, and breed into eight pens, four pens of males and four pens of females. There were five pigs in each pen. Table 3 shows the diet composition. The variables were cassava and copra meals. Each diet was fed to one pen of five males and one pen of five females. The experimental period was 35 days. Feed and body weight were obtained weekly.

The data in Table 4 show that average initial weights ranged from 80.00 to 92.40 pounds. There were no significant differences among means. Pigs fed 40.00 percent cassava meal, plus 25.00 percent copra meal (8-D), were only 76.94 percent as heavy as the control (5-A) at the end of the 35-day test period. The data also show that average daily gain was significantly affected by the treatment. Pigs fed the 40.00 percent cassava and 25.00 percent copra meals (8-D) gained significantly less than those fed 40.00 percent cassava meal without copra meal (6-B). The data also shows that diets containing 25.00 percent copra meal (7-C, 8-D) averaged the least daily gains, compared with those fed 0 percent copra meal with or without cassava meal (5-A, 6-B). It was also noted that finishing pigs fed copra meal consumed less feed than those fed their respective controls. Further analysis of the data showed that swine fed 40.00 percent cassava and 25.00 percent copra meals (8-D) consumed significantly more feed per pound of gain than the control. The preceding observation with finishing pigs (Experiment 2) conflicts with those obtained from growing swine (Experiment 1). Clarification of the discrepancy is the subject of further tests.

CONCLUSION:

Forty percent cassava meal may be incorporated in the diet of finishing pigs without significantly affecting final body weight gain and feed efficiency.

TABLE 1.
COMPOSITION OF GROWING DIETS

| INGREDIENTS | 1-A | 2-B | 3-C | 4 D |
|-------------------|-------|-------|-------|-------|
| | % | % | % | % |
| COPRA MEAL | | 15.00 | 25.00 | 35.00 |
| GROUND CORN | 20.00 | 20.00 | 17.00 | 17.00 |
| GROUND MILO | 47.75 | 45.50 | 40.75 | 34.25 |
| SAFFLOWER 26% | | | | |
| DEHY. ALFALFA 18% | 02.50 | 02.50 | 02.50 | 02.50 |
| PEANUT MEAL 48% | 08.75 | 06.50 | 06.50 | 03.00 |
| C-1 CONCENT 44% | 05.00 | 05.00 | 05.00 | 05.00 |
| MEAT MEAL 50% | 01.50 | 01.50 | 01.50 | 01.50 |
| GROUND LIME | 01.00 | 01.00 | 01.00 | 01.00 |
| C. D. P. | 00.25 | 00.25 | 00.25 | 00.25 |
| SALT | 00.20 | 00.20 | 00.20 | 00.20 |
| MULTI VITAMIN | 00.03 | 00.03 | 00.30 | 00.30 |
| BACIFERN 50 | * | * | * | * |
| TOTAL | 100 | 100 | 100 | 100 |

* = Ten grams Bacifern-50 were added per 100 pounds of feed.

TABLE 2.
EFFECT OF COPRA MEAL ON GROWING SWINE¹

| DIET | PIGS. (No.) | AVERAGE INITIAL WEIGHT (lb.) | AVERAGE FINAL WEIGHT (lb.) | AVERAGE DAILY GAIN (lb.) | AVERAGE DAILY FEED/CON- SUMPTION (lb.) | FEED/lb. DAILY GAIN (lb.) |
|------|----------------|---------------------------------------|-------------------------------------|-----------------------------------|--|------------------------------------|
| 1-A | 10 | 55.20 ^a | 92.40 ^a | 1.49 ^a | 3.55 ^a | 2.47 ^a |
| 2-B | 10 | 57.80 ^a | 88.20 ^a | 1.06 ^a | 3.53 ^a | 3.33 ^a |
| 3-C | | | | | | |
| 3-C | 10 | 56.60 ^a | 90.70 ^a | 1.07 ^a | 3.62 ^a | 3.38 ^a |
| 4-D | 10 | 53.00 ^a | 80.00 ^a | .87 ^a | 2.85 ^b | 3.28 ^a |

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

TABLE 3.
COMPOSITION OF FINISHING DIETS

| INGREDIENTS | DIET | | | |
|---------------------|-------|-------|-------|-------|
| | 5-A | 6-B | 7-C | 7-D |
| | % | % | % | % |
| CASSAVA | | 40.00 | | 40.00 |
| COPRA MEAL | | | 25.00 | 25.00 |
| GROUND CORN | 20.00 | 04.00 | 15.00 | |
| GROUND MILO | 46.75 | 14.75 | 45.75 | 11.25 |
| SAFFLOWER 26% | 15.00 | 15.00 | | |
| DEHY. ALFALFA 18% | 02.50 | 02.50 | | |
| SAFFLOWER 42% | 07.50 | 07.50 | | 07.50 |
| C-1 CONCENT 44% | 05.00 | 13.00 | 10.00 | 13.00 |
| HEAT MEAL 50% | 01.50 | 01.50 | 02.50 | 01.50 |
| GROUND LIME | 01.00 | 01.00 | 01.00 | 01.00 |
| CALCIUM DIPHOSPHATE | 00.25 | 00.25 | 00.25 | 00.25 |
| SALT | 00.20 | 00.20 | 00.20 | 00.20 |
| MULTI VITAMIN | 00.30 | 00.30 | 00.30 | 00.30 |
| BACIFERN 50 | * | * | * | * |
| TOTAL | 100 | 100 | 100 | 100 |

TABLE 4.
EFFECT OF CASSAVA AND COPRA MEAL ON FINISHING SWINE¹

| DIET | PIGS (No.) | AVERAGE INITIAL WEIGHT (lb.) | AVERAGE FINAL WEIGHT (lb.) | AVERAGE DAILY GAIN (lb.) | AVERAGE DAILY FEED CONSUMPTION (lb.) | FEED/lb. of GAIN (lb.) |
|------|------------|------------------------------|----------------------------|--------------------------|--------------------------------------|------------------------|
| 5-A | 10 | 92.40 ^a | 126.40 ^a | .81 ^{ab} | 2.86 ^{bc} | 3.52 ^a |
| 6-B | 10 | 91.60 ^a | 126.20 ^a | .86 ^b | 3.02 ^{bc} | 3.51 ^a |
| 7-C | 10 | 80.80 ^a | 110.70 ^a | .60 ^{ab} | 2.41 ^b | 3.99 ^a |
| 8-D | 10 | 80.00 ^a | 97.25 ^a | .41 ^a | 2.07 ^a | 5.04 ^a |

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

Agricultural Economics

Hari P. Marhatta

In 1979, over 264,000 visitors came to Guam. This represents a tremendous increase since 1967 when only 6,600 visited Guam. Despite this forty-fold increase in 12 years, Guam has not yet realized a fair share of the benefits.

Seventy-five percent of all tourists come from Japan and Guam has failed to attract visitors from other areas. Further, tourism in Guam is largely controlled by Japanese business interests and most of the benefits, therefore, have been gained by foreign firms who have been vigorous in their wooing of Japanese tourists.

These findings on socio-economic characteristics of Japanese tourists visiting Guam have been obtained from the study entitled "Study on Marketing Potential of Certain Agricultural Products of Guam in the Tourism Industry". The Method used was a survey questionnaire distributed to Japanese tourists prior to their departures from Guam during 1979 and 1980.

Survey data indicated that about fifty-five percent of the respondents were married (travelling in couples) and came to Guam as a honeymoon destination. Nearly seventy-five percent of these Japanese tourists stated they were between the ages of 21 to 30, the average age being 29 years. Sixty-four percent were travelling with one or more members of the family. A substantial number of the visitors indicated they came from Tokyo and Osaka. These two cities alone accounted for thirty-one percent of the total responding to the survey, although most of the areas of the country were represented. Nearly ninety percent of the tourists surveyed indicated they had either high school or college education.

One of the significant features of the survey data collected was the fact that a large number of the respondents were blue collar workers. Nearly

forty percent of these tourists were clerical or sales workers, and only nineteen percent were professionals and executives. While sixty percent had a gross monthly income of less than Y300,000, which is equivalent to \$1,277 U. S. dollars, approximately thirty-two percent had an income of only \$639 (mode income) as compared to the average income of \$1,591 (Table 1).

TABLE 1: INCOME LEVELS OF JAPANESE TOURISTS, GUAM, 1979 - 80

| INCOME LEVEL | EQUIVALENT DOLLARS- | PERCENTAGE |
|----------------------|---------------------|------------|
| Under Y50,000 | Under \$213 | 0 |
| Y50,001 to Y100,000 | \$214 to 426 | 3 |
| Y100,001 to Y200,000 | \$247 to 851 | 32 |
| Y200,001 to Y300,000 | \$852 to 1,277 | 24 |
| Above Y300,001 | Above \$1,277 | 38 |
| OTHER | | 3 |
| | | 100% |

According to the survey, it is evident that rich tourists who can afford to spend large sums of money did not come to Guam during the period studied. Blue collar workers who visited Guam had low incomes and they had a small proportion of income to spend on travel. It was found from discussions with many Japanese tour operators and some company officials in Japan, that a majority of workers coming to Guam for a honeymoon are company financed and the trip is a bonus to the employees. Without such assistance, the number visiting Guam would be substantially lower.

The tourists surveyed spent an average of \$317.33 on tour packages. After deducting the cost of air transportation of about \$250, they spent an average of \$67 for food, lodging and sightseeing purposes.

In contrast to the concept of travelling independently, the Japanese prefer to travel with tour packages and prefer to stay in hotels where Japanese is spoken. The survey showed that ninety-six percent of the tourists who responded, utilized a tour package. Likewise, seventy-five percent of them stayed in three Japanese owned and managed hotels; Okura, Reef and Dai-Ichi.

Because of the the tour package, these tourists were guided by tour companies which currently are under Japanese management. In order for Guam to obtain a better share of tourist spending from the burgeoning tourist industry, locally owned firms need direct participation in the tour business in order to compete with Japanese tour companies.

Finally, for successful tourism, repeat business is essential. Such repeat visits are possible if the first experience of tourists has been positive and if improvements are made to serve them better. This was a first visit for ninety-two percent of the respondents and nearly seventy-eight percent indicated that they may come back to Guam. Approximately eight percent were returning visitors.

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