Guam Agricultural Experiment Station

University of Guam
Annual Report
1983

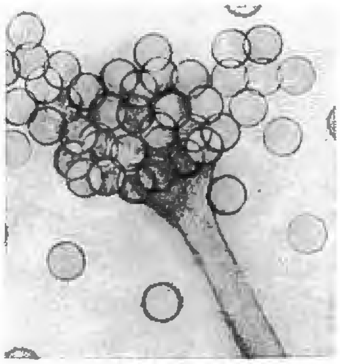
Message from the Director

Recruitment of a pomologist in December 1982 gave a boost for the pomology program in 1983. Fifteen acres of land in Southern Guam has been surveyed for developing a tropical fruit crops germplasm repository. Emphasis in the rest of the programs remained at the same level as that of 1982. However, four new Section 406 projects in the subject areas of Soils, Entomology, Economics, Plant Pathology and a Regional Research Project NE-124 were added in 1983.

Results of one of the early Section 406 projects on winged bean have become evident. Winged bean has become an item on the vegetable shelves of major grocery markets on Guam for the first time.

Outbreaks of spherical mealybug on *Leucaena leueocephala* and spiralling whitefly have been successfully controlled by utilizing bio-control agents. In addition, our scientists have supplied bio-control agents to Taiwan, Japan, Saipan, the Phillipines, and Kosrae for control of various pests.

WILFRED P. LEON GUERRERO
Dean/Director



The cover designed and illustrated by Perry A. Perez features Aspergillus flavus, *a fungus commonly associated with post-harvest decay. Guam's environmental conditions of high humidity and temperature facilitate the growth of this and other fungi, thus contributing to the loss of agricultural income.*

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1 Joined in early 1984
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Contents

Soil Science

Jefren Demeterio

Assessing Alternate Sources for Commercial Inorganic Petroleum Based on Fertilizer Nitrogen

This project which was initiated in 1979 involves various means of providing fertilizer nitrogen to satisfy the growing needs of bellpepper plants. The treatments involved intercropping with legumes, addition of chicken manure, sewage sludge, incorporating fresh tangan-tangan leaves *(Leucaena leucocephala)*, and ammonium sulfate (21-0-0). The ultimate aim was to identify a source for fertilizer nitrogen which would lessen dependence on petroleum based fertilizer nitrogen like ammonium sulfate. The evaluations were done during the dry season with subsequent residual studies done during the rainy season. Okra seeds were relay seeded between bellpepper plants in an attempt to maintain plot integrity.

The 1983 yield results are shown in Table 1. The control plots which received no nitrogen for the first time had yields lower than the rest of the treatments. This could signify depletion of native nitrogen in the soil. The yield ranged from 5.70 to 25.09 tons per hectare of fresh bellpepper fruits. The highest yields were observed in the plots where the nitrogen source was tangan-tangan leaves.

The yields from the sludge, chicken manure (10.2 tons), and commercial fertilizer nitrogen (21-0-0) treatments were similar and double that of the yield from the control plot. These yields were about half of that observed in the tangan-tangan leaf and high chicken manure treatments.

The residual study showed highest yields from the Leucaena intercrop treatment. The Leucaena leaf treatment plots which showed highest bellpeppers yields showed lowest the yields of okra. The nitrogen in the Leucaena apparently mineralizes fast and when used in the sludge treatment demonstrated a reduction of yield as compared to the control plot.

Conclusions:

1. Intercropping with legumes, *Leucaena leucocephala* depresses the yield of the main crop.
2. The beneficial effect of intercropping with peanuts is felt in the follow crop. This has led the way towards exhaustive experimentation with growing peanuts for maximum biomass and peanut seed yield.
3. The beneficial effect of intercropping with Leucaena is manifested by the campanion crop during the rainy season.
4. The addition of chicken manure, fertilization with inorganic fertilizers and sewage sludge resulted in increased yields.
5. Nitrogen in sewage sludge is lost after one cropping. Residual studies on sludge showed reduced yields.
6. The addition of fresh green leaves and stems of Leucaena resulted in significantly higher yields with all treatments. Residual studies on the Leucaena leaves showed drastically reduced yields.

Diazinon Degradation in Field and Greenhouse Conditions

Preliminary studies were conducted using filter paper strips (Whatman no. 1, 5x23 cm). Diazinon was added dropwise to the filter papers. In the field they were strung on wire held by metal poles. Another set of filter papers was hung in a greenhouse. Individual papers were sampled and placed in wide-month amber bottles (recycled reagent bottles). Fifty ml ethyl acetate was added and the bottles were shaken for 10 minutes. The solution was evaporated to dryness, taken up in the ethyl acetate then injected into the gas chromatograph.

The following conditions were programmed for the gas chromatograph column - 6ft. x ¼ in. o.d. glass packed with 4% SE 30 + 6% OV 210 on Gas Chrom Q(60/80); flow rate: H2 -60 ml/min., air-105 ml/min., N2 - 90 ml/min., temperatures: column -175°C, injector-185°., detector -160°C.

Table 1. Vegetable yield in tons per hectare from the long term nitrogen source study in 1983

Treatment	Bellpepper	Okra
No nitrogen	5.70	2.73
Leucaena leucocephala	7.10	6.00
Sewage sludge (Agana), 11.3 tons	12.83	2.44
Chicken manure, 10.2 tons	11.82	3.04
100 kgm, N, 21-0-0	9.78	3.17
100 kgm, N, 21-0-0- plus 5.1 tons chicken manure	11.21	4.00
Leucaena leucocephala leaves, 12 tons	25.09	1.07
Chicken manure, 20.4 tons	23.63	5.02
LSD. 01	8.73	2.94

Heavy rain preceded the 2-hr. sampling while light rain preceeded the 24-hr. sampling. It was alternately sunny and cloudy for the rest of the sampling.

Table I - Diazinon degradation on filter paper strips in field conditions

Time after addition of diazinon		ug diazinon/filter paper
0 hr.	159.3 165.2 161.6	162.0
2 hrs.	65.6 70.7 72.9	69.7
4 hrs.	42.7 36.6 47.7	42.3
6 hrs.	28.4 33.6 16.7	26.2
8 hrs.	30.1 39.0 22.2	30.4
1 day	5.5 9.3 4.8	6.5
2 days	0.60 .29 .51	0.47
3 days	0.12 .15 .09	0.12

Heavy rain preceded the 2-hr. sampling while light rain preceded the 24-hr. sampling. It was alternately sunny and cloudy for the rest of the sampling

Table II - Diazinon degradation on filter paper strips in field conditions

Time after addition of diazinon (hr.)		ug diazinon/filter paper
0	150.0 150.9 147.1	149.3
2	76.5 65.9 67.6	70.0
4	50.5 46.4 49.9	48.9
6	33.6 36.6 38.0	36.1
8	32.0 33.9 27.6	31.2
24	11.5 12.5 13.7	12.6

It was sunny during the sampling period. However, rain brought down the filter papers after one day so no further samples could be obtained.

Table III - Diazinon degradation on filter papers in field conditions

Time after addition of diazinon (hr.)		ug diazinon/filter paper
0	145.0 156.4 157.3	152.9
2	63.1 75.0 68.9	69.0
4	48.2 43.6 40.6	44.1
6	34.2 33.5 37.5	35.1
8	29.6 29.5 26.9	28.7
24	1.42 0.54 .55	0.84

Rain preceded the 24-hr. sampling and brought down the filter papers so that no further sampling could be made. In greenhouse conditions the following results were obtained

Table IV - Diazinon degradation on filter paper strips in greenhouse conditions

Time after addition of diazinon		ug diazinon/filter paper
0 hr.	159.3	
	168.2	166.1
	170.9	
2 hrs.	108.0	
	105.8	105.9
	103.8	
4 hrs.	79.9	
	75.6	75.7
	71.7	
6 hrs.	65.3	
	62.0	62.6
	60.4	
8 hrs.	63.4	
	59.2	60.0
	57.5	
1 day	37.7	
	32.0	32.2
	27.0	
2 days	15.0	
	13.5	14.1
	13.7	
3 days	8.6	
	7.9	8.0
	7.6	
1 week	0.26	
	.26	0.25
	.23	
2 weeks	n.d	
	n.d.	n.d.
	n.d.	

Table V - Diazinon degradation on filter paper strips in greenhouse conditions

Time after addition of diazinon		ug diazinon/filter paper
0	148.6 173.5 164.4	162.2
2 hrs.	103.2 93.3 82.1	92.9
4 hrs.	79.5 72.8 83.4	78.6
6 hrs.	63.4 65.9 55.9	61.7
8 hrs.	64.1 51.8 60.8	58.9
1 day	37.2 30.1 36.4	34.6
2 days	19.6 16.7 15.8	17.4
3 days	7.9 8.4 9.1	8.5
1 week	0.38 .31 .25	0.31

Diazinon degradation on bellpepper under field conditions.

Bellpepper plants were sprayed with Diazinon AG 500 containing 4 lbs. diazinon/gal. at a rate of 10 ml diazinon/gal. of water together with a sticker. Samples were taken one hour after spraying. Sample amounts were 10 to 25 g. for leaves and 25 to 50 g. for fruits. The effect of washing on the amount of diazinon on the fruit was observed. The fruits were washed under running tap water then patted dry with paper towels. The seeds and stems were removed and the fruit and leaves were chopped in a blender. The chopped leaves and fruits were weighed. The samples were blended 5 minutes with 200 ml. ethyl acetate, 35 to 60 g. Na2SO4 for fruits and 20 to 35 g. Na2SO4 for leaves. They were then filtered and 20 g. Na2SO4 added. The solution was swirled and allowed to stand for 10 minutes. It was filtered through glass wool and 100 ml was evaporated to dryness. Appropriate amounts of ethyl acetate were added and 5 ul injected into the gas chromatograph.

Table I - Diazinon degradation on bellpepper leaves under field conditions

Time after spraying	ppm diazinon	
1 hr.	14.80 14.73 14.11	14.55
1 day	1.82 2.51 2.26	2.20
2 days	.50 .38 .57	0.48
3 days	.33 .13 .27	0.24
7 days	.03 .03 .05	0.04
14 days	.008 .008 .008	0.008

Table II - Diazinon degradation on bellpepper fruits under field conditions

Time after spraying	ppm diazinon Unwashed		Washed	
1 hr.	0.64 .52 .67	0.61	0.50 .48	0.49
1 day	.12 .13 .22	0.16	0.15	
3 days	.07 .05 .06	0.06	0.03 .07	0.05
7 days	.02 .03	0.02	.03	0.03

The spray mixture from the backpack sprayer was analyzed at intervals. Fifty ml. of the spray mixture and 100 ml. acetonitride were blended 3 minutes and then concentrated on a rotary evaporator. The solution was extracted and 100 ml. methylene chloride and 50 g. Na2SO4 was added to it. The solution was swirled vigorously and allowed to stand for 10 minutes. It was filtered through glass wool and the glass wool as rinsed with methylene chloride. The methylene chloride was evaporated and ethyl acetate was added before injecting into the gas chromatograph.

Table III - Analysis of the spray mixture

Time after spraying (days)	ppm diazinon	
0	53.0 49.8	51.4
1	699.9 750.9	725.4
3	888.5 832.9	859.2
10	846.2 848.7	847.4
29	911.4 903.9	907.6

Diazinon degradation on okra in field conditions

The same spraying, sampling and extracting procedures were followed as those used for bellpepper. However, the final extracts were dissolved in hexane before injection into the gas chromatograph.

The following results were obtained:

Table I - Diazinon degradation on okra leaves

Time after spraying	ppm diazinon	
1 hr.	8.60 8.18 8.44	8.41
1 day	1.71 1.95 1.86	1.84
2 days	1.05 .98 .56	0.86
5 days	.18 .14 .14	0.15
12 days	.04 .05 .05	0.05

Table II - Diazinon degradation in okra fruit

Time after spraying	ppm diazinon Washed		Unwashed	
1 hr.	1.16		0.73	
	.43	0.67	.65	0.65
	.41		58	
1 day	.17		.11	
	.14	0.19	.11	0.11
	.26		.11	
2 days	.04		.04	
	.03	0.04	.03	0.04
	.04		.06	
5 days	.007		.008	
	.011	0.008	.008	.009
	.005		.010	
12 days	.006		.004	
	.003	0.004	.004	.004
	.004		.005	

Fifty ml of the spray mixture was extracted for 2 minutes with 50 ml 15% methylene chloride/hexane three times. The extracts were passed through 2 in. of Na2SO4. The Na2SO4 was rinsed with 3 10-ml portions of hexane. The extracts were evaporated to dryness and then dissolved in hexane. The spray mixture contained 268 ppm diazinon.

The disappearance of diazinon in water was followed. Diazinon AG 500 was mixed with water at a rate of 10 ml/gal. (corresponding to the proportion used in field spraying). Fifty ml was extracted with 15% methylene chloride/hexane at intervals. The following results were obtained:

Time after mixing	ppm diazinon	
(days)		
0	780	788
	796	
1	724	713
	702	
3	691	687
	683	
9	719	708
	697	
23	695	700
	704	
49	630	632
	634	

Recovery Tests

Diazinon in H2O, 1 ml of 10 ppm diazinon was added to 50 ml water and extracted using the preceding procedures (15% methylene chloride/hexane). The recovery percentages obtained were 115% and 120%.

Okra, 25 g chopped okra fruits fortified with 0.5 ml of 20 ppm diazinon were extracted with ethyl acetate. The recovery percentages were 96%, 103% and 108%.

The Effect of Intercropping Leucaena leucocephala on the Yield of Selected Vegetables During Guam's Dry and Rainy Seasons

The Leucaena intercrop in a five year nitrogen source study consistently showed higher yields during the rainy season (July to November). The hedge was trimmed and kept one foot above ground. The main crop of vegetables were planted within the "hedge." The only nitrogen received by the plots was from the Leucaena leaves and green stems which were laid on the ground or incorporated within the row.

Interest now focuses on the apparent high yields of the Leucaena intercrop during the rainy season. This new study aims to completely curtail commercial inorganic nitrogen fertilizer addition by using relay cropping with legumes, utlizing the nitrogen from the legume biomass and also rely on nitrogen additions from intercropping with Leucaena. The study was also designed to maximize yield during Guam's rainy season by growing selected vegetables in rows within Leucaena hedges.

A 21x30 meter field at Inarajan was cultivated and prepared in January, 1983. Twenty-one rows, thirty meters in length were established. *Leucaena leucocephala* seeds were scarified by boiling in water for 30 minutes prior to seeding. Rows 1, 5, 9, 13, 17, and 21 were seeded with *Leucaena* (2-3 seeds, 4-6 inches apart). The 3 Rows within the *Leucaena* rows (hedges) were the test rows for vegetables. The soil test results from soil samples randomly collected from the 5 plots are shown in Table 1. It was noted that the phosphours and potassium levels were on the low side, but adequate enough under Guam conditions. No P or K additions were deemed necessary.

The planting scheme was alternating peanut plants with the vegetable (peanuts-vegetables-peanuts and so on). Peanut CES 103 variety was planted in February, 1983, at three seeds per hill, 20 centimeters apart. The hills were later thinned to one. Peanut seed yields are shown in Table 2. It should be noted that the Leucaena plants were growing. The average shelled peanut seed yield was 1.71 tons per hectare. This is down roughly 1 ton from earlier field experiments in the same areas (AES Annual Report, 1982). Peanut plants thrive better with an abundance of water during seed formation.

The Leucaena hedges were allowed to grow to about 2 meters and later trimmed to a one meter height. The biomass yield of leaves and stems were taken. Total chemical analysis was done in an attempt to estimate the nitrogen addition attributable to the Leucaena hedge.

The following vegetables were selected as test crops - cherry tomatoes, bellpepper, and head cabbage. The three vegetables were randomly distributed in the three rows between the Leucaena hedges.

The first attempt to grow transplanted seedlings using Jiffy 7 pots was hampered by an extremely poor crop stand. The field was plowed under in November and prepared for replanting.

The Effect of Rate and Timing of Nitrogen Fertilization on the Yield of Cherry Tomatoes.

The El Nino related world wide weather disasters that occured in May, 1982 to August, 1983 was also felt in Guam. While fire ravaged some of Guam's drought stricken areas, a far more profound effect was felf in Guam's irrigated agriculture. Farms which had ample water for irrigation had extraordinarily high yields for certain crops.

The nitrogen rate and timing study at the Agricultural Experiment Station in Inarajan exhibited yields almost double the previous year. The yield of marketable tomatoes ranged from 45.59 tons/ha to 63.49 tons/ha. The treatments had no significant yield differences. One postulation for the high yields was the relative absence of pests and diseases associated with tropical rainfall.

Table 1 - Soil test results of a fine, gibbsitic, isohypertheromic, Lithic Ustropept. Guam clay intercropped with Leucaena and selected vegetables.

Plot	pH	%O.M.	P	K	Ca	Mg	Zn	Fe	Mn	Cu
I	7.70	3.14	18.20	110	4,000	120	6.60	45.09	218.75	9.99
II	7.75	4.13	16.84	110	4,800	120	8.20	45.09	243.75	19.98
III	7.75	5.29	35.24	110	4,800	140	10.20	35.07	237.50	9.99
IV	7.75	5.29	26.46	115	4,800	140	10.60	35.07	250.00	11.10
V	7.75	5.46	28.72	125	5,000	140	11.40	35.07	275.00	12.21

Table 2 - Seed and biomass* yield, in metric tons per hectare of peanuts grown between Leucaena hedges

Row		I	II	III	IV	V
1.	Seed	2.03	1.81	1.60	1.63	1.54
	Leaves/Stems	4.58	5.69	4.22	2.94	4.72
	Roots	.31	.31	.31	.39	.31
2.	Seed	2.06	1.77	1.46	1.91	1.60
	Leaves/Stems	4.13	3.86	3.77	4.23	5.35
	Roots	.27	.31	.31	.38	.39
3.	Seed	2.05	1.54	1.51	1.48	1.71
	Leaves/Stems	4.02	4.76	4.36	3.13	5.22
	Roots	.31	.35	.28	.32	.31

*Adjusted to 70°C dry matter yield.

Horticulture - Vegetable Crops

Chin-Tian Lee

Horticultural research work on vegetable crops in 1983 continued to concentrate on screening and determining the adaptability of major vegetable varieties which have economical potential and suitability for growth under the environmental conditions of Guam. The vegetable varieties studied in 1983 were bush beans, cucumber and winged bean. The responses of eggplant to trickle irrigation and irrigation frequency in the shadehouse was studied in cooperation with agricultural engineering personnel to explore the possibility of year round production.

I. VARIETAL PERFORMANCE STUDIES ON BUSH BEANS.

A. Material and Methods:

This bush bean experiment was conducted during the dry season of 1983. The objective was to evaluate climatic factors on the varietal performance. Seven varieties of bush beans included were White Seeded Provider, Roma Green Pod, June Green, Green Lord, Green Processor, Seminole and Splendor. Seeds of bush beans were sown directly in the field. A randomized complete block design with three replications was used. Each experimental plot consisted of one single row of 3.66 meters. A spacing of 1.22 meters between rows and 0.15 meters within rows was adopted. A 10-20-20 fertilizer was broadcast at a rate of 870 kg/ha and incorporated into the soil before sowing the seed. Side-dressing with the same fertilizer at the same rate was done immediately after the first harvest. A preventive pest control program was followed twice weekly to reduce possible insect, mite, and disease damage. Lannate 1.8 L, Cygon E.C. Diazinon Ag 500, Malathion 50, Dithane M-45, and Tribasic Coppers were used. A rotary tiller and garden hoe were used for weed control. Sprinkler were used for irrigation.

B. Results and Discussion:

The cost of materials and labor for growing bush beans is probably lower than costs for growing pole beans because bush beans do not require any means of support by staking or trellising.

Bush beans were harvested when the pods reached full size and while the seeds were still small. They were

Table I. Performance of Selected Bush Bean Varieties During the Dry Season of 1983 in Guam

Variety	Pod Weight (gm)	Number of Pods Per Plant	Marketable Pods Yield (MT/ha)	Unmarketable Pods Yield (MT/ha)
White Seeded Provider	2.11	29.32	3.09	0.09
Roma Green Pod	3.10	15.96	2.37	0.05
June Green	2.18	17.68	1.87	0.03
Green Lord	3.04	21.89	3.45	0.07
Green Processor	2.78	27.92	3.85	0.08
Seminole	2.61	38.53	5.25	0.07
Splendor	2.01	21.41	2.11	0.04
LSD 0.05	0.28	2.35	0.30	0.01

picked by hand at the time of harvest.

If bush beans are harvested when seeds develop to considerable size they may have fibers on the side walls or strings and become tough.

1. Pod Weight:

The average pod weight of each of the seven varieties ranged from 2.01 to 3.10 gm (Table 1). The pod weights of Roma Green Pod and Green Lord with an average of 3.07 gm were significantly larger than the remaining five varieties. There was no significant difference in pod weight among Splendor, White Seeded Provider, and June Green ranging from 2.01 to 2.18 gm.

2. Number of Pods Per Plant:

Seminole, with 38.53 pods per plant produced the highest number of pods and Green Processor the next highest with 27.92 pods. Roma Green Pod and June Green produced the lowest number of pods per plant. There was no significant difference in pod numbers between Green Lord and Splendor (Table I).

3. Marketable Pod Yield:

Seminole, with a marketable pod production of 5.25MT/ha significantly outyielded the other six varieties. Green Processor with 3.89 MT/ha was the next highest. June Green and Splendor, which showed approximately 1.99 MT/ha, were the lowest in terms of marketable pod production. Roma Green Pod, White Seeded Provider and Green Lord production ranged from 2.37 to 3.45 MT/ha (Table I).

4. Unmarketable Pod Yield:

Unmarketable pods were attributed mostly to insect and disease damage, especially from the pod borer.

Green Lord, Green Processor and Seminole, with an average of 0.07 MT/ha, produced the highest unmarketable pod. June Lord and Splendor, with only 0.33 MT/ha produced the lowest unmarketable pods. There was no significant difference in unmarketable pod yield between Roma Green Pod and White Seeded Provider (Table I).

C. Conclusion

Based on appearance, size and production, Seminole and Green Processor were the most promising varieties from the results of the experiment conducted during the dry season of 1983.

II. VARIETAL PERFORMANCE STUDIES ON CUCUMBER:

A. Material and Methods:

This experiment was conducted during the dry season. The objective was to evaluate how environmental factors affected varietal performance. Eight varieties of cucumber were included in this experiment. The varieties were Moneymaker Special, Giant Climbing, Southern Cross, Green Slicer, Victory, Salad Ace, Every Day, and Tokyo Slicer. Seeds were sown directly in the field. A randomized complete block design with three replications was used. Each experimental plot consisted of one single row of 4.87 meters. A spacing of 1.22 meters between rows and 0.31 meters within rows was adopted. A 10-20-20 fertilizer was broadcast at the rate of 580 kg/ha and incorporated into the soil before sowing the seed. Side-dressing with the same fertilizer at the same rate was accomplished three to four weeks after sowing the seed. A preventive spraying program was followed twice weekly to reduce possible insect and disease damage by using Dibrom 8E, Malathion 50, Lannate 1.8L, Dithan M-45 and Tribasic Coppers. A rotary tiller and a garden hoe were used to control weeds. Sprinklers were used for irrigation. Cucumber vines and fruits were trained onto a plastic net to reduce the problem of fruit rot.

B. Results and Discussion:

All tested varieties were monoecious, producing both male and female flowers separately on the same plant. All of the tested varieties were best suited for slicing purposes. The fruits of cucumbers were harvested as soon a they had reached marketable size. They were picked by hand, care being taken to avoid injuring the vine.

1. Fruit Weight:

The fruit weight ranged from 0.201 to 0.320 kg. Green Slicer with 0.327 kg was significantly heavier than the rest of the varieties. There was no significant difference in fruit weight among Victory, Southern Cross and Giant Climbing, which ranged from 0.251 to 0.270 kg. Tokyo Slicer and Salad Ace, with an average of 0.211

Table II. Performance of Selected Cucumber Varieties During the Dry Season of 1983 in Guam

Variety	Fruit Weight (kg)	Number of Fruit per Plant	Marketable Fruit Yield (MT/ha)	Unmarketable Fruit Yield (MT/ha)	Fruit Length (cm)	Diameter (cm)
Moneymaker Special	0.232	5.60	32.12	0.66	17.50	6.00
Giant Climbing	0.270	2.10	14.01	0.27	20.50	5.75
Southern Cross	0.263	4.95	33.56	0.30	26.50	4.00
Green Slicer	0.320	4.67	35.44	0.71	27.50	5.00
Victory	0.251	6.21	38.50	0.80	18.50	6.15
Salad Ace	0.220	6.15	33.81	0.29	25.10	3.75
Every Day	0.226	2.91	16.25	0.31	23.75	4.25
Tokyo Slicer	0.201	7.06	35.38	0.72	24.00	3.75
LSD 0.05	0.024	0.50	3.02	0.04	1.95	0.50

kg, yielded the lightest fruit weight (Table II).

2. Number of fruit per plant:

Fruit number on cucumber is primarily affected by pollination and fertilization. Poor pollination and fertilization generally result in lower fruit number. Tokyo Slicer production was the highest with 7.06 fruits per plant and Giant Climbing produced the lowest fruit number with 2.10 fruits per plant. Victory and Salad Ace were the next highest producers in terms of fruit number (Table II).

3. Marketable Fruit Yield:

Marketable fruit yield was based on the fruit which was firm and crisp while seeds were still quite immature and free of pest damage. Victory, with a fruit production of 38.50 MT/ha, significantly outyielded the rest of the varieties tested. There was no significant difference in marketable fruit yield among Southern Cross, Salad Ace, Tokyo Slicer, and Green Slicer, which ranged from 33.56 to 35.44 MT/ha. Giant Climbing with 14.01 MT/ha was the lowest marketable fruit producer (Table II).

4. Unmarketable Fruit Yield:

The unmarketable fruit was primarily attributed to insect and disease damage. Unmarketable fruit yield ranged from 0.27 MT/ha for Giant Climbing to 0.80 MT/ha for Victory. There was no significant difference in unmarketable fruit yield among Every Day, Southern Cross, Salad Ace, and Giant Climbing. (Table II).

5. Conclusion:

Based on appearance, size and production, Southern Cross, Salad Ace, and Tokyo Slice were the most promising varieties from the results of the experiments conducted during the dry season of 1983.

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

Two experiments dealing with cultural practices were conducted. The first experiment was designed to evaluate the effect of support and no support on the nodule and green pod production for three selected winged bean varieties (Chimbu, Tinge and Dual). The second experiment was conducted to determine the effect of nitrogen application on nodule and green pod production for the selected winged bean varieties (Chimbu, Tinge, and Dual).

A. Materials and Methods:

Seeds of winged bean were directly sown in the field. Each experimental subplot was a single row of 4.57 meters long. The spacing adopted was 1.22 meters between rows and 0.46 meters within rows. Side-dressing with a 10-20-20 fertilizer at the rate of 387 kg/ha was accomplished four weeks after sowing the seed for the first experiment. For the second experiment, side-dressing with 168 kg/ha of 0-46-0 and 151 kg/ha of 0-0-51 fertilizer was accomplished four weeks after sowing the seeds. Split-application of nitrogen fertilizer at 0, 50, 100, 150 and 200 kg/ha were broadcast at 2, 4 and 6 weeks after sowing the seed.

A preventive spraying program was followed once weekly to reduce possible insect damage. Kelthan and Malathion 50 were used. A rotary tiller and a garden hoe were used to control weeds. Sprinklers were used as needed for irrigation. Nodule numbers were determined eight weeks after sowing the seeds. Mature green pods were harvested for a period of two months for yield determination. Experimental designs were as follows:

1. First Experiment:

A split-plot design with six treatments replicated three times was used. Three varieties (Chimbu, Tinge

Table III. Effect of Support vs. No Support on Nodule Number, Green Pod Number, Green Pod Weight and Green Pod Yield

Treatment	Nodule No. per Plant	Total Green Pod No. per Plant	Green Pod Weight (g)	Green Pod Yield (MT/ha)
Chimbu				
Support	20.20	28.9	25.0	11.45
No Support	50.12	81.1	26.0	33.43
Mean	35.16	55.0	25.5	22.44
Tinge				
Support	17.15	47.3	14.0	10.51
No Support	47.05	125.1	14.5	28.77
Mean	32.10	86.2	14.3	19.64
Dual				
Support	18.50	26.8	23.5	9.97
No Support	45.01	74.1	24.0	28.19
Mean	31.76	50.5	23.8	19.08
LSD 0.05 Within Subtreatment (support vs. no support)	5.20	7.15	NS	3.53
LSD 0.05 Between main treatment means (varieties)	NS	8.71	3.8	4.85

and Dual) were utilized for the main treatment and support vs. no support were the subtreatment.

2. Second Experiment:

A split-plot design with 15 treatments replicated three times was used. Three varieties (Chimbu, Tinge and Dual) were utilized for the main treatment while five nitrogen fertilizer levels (0, 50, 100, 150 and 200 kg/ha) were the subtreatments. The winged bean seeds were not inoculated before sowing.

B. Results and Discussion:

1. First Experiment:

The results are presented in Table III. Nodule number was significantly higher in the supported plants when compared to the plants not supported. There was no difference in the nodule number among the varieties. Non supported plants produced significantly fewer green pods per plant than supported plants. Supported plants yielded about three times more green pods than the plants that were not supported. No difference in green pod weight was obtained among the three varieties. There was no significant difference in green pod number and green pod yield among the varieties.

2. Second Experiment:

Nodule number was determined eight weeks after sowing the seeds and mature green pods were harvested for two months for yield determination. The results are shown in Table IV. The winged bean was found to nodulate freely even when the seeds were not inoculated. Nodulation was found to commence two weeks after sowing and by the end of the fourth week large nodules became apparent. Application of nitrogen at a the rate above 50 kg/ha significantly reduced nodule number. Nodule number of 0 kg N/ha was about four times that of the 200 kg N/ha. Green pod number per plant was significantly higher at the rate of 50 kg N/ha than that of the 0 kg/ha. However, there was no significant difference in green pod number and green pod yield among those varieties receiving the application of nitrogen at 100, 150 and 200 kg/ha. Application of nitrogen did not affect the green pod weight.

3. Conclusions:

(a) First Experiment:

From the results of the first experiment it could be concluded that support (staking) is essential for high yields of green pods. A probable explanation for the increase in yields due to support would be that the plant can easily spread its foliage, exposing a larger surface area to sunlight. This could allow a greater amount of photosynthate to be formed, resulting in more translocation of photosynthate for the winged bean pods.

(b) Second Experiment:

Since nodules were formed without inoculation, it was presumed that indigenous *Rhizobium* bacteria, specific for winged bean, was present in the experimental area. There was no increase in the yield of green pod at a nitrogen rate higher than 50 kg/ha. This suggests that a small amount of nitrogen fertilizer could be added to promote the early growth of winged bean in soils low in nitrogen.

Table IV. Effect of Nitrogen Application on Nodule Number, Green Pod Weight and Green Pod Yield

Treatment	Nodule No. per Plant	Green Pod Weight (g)	Total Green Pod No. per Plant	Green Pod Yield (MT/ha)
Chimbu				
0 kg N/ha	48.50	24.6	58.07	23.51
50 kg N/ha	51.25	24.2	67.29	27.30
100 kg N/ha	39.55	25.5	76.99	31.27
150 kg N/ha	20.45	25.0	80.51	32.60
200 kg N/ha	11.32	26.0	85.64	34.70
Mean	34.21	25.1	73.70	29.88
Tinge				
0 kg N/ha	49.25	14.8	81.24	18.38
50 kg N/ha	50.80	14.6	99.34	22.50
100 kg N/ha	37.23	14.0	177.66	26.62
150 kg N/ha	22.46	14.5	123.23	27.88
200 kg N/ha	12.50	15.0	126.94	28.72
Mean	34.45	14.6	109.68	24.82
Dual				
0 kg N/ha	51.75	23.5	53.32	20.12
50 kg N/ha	50.70	23.0	64.91	24.50
100 kg N/ha	38.40	23.2	77.14	29.13
150 kg N/ha	21.15	22.4	79.28	29.95
200 kg N/ha	12.01	24.2	82.17	31.02
Mean	34.80	23.3	71.36	26.94
LSD 0.05 Within substraction (CN rates)	4.05	NS	7.21	3.62
LSD 0.05 Between main treatment means (varieties)	NS	3.8	10.10	3.95

Entomology - Pest Management

Ilse H. Schreiner
and Donald M. Nafus

Mango

On Guam, mangoes suffer extensive damage from insects and disease. As a result, few fruits are produced. Common insect pests are the mango shoot moth, and the mango beetle. To determine if insects and diseases could be effectively controlled, a pesticide trial was initiated.

Materials and Methods

The experiment was run in a mango orchard in Agat. Trees were of mixed varieties and ages, but were all at least ten years old. Trees of similar size were chosen and four were randomly assigned to each treatment. They were sprayed once every two weeks with carbaryl *(Sevin)* alone, or with a mixture of carbaryl and either benomyl *(Benlate)* or captan. All chemicals were applied at the rate of one pound AI/100 gallons. Four trees were isolated as an unsprayed check. To evaluate the effectiveness of the insecticide treatment, leaf damage was estimated on a monthly basis. Terminal shoots were chosen by randomly selecting 4 spots around a tree. At each spot a transect rod was placed running between that spot and the top of the tree. The 5 shoots which most closely touched the rod were sampled for a total of 20 shoots per tree. For each shoot, the number of leaves was counted, and each leaf present was evaluated for damage. Leaves having no damage were rated with the number 1, leaves having 1 to 25% of their tissue missing were rated with the number 2, 26 to 50% was 3, 51 to 75% was a 4, 76 to 99% was a 5. This sample was repeated six times between June and November, which was the period of maximal flushing.

To evaluate the fungicide treatments, leaves were picked from each tree once a month. The number of anthracnose *(Colletotrichum)* induced spots or holes was counted. Tips for sampling were chosen using the same transect system as for insect damage, except that 5 sites per tree were used. From each of the 5 tips sampled per site, 2 leaves were randomly picked from the most recent flush. Fifty leaves were sampled for each tree each month.

Results

Sevin was found to provide significant control of leaf feeding insects (Table 1). Untreated trees had about half as many leaves as treated trees on branches with leaves and 30 times as many shoots with no leaves remaining at all. The leaves remaining had sustained a significantly higher level of damage. The two main leaf feeders were the noctuid mango shoot moth *Bombotelia jocosatrix* and the mango leaf beetle, *Phytorus lineolatus. B. jocosatrix* was observed to feed only on very young leaves still retaining some of the bronze or reddish color of a newly flushed leaf. The beetle also fed only on new leaves, but continued feeding until a somewhat later stage of leaf development. *B. jocosatrix* also feeds on green fruit.

In the months June through August, which were quite dry in 1983, no difference could be observed between any of the fungicide treatments (Table 2). In the months of September through November, there were also no significant overall differences between treatments. However, a linear comparison of the Sevin only versus the Sevin plus fungicide trees showed that the trees treated with sevin alone had significantly more spots. Also, 1983 was a very dry year on Guam, and less damage may have resulted than would be normal.

Beans

Research continued on the leafminer *Liriomyza trifolii* a pest of yardlong beans. An insecticide screening trial was set up to determine if any insecticides provided control of the leafminer. The impact of the pesticides on leafminer parasites was also monitored. A second trial of the previous years' experiment to determine what effect overfertilization has on leafminer and parasite numbers was also run.

Materials and Methods

Both experiments were run at the Agricultural Experiment Station in Inarajan. For the pesticide screening trial, yardlong beans *(var. green pod Kaohsiung)* were planted October 20, 1982 during the transition between the wet and dry seasons. Seeds were planted 6 inches apart, in rows 3 feet apart. Plots consisted of 3 trellised rows 10 feet long. Each plot was replicated four times. The beans were fertilized preplant with 10-20-20 at the rate of 40 lbs. N per acre, and side dressed at the same rate as that of the first flowering. Plots were sprayed twice weekly with a Solo backpack sprayer 425 with the chemicals listed in Table 1. Triton B 1956 was added to all pesticide treatments at the rate of 1 tsp./3 gallons. Mines were counted on thirty-six mature leaflets per plot. Numbers of live miners and parasites in each plot were estimated by examining a sample of fifteen mature leaflets through a backlit microscope and counting all live insects. To identify the parasites, all pupae found were held for emergence. To determine how treatments affected premature leaf

Table 1. Estimates of insect damage to mango foliage in treated and untreated trees

	Sevin	Check	Students "t"	Significance level
Number leaves/shoot	13.9 ± 2.7	5.4 ± 1.5	5.41	0.005
Number shoots with no leaves (120 shoots sampled)	1.2 ± 1.2	41.0 ± 19.4	10.02*	0.001
Mean damage score/ leaf	1.3 ± 0.2	2.7 ± 0.5	5.24	0.005

*Data transformed to $X = \ln (4 + 1)$ for statistical calculation.

drop, the number of leaves per plot was estimated on December 20 by taking a transect from the bottom to the top of the trellis and counting the number of leaves intersecting the line. Bean yield was measured for the center row only.

An experiment to test the effect of nitrogen fertilizer level on yardlong bean was planted March 16, 1983. The variety green pod Kaohsiung was used. Plots consisted of 3 rows 12 feet long and 4 feet apart. Phosphorus and potassium were applied at the rate of 300 and 100 lbs./acre respectively. Nitrogen was applied at the rate of 0,60,120,180,240 and 480 lbs. of nitrogen per acre as a 50/50% split application. One application was applied preplant and the second at flowering. Each plot was predicated four times. Dibrom was applied at the rate of one tsp./gallon from the time of flowering onwards to control French bean fly *(Melanagromyza phaseoli)* and the pod borer (*Maruca testulalis*). Previous tests had shown that Dibrom does not significantly affect leafminer numbers, and had the least effect on parasites of the chemicals tested. The number of mines, live miners and parasites was sampled as in the previous pesticide trial. Yield was measured for the center row only.

Ilse Schreiner

Results

The pesticide screening trial showed that the pyrethroids Pydrin and Ambush significantly reduced the number of mines and live miners, and prevented premature leaf drop (Table 3). The plants in the pyrethroid plots had 2 to 3 times as many leaves as the plants in the other plots (Table 3). The other chemicals tested had no effect on leafminers, and yields were much lower than in the pyrethroid plots (Table 2). However, yields in these treated plots were higher than the check probably because of better control of the french bean fly. The pyrethroids were more effective against the pod borer than the other chemicals as evidenced by the smaller percentage of pod damaged. No phytotoxicity was observed.

The total number of parasites was significantly reduced by all the pesticide treatments except Dibrom. Of the three leafminer parasites found in this trial, *Hemiptarsenus semialbiclavus* appeared to be the most resistant to pesticides, with relatively high numbers in several of the plots, although numbers were reduced in the Ambush, malathion and Sevin plots (Table 4). Surprisingly, given the chemical similarity of Pydrin and Ambush, the Pydrin plots had the greatest number of *H. semiabiliclavus*, and the Ambush plots one of the smallest. *Chrysonotomyia formosa* was significantly more abundant in the Dibrom plots than in any other treatments including the check. Overall, Dibrom had the least effect on the parasites, as relatively high numbers of all three species were found in the Dibrom plots. *Eulocoidea guamensis* was only

Table 2. Number of anthracnose lesions per leaf on treated and untreated mango trees

	Mean number spots/leaf	
	June-August	September-November
Benomyl	1.2 ± 0.4	2.3 ± 1.1
Captan	2.0 ± 0.9	3.3 ± 1.7
Check	1.4 ± 0.9	6.1 ± 5.1
	F = 0.93 not significant	F = 1.5 not significant check vs. Benomyl and captan F = 5.78 prob. = 0.05

Table 3. Effects of pesticides on number of leafminers, parasites and yield of yardlong beans

Treatment and lbs.AI/100 gals.	Number Mines per leaflet	Number Leaves per Transect	Mean Number/ Live Miners	Leaflet Parasites	Yield per row (kg.)	% pods damaged*
Ambush 0.1 lbs	25b**	15.8a	2.2b	0.8c	4.3b	5.4c
Dibrom 0.9 lbs	58a	7.8b	10.4ab	3.2ab	2.6c	20.2b
Ethion 2 lbs	58a	7.4b	14.1a	2.3bc	2.3cd	32.2b
Malathion 3 tsp/ gallon 50%EC	59a	6.2b	12.4b	1.6c	2.3cd	22.4b
Pydrin 0.2 lbs	24b	15.2a	2.4b	1.4c	5.2a	4.4c
Sevin 4 lbs	48a	5.1b	15.8a	1.6c	1.7ed	30.4b
Check	51a	4.3b	7.0ab	4.7a	1.3e	45.1a

* Transformed to arcsin y before analysis

** Numbers followed by the same letter within a column are not significantly different at the 5% level (ANOVA and Duncan's multiple range test).

found in low numbers even in the check plot. No effect of the pesticides was apparent (Table 4).

There appeared to be no effect of nitrogen fertilizer level on leafminer populations. The number of mines, live miners and parasites were similar in all of the plots (Table 5). The yield of beans was also not affected by fertilizer levels.

Cucumbers

Donald Nafus

Trellissing cucumbers as opposed to growing them on the ground generally results in fewer rot problems and higher quality fruit. The effect of trellissing on populations of insects attacking cucumbers has been less well studied.

Materials and Methods

Cucumbers (var. Victoria) were planted May 23, 1983 at the Agricultural Experiment Station, Inarajan. Plots consisted of four 13 foot rows, 3 feet apart. Hills were spaced 3 feet apart. Hills were planted in each hill and then thinned to three plants. The cucumber were either grown on a nylon net trellis or on the ground. Leafminer numbers were estimated by finding the end of a vine, counting 10 leaves backwards and then counting the number of mines on that leaf. Forty leaves per plot were sampled. All cucumbers harvested were examined for melon fly punctures.

Results

The first leafminer samples were taken three weeks after planting, before the cucumbers had begun to grow up the trellis. At that time, there was no difference in number of mines between treatments (Table 6). Once the vines had grown up the trellis, however, significantly more leafminers attacked the trellised cucumbers than the ones on the ground (Table 6). The number of

Table 4. Effects of pesticides on various parasites of *Liromyza trifolii.*

	Number of parasites reared/15 leaf sample		
Insecticide	**C. formosa**	**H. semialbiclavus**	**E. guamensis**
Ambush	0.2a	0.2a	0.2a
Dibrom	10.0b	5.2ab	2.5a
Ethion	2.8a	2.5ab	1.8a
Malathion	2.8a	0.2a	3.2a
Pydrin	2.0a	13.7c	0.2a
Sevin	1.2a	0.2a	1.5a
Check	4.2a	7.8b	3.2a

Numbers within a column followed by same letter are not significantly different at the 0.05 level (ANOVA and LSD).

Table 5. Effect of nitrogen fertilizer levels on numbers of leaf miners and associated parasites

	Seasonal Mean Number Per Leaflet			
lbs. N/Acre	**Mines**	**Live Miners**	**Parasites**	**Yield Kg.**
0	14	2.5	4.1	5.2
60	13	2.3	4.0	4.0
120	15	2.4	4.3	5.7
180	12	2.7	4.0	3.4
240	15	2.9	4.6	4.4
480	12	3.3	3.3	2.4

Table 6. Number of leaf miners and melon flies on trellissed and untrellissed cucumbers

	Trellis	**Ground**	**Student "t"**	**Significance Level**
# Leafminers/Leaf 7/8/83	1.2 ± 0.6	1.1 ± 0.1	0.293	Not significant
# Leafminers/Leaf 8/3/83	5.6 ± 1.0	1.2 ± 0.8	6.012	0.005
# Melon Fly Puncture Cucumber	0.6 ± 0.2	0.5 ± 0.2	0.567	Not significant

melon fly punctures per cucumber did not differ between treatments (Table 6).

Corn

Several projects relating to IPM of corn were continued from 1982 or started in 1983. These projects included: A. efforts to locate the alternate hosts of *Ostrinia furnacalis*, B. a survey for natural enemies and an assessment of their effectiveness, C. an insecticide screening program, and D. screening for host plant resistance.

A. Alternate hosts: Donald Nafus

The identification of alternate hosts of insect pests is extremely important for management of both the pest and its natural enemies. *O. furnacalis* is known to attack a fairly wide range of hosts, the majority of which are grass species. Efforts to identify alternate hosts on Guam have initially concentrated on species which are known alternate hosts elsewhere and on local species of grasses.

Methods

All plant parts were searched for evidence of borer damage and for any of the life stages of the Asiatic corn borer. In hosts where borers were found, the rate of infestation was determined by randomly selecting 100 stalks (shoots) and counting the number of stalks showing evidence of infestation or noninfestation. For alternate hosts which had very low infestation rates, no attempt was made to determine rate of infestation.

Results

Phragmites karka, Coix lachryma-jobl, Pennisetum sp., *Miscanthus floridulus*, and *Hibiscus tiliaceus* showed no evidence of borer infestation. *Sorghum halpense, S. bicolor, Capsicum annuum*, and *Digitaria* sp. all had larval stages of the ACB. On Johnson grass (*S. halpense*) eggs, all instars of larvae, pupae and emerged pupae were found. In one cornfield 56% of the Johnson grass stalks were infested or showed evidence of infestation (Table 7). In the absence of corn, evidence of infestation was found, but less than 1% of the stalks were damaged. A range of instars (1-6th) was also found in crabgrass (*Digitaria sp*), but infestation in this host varies widely. In most areas examined, no borers were found in this host, although a high infestation rate was found in the area of Barrigada village. Borer damage was also found in *Saccharum spontaneum*, but no insects were found so the species causing the damage is unknown.

B. Natural Enemy Survey and Assessment of Effectiveness. Donald Nafus

Natural enemies are an integral part of an IPM system. Before setting up a pest management program, the natural enemy complex, its effectiveness under various conditions, and the best methods of pest population reduction without interfering with natural enemies must be known. At this time we are identifying natural enemies which are present on Guam and assessing their effectiveness. Later, if parasitism/predation ratios prove to be too low, other biological control agents will be imported.

Methods

In corn fields on Guam and Saipan corn plants were examined for egg masses of ACB when the corn was between the mid-whorl and the mature stages. The number of parasitized and unparasitized egg masses found were counted. Parasitized egg masses were removed and held for emergence.

Mature plants from these fields were dissected and all pupae collected. Pupae were held in 1 oz. plastic cups (10 per cup) and checked daily for moth or parasite emergence. Pupae were held for one month after collection if no moths emerged.

Results

Egg parasites were the most abundant natural enemy on Guam. Out of total of 9985 egg masses examined 2,406 (24%) had at least 1 egg parasitized (Table 8). Only rarely, however, were all the eggs within a mass parasitized. Typically between 20-40% of the eggs within a mass are parasitized. To date all the egg

Table 7. Alternate Host Survey

Species	Area	Infested	Life Stages Found	Percent Stalks Infested
Sorghum halpense	Central	Yes	Egg, larvae, pupae	56
Phragmites karka	Central	No		-
	North	No		-
Coix lachryma-jobi	Central	No		
Pennisetum polystachyon	Central	No		
	North			
Saccharum spontaneum	North	?	Stalk damage but no borers so unable to identify species	
Miscathus floridulus	South	No		
Unidentified Grass	Central	?	Extensive boring no larvae found	
Hibiscus tiliaceus (pods)	North	No		
Sorghum bicolor	North	Yes	larvae	stalk not counted
Digitaria sp.	Central	Yes	larvae	
Capsicum annuum	Central	Yes	larvae	fruits infested

parasites identified have been *Trichogramma chilonis*.

Very few larval or pupal parasites have been found. In 1983, 1,310 pupae were collected and held for parasite emergence. Only eight pupae produced parasites. Three species, *Tetrastichus inferens*, *Brachymeria albotibialis*, and an unidentified Icheumonid wasp were recovered (Table 9).

On Saipan only 7.9% of the egg masses found had any parasitized eggs (Table 8). No parasites emerged, so the identity of this species is unknown. No pupal or larval parasites were collected (Table 9).

Pesticide Trial: Methods Don ~~Else~~ Schreiner

A trial was set up in a cooperator's field in Talofofo on December 15, 1982. Each plot consisted of one 10 foot row of Hawaiian Supersweet #10. Three pesticides were used; Lannate, Pydrin and Dipel (*Bacillus thuringiensis*). Each treatment was replicated six times. Spraying was begun when borer damage first became visible and continued at weekly intervals until ears were mature.

Data was collected on the number of marketable sized ears, length of the ears, yield per plot, number of corn borer holes in the cob portion of the ear, number of holes in the silk portion of the ear and number of corn borers per ear.

The corn plots were too lightly infested and variable to show any significant differences (Table 10). There was no difference in the number of marketable size ears, the length of the ear or the weight of ears per plot. There was also no significant difference in any of the measures of insect damage. However, the data suggests that Pydrin and Dipel may provide better control of the corn borer than Lannate.

Host Resistance

A total of 160 inbreds either of tropical adaptation or of commonly used North American varieties were screened. Two trials were run. Trial I utilized U.S. mainland inbreds obtained from W.D. Guthrie in Iowa. Trial II used inbreds known to do well in the tropics. These were obtained from J. Brewbaker in Hawaii. Four inbreds showing resistance to the Southwestern corn borer were also screened in the second trial. Inbreds were evaluated for leaf resistance in both trials. In the second trial a preliminary evaluation of tassel rating methods was done.

Methods Ilse Schreiner

Trial I. The inbreds were planted in 16 foot rows with a spacing of 9" between plants and 3' between rows. Twenty plants of each variety were planted in a single row. All plants were fertilized with a preplant band of 10-30-10 NPK at 100/300/100 lbs./acre AI. The entire field was surrounded by 2 rows of border plants of Pioneer X304C. Three weeks after emergence, all plants were checked for moth eggs. Uninfested plants were seeded with one egg mass per plant. Plants were rated using Guthries 1-9 leaf rating scale on weeks 5, 6, and 7. When the plants were mature, height, number and condition or ears, number of holes in stalk and ears, degree of boring in shank and nodes, and length of tunnelling in stalk were measured. Donald Nafus

In Trial II the same techniques were used, except 2 replicates were run. In addition tassels were characterized for damage using several different scales (Table 11).

Results

TRIAL I. Ilse

Poor germination and growth were noted for most of the Iowa inbreds. Infestation levels were initially light but increased to heavy by 7 weeks. At the first rating (5 weeks) 29 inbreds were rated as resistant. By week 7 only 4: B49, Ch593-9, H60 and MP496 had a rating under 4, and about 20 were between 4.0 and 6.9 (Table 12). With the exception of MP496, (not run in 1982), these inbreds also showed resistance in last year's trial.

Trial II missing from report - data is Table 13

Table 8. Parasitism rates of *O. furnacalis* egg masses by *T.chilonison* on various farms

Area	Farm	Number plants examined	# Egg masses O. furnacalis found	# Parasitized egg masses	%
Central	Cruz, A	34	70	12	17.1
Central	Cruz, B	34	43	13	30.2
Central	Cruz, C	33	1	1	100.0
Central	Lizama A	60	448	230	51.3
Central	Lizama B	2615	7730	1838	23.8
Central	DOA B	1728	1687	309	18.3
South	Castro	N.C.	6	3	50.0
Saipan	Various Locations	N.C.	140	11*	7.9*
Total			9985	2406	24.1

*Unidentified

Table 9. Ratcs of parasitism and identity of parasites attacking pupal/larval stage of *O. furnacalis*

Area	**Farm**	# Pupae Collected	# Parasitized	Parasite Species
Central	DOA A	1034	6	5 *Brachymeria albotibialis.* 1 unidentified Ichneumonid
Central	DOA B	122	0	
Central	Lizama A	55	2	*Tetrastichus . ? inferens*
South	Castro	15	0	
North	Guerrero	84	0	
Saipan	Several locations	154	0	
Total		1310	8	

Table 10. Effects of Dipel, Pydrin, and Lannate on Yield and Ear Damage of Sweet Corn

Chemical---lbs AI/100 gal	Number marketable sized ears/plot	Ave. length ears	lbs. per plot	# holes in cob portion of ear	# holes in silk portion of ear	# worms per 5 ears
Dipel 4	14	18	6.8	0.5	0.5	3.0
Fenvalerate 0.2	13	18	7.4	0.2	0.3	0.8
Methomyl 0.4	15	18	7.3	1.5	1.1	6.5
Check	15	18	7.0	1.0	1.1	6.8

Table 11. Rating scales used to measure infestation of corn tassels by *O. furnacalis*

A. Amount of feeding	**B. Number branches broken**	**C. Number of branches webbed together**	**D. Number of bore sites**
1. No Feeding	1. None	1. None	1. None
2. 1-2 sites with minor damage	2. 1	2. 1-2	2. 1 small
3. 1-3 branches extensive damage	3. 2-3	3. 3 to ½ of tassel	3. 1 large
4. 3 branches to ½ of tassel damaged	4. 4-½ of tassel	4. ½ to ¾ of tassel	4. 2, up to ¼ of main tassel bored
5. ½-⅔ damaged	5. ½ to ⅔	5. ¾ of tassel	5. More than 2 - ¼ to ½ tassel bored
6. Extensive feeding whole tassel	6. ⅔ a. broken at base b. broken above base		6. More than ½ of tassel

Table 12. Screening Trials for Host Plant Resistance, Inbreds from Iowa, SECOND TRIAL

Variety	Leaf Rating 5 weeks mean	Leaf Rating 5 weeks std. dev.	Leaf Rating 7 weeks mean	Leaf Rating 7 weeks std. dev.	Plant Height cm to Tassel Base (mean)	Number Hole/Stalk	Total Length Stalk Bored	% Stalk Bored	Number Plants Rated
A 239	6.1	1.2	9.0	0.0	39	24.9	21.9		13
A 257	4.1	2.8	8.5	0.5	.	.	.		9
A 495	4.0	2.2	8.3	0.9	45	8.9	18.0		13
A 509	5.8	2.4	8.9	0.2	46	14.1	21.7		18
A 554	4.6	2.4	7.7	1.7	50	18.9	34.4		9
A 619	2.4	1.2	3.4	1.0	86	12.2	31.5		14
A 632	4.9	2.9	8.0	1.2	60	6.2	15.2		8
A 634	4.2	2.0	7.8	1.5	78	10.9	28.7		9
A 635	3.1	2.1	7.8	1.2	80	15.9	26.9		9
A 638	2.2	1.2	5.3	1.6	71	7.9	18.7		9
A 641	6.2	1.2	8.1	0.9	72	7.1	20.0		12
A 654	4.4	2.8	7.8	2.4	53	7.8	21.9		15
B 14A	5.8	2.6	8.3	0.9	57	3.3	6.2		9
B 37	6.8	1.3	8.0	1.2	96	13.0	28.9		13
B 49	2.0	2.1	3.1	3.4	28	0.9	1.6		8
B 52	3.9	2.9	7.3	2.0	76	3.3	8.6		7
B 64	4.0	2.7	6.6	2.2	68	2.6	9.6		12
B 68	4.2	2.7	5.9	2.9	94	10.5	20.8		8
B 73	5.2	3.2	8.2	1.3	63	8.5	15.6		10
B 75	3.3	1.3	6.4	2.1	66	4.6	9.1		7
B 85	3.8	0.9	6.5	1.2	80	8.1	17.7		11
B 86	2.7	1.9	6.8	2.3	82	2.5	7.1		10
CH 593-9	2.0	1.6	3.6	1.2	58	9.4	17.0		9
CI 21E	4.8	3.0	7.3	1.6	61	5.9	18.9		12
CO 106	5.4	2.1	8.3	1.5	41	15.7	19.7		7
C 103	3.7	2.3	8.5	0.8	62	8.7	19.2		6
C 103D	5.8	1.5	8.9	0.3	54	16.4	31.6		10
C 123	3.4	2.3	6.6	2.1	54	7.9	19.8		13
C 131A	2.2	1.1	5.9	2.3	49	4.1	7.6		11
C 144	4.5	2.0	8.1	2.0	94	6.1	16.7		13
C 166	1.6	0.8	4.8	2.5	65	4.9	4.6		12
FR 4A	3.9	2.3	7.2	1.7	68	8.3	19.7		17

cont...
Table 12. Screening Trials for Host Plant Resistance, Inbreds from Iowa

Variety	Leaf Rating 5 weeks mean	Leaf Rating 5 weeks std. dev.	Leaf Rating 7 weeks mean	Leaf Rating 7 weeks std. dev.	Plant Height cm to Tassel Base (mean)	Number Hole/Stalk	Total Length Stalk Bored	% Stalk Bored	Number Plants Rated
GT 112	7.3	2.5	8.5	0.5	66	5.0	13.7		9
H 49	3.9	3.2	7.6	2.1	57	13.0	20.3		14
H 60	2.8	2.0	2.4	1.8	57	3.2	8.5		10
H 93	3.5	3.1	8.2	0.8	90	6.8	14.9		11
H 95	7.1	1.7	9.0	0.0	37	11.3	23.2		9
H 99	3.0	0.9	4.8	2.0	66	5.0	13.7		13
KY 228	4.1	2.5	8.9	0.4	.	.	.		7
K 55	4.4	2.2	5.6	2.4	76	13.1	26.7		10
MO 13	1.9	1.4	5.4	3.0	79	7.7	22.3		16
MO 17	2.6	1.6	8.2	1.7	57	10.2	21.8		9
MO 21R	4.2	2.5	8.9	0.4	32	4.0	20.0		8
MP 496	3.3	2.2	3.4	2.1	88	2.0	6.2		25
MP 701	4.4	1.5	7.9	1.1	100	12.7	34.0		14
MP 702	4.2	1.8	5.8	1.8	90	10.8	21.0		13
MP 704	4.4	2.0	4.2	2.0	97	6.6	21.0		9
MS 1334	3.2	2.3	5.8	2.1	58	4.8	14.3		7
ND 203	6.8	1.6	7.2	2.1	44	6.0	12.6		11
NY 821	6.2	1.0	8.0	1.0	54	12.0	22.1		17
N 28	5.4	1.7	8.7	0.8	22	4.0	5.0		8
N 6	4.6	2.3	8.9	0.3	30	3.8	5.7		8
N 7A	3.4	2.5	5.9	2.3	68	3.6	12.4		8
OHO7B	6.2	2.6	8.1	1.4	73	1.6	3.4		15
OH43	3.1	2.6	7.1	1.0	76	4.1	12.9		16
OH514	3.5	3.1	8.2	0.9	90	12.5	24.5		15
OH545	4.3	1.0	8.1	1.4	83	14.7	42.4		14
OH551	5.8	2.5	8.2	1.4	63	8.8	32.3		9
PA 762	2.0	1.5	4.0	2.3	59	2.1	8.0		11
PA 884P	5.0	1.5	7.6	1.2	100	17.7	49.9		7
SC 213	4.0	1.9	8.7	0.5	96	10.5	18.5		10
SD 15	5.2	2.0	7.9	0.8	94	5.5	23.6		8
TX 441	4.9	3.1	8.9	0.4	52	18.9	27.0		7
TX 508	6.2	2.4	7.4	1.5	79	3.4	9.2		
TX 61M	5.8	2.3	7.6	1.4	92	7.1	12.6		
T 101	4.7	1.5	8.6	0.5	62	14.7	43.4		

cont...
Table 12. Screening Trials for Host Resistance, Inbreds from Iowa

Variety	Leaf Rating 5 weeks		Leaf Rating 7 weeks		Plant Height cm to Tassel Base (mean)	Number Hole/Stalk	Total Length Stalk Bored	% Stalk Bored	Number Plants Rated
	mean	std. dev.	mean	std. dev.					
T 111	5.4	2.7	7.6	2.6	37	2.6	4.0		9
T 115	3.4	1.5	7.4	1.9	58	1.8	4.5		8
T 220	5.7	2.6	8.8	0.4	69	17.2	34.3		7
T 222	4.3	2.3	6.4	1.6	81	4.4	14.2		9
T 224	6.4	1.5	8.1	2.2	63	6.4	12.4		12
T 226	5.9	2.8	8.8	0.7	.	.	.		13
T 8	3.3	2.5	8.7	0.5	70	12.0	23.7		9
VA 26	3.5	1.6	7.1	1.8	82	14.6	31.2		12
WF9	6.1	2.1	8.4	0.9	57	12.3	29.5		14
WR3	5.2	1.6	8.0	1.3	75	11.0	32.9		11
W117	6.1	2.9	4.7	2.8	51	2.1	6.4		10
W153R	5.8	2.1	8.2	1.1	45	6.9	18.0		13
W182B	3.7	1.9	8.2	0.8	69	10.5	20.5		12
W59E	4.7	2.8	9.0	0.0	37	11.6	16.9		10
W64B	6.6	1.8	8.7	0.7	57	6.8	26.8		9
W73A	4.6	2.2	8.5	1.8	44	18.8	17.2		16

Table 13 Hawaii Corn Damage Ratings Winter 1983, Leaf and Tassel Damage from *Ostrinia furnacalis*

VARIETY	MHT	MEARHT1	MLEAFR2	MTASR	MTBRAN	MTTOP	MTASG	MTASBORE	MTUNNEL	MTUNLEN	MSTKH	MEARIH
A619	138	62	5.2	4.6	2.2	7.9	3.5	4.5	3.5	25.6	4.5	0.7
A619	119	48	2.3	2.8	1.3	3.2	2.1	2.1	1.7	8.0	1.5	0.1
A632	123	59	5.6	3.0	1.3	3.9	1.6	2.1	2.8	10.7	1.9	0.4
A632	109	48	3.2	2.6	1.8	4.0	1.1	2.3	2.3	8.4	2.3	1.2
B37	120	59	5.3	4.3	3.0	8.6	2.2	4.3	4.5	17.0	1.8	0.9
B37	109	60	5.4	3.4	2.0	7.4	1.9	3.1	1.5	5.0	2.5	0.0
CIMMYTA2	180	106	8.0	2.2	1.4	0.6	1.7	1.3	5.7	24.1	1.6	0.0
CIMMYTA2	182	115	7.1	2.6	1.5	4.1	2.1	1.6	4.0	20.1	2.0	0.3
CI64	108	64	6.7	3.4	1.7	3.9	1.7	2.2	2.3	6.2	2.0	0.8
CI64	127	78	6.3	4.0	2.1	5.2	2.1	3.8	3.7	14.7	2.1	0.7
CI66	138	77	6.9	4.2	1.5	5.2	3.2	3.4	5.6	22.9	3.8	0.6
CI66	127	67	3.9	2.2	1.7	2.1	1.1	1.9	2.2	7.3	1.3	0.2
CM103	140	96	6.5	3.1	2.1	5.2	1.8	2.9	2.7	8.3	1.8	0.3
CM103	170	109	6.4	3.6	2.5	8.4	1.7	4.1	3.6	13.5	3.4	0.5
CM109	144	99	7.4	4.1	2.3	7.4	3.2	3.0	4.2	16.5	7.0	1.9
CM109	141	90	4.6	2.6	1.5	3.0	2.1	1.6	2.2	8.8	2.1	0.1
CM201	146	84	4.1	4.8	2.0	4.9	3.6	4.5	5.5	21.5	4.4	0.4
CM201	138	72	3.0	3.2	1.8	6.1	2.2	3.4	3.4	15.5	2.2	0.3
C103	141	73	6.2	4.5	3.0	7.4	2.7	4.9	6.6	26.0	7.4	1.5
C103	129	73	2.8	2.2	1.8	1.8	1.7	2.5	0.8	2.6	1.0	0.5
F44	149	90	7.8	3.8	2.1	5.2	2.8	2.1	3.3	13.8	2.6	0.9
F44	141	79	3.9	1.8	1.5	2.0	1.2	1.3	2.3	10.6	1.0	0.3
GA209	120	76	7.9	4.6	4.3	8.4	3.4	4.0	3.0	12.8	4.5	0.4
GA209	78	30	4.8	1.6	1.0	2.1	1.0	1.0	0.2	0.6	0.1	0.4
HI25	141	68	5.0	3.6	1.3	1.9	1.7	2.7	3.3	16.8	3.2	0.7
HI25	125	57	4.0	3.2	1.4	1.9	1.6	2.7	3.9	15.8	3.7	0.9
HI26	140	76	7.0	4.0	2.2	5.2	3.5	3.1	1.8	9.0	1.2	0.1
HI26	108	55	5.1	2.3	1.6	1.9	2.2	1.5	1.8	6.6	1.1	0.1
HI27	98	53	3.2	2.2	1.0	0.0	1.6	1.4	2.3	9.6	1.7	0.2
HI27	164	107	4.4	3.4	1.6	5.4	1.7	3.7	5.4	19.6	5.8	1.7
HI28	163	100	5.9	3.7	1.6	4.5	2.1	3.7	4.7	16.9	3.0	0.6
HI28	156	103	5.2	3.2	1.4	4.1	2.4	3.1	3.6	16.5	3.4	0.7
HI29	98	60	5.2	2.6	1.4	2.0	2.2	2.2	1.1	2.7	1.0	0.0
HI29	166	92	4.8	3.5	1.8	8.4	2.4	4.1	3.4	19.0	3.9	0.8
HI30	144	64	4.9	3.3	1.7	0.6	2.1	2.5	4.2	18.9	4.8	0.5

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Table 13 Hawaii Corn Damage Ratings Winter 1983, Leaf and Tassel Damage from *Ostrinia furnacalis*

VARIETY	MHT	MEARHTI	MLEAFR2	MTASR	MTBRAN	MTASG	MTASBORE	MTUNNEL	MTUNLEN	MSTKH	MEARIH
HI30	122	46	3.7	2.0	1.0		1.2	1.0	4.6	0.4	0.1
HI31*	120	64	4.5	4.0	1.5	1.0	4.0	2.0	9.5	3.5	0.5
HI31*	116	59	3.1	1.5	1.1	1.0	1.1	2.5	9.3	0.8	0.0
HI32*	125	55	4.2	2.0	1.0	1.5	1.0	3.7	15.3	3.7	1.0
HI32	75	10	2.0	1.0	1.0	1.0	1.0	1.0	0.5	0.0	0.0
HI33	140	68	5.1	4.0	2.4	2.0	3.5	4.8	26.3	4.4	1.6
HI33	108	45	2.8	2.5	1.2	1.6	2.1	2.3	9.3	1.6	0.2
HI34-1	122	76	2.6	3.6	2.7	1.7	2.2	6.4	17.8	2.0	2.2
HI34-1A	125	75	2.0	2.5	1.0	1.0	1.5	2.2	7.2	3.6	0.3
HI34-2	136	77	2.5	4.8	3.4	4.0	4.5	4.6	15.7	3.0	1.5
HI34-2	126	71	2.3	2.2	1.6	1.5	2.0	3.0	9.9	1.5	0.2
H60	127	64	3.5	2.9	1.2	1.6	3.0	2.2	8.6	2.7	0.6
H60	121	60	3.2	2.7	1.5	1.9	2.3	2.7	14.2	3.6	0.3
H620*	145	79	5.0	3.7	2.2	2.0	3.0	3.1	9.5	1.8	0.4
H620	164	99	2.6	1.0	1.0	1.0	1.0	0.6	2.3	0.6	1.0
H632F	160	115	7.6	3.8	2.3	3.2	3.0	3.8	19.0	4.2	1.2
H632F	182	110	6.5	3.9	2.9	2.8	3.7	4.9	23.7	5.2	1.5
H632GA	157	94	8.4	4.4	3.3	3.6	3.7	6.2	29.7	5.1	0.7
H632G	171	97	6.3	2.7	1.5	1.7	1.5	4.3	18.3	3.7	0.8
H84	120	48	4.4	4.0	1.6	1.3	3.6	3.3	24.8	1.9	0.3
H84	111	43	2.5	1.6	1.0	1.2	1.3	3.0	17.7	1.7	0.1
H95	141	69	7.4	4.1	2.3	2.7	2.9	3.6	13.8	4.8	1.0
H95	152	71	4.3	3.3	1.5	1.6	3.0	3.0	13.7	2.8	0.4
H98	102	58	7.0	4.1	2.2	2.8	3.2	2.5	9.1	3.9	2.3
H98	106	61	5.9	3.9	1.6	2.9	3.8	2.4	11.6	1.5	0.3
ICAL210	151	84	3.5	2.8	1.3	1.3	3.1	2.8	12.3	2.5	1.1
ICAL210	174	101	5.4	3.0	1.2	1.7	2.6	2.1	10.6	3.2	0.3
ICAL222	76	40	3.4	2.0	1.2	1.8	1.4	1.0	3.6	1.3	0.5
ICAL222A	111	52	3.1	2.6	1.3	2.1	1.6	2.6	12.2	2.4	0.5
ICAL223	69	45	3.6	2.5	1.5	2.0	1.4	0.8	3.8	0.6	0.1
ICAL223	111	58	4.6	2.9	1.3	2.4	1.9	3.1	17.5	3.9	1.9
ICAL224	110	57	3.4	2.8	2.1	2.4	1.9	2.1	11.0	1.6	0.4
ICAL224	102	61	2.5	2.6	1.8	1.9	2.0	1.6	7.6	1.8	0.7
ICAL29	152	87	3.2	1.8	1.2	1.3	1.2	1.3	4.3	0.2	0.1
ICAL29	152	78	2.5	1.3	1.1	1.2	1.1	0.6	2.9	0.0	0.0
ICAL36	150	90	4.0	2.5	1.6	1.6	1.7	2.1	7.9	1.0	0.1
ICAL36	148	89	4.4	1.7	1.3	1.2	1.4	3.5	14.6	1.7	0.3

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Table 13 Hawaii Corn Damage Ratings Winter 1983, Leaf and Tassel Damage from *Ostrinia furnacalis*

VARIETY	MHT	MEARHT1	MLEAFR2	MTASR	MTBRAN	MTASG	MTASBORE	MTUNNEL	MTUNLEN	MSTKH	MEARIH
INV138	141	97	3.6	2.6	1.1	2.5	2.2	3.5	12.0	2.6	0.6
INV138	151	98	4.2	2.6	1.8	2.0	2.7	2.3	8.0	1.2	0.4
INV575	153	86	3.9	4.0	2.7	2.0	4.5	5.9	18.6	5.1	1.0
INV575	160	84	4.5	2.5	1.5	1.3	2.2	2.4	9.0	1.8	0.6
KY226	112	56	4.8	2.7	1.3	.1	1.1	1.4	5.8	1.4	0.1
KY226	95	45	3.8	1.9	1.0	1.5	1.4	1.2	5.0	0.6	0.0
M05	94	55	3.8	3.4	1.9	1.8	2.5	1.7	5.0	2.6	0.0
M05	120	62	2.5	2.4	1.3	1.6	2.5	4.6	19.7	4.6	0.8
MP68-616	118	64	5.0	3.0	1.9	2.2	2.5	3.5	14.5	2.1	1.4
MP68-616	163	94	4.3	3.6	2.0	1.4	3.7	4.8	22.3	2.8	1.4
NY821	104	58	3.9	4.2	2.1	2.9	3.9	2.5	15.1	4.0	0.6
NY821	95	46	3.2	2.5	1.0	1.3	1.8	1.2	4.7	0.7	0.0
N28	133	65	5.5	3.2	2.0	1.4	3.2	3.4	19.5	1.9	0.2
N28	138	65	6.0	3.1	1.9	1.2	3.4	3.5	16.6	3.0	1.0
N6	149	83	7.8	4.3	3.5	3.8	2.8	5.8	20.0	2.6	0.3
N6	126	66	5.5	3.9	3.5	3.0	3.5	5.0	20.3	3.3	0.4
OHO7	96	52	3.9	3.9	1.7	2.6	3.2	1.8	5.7	1.6	0.3
OHO7	89	43	4.1	4.0	1.0	3.0	2.5	2.0	8.3	2.1	0.4
OH43	130	61	5.5	3.7	1.4	2.4	3.7	2.5	11.6	2.1	0.1
OH43	132	63	4.3	3.1	2.1	1.6	2.3	2.8	12.5	2.4	0.4
OH514A	126	70	6.4	3.2	2.6	2.6	2.0	1.6	5.5	1.6	0.0
OH514	111	56	4.9	2.9	1.4	1.9	2.5	1.4	6.1	1.2	0.4
R168	109	47	3.6	2.7	1.3	1.6	2.5	2.4	14.1	2.4	1.0
R168	126	57	2.8	2.7	1.3	1.6	2.6	2.2	8.4	1.5	0.0
SC301D	114	63	3.7	3.3	1.8	2.1	2.7	2.8	8.4	1.7	1.2
SC301D	128	68	3.8	2.5	1.4	1.8	2.1	2.3	8.9	1.9	0.2
SR25F	95	56	4.0	2.9	2.5	1.9	1.4	2.5	8.5	0.6	0.4
SR52F	125	84	5.6	4.8	3.7	3.6	4.9	6.3	26.0	5.1	1.5
SR52MA	130	75	4.3	3.9	2.6	3.3	3.7	5.9	21.0	3.7	1.9
SR52M	129	83	6.3	4.4	2.6	3.0	3.7	3.1	16.6	3.0	1.1
TX5855	120	65	7.1	4.6	2.2	4.0	3.4	4.8	25.2	3.2	0.9
TX5855	138	72	5.8	3.4	2.3	2.6	3.4	3.5	13.4	1.8	1.1
TX601	134	81	5.9	2.0	1.0	1.5	1.6	2.3	9.5	1.6	0.4
TX601	83	51	2.0	1.2	1.0	1.0	1.5	2.8	7.9	0.0	0.0
T232	150	76	6.6	4.0	2.4	2.9	2.4	2.2	8.0	1.4	0.0
T232	132	66	3.7	3.5	1.7	2.5	2.7	3.0	15.1	2.5	1.4
VA26	112	51	3.2	3.3	1.8	2.0	3.4	2.9	16.0	2.6	1.0
VA26	113	55	4.0	4.1	2.4	3.1	4.0	2.7	10.1	2.7	0.9
VA35	119	55	5.2	4.3	2.1	2.8	4.1	5.7	23.4	5.5	1.3
VA35	101	35	3.4	1.9	1.1	1.2	1.4	1.0	4.3	1.1	0.3

*Fewer than 10 plants germinated
A Rating Based on 10-17 Plants

Entomology Biological Control

James R. Nechols

I. SPHERICAL MEALYBUG

A. Field Evaluation of Natural Enemies

Experiments that excluded ants *(Technomyrmex albipes)* from field populations of the spherical mealybug *(Nipaecoccus vastator)* allowed an assessment of natural enemies by the use of the biological check method. The study was conducted on a stand of the woody legume, *Leucaena leucocephala*, at a remote site in northern Guam. Initial exposure to natural enemy populations, with or without ants present, began at either the 1st or 3rd (last) nymphal stage. The results after one generation showed that the number of mealybugs serving to the adult stage—was significantly (P 0.02) lower on the ant-excluded branches in both exposure groups. Also, the percentage parasitism by *Anagyrus indicus* was significantly (P 0.02) greater in the treatments without ants. These findings indicate that (1) natural enemies have an important influence on *N. vastator* populations; and (2) predation and/or host killing may be important sources of mortality for early instar mealybugs. Because previous surveys had established that ant interference with natural enemies occurs infrequently (see Guam Annual Experiment Station Report, 1982), ants probably have a negligible influence on spherical mealybug populations in Guam.

B. Reproductive Biology of A. indicus

The gregarious encyrtid parasitoid, *A. indicus,* mates in less than one hour after emerging from its host. It begins oviposition, in the laboratory within six to seven hours postemergence (temperature = 27 ± 1°C). The parasitoid's overal mean fecundity in early adult female hosts was 135 eggs and the mean longevity was ca. 10 days. Female size influenced fecundity and longevity; but mating status did not. Larger females (1.2 - 1.4 mm long) deposited twice as many eggs, and tended to live longer, than smaller females (0.85 - 1.15 mm long) did. Mated parasitoid females produced offspring of both sexes; whereas unmated females produced only male progeny.

C. Reproductive Biology of the Spherical Mealybug

Mating is required for reproduction in *N. vastator*. Specifically, although ovisac development occurred in mealybug females, they did not oviposit. Ovisac formation began in a low percentage of the adult females that were reared in the laboratory on the ornamental, *Jatropha integerima,* by 17 days from the early 1st nymphal stage (Table 1). By day 19, two-thirds of the mealybug females had initiated ovisacs. By day 20, 50% had fully formed ovisac. Almost all of the adult female mealybug had fully formed ovisac between days 23 and 26.

Very few eggs were deposited into the ovisac before day 21. However by days 24 and 25, N. vastator *females laid an average of 100 and 133 eggs, respectively.*

II. SPIRALING WHITEFLY

The spiraling whitefly *(Aleurodicus dispersus)* continues to be under substantial biological control in Guam. The imported parasitoid, *Encarsia haitiensis,* ap-

Table 1. Timing of ovisac formation and early egg production in adult female spherical mealybugs. 1,2

Number of days from infestation with early 1st stage nymphs	Average number of days from molt of adult female stage	N	Degree of ovisac development/ undeveloped	Initial	Partial	Full	Average number of eggs deposited
			Percentage of Mealybug in Each Category				
17	0-1	14	64	14	14	7	0.7
18	1-2	7	57	29	14	0	0
19	2-3	21	33	38	14	14	0
20	3-4	14	43	0	7	50	0.7
21	4-5	21	5	0	29	67	11.3
22	5-6	21	0	5	9.5	86	21.7
23	6-7	21	0	0	0	100	56.3
24	7-8	21	0	0	0	100	99.5
25	8-9	14	36	5	0	57	132.9
26	9-10	14	0	0	0	100	118.

1 Temperature = 28 ± 2°C; RH = 60-70%; host plant = *Jatropha integerrima*
2 Different mealybugs were subsampled from different plants

pears to be capable of maintaining this pest at very low levels except during dry periods. In the 1982 dry season—which had a typically low precipitation—moderate resurgences were observed on guava, Indian almond, and other host plants. Surveys indicated that parasitoids were present in all affected areas. The introduced cocinellid, *Nephaspis amnicola*, responded to pest increases, but not until after high whitefly densities were reached. Pest populations declined following the onset of the rainy season. In addition to *A. indicus*, a new parasitoid that has been indentified as Arrhenophagus albitibige Gir. was recovered from a low proportion of spiraling whiteflies.

Plant Pathology

Vincent M. Russo

I. IDENTIFICATION OF PLANT DISEASES

The on-going project to identify diseases and associated organisms on Guam was continued. During 1983 over 200 reports of pathogenic conditions were reported. Many were the same as those observed in previous years. However, new reports include fungi isolated from orchid, white potato, various ornamental species, bell pepper, peanut, Sunn Hemp, and corn. Panama Wilt continues to be found at new locations in Agat and Apra Heights. On noxious weeds, *Phomopsis* sp. was isolated from Masicsic *(Chromolaena odorata)*, and a *Puccinia* sp. has been found on *Dichanthium blahdii* and Johnson Grass *(Sorghum halpense)*. In both cases, the rust fungus is being parasitized by *Darluca filum*. Data for almost 700 reports, covering a period of three years, is being entered into computer files for access, easy retrieval, and eventually more detailed analysis. Particularly interesting reports are summarized in Table 1.

II. CONTROL OF SOILBORNE PLANT PATHOGENS

A project was undertaken to determine some of the inorganic nutrient requirements of two soilborne pathogens. *Fusarium oxysporum* f. sp. *lycopersici* and *Rhizoctonia solani* were grown in a complete 1.0mM nutrient solution, and in solutions where Ca, Fe, K, Mg, N, P, and S were either excluded (0.0mM) or included at depleted levels (0.1mM) while all other constitutents were maintained at 1.0mM levels. Fungal dry weights were determined. For both fungi, some of the lowest dry weights were recorded for samples grown in complete solution.

Exclusion of K, Mg, and S significantly increased the dry weight of *Fusarium*. Inclusion at the 0.1mM level of most components significantly increased *Fasarium* dry weight over both the complete and corresponding excluded nutrient solutions. The exception was for S, where there was no difference between excluded and 0.1mM solutions. For *Rhizoctonia* dry weights in Fe solutions were less than the complete solution, while dry weights in S excluded solutions were greater than the complete solution. At the 0.1mM level Fe, K, and Mg, dry weights were significantly increased over the dry weights produced in both the complete and deficient solutions. These results could have importance in determining pesticide and fertilizer recommendations.

Table 1. Reported associated agents with symptoms on various hosts
New reports are indicated by an *

Fruits

HOST	ASSOCIATED AGENT(S)
Banana *(Musa paradisica)*	
1. Premature ripening	1. Physiological
2. Bunchy-top	2. Virus
3. Panama wilt	3. *Fusarium oxysporum* var. *cubense*
Betel-nut Palm *(Areca cathecu)*	
1. Leaf spot	1. *Colletotrichum acutatum*
Citrus (Citrus spp.)	
1. Algal leaf spot	1. *Cephalovorus viriscens*
Date Palm *(Phoenix dactylifera)*	
1. Leaf spot	1. *Phomopsis* sp.*

Mango *(Mangifera indica)*	
1. Leaf spot	1. *Colletotrichum sp.*
2. Fruit spot	2. *Phomopsis* sp.*
Papaya *(Carica papaya)*	
1. Fruit spot	1. *Colletotrichum* sp.
Soursop *(Annona muricata)*	
1. Fruit rot	1. *Phomopsis* sp.*

Root Crops

HOST	ASSOCIATED AGENT(S)
Cassava *(Manihot esculenta)*	
1. Tuber rot	1. *Rhizopus* sp.*
White (Irish) Potato *(Solanum tuberosum)*	
1. Leaf spot	1. *Phyllosticta* sp.*
2. Southern blight	2. *Sclerotium rolfsii**
3. Tuber Lesions	3. *Streptomyces scabies*
4. Tuber rot	4. *Fusarium* sp.*
5. Warts	5. Unknown bacterium
White Yam *(Dioscorea allata)*	
1. Leaf spot	1. *Fusarium* sp.

Vegetables

HOST	ASSOCIATED AGENT(S)
Bell pepper *(Capsicum annuum)*	
1. Wilt	1. *Fusarium* sp.
2. Southern blight	2. *Sclerotium rolfsii*
3. Fruit lesions	3. Various weakly pathogenic fungi
4. Bacterial leaf stem	4. *Xanthomonas vesicatoria*
Cabbage *(Brassica oleracea* var. *capitata)*	
1. Leaf spot	1. *Phoma ligam**
Cantaloupe *(Cucumis melo)*	
1. Southern blight	1. *Sclerotium rolfsii*
Corn *(Zea mays)*	
A. Local hybrid	
1. Stem lesions	1. *Erwinia dissolvens**
2. Rust	2. *Puccinia* sp. [hypoparasite *Darluca filum* present]
B. Silo Queen	
1. Rust	1. *Puccinia* sp. [hypoparasite *Darluca filum* present]

HOST	ASSOCIATED AGENT(S)
Eggplant *(Solanum melongena)*	
1. Leaf spot	1. *Phoma* sp.
2. Stem lesion	2. *Pseudomonas solanacearum*
Peanut *(Arachis hypogaea)*	
1. Pod spot	1. *Fusarium* sp.*
Pepino *(Cucumis sativus)*	
1. Powdery mildew	1. *Erysiphae* sp.
Pumpkin *(Curcubita pepo)*	
1. Mosaic	1. Virus
2. Powdery mildew	2. *Erysiphe cichoracearum*
Sarawak bean *(Dolichos hosei)*	
1. Leaf spot	1. *Colletotrichum dematium**
Tomato *(Lycopersicon esculentum)*	
1. Leaf spot	1. *Alternaria solani*
2. Leaf spot	2. *Stemphyllium* sp.
3. Southern blight	3. *Sclerotium rolfsii*
4. Root lesions	4. *Fusarium* sp.
Watermelon *(Citrullus vulgaris)*	
1. Leaf spot	1. *Phyllosticta* sp.
Yard-long bean *(Vigna sesquipedalis)*	
1. Mosaic	1. Virus
2. Leaf spot	2. *Colletotrichum dematium**
3. Leaf spot	3. *Helminthosporium vignae**
4. Leaf and stem spot	4. *Diaporthe* sp.*

Ornamentals

HOST	ASSOCIATED AGENT(S)
Copper leaf *(Acalypha indica)*	
1. Leaf spot	1. *Colletotrichum dematium**
Orchid *(Aranthera* var. *Garcia Singapore)*	
1. Leaf spot	1. *Fusarium* sp.
Rose *(Rosa sp.)*	
1. Powdery mildew	1. *Peronospora sparsa*

Forage

HOST	ASSOCIATED AGENT(S)
Sunn Hemp *(Crotalaria juncea)*	
1. Leaf spot	1. *Stemphyllium* sp.*
2. Leaf spot	2. *Curvularia* sp.*

Noxious Weeds

HOST	ASSOCIATED AGENT(S)
Grass *(Dichanthium blahdii)*	
1. Rust	1. *Puccinia* sp. [hypoparasite *Darluca filum* present]
Johnson Grass *(Sorghum halpense)*	
1. Rust	1. *Puccinia purpurea* [hypoparasite *Darluca filum* present]
Masicsic *(Chromolaena odorata)*	
1. Leaf spot	1. *Phomopsis* sp.*

III. CULTURAL PRACTICES, YIELD AND DISEASE INCIDENCE IN BELL PEPPER

Seedlings of Bell Pepper *(Capsicum annum* L. var *annum*) were established in an experimental field in Barrigada, a centrally located village on Guam. The field was sub-divided and affects of 1) field orientation (parallel to wind flow vs. perpendicular to wind flow); 2) plant spacing (18/7.6m row (S1) 14/7.6m row (S2) 9/7.6m row (S3)); 3) presence or absence of black plastic mulch and 4) presence or absence of fungicides. Each treatment was replicated four times for a total of 192 combinations. Insecticides were applied as a blanket treatment. Plantings were established in January and July, 1983 to reflect the dry and wet seasons respectively.

During each season, 16 harvests were made. At each harvest data on the following were collected for each sub-treatment: 1) Yield (total); 2) total number, weight, and percent of non-marketable fruits and 3) total number and percent of non-marketable fruits due to pathogenic infection, insect infestation, physiological or mechanical distortion or damage, and premature ripening. During the growing season a continuing record of numbers of dead plants was maintained. Pathogens which were found to be associated with dead or infected plants were identified. Also, periodic soil samples were taken, and numbers and types of nematodes found in the soil of each sub-treatment recorded. Financial records were maintained for all aspects of the crop production phase of the experiments.

Express Bell consistently outproduced Keystone Giant in both total harvest and marketable fruit. However, seasonal conditions affected production of both cultivars. During the dry season Express Bell produced nearly twice as many total and first quality fruit as Keystone Giant. During the wet season Keystone Giant effectively experienced crop failure (healthy plants, but no production), and the yield for Express Bell was approximately 1/5 that of the dry season. This being the case, discussion will be limited to the dry season. Field orientation had little effect on yield or number of first quality fruit produced. Mulching improved total and first quality yield at an average of 12%. Overall, application of fungicide increased total yield by 45% and first quality yield by 55%.

Spacing also had significant affect on both total and first quality fruit yields. Spacing of S1 and S2 were alike, but spacing of S3 produced approximately 67% of the output of either S1 or S2.

Disease and physiological conditions accounted for the majority of fruit being classified as unmarketable. Of the variables tested (orientation, variety, fungicide, mulch, spacing) only mulch and spacing did not affect the percent of first quality fruit produced. Although field orientation had little effect on total yield there was some effect on the percent of first quality yield. Plants which were oriented parallel to wind direction produced only 66% of fruit as first quality, while those which were oriented perpendicular to the wind direction produced 71% of fruit as first quality. Express Bell produced fruit in which 71% were first quality. For Keystone Giant only 56% were first quality. With the application of fungicides 73% of fruit were first quality. When fungicides were excluded, only 62% of fruit were first quality.

A detailed examination of inputs into production costs is being developed. Analysis of nematode data is not complete at this time.

Agricultural Engineering

Calvin A. Saruwatari
and Chin-tian Lee

Research in agricultural engineering continued in cooperation with horticulture to study trickle irrigation of vegetable crops. An experiment was initiated in October of 1982 in a screenhouse to determine the response of eggplant to trickle irrigation. The objective was to explore the possiblity of year round eggplant production.

Description of Experiment

The experiment was conducted in a screenhouse located at the Agricultural Experiment Station. Four-week-old eggplant seedlings (B-1) were transplanted into 30 cm (19 liter) pots which contained a mixture of 50% soil, 33% peat moss and 17% manufactured sand with 30 grams of 10-20-20 fertilizer. Foliar fertilizer was applied once every two weeks. An additional 30 grams of 10-20-20 was applied at flowering and then monthly thereafter. The drip line was placed 5 cm away from the plant with one emitter per plant.

Four trickle irrigation treatments (94.63, 79.49, 64.35, and 47.31 liters per treatment) (4.54, 3.78, 3.03, and 2.27 liters per plant) were used. The irrigation frequency was once every three days. A completely randomized design with three replications was used. Each replication consisted of seven plants. Domestic water was used for irrigation. For soil moisture observations, tensiometers were installed (one per replication). Evaporation from a Class A evaporation pan was measured and recorded for each day that the irrigation system was turned on. Temperature measurements outside and inside the screenhouse were taken.

Insects (mites, scales, ants) and diseases (unidentified fungal and blossom end rot) were noted on all plants. Dibrom, diazanon, dithane, malathion, sulfur and tribasic copper sulfate were used to control the insects and diseases as part of a general spraying program.

Data and Discussion

Results from the experiment showed a significant difference in the total number of unmarketable fruits between treatments. In treatments 1 and 2 (high water treatments) the number of unmarketable fruits were 11% and 8%, respectively, while for treatments 3 and 4 the number of unmarketable fruits were 20% and 31%, respectively, of the total number of fruits produced per treatment. No significant difference was found in the total number of marketable fruits and total marketable yield between treatments.

The average daily evaporation from the Class A evaporation pan was found to be 0.25 ± 0.08 cm per day. The effect of wind-driven rain into the screenhouse on the evaporation measurement was not determined. It was assumed that there was no effect because the pan was in the screenhouse.

Temperature measurements outside and inside the screenhouse showed that the average· temperature diference was 1.2°C higher in the screenhouse. The average outside temperature was 27.3°C and the average inside temperature was 28.5°C. However, on any particular day the range could extend from 7°C cooler to 10°C higher in the screenhouse, irrespective of the time of day.

Tensiometer data was not analyzed due to soil cracking in treatments 3 and 4 and loss of tensiometer fluid at the end of the second day after irrigation.

Conclusions

No significant difference was found in the total number of marketable fruits and the total marketable yield between treatments. A minimum water requirement of 3.78 liters per plant every 3 days should be used due to decrease in the number of unmarketable fruits and to avoid soil cracking that developed in treatments 3 and 4.

Evaporation from the Class A pan of 0.25 cm per day represents the pan evaporation for the transitional period between the wet and dry seasons. Previous measurements gave a value of 0.32 cm per day for the dry season.

Although the average temperature difference inside and outside of the screenhouse was only 1.2°C, further study must be made on the daily difference which exists.

Treatment (L/Treatment) (Liters/Plant)	Marketable Yield (Fruits/ Treatment) (KG/ Treatment)	Average Marketable Fruit Weight (G)	Unmarketable Yield (KG/Treatment) (Fruits/Treatment)
94.63	97	47.61	12a
4.54	4.618		0.394
79.49	106	50.45	9a
3.78	5.348		0.258
64.35	110	32.06	28
3.03	3.527		0.729
47.31	85	51.29	38
2.27	4.360		1.150
LSD* 0.05			5.51

*Means flanked by the same letter are not significantly different at the 0.05% level.

Animal Sciences

Anastacio L. Palafox

Continuing studies were conducted on the potential of locally produced and available feed ingredients for animal production.

I. Gallus domesticus

1. Introduction

A study was conducted with *Gallus domesticus* to determine the level of protein for optimum productive performance (PF100).

2. Materials and Methods

The experiment was conducted with 22-week old White Leghorn pellets. They were randomly distributed into fifteen groups, of nine birds each. The birds were individually housed in 31 cm x 46 cm all wire laying cages. Three isocaloric diets containing 15, 16, and 17 percent protein were distributed at random in a randomized block design. Five replicate groups, of nine birds each were fed each diet. Feed and water were provided ad libitum. Data obtained were daily egg production and feed consumption. Body weight and feed consumption data were recorded at the start of the experiment at 22 weeks, at 24 weeks and every other four weeks thereafter until the end of the 32nd week of age. The composition of the isocaloric diets is shown in Table 1. It can be seen that the diets have similar concentrations of calcium, phosphorus and protein.

3. Results and Discussion

Hen day egg production is shown in Table 2. During the first week of the experiment (week 22), egg production was the lowest for pullets fed 15% protein (18.57%), while those fed 16% protein showed a production of 24.58% and for those fed 17% protein, the production was 21.14%. The preceding data suggest that 16% protein was optimum for egg production under the conditions of the present study. The data also showed that the 16% and 17% diet fed pullets producted 13.85-32.36% more eggs than the control (15%). At the end of the experiment of 11 weeks, egg production was similar for all groups, suggesting that at age 32 weeks, a 15% protein diet was as good as the diets which contained 16 and 17% protein. Egg production of the test diets were 99.58% and 101.63% as much as the control birds which were fed the 15% protein diet. The average of the 11 week egg production tended to increase with protein concentration from 61.86% to 63.01%.

There was no significant difference in body weight (Table 3). Gain in body weight was 133.0, 123.6 and 132.8 grams for birds fed 15, 16, and 17% protein, respectively. The effect of dietary protein on egg production feed consumption and feed consumed per egg produced every four weeks may be seen in Table 4. Hen-day production during the 24-28 week period tended to increase with protein concentration, much more than the 24-32 and 28-32 week periods.

Feed consumption increased with protein concentration during each of the three 4-week periods. During the 24-28 period, feed consumption for pullets fed 15% protein consumed significantly less than those fed 17% protein.

Table 4 also showed the amount of feed consumed per egg produced. Although no significant differences were noted in the feed conversion, the birds fed 15% protein were more efficient than those fed the 16% and 17% protein diets.

Table 1. Composition of Diets (PF100)

Diet	**643**	**644**	**645**
Unit	%	%	%
Tallow	.06	.98	1.96
Cornoil	.10	.10	.10
Corn	69.00	65.19	61.23
Soybean meal (44%)	18.88	21.82	24.82
Alfalfa meal (17%)	3.00	3.00	3.00
Limestone	5.70	5.71	5.71
Tricalcium phosphate	2.30	2.24	2.20
Salt	.50	.50	.50
Premix	.25	.25	.25
DL-mathimine	.21	.21	.21
Total	**100**	**100**	**100**
Calculated Analysis:			
Protein, %	15.00	16.00	17.00
Calcium, %	3.00	3.00	3.00
Phosphorus, %	.75	.75	.75
M.E./Kg. Kcal.	2843	2843	2843

Conclusion

Under the conditions of the present study White Leghorn pullets fed 15% protein from 21 through 32 weeks of age produced as well as those fed 16 and 17% protein. Those fed 15% protein consumed less feed per egg produced than those fed 16 and 17% protein. The preceding data suggest that 15 percent protein diets containing 15% protein may be fed to laying pullets without significantly affecting productive performance compared with those fed 16 and 17% protein.

II. Manihot esculenta

1. Introduction

A research grant (Section 406, Tropical Agricultural Research) made possible the continuance of studies relating to cassava as a source of nutrients for animal consumption. It grows well in Guam and Micronesia. There is a need to study its potential as a crop for human and animal food.

2. Materials and Methods

A study (ME 2.1) was conducted to determine the productive performance of Guam cassava cultivars (CV) six and nine planted in ridged and unridged rows. They were planted in a randomized block design. There were seven replicate plots, six plants each for each clone. A total of 14 plots for the two cultivars were alloted for the ridged rows and likewise 14 plots were alloted for the unridged rows.

Seed pieces with 4-5 nodes were planted horizontally and covered with one inch of soil. During the first week, they were watered daily. Thereafter, watering or weeding was done as needed. Seed pieces were planted on May 19, 1982. The test was terminated 32 weeks after planting. The number of roots, root weight, diameter, circumference and length was recorded. Also the number of marketable and unmarketable roots was recorded.

3. Results and Discussion

A. Ridged and Unridged Rows Roots per Plant

Table 5 shows the number of roots produced per plant. There was a significant difference due to ridged and unridged rows. Cassava planted in ridged rows produced an average of 7.09 roots compared to only 4.83 roots for those planted in unridged rows. Plants in ridged rows produced 46% more roots than those in unridged rows. These data suggest that ridged rows are superior to unridged rows.

Root Weight Per Hectare

The research data also shows that root yield was significantly affected by rows, ridged and unridged. Cassava planted in ridged rows produced 30,296 kg per hectare, whereas, those in unridged rows only produced 19,800 kg. Plants in ridged rows produced 58% heavier roots per hectare than those in unridged rows. Likewise the root yield data favor the use of ridged rows over that of unridged rows. It would be advantageous to determine why there is a significant difference in subsequent studies.

Marketable and Unmarketable Roots

The data in Table 5 shows that the marketable roots were composed of 90.69% for the ridged rows and only 84.98% for the unridged rows. The difference of 6.94% in favor of the ridged rows was not significantly different.

The unmarketable roots were 9.31% for the ridged and 15.02% for the unridged. Although the cassava plant in ridged rows produced 5.1% less unmarketable roots, the difference was not significant. Plants in

Table 2. Effect of dietary protein on hen-day egg production of S.C.W. Leghorn pullets from 22-32 weeks of age (PF 100)

	Diet		
	643	644	645
	PROTEIN %		
Age, week	15	16	17
	%	%	%
22	18.57	24.58	21.14
23	44.00	41.42	42.85
24	59.71	53.14	62.49
25	66.85	71.14	72.68
26	69.71	68.85	72.85
27	71.99	72.00	72.85
28	71.14	72.57	70.57
29	68.28	69.71	69.71
30	70.83	71.13	68.28
31	69.71	69.71	68.85
32	69.71	69.42	70.85
Average	61.86	62.15	63.01

unridged rows produced more small roots which were classified as unmarketable than those in ridged rows.

Root Circumference, Length and Diameter

The data in Table 5 shows root circumference, 15.86 cm and 1586 cm, respectively for the ridged and unridged rows, were not significantly different. Root length and root diameter were also not significantly affected by ridged and unridged rows.

B. Cultivar 6 vs Cultivar 9

Roots per Plant

The data in Table 6 shows the cultivar performance. Root number per plant was 5.67 and 6.64, respectively, for cultivars 6 and 9. The difference of 0.97 roots per plant was not statistically significant.

Root Yield per Hectare

Cultivar 6 showed a root yield of 25,677 kg per hectare, whereas, the root yield of cultivar 9 was 25,769. The two cultivars were not significantly different in root yield.

Marketable and Unmarketable

Cultivar 6 showed 90.49% marketable roots, whereas, cultivars 9 showed 85.36% root marketability. Statistical analysis showed that the difference in marketable roots between the two cultivars was not significant.

The difference in unmarketable roots between cultivar 6 and cultivar 9 was not significantly different. Cultivar 6 showed less unmarketable roots (9.51%) than cultivar 9 (14.64%).

Root Circumference, Root Length and Root Diameter

As shown in Table 6, root circumference of roots in cultivar 6 was signficantly longer than that of cultivar 9. The root average circumference of clone 6 roots was 16.35 cm, whereas it was 15.42 cm for those of cultivar 9.

Root length average for cultivar 6 roots (30.47 cm) was similar to that of cultivar 9 (30.47 cm). Analysis of the data showed no statistical difference.

On the other hand, root diameter analysis showed significant difference between the two clones. Cultivar 6 roots averaged 5.60 cm, whereas, the average for cultivar 9 roots was 5.20 cm.

Conclusion

Ridged rows are superior to unridged rows for cassava plants based on the conditions of the present study. Plants in ridged rows produced significantly more roots than those in unridged rows. Ridged and unridged rows did not significantly affect the percentge of root marketability, unmarketability, circumference, length, and diameter.

Cultivar 6 tended to be superior to cultivar 9. Root circumference and diameter were superior to those of cultivar 9. The two cultivars were similar in average root number, yield, marketablility, unmarketability and length.

Table 3. Effect of dietary protein on body weight of S.C.W. Leghorn pullets from 22 - 23 weeks of age, PF 100

		DIET 643	644	645
		PROTEIN % 15	16	17
Body weight, 23 wk[1]	g	1456.6	1472.2	1465.4
Body weight, 36 wk	g	1589.6	1595.8	1598.2
Body weight gain	g	133.0	123.6	132.8

[1]Age, week

Table 4. Effect of dietary protein on hen day egg production, feed consumption per bird and feed consumed per egg produced from 24-32 weeks of age (PF 100) [1,2]

	DIET 643	DIET 644	DIET 645
	PROTEIN %		
	15	**16**	**17**
Hen-day production, %			
24 - 28 wk	69.92	71.14	72.24
28 - 32 wk	69.63	69.99	69.42
24 - 32 wk	69.78	70-57	70-83
Feed/day, g			
24 - 28 wk	86.44B	88.80B	91.84A
28 - 32 wk	95.08	99.00	100.66
24 - 32 wk	90.76	93.90	96.25
Feed/egg			
24 - 28 wk	125.14	131.74	127.26
28 - 32 wk	137.38	149.20	146.60
24 - 32 wk	131.26	140.47	136.93

[1] Age, wk
[2] Means with different letters are significantly different

Table 5. Effect of ridged and unridged rows on the productive performance of *Manihot esculenta.* [1]

Parameter		**Rows: Ridged**	**Rows: Unridged**
Number of roots/plant		7.09a	4.83b
Root weight/ha	kg.	30,296a	19,800b
Marketable roots	%	90.69	84.98
Unmarketable roots	%	9.31	15.02
Root circumference	cm	15.82	15.86
Root length	cm	30.99	29.41
Root diameter	cm	5.34	5.55

[1] Means with different letters are significantly different.

Table 6. Productive performance of two *M. esculenta* clones available in Guam.[1]

Parameter		**Clones: 6**	**Clones: 9**
Number of roots/plant		5.67	6.64
Root weight/ha	kg	25,677	25,769
Marketable roots	%	90.49	85.36
Unmarketable roots	%	9.51	14.64
Root circumference	cm	16.35a	15.42b
Root length	cm	30.47	30.42
Root diameter	cm	5.60a	5.20b

[1] Means with different letters are significantly different

Aquaculture

Stephen G. Nelson

This past year our studies continued on the processing of nitrogen by species with potential for aquaculture development on Guam. Nitrogen is an appropriate focus for the study of aquaculture systems since the basic goal of food production in aquatic systems is the production of high quality protein, either from low quality protein or from inorganic nitrogen. In addition, ammonia, the major nitrogenous excretory product of aquatic organisms, is so toxic that even very low concentrations inhibit production.

This year's experiments focused on two species of brackish water algae, *Gracilaria edulis* and *G. lichenoides,* and two species of fishes, *Liza vaigiensis* (a mullet) and *Siganus argenteus* (a rabbitfish). These are all local species which are found in the markets of Guam and which have been shown to have potential for aquaculture development. The past year's studies involving each of these species are summarized in this report on algal studies.

Our previous experiments showed that *Gracilaria edulis* and others of this genus take up ammonia very rapidly, apparently by diffusion. The nitrogen uptake was shown to be in excess of that needed for growth as the nitrogen content of the thallus increases upon prolonged exposure to elevated nitrogen concentrations. Growth is enhanced with either prolonged enrichment or with exposure to periodic pulses of nutrients. This year's studies indicated that brief exposure, a matter of seconds, to elevated concentrations of ammonia levels will increase both the rate of apparent photosynthesis as well as the photosynthesis to respiration ratio. An example of the results obtained from these experiments is shown in Table 1. These experiments showed that while photosynthesis is stimulated by brief exposure to ammonia, respiration is unchanged. Therefore, ammonia at these levels does not act simply to increase the metabolic rate but specifically to enhance photosynthesis. This effect takes place within a matter of minutes. This indicates that even exposure to very brief pulses of ammonia could increase production. This is significant in that a nutrient pulse fertilization scheme could be utilized. This would aid in the control of epiphytes since nutrient levels in the culture system could be maintained at a low level.

Previously our work identified *Liza vaigiensis* as a mullet with potential for culture on Guam. We examined the ability of different sizes of fish of this species to assimilate nitrogen from commercial pellets. Table 2 displays results of these assimilation trials. The feed used was a commercial fish feed which was 17.1% ash, 82.9% organic matter, and 6.3% nitrogen. The assimilation efficiency both of total organics and of nitrogen were influenced by the size of the fish. Smaller fish had higher assimilation efficiencies both for total organic material and for nitrogen. Fish of all sizes were more efficient at assimilation of nitrogen (79 to 89%) than of total organics (60 to 74%).

Similar experiments were run with rabbitfish, *Siganus argenteus.* Those are herbivorous fish which are found in markets throughout the Pacific. The seasonal occurrence of large numbers of juveniles of this species on the reef-flats makes it feasible to culture these fish based on wild-caught fry for stocking the ponds. Also artificial spawning techniques have been developed for rabbitfish at the Micronesian Mariculture Demonstration Center in Palau. The species can be grown in brackish water ponds or tanks. Assimilation efficiencies for total organics and nitrogen were determined for groups of *S. argenteus* fed selected algal diets.

Data are presented in Table 3 on the composition of four algal diets which were used in assimilation experiments with rabbitfish. The organic content of the algae ranged from 55 to 94% of the dry weight, with nitrogen contents from 1.5 to 2.3%. The nitrogen content data indicate that these algae contain from 9 to 14% protein. The algal diets are low-protein diets and their use as feed for cultural species would probably require a continuous feed regimen in order to supply the protein required for maintenance and growth of the fish.

These algae are common on the reef-flats of Guam and earlier studies indicated that these species were common in the stomach contents of wild-caught specimens of *S. argenteus.* The algal diets include representatives of the Chlorophyta (green algae), Rhodophyta (red algae) and Phaeophyta (brown algae).

The results of the assimilation trials with these algal diets are shown in Table 4. The net assimilation efficiency of organic matter ranged from 47 to 73% of the dry weight of the diets. In most cases the assimilation efficiency for nitrogen was higher than the corresponding value for total organics. The assimilation efficiency for nitrogen ranged from 56 to 84%. The diet most readily assimilated in terms of both total organics and nitrogen was *Gracilaria.* It is not surprising then that this algae is commonly used as a feed for milkfish cultivation in the Philippines.

It is not uncommon to find statements in the literature which suggest that the herbivorous fishes may be receiving nutrition primarily from various small invertebrates that are ingested along with the algae. Since there has been very little work on the digestive capabilities of herbivorous fishes many seem to find it difficult to believe that a fish can digest algae. Our studies show that not only can they digest algae, but that they are quite efficient at doing so.

Table 1
Comparison of the rates of photosynthesis and respiration (expressed as ml 0_2 per gdw per hour) for thalli of *Gracilaria edulis* in enriched and unenriched seawater. Nitrogen source was NH 4 Cl

Pair	Condition	R	Pa	Pg/R
1	unenriched	0.69	2.00	4.10
	100 uM Nitrogen	0.69	2.14	4.82
2	unenriched	0.58	1.10	2.14
	100 uM Nitrogen	0.50	1.18	3.37
3	unenriched	0.29	1.25	5.33
	100 uM Nitrogen	0.26	1.86	8.24

R = respiration rate
Pa = apparent photosynthetic rate
Pg = gross photosynthetic rate

Table 2 Results of assimilation experiments with the mullet *Liza vaigiensis*

Mean fish weight (g)	% organics in feed	% organic in feces	Assimilation efficiency for total organics (%)	Assimilation efficiency for nitrogen (%)
3.1	82.9	55.5	74.3	88.5
8.5	82.9	57.8	71.8	87.1
33.1	82.9	66.0	60.1	78.8

Table 3
Composition of diets used in assimilation trials with rabbitfish, *Siganus argenteus,* and of the feces produced by the fish after they fed on these diets. Figures are for the mean of two replicates (± standard deviation)

	Diet Composition		Feces Composition	
Diet	**% Organic Matter**	**% N**	**% Organic Matter**	**% N**
Enteromorpha	81.52 ± 0.88	2.72 ± 0.36	66.84 ± 0.23	1.06 ± 0.05
Hypnea	81.38 ± 1.23	3.23 ± 0.30	69.66 ± 2.35	2.30 ± 0.20
Gracilaria	94.20 ± 0.57	3.66 ± 0.14	81.16 ± 1.18	1.88 ± 0.25
Sargassum	*87.10* ± 1.6	2.36 ± 0.46	77.00 ± 2.83	1.47 + 0.13

Table 4 Assimilation efficiencies of rabbitfish, *Siganus argenteus,* fed specific algal diets

	Assimilation Efficiency	
Algal Diet	**% Total Organics**	**% Nitrogen**
Enteromorpha	54.63	72.67
Hypnea	47.44	56.24
Gracilaria	73.41	84.15
Sargassum	50.86	65.38

Agricultural Economics

Thao Khamoui

Two research projects were continued on the efficiency of agricultural marketing of fresh produce on Guam and the economic feasibility of growing selected field crops to substitute some feed grains imported from the United States. Another project was started in 1983 to study the produce market potentials and production constraints on Guam and in Micronesia.

I. FEED CROPS

The total value of imported meat, frozen poultry, and fresh fish is three times greater than the value of fruits and vegetables imported to Guam annually. Almost all of the beef and poultry consumed on Guam is imported and Guam imports approximately 80 percent of its pork consumption.

The absence of a slaughterhouse on Guam often is given as a reason for the low level of animal production. It is argued that farmers are reluctant to increase their production without a USDA approved slaughter facility. However, the high cost of imported feeds and strong competition from imported meats are believed to be important reasons for slow development of the livestock industry on Guam.

Recently, there has been interest in finding ways to reduce livestock production costs. The cost of feed could be reduced if some feed crops can be grown competively on Guam to substitute feed grains imported from the United States, or if some feedstuffs can be imported from nontraditional foreign sources at relatively low cost. For example, copra meal is available in the Philippines and some Western Pacific islands; cassava products are produced in Thailand and Indonesia for export, and other feed grains could also be imported from Australia when prices are competitive. Feeds can be specially formulated for Guam using ingredients available in this part of the world.

This study focuses on an economic evaluation of cassava, which is scientifically known as *Manihot esculenta*. Other common names are tapioca, yuca, yuacamote, manioc, and mandioca. Cassava is a tropical root crop that has a wide range of adaptability, resistance to drought, tolerance to poor soils and relative ease of cultivation. The ability of cassava to survive low inputs and its demonstrated resistance to most pests and diseases make this crop an excellent choice for low-input agricultural systems. Depending on the variety grown, cassava can be harvested between 9 to 12 months after planting. Cassava roots are rich in energy but poor in protein. Cassava leaves, however, have a high level of protein.

There is no doubt that cassava con-

Table 1 Per Capita Consumption of Selected Fresh Fruits and Vegetables in Guam, Hawaii and the U.S., 1980

Crop	Guam[1]	Hawaii	U.S.
		(Pounds)	
Avocado	1.87	1.70	0.8
Banana	11.92	13.38	20.8
Beans[2]	4.21	1.32	1.4
Bittermelon	2.58	1.04	N/A
Cabbage, Chinese	6.30	6.08	N/A
Cabbage, Head	7.32	13.49	8.0
Cantaloupe[3]	6.21	5.79	6.5
Corn	1.53	0.90	6.6
Cucumber	8.38	5.64	4.0
Eggplant	6.88	1.59	0.5
Onion, Guam	4.90	1.41	N/A
Pepper, Bell	6.00	2.40	3.3
Radish	2.70	0.28	N/A
Sweet Potato	3.30	1.96	3.2
Tomato	13.54	14.98	11.4
watermelon	18.88	6.36	10.4

[1] Based on the estimates of the U.S. Army Corps of Engineers: avocado 93%, banana 80%, beans 90%, bittermelon 100%, Chinese cabbage 75%, head cabbage 4%, cantaloupe 46%, corn 100%, eggplant 100%, green onion 50%, bell pepper 70%, radishes 80%, sweet potato 65% and tomato 80%. Cucumber and watermelon were adjusted from 30% to 100%.

[2] See Guam and Hawaii data in Table 1.

[3] Multiply per capita consumption by the projected population of 154,500 and the estimated local production share of consumption presented in footnote 1 above.

[4] Divide total production by the 1980-82 average yield on Guam.

tains a large amount of energy and is a good ingredient for livestock feeds, provided it is well supplemented with protein. It is a relatively less expensive source of energy for animals. The nutritive value of cassava as an animal feed has been well documented in the United States as early as 1902, and it is now being used in Europe on a large scale for commercial feed production. The economic value of cassava, however, depends on the prices of other cereals, mainly corn, and protein supplements such as soybean meal.

In this study, whole corn and soybean meal prices of $280 and $500 per ton in 1983 were used in the price analyses. The maximum cassava pellet price of $225 per ton was determined based on the fact that four parts cassava and one part soybean meal can replace corn. Since this price was higher than an estimated price of $196 per ton of imported Thai cassava pellets, it was economically feasible to import cassava from Thailand for the manufacturing of animal feeds on Guam.

If cassava pellets and soybean meal were imported instead of corn at the aforementoned prices, the substitution cost would be $257 per ton based on a 4 to 1 ratio of cassava-soybean meal mixture. This represents a reduction of 8 percent compared with $280 per ton of whole corn.

The economic feasibility of growing cassava on Guam for commercial feeds depends on the competitiveness of this crop which can be determined by the estimated maximum price of $225 per ton. This price indicated that in order to compete with imported corn, cassava pellets produced on Guam must cost less than eleven cents per pound and fresh cassava roots would be worth less than four cents per pound based on a conversion ratio of 2.53 tons of roots to one ton of pellets. This basic economic consideration is very important because the replacement of corn by cassava is feasible only when the price of the nutritionally equivalent mixture of cassava-soybean meal is lower than that of corn to be substituted. Therefore locally grown cassava roots must cost less than 4 cents per pound in order to compete with imported corn.

Market prices for cassava on Guam are not well established because it has not been grown commercially. A price of $0.50 per pound was reported by the Naval Supply Depot on Guam in 1982. The price has to be significantly lower than $0.50 per pound before it can become a competitive feed. It is very unlikely that cassava can be grown profitably on Guam for commercial feed purposes, given the estimated import price of cassava and the price of imported corn at $0.14 per pound.

The feed mill on Guam would substitute a cassava-soybean meal mixture by using locally produced or imported cassava products, whichever costs less, for imported corn only if the price of the mixture is

Table 2 Estimated Levels of Production and Land Requirement for Selected Crops on Guam with Population Growth, 203

	Per Capita Consumption[2]	Total Production[3]		Land Requirement[4]		
Crop[1]	High	Low	High	Low	High	Low
	(pounds)	(1,000 pounds)		(acres)		
Avocado	1.87	1.70	268.7	257.2	36.8	35.2
Banana	13.38	11.92	1,653.8	1,473.3	80.3	71.5
Beans	4.21	1.32	585.4	183.6	162.6	51.0
Bitter-melon	2.58	1.04	398.6	160.7	33.8	13.6
Cabbage, Chinese	6.30	6.08	730.0	704.5	61.9	59.7
Cabbage, Head	13.49	7.32	83.4	45.2	7.7	4.2
Cantaloupe	6.21	5.79	414.4	411.5	45.0	44.7
Corn	1.53	0.90	236.4	139.1	73.9	43.5
Cucumber	8.38	5.64	1,294.7	871.4	115.6	77.8
Eggplant	6.88	1.59	977.9	226.0	120.7	27.9
Onion, Green	4.90	1.41	378.5	108.90	122.1	35.1
Pepper, Bell	6.00	2.40	648.9	108.2	166.4	27.7
Radish	2.70	0.28	333.7	34.6	47.7	4.9
Sweet potato	3.30	1.96	331.4	196.8	29.3	17.4
Tomato	14.98	13.54	1,851.5	1,673.5	272.3	246.1
Watermelon	18.88	6.36	2,917.0	982.6	219.9	71.7
Total			13,104.3	7,586.1	1,596.0	832.0

lower than the price of corn. Since cost reduction could be realized by using cassava pellets and soybean meal to replace corn, efforts should be made to use cassava from the least expensive source of supply for animal feeds if the feed mill on Guam is to become economically viable, and if the livestock industry on the island is to be developed. Guam can certainly capitalize on its duty free port status. Guam also has excellent port facilities and is close to Thailand, the world's largest exporter of cassava products.

Should a tuna cannery and a slaughterhouse be built in the future, the by-products of these plants could also be utilized as sources of protein for feeds. To be competitive, the feed mill on Guam must capture a sizeable market share in order to produce feeds efficiently by achieving economies of scale. Forward integration by the feed mill into poultry and/or hog farms will assure a constant internal demand for feeds in addition to the open market demand.

II. PRODUCE MARKET POTENTIALS

Agricultural development on Guam is hampered by the lack of a reliable irrigation system, agricultural loans, farm labor, agricultural support services such as market information and crop insurance programs, and inadequate infrastructure such as access roads, storage and handling facilities. The presence of pests and diseases also hinder agricultural development. Assuming optimistically that these problems will be successfully addressed, agriculture on Guam can be further developed. One way to stimulate more agricultural production on Guam is to increase the local market share of import substitution crops.

There are four major factors affecting per capita consumption of fresh fruit and vegetables on Guam: per capita income, prices, the availability of produce, and taste and preferences. In 1980, per capita income in the U.S., and Hawaii was $11,566 and $10,196, and the latest report on Guam was $4,198 in 1978. Since per capita income is lower and produce prices are generally higher on Guam than in the U.S., it is likely that per capita consumption of most produce on Guam would be lower than in the U.S.

Per capita consumption in Hawaii, shown in Table 1, was based on the market supply of each crop and the de facto population of 1,055,900 in 1980. The market supply is the total of local produce and import, and the de facto population is the number of people physically present in an area, which includes tourists and excludes residents temporarily absent. The de facto population on Guam in 1980 was 108,750.

Import substitution appears to be the most viable agricultural development strategy for Guam in the immediate future. However, this development will be limited. Even if the production of import substitution

Table 3 Comparision of the Number of Acreage Harvested During 1980-82 and the Estimated Land Requirement for 2035

	Acres Harvested			Estimated Land Requirement[1]	
Crop	**1980**	**1981**	**1982**	**High**	**Low**
			(acres)		
Avocado[2]	31.8	22.4	15.6	36.8	35.2
Banana	14.8	16.2	9.7	80.3	71.5
Beans	40.7	36.6	38.4	162.6	51.0
Bittermelon	16.9	5.5	8.0	33.8	13.6
Cabbage, Chinese	8.3	6.2	3.9	61.9	59.7
Cabbage, Head	1.8	14.5	13.0	7.7	4.2
Cantaloupe	12.7	12.5	24.5	45.0	44.7
Corn	3.3	4.5	7.0	73.9	43.5
Cucumber	56.2	49.2	41.0	115.6	77.8
Eggplant	28.0	8.4	11.3	120.7	27.9
Onion, Guam	3.8	1.8	4.5	122.1	35.1
Pepper, Bell	19.0	9.8	9.5	166.4	27.7
Radish	3.6	3.0	1.4	47.7	4.9
Sweet Potato	22.3	4.3	9.0	29.3	17.4
Tomato	14.3	29.9	29.1	272.3	246.1
Watermelon	200.2	144.5	206.3	219.9	71.7
Total	477.7	369.3	432.2	1,596.0	832.0

[1]See Table 2.
[2]Acres harvested are based on 45 trees per acre.
Source: Guam Department of Agriculture, Annual Report, Various years.

crops were to increase to the estimated self-sufficiency level, the potential for expansion and the economic significance of these crops would not be as great as had been suggested due to the overestimation of their per capita consumption on Guam. Given the limited market on Guam without alternative export or processing markets, it is not economically adviseable to aim at 100 percent self-sufficiency for import substitution crops because overproduction resulting from overplanting or bumper harvests would glut the market and depress farm prices. Therefore, the market share which a particular crop can achieve will depend partly on seasonality patterns on Guam, dry and wet seasons, as well as in the U.S., Japan, the Commonwealth of the Northern Marianas and Taiwan where competitive crops are grown and exported to Guam.

III. GUAM PINEAPPLE INDUSTRY

In the pineapple industry on Guam the control of superior production techniques by the established growers is a barrier to entry for prospective growers. At the present time there are very few growers who have experience in applying calcium carbide to induce flowering and fruiting of pineapple out of the natural season. As a result, there is a noncompetitive market in this industry. Pineapple grown on Guam is priced as high as imported Hawaiian pineapple without inducing competition from Hawaii. However, this high price has attracted new entrants into the industry and increased competition and lower prices are expected. Although there is a lack of competition in this industry, prices of locally grown pineapple are checked by prices of Hawaii pineapple and shipping costs. Despite its noncompetitive market structure, the existence of the pineapple industry on Guam is desirable as far as the agricultural development on Guam is concerned. This industry can serve as a model of how specialization and commercial scale farm production on Guam can reduce or eliminate some agricultural imports.

Pomology

R. Rajendran

I. Fruit Crop Survey

A survey of the fruit crops of Guam was initiated in 1983. One hundred and twenty-nine different species of fruit trees producing edible fruits or nuts were identified. The botanical name, English, Chamorro and Filipino equivalents for these are given in Table 1. Fruits of commercial potential are marked with an asterisk. The survey will continue to locate acclimatized, elite cultivars.

This year promising cultivars were identified in mango, lemon, grapefruit, sour orange, and star fruit. Cultivars of identified lemon, grapefruit and star fruit have been planted at the Experiment Station field for further study. Root sticks of mango, citrus and avocado have been raised for further study and for receiving scion material of selected plants.

Attempts were made to graft mango during the rainy season. Interference from fungal pathogen limited success. Further attempts will be made during the dry season.

II. Papaya

An experiment on papaya *(Carica papaya L.)* performance and planting density was initiated, using three (3) different local cultivars, an introduction from Truk island and the 'Solo' variety as control.

Materials and Methods

Promising single plants growing in isolation were selected and seeds collected from them were sown in black polyethylene bags containing potting mixture. Pigmentation segregation at the seedling stage was observed in most of the lines. Only five cultivars were found to be uniform. Four of the five were taken for the present experiment.

The seedlings were transplanted to two separate fields in a randomized block design with two replications in each. In one field planting was done at 11 x 11 feet and the other 6 x 6 feet to give each plant an area of 121 and 36 square feet per plant respectively. Dwarf Hyacenth bean *(Dolichos lablab)* was planted as an intercrop to provide mulch.

Results

The papaya cultivars were segregated into three groups; male, female and hermaphrodite. The male trees were unproductive. The hermaphrodite plants produced cylindrical or pear shaped fruits. The dwarf hermaphrodite plants produced both long, and oval fruits with deep ridges. The number of fruits per plant was higher in the female plants than the hermaphrodite trees of the same cultivars.

The dwarf selections bore flower on eary nodes at lower height and were the earliest. Wider spacing produced flowers early and fruit matured early. But the total number of fruits per plant were greater with closer spacing and they needed less weeding and cultural operations.

Tables 2 and 3 give the initial observation under the two spacing trials.

Table 1. List of fruits that could potentially be grown on the island of Guam

Scientific Name	English	Chamorro	Filipino
Adonsonia digitata	Monkey Bread Tree	------	Lumbang
Aleurites fordii	Tung oil	------	------
Aleurites moluccana	Candlenut	Kukui	Lumbang
Anacardium occidentale	Cashew nut	Kasoy	Kasoy
Ananas comosus (L.) Merrill	Pineapple**	Pina	Pina
Annona muricata L.	Soursop*	Laguana	Guyabano
Annona reticulata	Custard apple*	Anonas	Anonas
Annona squamosa L.	Sweetsop*	Atis	Atis
Antidesma bunius	Bignay	Bignay	Bignay
Areca catechu	Betel nut**	Pugua	Bunga
Artocarpus altilis (syns. A. Communis)	Breadfruit**	Lemai	Rimas
Artocarpus heterophyllus Lmk. *(A. integerifolia)*	Jakfruit*	Langka	Nanka
Artocarpus integer	Champeden	Lemasa	Champendak
Artocarpus mariannensis	Marianas bread-fruit*	Dokdok	------
Averrhoa bilimbi L.	Picklefruit, cucumber tree	Pickue	Kamyas
Averrhoa carambola L.	Starfruit*	Bilimbines	Bilimbing
Bactris gasipaes	Pejibaja palm	------	------
Bixa orellana	Lipstick tree	Achote	Atsuwete
Cananga odorata	Ylang-Ylang	Ylang-Ylang	Ylang-Ylang
Cappais cordiflora (G. Kmoriana)	Capers	Atkaparas	Atcapara
Carica papaya L.	Papaya**	Papaya	Papaya
Carissa grandifolia	Natal palm	------	------
Chrysophyllum cainito L.	Star apple	Cainito	Kaimito
Citrofortunella mitis (Citrus mitis)	Calamondin*	Kalamansit	Calamanch
Citrus aurantifolia	Lime**	Limon	Limon
Citrus aurantium L.	Sour orange	Kahet	Massim na Kahel

Table 1, con't.

Citrus grandis (L.) Osbeck	Pummelo*	Lalangha	Suha
Citrus hystrix (C. histrix)	Mauritius	Admedo	
Citrus limonia	Lemon**	Limon	Limon
Citrus macroptera L.	Melanesian papeda	Kahet	------
Citrus medica L.	Citron	Setlas	------
Citrus paradisi Maclady	Grapefruit**	Kaheetmaagas	
Citrus reticulata Blanco.	Mandarin*	Lalanghita	Dalanghita
Citrus sinenis L.	Orange*	Kahet	Kahel
Coccoloba uvifera	Sea grape	Sea grape	------
Cocos nucifera L.	Coconut**	Niyog	Niyog
Coffea arabica	Arabian coffee	Cafen arabia	Kape
Coffea canephora (C. robusta)	Robusta coffee	Cafe	Kape
Coffea liberica	Liberian coffee	Cafen liberia	Kape
Cordia dichotoma (C. myxa)	Sebestan plum	------	------
Cordia sebestena	Geiger tree	------	------
Cordia subcordata	Cordia	Niyoron	------
Cycas circinalis	Federico palm	Fadang	Federico
Cyphomandra betacea	Tree tomato	Tamarillo	Kadyotong
Diospyros discolor (D. mabolo)	Butter fruit	Mabolo	Mabolo
Diospyros digyna (D. ebenaster)	Black sapote	Chico	Sapote
Diospyros kaki L.F.	Persimmon	------	------
Discocalyx megacarpa	------	Otot	------
Dovyalis caffra (Aberia caffra)	Kei apple	------	------
Dovyalis hebecarpa (A. gardneri)	Ceylon gooseberry	katembilla	------
Duchesnea indica	Indian strawberry	Strawberry	Strawberry
Elaeis guineensis	Oil palm	------	Oil palm
Eriobotrya japonica (Thumb) Lindl.	Loquat	Loquat	------
Eugenia palumbis	Palomo's jossina	Agatelany	Lambog
Eugenia reinwardtiana	Common jossina	A'abang	------
Eugenia thompsonii	------	Atoto	------
Eugenia uniflora L.	Surinam cherry	Pitanga	Serale
Ficus carica L.	Fig	Higo	Balite
Ficus tinctoria	Eild fig	Hoda	------
Garcinia mangostana L.	Mangosteen	Mangosteen	Mangosteen
Grewia crenata	Grewia	Angilao	------
Guamia mariannae	Custard apple	Paipai	------
Hevea brasiliensis	Para rubber	Tronlo-Goma	Goma
Hibiscus sabdariffa	Roselle	Roselle	lampunaya
Inocarpus edulis	Polynesian chestnut	Budo	Buoy
Lansium domesticum Corr.	Langsat	Lanson (Duke)	Lanzone
Litchi chinensis Sonn.	Lychee	Lychee	Letsiyas
Macadamia integrifolia M&B.	Macadamia nut	Macadamia nut	Macadamia nut
Malpihghia glabra	Barbados cherry	Escobillo	------
Malpihghia punicifolia L.	Acerola	------	------
Mangifera indica L.	Mango**	Manga	Manga
Mangifera odorata Griff.	Saipan mango	Manga de Saipan	Manga
Manihot glaziovii	Ceara rubber	Tronko-Goma	------
Manilkara zapota L. Royen. *(M. achras)* (Mill.) Fosberg.	Chicle	Chico	Chico
Merrilliodendron megacarpum	Faniok	Faniok	------
Metroxylon amicarum	Ivory nut palm	Pina-D'-Mudfit	Ivory palm
Monstera deliciosa	Fruit salad plant	Monstera	------
Morinda citrifolia	Indian mulberry	------	------
Moringa pterygosperma (M. oleifera)	Horseradish tree	Malungay	Palunggay
Mori (Gaindica)			
Morus alba	White mulberry	------	------

Table 1, con't.

Morus rubra, nigra	mulberry**/Black	------	------
Muntingia calabura	Panama cherry	Manzanita	Kalabura
Musa acuminata	Banana*	Chotda	Saging
Musa acuminata f. nana	Dwarf banana	Chotda	Saging
Musa paradisiaca	Plantain**	Chotda	Saging
Musa sapientum	Banana	Chotda	Saging
Musa textiles	Manila hemp	Abaca	Abaca
Myrica rubra	Strawberry tree	------	------
Myciaria cauliflora	Jaboticaba	Duhat	Duhat
Mycristica fragrans Houtt.	Nutmeg	------	------
Nephelium lappaceum L	Rambutan	Rambutan	Rambutan
Nephelium longan Camb. *(Euphoria longan)*	Longan	Longan	Longan
Nopalea cochenillifera	Cactus	lengua-de-vaca	------
Orchrosia oppositifolia	Nipa palm	Nipa palm	Nipa palm
Pachira aquatica (P. macrocarpa)	Wild plumeria	Fago	------
Pandanus dubius	Screwpine	Pahong	------
Pandanas fragrans	Screwpine	Kafo	------
Pagnium edule	Football fruit	Raval	Raual
Passiflora foetida	Wild water lemon	------	------
Passiflora edule f. flavicarpa Deg.	Yellow passio-fruit	Passion-fruit	Passion-fruit
Persea americana Mill.	Avocado**	Alagata	Abokado
Phoenix dactylifera	Date palm	Dathes	Bunga
Phyllanthus acidus	Otaheite gooseberry	Iba	Bangkiling
Pithecellobium dulce (Igna dulcis)	Stink bean	Kamachile	Kamatsile
Pouteria campechiana	Eggfruit	------	------
Pouteria sapota	Mamey sapote	Sapota	Sapota
Prunus persica	Peach	------	Peras
Psidium littorale f. littorale	Yellow cherry guava	Abas	Bayabas
Psidium littorale f. longipipes	Red cherry guava	Abas	Bayabas
Psudium guajava L.	Guava**	Abas	Bayabas
Punica granatum L.	Pomegranate*	Granada	Granada
Sandoricum Koetjape	Santol	Santol	Santol
Sesbania grandiflora	Sesban	Katurai	Katuray
Spondias cytherea (S. dulcis)	Otaheite	------	------
Spondias purpurea	Spanish plum	Siniguelas	Siniguelas
Syzgium cumini (Eugenia cumini)	Java plum	Lumbuoy	Jambolan
Syzgium malaccense L. Merr. & Perry *(E. Mallaccensis)*	Malay apple	Macupa	Makopa
Syzgium samaragense (E. javanica)	Wax apple	Macupa	Makopa
Tamarindus indica L.	Tamarind*	Camalindo	Sampaloc
Terminalia catappa	Tropical almond	Talisai	Talisai
Theobroma cacao	Cacao	Cacao	Cacao
Triphasia trifolia	Lemon berry	Lemon-di-china	------
Vitis rotundifolia	Grape	Ubas	Ubas
Eimenia americana	Wild olive	Pi'ut	------
Xylocarpus moluccensis (oil source)	Cannon ball	Lalanyog	------
Ziziphus mauritiana	Indian jujbe	Mansana tagalog	------

*Priority I
**Priority II

Conclusion

Local cultivars have potential for further adaptation as a variety.

For Guam's soils and environment, closer planting of papaya will provide higher yields per unit area.

Dwarf papayas with large fleshly pink fruits are more suitable for Guam as they are less susceptable to tropical winds, have good transport and storage qualities, and multiple uses.

Self grown papayas which are of poor commercial value deteriorate the good cultivares due to cross-pollination.

Table 2 (11 x 11 ft. spacing)

	Height of Plant at the end of Dec.	Node of first flowering	Height of first fruit	Average size of market-able fruit lbs.	No. of fruits set per plant	TSS variation
Solo	250 cm.	29-32	49 cm.	1.32	43	13-17
Dwarf red fresh	124 cm.	12-18	18 cm.	4.87	40	9.14
Semi dwarf red fresh	150 cm.	18-24	24 cm.	5.12	27	9-14
Tall yellow fresh	208 cm.	32-35	54 cm.	2.30	35	12-15
Introduction from Truck	278 cm.	35-41	69 cm.	2.21	30	13-15

Table 3 (6 x 6 ft. spacing)

	Height of Plant at the end of Dec.	Node of first flowering	Height of first fruit	Average size of market-able fruit lbs.	No. of fruits set per plant	TSS variation
Solo	263 cm.	29-32	48 cm.	1.22	44	13-17
Dwarf red fresh	129 cm.	12-18	23 cm.	4.93	43	9.14
Semi dwarf red fresh	158 cm.	18-29	27 cm.	5.31	27	9-16
Tall yellow fresh	209 cm.	32-37	50 cm.	2.31	34	12-15
Introduction from Truck	278 cm.	35-43	61 cm.	2.11	31	13-15

Limitations in Production of Crops Due to Pathogens, Pests, Typhoon, Production Problems, Marketing and Nutrition

Fruit	**Pathogen**	**Pest**	**Typhoon**	**Production Problem**	**Home Garden**	**Market Garden**	**Export Prod.**	**Nutrition**
Avocado	1	2	1	2	1	1	3	2
Banana	3	3	3	1	1	1	3	2
Betel Nut	1	2	1	1	1	1	1	1
Breadfruit	3	2	1	1	1	2	3	2
Coconut	3	3	1	1	1	1	2	3
Custard Apple	2	2	1	1	1	2	3	1
Grapefruit	1	2	3	1	1	1	3	2
Guava	1	2	1	1	1	1	3	3
Jackfruit	1	1	2	1	1	2	3	2
Lemon	3	2	1	1	1	1	3	3
Lime	3	2	1	1	1	1	3	2
Mango	3	3	1	2	1	1	3	3
Orange	3	2	1	2	1	1	3	2
Papaya	3	2	3	1	1	1	3	4
Passion fruit	4	1	2	1	1	3	3	2
Pineapple	2	1	1	1	3	1	2	1
Pomello	3	2	2	1	1	1	2	2
Sour sop	2	1	1	1	1	1	3	2
Star fruit	4	4	1	1	1	1	2	2
Sweet sop	2	1	1	1	1	1	3	2
Tangerine	3	2	1	1	1	1	3	2
China lemon	3	1	1	1	1	1	4	2

1, 2, 3, and 4 represent, in ascending order, the seriousness of the problem