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Evaluation of Papaya Lines and Cultural Practices at Moloaa, Island of Kauai, Hawaii

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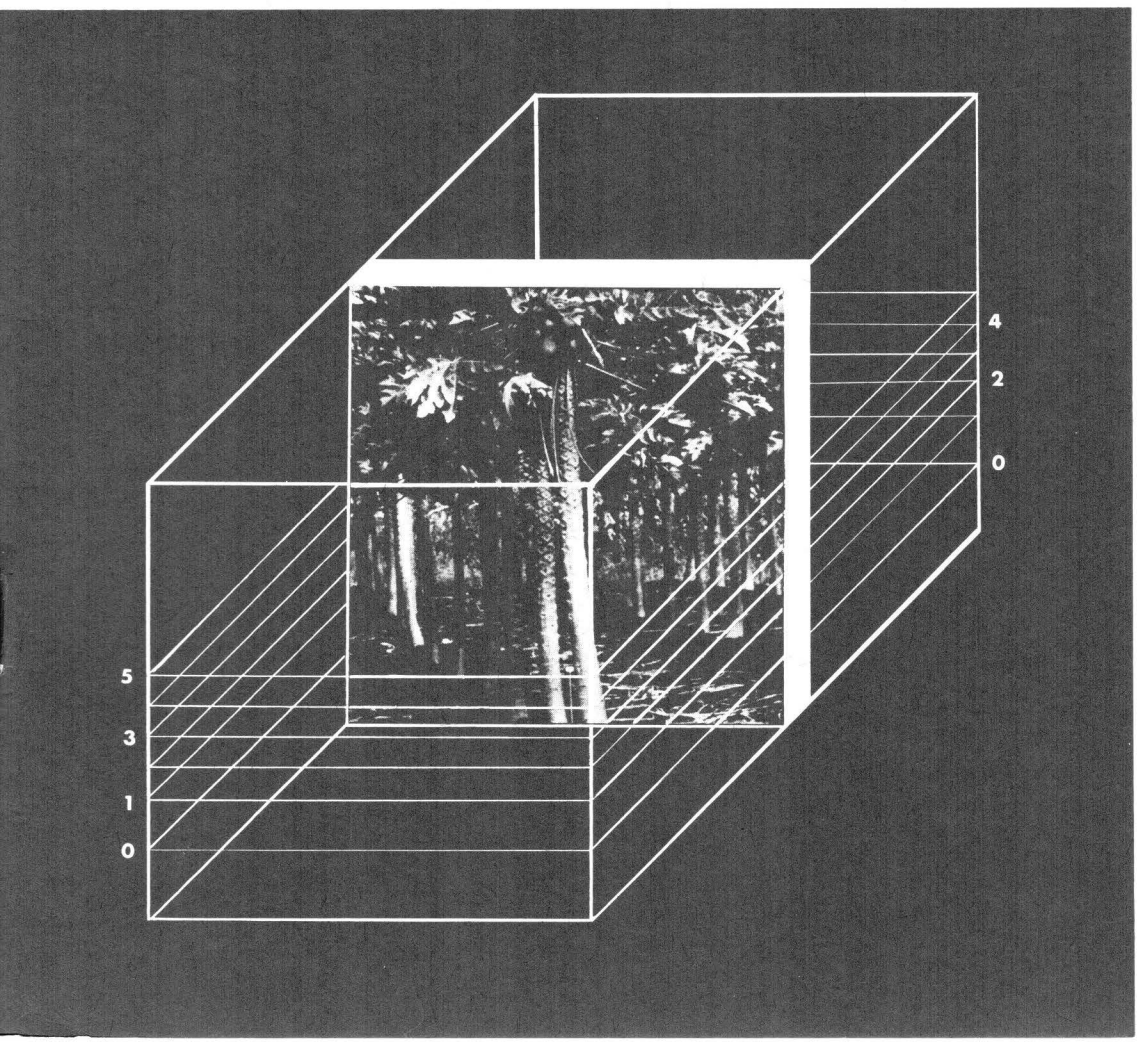

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EVALUATION OF PAPAYA LINES AND CULTURAL PRACTICES AT MOLOAA, ISLAND OF KAUAI, HAWAII

Warren Y. J. Yee, Terry T. Sekioka, Henry Y. Nakasone, Dennis K. Ikehara, Jeri J. Ooka, Ernest K. Akamine

INTRODUCTION

The land at Moloaa, Island of Kauai, Hawaii, was intensely cultivated with sugarcane or pineapples for more than 50 years. When these crops were phased out in 1973 because of insufficient returns, small farmers supported with Hawaii State funds attempted to grow papayas in the area. Being unfamiliar with the area, the growers requested assistance from the State. Under a joint agreement involving members of the Moloaa Farmers' Cooperative, the University of Hawaii's College of Tropical Agriculture and Human Resources, and the Kauai Task Force (State supported), the Horticulture Department of the College was given the responsibility to: (1) develop cultivars adapted to Moloaa by evaluating advanced hybrid lines and segregating populations, and (2) develop a model papaya demonstration farm, using the latest cultural practices and technologies available and obtain information that would be helpful to the growers. Other departments in the College that were involved in the Project included Agricultural Engineering, Plant Pathology, Plant Physiology, and the Soils section of the Agronomy and Soils Department.

Because time was important to the growers and the Project would take approximately three years to complete, periodic field days were scheduled to keep growers abreast of developments, so that farm management changes could be made as soon as pertinent information became available.

MATERIALS AND METHODS

Two acres were used in the trials, with approximately one acre for cultivar and selection evaluations and the other for cultural practices. Soil preparation included subsoiling, plowing, harrowing, and broadcasting of 2000 pounds lime per acre. Lime was added to the soil because pH 4.7 was considered less than minimum for the optimum growth and production of papayas. Wild sugarcane (*Saccharum* hybrid clone 'Moentai'), ironwood (*Casuarina equestifolia*), and brush box (*Tristania conferta*) were planted around the perimeter to provide wind protection against strong tradewinds and rainy weather, which, when occurring at the same time, could cause uprooting of the papaya trees. Drip irrigation was installed, and microtubes of 0.036-inch diameter were used as emitters to deliver the water from 1/2-inch plastic lateral lines. Seeds were planted in 3-inch peat pots. Two papaya seedlings were transplanted into each hole. The double-row system of spacing of plants was used. Toxaphene bait at 90 pounds per acre was applied for cutworm control. Four months after transplanting, the sex of the trees was determined and one tree was allowed to grow at each hole. Each double row consisted of 40 or more plants. The soil was not fumigated for nematode control although soil test samples showed the presence of *Helicotylenchus* (spiral) and *Rotylendulus* (reniform) nematodes. *Meloidogyne* (root-knot) and *Pratylenchus* (lesion) type nematodes were absent.

PART A—EVALUATION AND SELECTION

The line evaluations consisted of 9 Hawaii Agricultural Experiment Station (HAES) inbred advanced lines and 1 grower line. The inbred advanced lines were 'Higgins', 'Wilder', and lines 26, 34, 37, 40, 93, 96, and 116; the grower line was 'Kapoho' Solo. Studies on selection of individual trees showing adaptability and commercial characteristics were conducted with the following segregating populations: 197_2, $108F_2$, $110F_2$, $181S_2$, 233bc, and 234bc. Traits evaluated in the line-testing phase included average fruit weight; average percent total soluble solids; flesh color and firmness; average number of fruits per tree and average pounds of fruits per tree; uniformity of fruit size and shape; degree of carpellody or sterility; and *Phytophthora* root rot tolerance.

Factors evaluated in the segregating lines were the same as those in the inbred line trials but more general in nature, and detailed data were not recorded.

Seeds were sown on January 21, 1975, and field transplanted in May 1975. There were 4 replications with 8 trees per replication in the inbred line evaluations. The segregating line selection consisted of 8 lines with 50 trees per line.

Results and Discussion

Of the 9 inbred advanced lines tested, 'Higgins' and HAES $26F_6$ compared favorably with 'Kapoho' Solo in fruit size and shape, firmness, and production tendency. Table 1 lists the characteristics and performance of each of the lines tested. 'Higgins' showed a multiple-fruiting tendency. Although its yields were high, 10–20 percent of the fruits were less than minimum in weight. Subtracting 20 percent of the fruit weight from estimated production, per-acre yield of 'Higgins' was still higher than the grower line, 'Kapoho' Solo.

HAES $26F_6$ also showed promise as a commercial line, with smooth, well-shaped, uniform fruits; however, the relatively low percent total of soluble solids was unexpected, because refractometer readings taken at the Waimanalo Branch Station on the Island of Oahu have shown 13.5–15 percent.

Higgins and $26F_6$ showed some resistance to powdery mildew. Seeds of these 2 advanced lines tested were recommended for trial plantings by growers.

Ten selections were made from segregating lines $107F_2$ (1 selection); $108F_2$ (4 selections), $174F_3$ (3 selections), and 234bc (2 selections). A short description of each selection is listed below:

1. $107F_2$ (R2-H21) smooth, 1-lb fruits; good production; best overall performance in this population.
2. $108F_2$ (R4-H18) smooth, 14- to 16-oz fruits; less compaction than others.
3. $108F_2$ (R5-K25) smooth, 15-oz fruits; good fruit set but somewhat compacted due to multiple fruiting. May produce selections with less compaction in next generation.

Table 1. Tree and fruit characteristics of 9 inbred advanced lines and the Kauai selection of 'Kapoho' Solo planted by growers

Lines	Average fruit weight (lb)	Average soluble solids (%)	Flesh color	Average number fruits per tree[a]	Average yield per tree (lb fruit)	Estimated total yield (lb fruit/acre)[b]
'Higgins'	0.9	13.7	orange	56.3	55.7	38,489
'Wilder'	1.2	12.6	orange	24.9	29.9	20,661
'Kapoho'	0.95	13.4	orange	36.5	34.7	23,978
$26F_6$	1.0	11.4	light orange	31.6	31.6	21,836
$34F_6$	1.12	10.5	orange	21.5	24.1	16,653
$37F_6$	1.17	12.1	light orange	33.7	39.4	27,225
$40F_5$	1.74	11.2	orange	26.3	45.8	31,648
$93F_4$	1.64	11.7	orange	29.6	48.5	33,514
$96S_4$	1.0	11.5	light orange	30.82	30.8	21,283
$116S_5$	0.89	12.0	pink	36.75	32.7	22,596

[a] Average of 4 replications; fruit count included all fruits.
[b] Estimates based on 691 trees per acre (spacing 7 × 7 × 11 ft) from approximately 1–76 to 5–77.

4. 108F_2 (R6-H28) 16- to 22-oz fruits; smooth, slight compaction.
5. 108F_2 (R6-K28) 15-oz fruits; smooth, some compaction.
   NOTE: The last 2 selections in 108F_2 seem to be the best trees in this population. Fruits are very smooth and firm even upon coloring.
6. 174F_3 (R10-H25) smooth, 14- to 16-oz fruits; good production.
7. 174F_3 (R11-K16) smooth, 16- to 20-oz fruits; very productive, firm; low carpellody and sterility.
8. 174F_3 (R11-K25) 15- to 18-oz fruits; very productive, vigorous tree.
9. 234bc (R15-H6) 14- to 18-oz fruits; slightly ridged; tree has short, obliquely upright leaf petioles.
10. 234bc (R15-H11) 14- to 16-oz fruits; fruits slightly ridged; short, obliquely upright petiole.
    NOTE: 234bc is an attempt to produce a short, upright-petiole type of tree to increase number of trees per acre without reducing production and fruit quality.

Other lines were eliminated for various reasons such as high carpellody or high sterility; large fruits; compaction; and soft fruits. Line 233bc was completely eliminated because many trees produced fruits that tasted bitter.

Self-pollinated seeds were obtained from all selections to produce the next generation for evaluation.

Important factors to consider in the development of new cultivars for the export markets are: (1) tolerance to the standard disinfestation treatment, and (2) shelf life. Disinfestation consists of submersion of fruits in 120°F water for 20 minutes followed by cooling in water for 20 minutes and then fumigating with ethylene dibromide at the rate of 1/2 lb/1000 cubic feet of fumigation chamber space for 2 hours at ambient temperatures. Papaya lines that showed promise were subjected to disinfestation treatment and then stored at 55°F for 6 days to simulate shipping storage conditions. Presented in Table 2 are observations, after storage at room temperature, of two shipments that showed that the shelf life of promising papaya lines in the Moloaa Project was similar to shelf life in other areas of production and with other varieties tested.

Table 2. Tolerance of selections made to disinfestation treatment and shelf life

Cultivar or selection	Initial surface color (%)	Storage	Number of fruits	Average salable days at room temperature
$26F_6$	2–30	Stored 6 days at 55°F and removed to room temperature storage	20	7.6
			20	6.5
'Higgins'	25–85[a]	"	20	4.6
			20	4.2
'Kapoho'	0–30	"	23	6.1
			23	4.3
'Waimanalo'	5–25	"	19	7.3[b]
			19	4.9

[a] The advanced degree of ripeness of 'Higgins' at the initial stage has probably contributed to its lower number of salable days.

[b] A significant observation noted was the susceptibility of 'Waimanalo' to storage decay caused by *Rhizopus* and anthracnose.

Table 3. Effects of spacing and irrigation levels on trunk diameter, tree height, and fruit count per tree (August 11, 1975–October 6, 1977)

Treatment	Trunk diameter (inches)	Tree height (feet)	Fruit count/tree[a]
Spacing 6 X 6 X 11 feet (854 plants)			
Low irrigation[b]	6.02	15.20	179.34
High irrigation[c]	6.78	16.85	210.08
Average	6.40	16.03	194.71
Spacing 8 X 6 X 11 feet (640 plants)			
Low irrigation[b]	6.80	16.21	206.16
High irrigation[c]	6.84	16.83	233.13
Average	6.82	16.52	219.65

[a] Harvest period October 1976–March 1978.

[b] Approximately 3 gal/day.

[c] Approximately 6 gal/day.

Note: Irrigation level not consistent because of pressure differences due to amount of water available in storage tank.

PART B—CULTURAL DEMONSTRATIONS

The cultural trial was divided into two blocks. Block I consisted of factors involving fertilization, spacing, and irrigation. Generally, treatments for these factors were comparisons between the recommended practice and general farmers' practice. Data were taken from October 1976 to December 1977.

Seeds were planted on August 11, 1975, and transplanted into the orchard on October 30, 1975. In addition to soil preparation as discussed earlier, 1 pound of treble superphosphate was mixed with the soil at the bottom of each hole just before transplanting and irrigation.

Planting and field preparation procedures of Block II were the same as those of Block I; however, trees were planted later. Treatment groups consisted of 20 or more trees. Treatments were suggested by papaya growers, agricultural business agents, and University of Hawaii personnel. The treatments included mulching, soil fumigation, "Jorgen" nutritional mushroom foliar spray, planting techniques, and fertilization methods.

Block I—Results and Discussion

The results of spacing, irrigation, and fertilization tests in Block I indicate that with good cultural practices and management, papaya production is feasible at Moloaa. The estimated total yield obtainable is competitive with principal papaya-producing areas in the State.

Effects of Spacing and Irrigation Levels on Tree Characters

Trees that were spaced 8 × 6 × 11 feet were more productive and larger in trunk diameter than those planted at 6 × 6 × 11 feet (Table 3). At 6 gallons per day the differences in trunk diameter, tree height, and fruit count per tree between the two planting distances decreased (Table 3). This seems to indicate that the closer spacing of 6 × 6 × 11 feet is still sufficient for normal growth if there is adequate moisture.

Effects of Spacing and Irrigation Levels on Average Fruit Weight

The results in Table 4 did not provide sufficient evidence to support the belief that close spacing will reduce fruit size as this was not apparent in the spacings used. Fruit weight was not significantly affected by the difference in irrigation levels, indicating that the irrigation levels were not wide enough to cause differences either at the high- or low-density planting.

Table 4. Effects of spacing and irrigation levels on average fruit weight

Treatment	Date and fruit weight (in pounds)			
Spacing 6 X 6 X 11 feet (854 plants/acre)	6/13/77	9/16/77	12/27/77	Avg. Wt.
Low irrigation	1.01	.96	1.12	1.03
High Irrigation	.99	.93	1.14	1.01
Average	1.00	.95	1.13	1.02
Spacing 8 X 6 X 11 feet (640 plants/acre)				
Low irrigation	.99	.88	1.09	.99
High irrigation	.88	.93	1.12	.98
Average	.94	.91	1.11	.99

Effects of Spacing and Irrigation Levels on Percent Total Soluble Solids

Data in Table 5 seem inconsistent and possibly indicate sampling error, but they do support experimental work carried on at Princess Orchards at Pulehu, Island of Maui, that indicated that total soluble solids are not affected by differences in irrigation rates. On the other hand, the data show that the sugar levels tend to increase from May to November, with a possible decline setting in during December. Plant spacing did not seem to affect the percent total soluble solids during the 8-month period.

Effects of Fertilizer Treatments with Two Lime Levels on Fruit Count

As shown in Table 6, the highest fruit count in both lime plots was obtained in treatment F_1, with 2 pounds of treble superphosphate placed at the bottom of the planting hole and .20–.25 pound 16–16–16 per month until flowering, followed by .75 pound of 16–16–16 broadcast on the soil surface bimonthly. Similar to papaya research carried on in 1970–1972 in Puna, Island of Hawaii, the greatest response with phosphorus was in the initial fruit count in relation to the amount of phosphorus applied. Thereafter, the fruit count remained relatively the same, with treatments having 2 or 4 pounds of treble superphosphate. Doubling the amount of treble superphosphate (treatment F_4) was not as effective as the 2 pounds of treble superphosphate used in treatment F_1, possibly because of initial toxicity to the trees.

All fertilizer treatments that had the fertilizer injected into the irrigation system bore less fruit in the initial fruit count than those that had the fertilizer broadcasted. However, fruit counts taken at later dates seem to indicate that fertilization through the irrigation system was just as effective as broadcasting.

Interaction of Spacing, Fertilizer, Lime, and Irrigation

Treatment 11 (Table 7), which consists of 2000 pounds of lime per acre, 6 gallons of irrigation water per day, 2 pounds of treble superphosphate at time of planting followed by broadcasting of .75 lb of 16–16–16 every 8 weeks after flowering, and spaced at 8 × 6 × 11 feet, was found to be most effective in obtaining the highest fruit count, with 270 fruits per tree for the 17-month period. However, treatment 9 with 236 fruits per tree at closer tree spacing was calculated to yield 201,962 fruits, or 28,962 more fruits, within the

Table 5. Effects of spacing and irrigation levels on percent total soluble solids

Treatment	Percent total soluble solids								
	Months, 1977								
	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
Spacing 6 X 6 X 11 feet									
Low irrigation	11.63	13.11	14.18	13.58	13.42	14.38	13.74	13.24	13.41
High irrigation	12.08	12.88	14.18	12.92	14.06	13.48	14.52	13.90	13.50
Average	11.86	13.00	14.18	13.25	13.74	13.93	14.13	13.57	
Spacing 8 X 6 X 11 feet									
Low irrigation	11.42	13.26	14.32	12.78	13.72	14.34	13.94	14.26	13.50
High irrigation	11.42	13.27	14.66	13.34	13.62	14.34	14.00	13.26	13.49
Average	11.42	13.27	14.49	13.06	13.67	14.34	13.97	13.76	

Table 6. **Effects of fertilizer treatments under two lime levels on fruit count per tree at a spacing of 6 X 6 X 11 feet and irrigated at the rate of 3 gallons per day**

Treatment	Number of fruits per tree[a]				
	10/14/76	6/9/77	10/6/77	Per tree total	Per acre/year
High-lime plots (4000 lb/acre)					
F_1 (2 lb treble superphosphate; .20–.25 lb 16-16-16/month until flowering; broadcast .75 lb/tree/8 weeks 16-16-16)	103.50	56.83	45.50	205.83	108,269
F_2 (1 lb treble superphosphate and 1 lb 16-16-16 at planting; .15–.334 lb 16–16–16/tree/month injected)	49.00	45.00	32.50	126.50	66,702
F_3 (2 lb treble superphosphate and 1 lb 16-16-16 at planting; .15–.334 lb 16-16-16/tree/month injected)	68.16	53.08	50.00	171.24	90,294
F_4 (4 lb treble superphosphate; .20–.25 lb 16-16-16/month until flowering; broadcast .75 lb/tree/8 weeks 16-16-16)	81.00	58.90	50.17	190.07	100,223
F_5 (2 lb treble superphosphate; injected .62 lbs 16-16-16/8 weeks)	64.50	52.50	52.17	169.17	89,202
Low-lime plots (2000 lb/acre)					
F_1	106.33	50.17	56.17	212.67	112,140
F_2	66.00	58.17	48.17	172.34	90,874
F_3	37.42	56.75	59.50	153.67	81,029
F_4	85.33	54.50	57.00	196.83	103,787
F_5	96.16	56.67	52.50	205.33	108,269

[a]The number of fruits was obtained by averaging fruits per tree for 17 months. Young fruits counted on 10-6-77 would mature approximately 5 months later.

Table 7. Effects of spacing, fertilizer, lime levels, and irrigation on fruit count

No.	Treatment[a]	Fruit count				
		10/14/76	6/9/77	10/6/77	per tree[b]	per acre/year
1	$I_1F_2S_1L_1$	66.00	58.17	48.17	172.34	103,890
2	$I_1F_2S_1L_2$	49.00	45.03	32.50	126.50	77,257
3	$I_1F_2S_2L_1$	94.16	61.83	60.0	215.99	97,576
4	$I_1F_2S_2L_2$	68.66	46.33	45.67	160.66	72,580
5	$I_1F_1S_1L_1$	106.33	50.17	56.17	212.67	128,202
6	$I_1F_1S_1L_2$	103.50	56.83	45.50	205.83	124,078
7	$I_1F_1S_2L_1$	121.16	62.17	54.0	237.33	107,217
8	$I_1F_1S_2L_2$	95.50	61.83	53.33	210.66	95,168
9	$I_2F_1S_1L_1$	126.66	56.83	53.0	236.49	142,561
10	$I_2F_1S_1L_2$	103.66	53.0	53.83	210.49	126,888
11	$I_2F_1S_2L_1$	148.00	57.17	65.17	270.34	122,130
12	$I_2F_1S_2L_2$	96.50	67.5	71.5	235.5	106,390
13	$I_2F_2S_1L_1$	72.16	57.83	57.5	187.49	113,023
14	$I_2F_2S_1L_2$	72.66	78.0	55.16	205.82	124,073
15	$I_2F_2S_2L_1$	96.83	63.5	74.67	235.0	106,164
16	$I_2F_2S_2L_2$	67.66	67.17	56.83	191.66	86,585

[a] I_1 1.5 gal/2 days; increased to 3 gal/day at flowering.
I_2 3 gal/2 days; increased to 6 gal/day at flowering.
F_1 Fertilization 2 lb treble superphosphate in hole and broadcast .20 lb of 16–16–16/month and increased up to .75 lb/tree/8 weeks at or before flowering.
F_2 1 lb treble superphosphate in hole and broadcast 1 lb 16–16–16 until 3 months. Thereafter inject .15 lb of 16–16–16/tree/month in irrigation water.
S_1 Spacing 6 X 6 X 11 feet (854 plants/acre).
S_2 Spacing 8 X 8 X 11 feet (640 plants/acre).
L_1 2000 lb lime/acre broadcast before planting.
L_2 4000 lb lime/acre broadcast before planting.

[b] The number of fruits per tree is for a period of 17 months since youngest fruits counted will mature approximately 5 months later.

same period. This is a difference of approximately 16.7 percent in productivity per acre. On a yearly basis, the fruit count is 142,561 for treatment 9 as compared with 122,130 for treatment 11.

Data on spacing from Table 4 show that the closer spacing in the trial did not reduce fruit size. Small or undersized fruits could be a marketing problem if reduced fruit size did result from closer spacing. Based on the 1977 average wholesale price of 12 cents per pound, this means that with the closer spacing in treatment 9 as compared to the spacing in treatment 11, there would be $1737 more income per acre if only 50 percent of the fruit were marketed from the date of harvest, October 14, 1976, to March 6, 1978, a period of almost 17 months.

Irrigation is a major cost factor in papaya production at Moloaa. Treatments 5 and 9 (Table 7) are the same except for irrigation rates, which are 3 and 6 gallons of water per day, respectively. On the basis of agriculture water rates of July 1, 1978, the cost of irrigation of these two treatments at 36 cents per 1000 gallon is $.005 per fruit (1-lb average) and $0.009 per fruit, respectively, based on 50 percent marketable fruits.

Calculations below are figured on a per-acre basis for 17 months:

Irrigation Costs

Treatment 5:	181,620 fruits per 17 months' yield	
3 gal/tree × 480 days[1]	=	1440 gal water/tree
1440 gal × 854 trees/acre	=	1,229,760 gal water
$0.20/1000 gal water	=	$245.95/acre
$244.95/90,810[2]	=	.003/fruit
Treatment 9:	201,961 per 17 months' yield	
6 gal/tree × 480 days	=	2880 gal water/tree
2880 gal × 854 trees/acre	=	$491.90
491.90/100,981 lb	=	.005/fruit

At the average wholesale farm price of marketable fruits of 12 cents per pound, and with fruits weighing approximately 1 pound each, the monthly net gain with treatment 9 over treatment 5 with 50 percent marketable fruits is $60.91 per acre per month. However, this does not take into consideration the extra cost of water used to grow the trees before harvesting in treatment 9.

[1] **Irrigation for 16 months with 1 month of adequate rainfall.**

[2] **50 percent marketable fruit.**

Table 8. **Effects of mulch, fumigation, and propagation methods on trunk diameter, tree height, fruit count, total soluble solids, and average fruit weight**

Treatments			Trunk diameter (inches)[a]	Tree height (feet)[a]	Fruit count[b]	Total soluble solids (%)[c]	Average fruit weight (pounds)[c]
Mulch	Fumigation gals/acre BBC	Propagation					
Bagasse[d]	0	Transplanted	7.69	17.46	261.33	12.99	1.01
Wood shavings[d]	0	Transplanted	6.31	15.28	215.42	13.19	1.07
Aluminum painted plastic	0	Transplanted	6.31	16.22	230.17	13.40	1.03
Black plastic	2	Seeded	6.23	15.09	247.08	13.29	1.02
Black plastic	0	Seeded	5.63	14.17	227.08	13.39	0.99
Black plastic	4	Transplanted	6.44	16.17	225.33	13.37	0.97
Black plastic	0	Transplanted	6.29	15.53	220.08	13.38	0.95
Black plastic	2	Transplanted	6.06	14.49	195.58	13.82	1.00

[a]Measurements taken 10–6–77.
[b]Harvest period 10–14–76 to 3–78.
[c]Average of 11 sampling periods through harvesting season.
[d]'Kapoho' Solo. All others 'Waimanalo'.

Block II—Results and Discussion

Effects of Mulch, Fumigation, and Propagation Methods on Tree Characters

Effects of the mulch, fumigation, and propagation treatments are presented in Table 8. The largest trees and the highest fruit count resulted from the bagasse mulch treatment, and the lowest fruit count from the wood shavings mulch.

The BBC fumigation treatments did not produce consistent results. For the direct-seeded plots, the BBC fumigation treatments produced larger plants and more fruits. However, for the transplanted plots, the 2-gallon-per-acre-rate treatment produced smaller plants with fewer fruits than did no fumigation, while the 4-gallon-per-acre-rate treatment produced better plants and more fruits.

The direct-seeded plots and the transplanted plots were planted in the field on the same day. Thus the direct-seeded plants were much younger than the transplanted plants, and this is reflected in smaller trunk diameter and shorter tree height. However, the direct-seeded plots had more fruits than the transplanted plots.

Effects of "Jorgen" on Fruit Set and Total Soluble Solids

The results of the "Jorgen" treatments on the papaya cultivar 'Waimanalo' (Table 9) do not show any advantage over the nontreated controls.

Table 9. Effects of "Jorgen" on papaya cultivar 'Waimanalo' at Moloaa sprayed at 3, 5, and 7 months

"Jorgen" treatment	Trunk diameter (inches)[a]	Tree height (feet)[a]	Fruit count[b]	Total soluble solids (%)[c]	Average fruit weight (pounds)[c]
0	5.50	12.21	159.17	12.06	1.98
4000 ppm	5.04	12.61	158.50	12.05	2.03
8000 ppm	5.54	12.27	144.67	11.84	1.95

[a]Measurements taken 1-78.
[b]Harvest period 10-14-76 to 6-78.
[c]Average of 12 sampling periods through harvesting period.

Table 10. Effects of methods of fertilizer application on trunk diameter, tree height, fruit count, total soluble solids, and average fruit weight

Treatment	Trunk diameter (inches)[a]	Tree height (feet)[a]	Fruit count[b]	Total soluble solids (%)[c]	Average fruit weight (pounds)[c]
Dry only (preplant 2 lb TSP[d]; .25 lb of 16–16–16 per month for 6 months; then .75 lb of 16–16–16 per 8 weeks)	6.25	11.17	92.83	15.43	0.73
Dry and liquid (preplant 2 lb TSP; .25 lb of 16–16–16 per month for 6 months; then 1.33 lb of liquid 9–9–9 per 8 weeks)	6.88	12.08	103.50	15.04	0.72
TSP and liquid (preplant 2 lb TSP; .44 lb of liquid 9–9–9 per month for 6 months; then 1.33 lb of liquid 9–9–9 per 8 weeks)	5.75	10.32	84.67	14.97	0.78
Liquid only (.5 lb of liquid 8–20–8 per month for 5 months; then 1.5 lb of liquid 8–20–8 per 8 weeks for 6 months; then 1.33 lb of liquid 9–9–9 per 8 weeks)	5.83	10.83	71.33	14.86	0.79

[a]Measurements taken 1–78.
[b]Harvest period 7–1–77 to 6–78.
[c]Average of 5 sampling periods through harvesting period.
[d]Treble superphosphate.

Effects of Dry (F_1 Table 6) and Liquid Fertilizer Combinations

The four methods of fertilizer application are presented in Table 10. Although the actual amounts of fertilizer were different initially, at the eighth month the total amounts were quite similar. The treatment that combined dry and liquid formulations produced larger plants and the highest fruit count. The treatment that used only liquid formulations produced the lowest fruit count as well as the lowest percentage of total soluble solids. It should also be pointed out that the liquid formulation treatment had the lowest initial amount of phosphorus.

SUMMARY AND CONCLUSIONS

If Moloaa is to make any advances in improving its strains in papaya production, it will be necessary to have more time for varietal evaluations of the grower lines as well as of those lines from the College of Tropical Agriculture and Human Resources. HAES $26F_6$, and 'Higgins', as well as a few selected individuals from segregating lines, show considerable promise.

The effects of cultural practices at Moloaa were initiated and studied with a limited objective in mind because of economic constraints. However, the results show that papaya production is feasible at Moloaa with the proper combination of cultural practices. The results of the trials show that, with good management and cultural practices, papayas can be a viable commercial crop at Moloaa, Island of Kauai, on former sugarcane and pineapple land.

The cultural recommendations presented here are based on the information obtained from Moloaa as well as from experiences obtained elsewhere within the State of Hawaii. We expect that these recommendations will be amended to meet individual situations and as new information becomes available.

CULTURAL RECOMMENDATIONS

It is assumed that normal orchard practices such as field preparation as described and disease, insect, and weed control are being carried on. The following cultural recommendations will be effective only as other orchard practices are accomplished.

1. 2000 pounds of lime per acre.
2. Approximately 3 gallons of water per tree per day during the rainy season and up to 6 to 8 gallons during dry periods.
3. (a) 2 pounds of treble superphosphate placed at bottom of planting hole and .20 pound of 16–16–16 per month until flowering. Thereafter, .75 pound of 16–16–16 fertilizer broadcast every 2 months.

   OR

   (b) A combination of dry and liquid preplant application of 2 pounds of treble superphosphate and .25 pound of 16–16–16 per month for 6 months then 1.33 pounds of liquid 9–9–9 fertilizer injected through the irrigation system thereafter once per 8 weeks. Increase fertilization, if found necessary by visual observation and/or plant tissue analysis.
4. Spacing 6 × 6 × 11 feet.

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