PILOT ORIENTAL FRUIT FLY MANAGEMENT PROGRAM IN GUIMARAS ISLAND

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Abstract

A pilot project on the integrated fruit fly management program based on sterile insect technique (SIT) was conducted in Guimaras Island.

The first island-wide male annihilation treatment (MAT) was implemented from February to October 1997. A total of 6 applications consisting of 525,534 pieces of lured particle board squares (PBS) were distributed in Guimaras both by aerial and ground applications. There was a significant reduction in fruit fly population indicating fruit fly suppression through MAT. However, MAT only reduces the male fruit fly density so many fruits were still found infested with fruit flies. Hence, biweekly releases of sterile flies were conducted from November 1997 to April 1998. About 91.74 million sterile pupae were sent by the Philippine Nuclear Research Institute (PNRI) to Guimaras. A total of 34,490,888 sterile flies were released by aerial applications and 12,632,163 sterile flies were released by ground applications. An increase in the S/N ratio was observed from 0.37 in December 1997 to 4.19 in April 1998. However, since the eradication phase was discontinued due to budgetary constraints, the required S/N ratio of more than 10 for a successful application of SIT was not achieved. A second series of MAT application were again conducted from May to September 1998. A total of 4 applications consisting of 357,650 pcs. of lured PBS were distributed throughout the island. Interestingly, the results of fruit fly density estimation before (1995) and after application (1998) of MAT and SIT using Lincoln method showed that the number of fruit flies per hectare was significantly reduced in all areas in Guimaras. Continues biweekly releases of 25 million flies therefore have to be undertaken to eradicate the remaining population.

Introduction

Guimaras province, a 60,000-ha island in Western Visayas is a major producer of sweet 'Carabao' or 'Manila Super' mango in the country. Mango is the third most important crop in the island with 5,107 ha or about 16% of the total land area is devoted to this fruit tree. In 1995, there were about 158,335 mango trees and under the Mango Development Program of the island, one million trees will be planted until the year 2000. The island has been found free from mango seed weevil and was declared as a "Special Quarantine Zone" in 1993 under Proclamation No. 314. This proclamation was made as a result of a thorough survey conducted by the US Department of Agriculture, Animal Plant Health Inspection Service (USDA-APHIS).

However, expansion in the production and market of mangoes is greatly restricted by the presence of Oriental fruit fly (OFF). The pest causes damage equivalent to 13% of the present production value of the fruit. Losses in the farm income is estimated at P13.4 million annually. This includes losses from export earnings due to quarantine barrier imposed by countries with strict quarantine regulations like Japan, the USA and Australia. For Japan, mango fruits can be exported after they are subjected to vapor heat treatment (VHT)(Merino, 1986).

Pre-harvest control of fruit fly is done either by repeated pesticide spraying or by putting a paper bag around each mango. Both technologies are quite expensive and labor intensive. In addition, the use of insecticides can not be relied upon because of problems like development of insect resistance, environmental contamination and resurgence of secondary pests.

The use of sterile insect was proposed as a solution to the fruit fly problem in Guimaras. The successful applications of SIT for the control and eradication of melon and Oriental fruit fly in the southern islands of Japan (Kawasaki, 1991), Mediterranean fruit fly in the USA, Mexico, Guatemala and Chile; the establishments of non-tariff barriers for the international marketing of fruits and vegetables that do not host fruit flies; and the international acceptance of new concepts such as the pest-free zone are among the reasons for the increased interest in the SIT. The SIT requires no insecticide and therefore environmentally-friendly. Moreover, the relative isolation of Guimaras Island and the absence of the mango seed weevil and pulp weevil suggest its suitability for an area-wide fruit fly eradication program.

The project was undertaken to control/eradicate the Oriental fruit fly in Guimaras by an integrated method including the SIT. Specifically, the project aims to:

1. Expand Oriental fruit fly production at the PNRI entomology laboratory
2. Conduct island-wide male annihilation treatment in Guimaras
3. Conduct ground/aerial releases of sterile flies
4. Conduct quality control of mass produced flies
5. Evaluate the effectiveness of male annihilation (MAT) and SIT

Materials and Methods

1. Oriental Fruit Fly Production

Oriental fruit flies (OFF) originally collected from infested fruits in Guimaras were reared and maintained at the PNRI laboratory. Eggs laid by adult females were collected weekly eight

to ten days after adult emergence from oviposition receptacle provided with a wet sponge to stimulate the adults to lay eggs. Eggs were collected until adults are 30-40 days old. About 4 mL of eggs were seeded per tray containing about 5 kgs. of artificial diet developed at PNRI . The artificial diet is made up of the following ingredients: yeast, rice bran, cooked yellow sweet potato, sugar, muriatic acid, sodium benzoate and water (Rejesus et al., 1975). One diet preparation using the diet mixer yielded 22 to 24 trays of diet. Seven days later, the larvae were allowed to pop out of the diet into the water and then drained to collect the larvae. The larvae were then placed in pupal boxes containing coir dust for pupation. For quality control, tests conducted include: percentage egg hatchability, pupation, weight of pupae, adult emergence, fliers and sex ratio. Each test consisted of 100 samples replicated five times.

2. Male Annihilation

An island -wide male annihilation treatment was done from February to November 1997 and again from May to September 1998 through the use of particle board squares (PBS) (5 x 5 x 1.8 cm.) impregnated with 10-12 mL lure toxicant containing 90-96% methyl eugenol and 4-10% malathion to reduce field population of male OFF prior to implementation of sterile fly releases.

For ground application, PBS were tied with GI wire prior to soaking on the lure toxicant. Allocated number of PBS per barangay were placed in black vinyl bag and transported to target areas. The area covered for ground application which is about 19,668 hectares included areas planted to various fruit trees, coconut, bamboo orchard, residential and school site. Ground application was done by hanging PBS preferably on host trees if present at the density of 4 PBS per hectare. These were done by the designated officials and residents of each respective barangays in Guimaras.

Aerial application was done using a light Cessna plane of the Bureau of Plant Industry (BPI). Impregnated PBS were packed in screen bag containing 200 pieces per bag and transported to Iloilo airport a day before the scheduled distribution. The screened bags were individually opened before loading into the plane to facilitate distribution. This was done in forested areas at the rate of 2 PBS per hectare. A flight could be finished within 30-40 minutes depending on the area covered with a flight velocity ranging from 40-70 kph at an altitude of 300-600 ft above the ground. Fig 1. shows the flight course of the airplane for releasing sterile pupae.

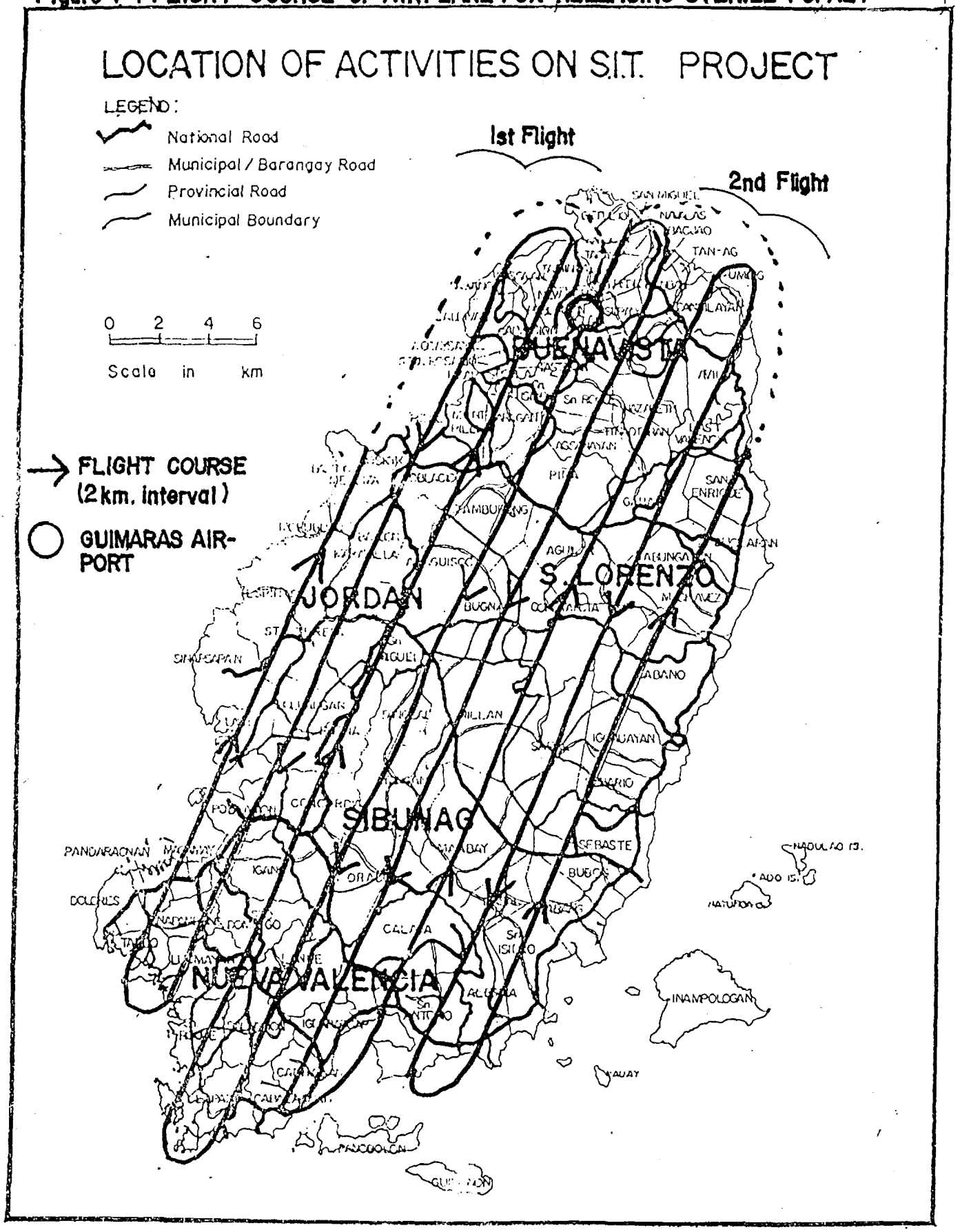
Evaluation of the effectiveness of MAT

a. Trapping

Two monitor traps baited with toxic methyl eugenol were placed in each of the 93 barangays and flies caught were collected at 15 days interval. The number of flies caught was counted and expressed as CPTD (average number of flies caught per trap per day).

$$\text{CPTD} = \sum(\text{no. of flies caught by trap } i) \,/\, \sum(\text{exposed days of trap } i)$$

Figure 1 : FLIGHT COURSE OF AIRPLANE FOR RELEASING STERILE PUPAE.



Average CPTD during MAT period in 1997 is compared with those in 1996 before MAT was applied . Percentage monthly reduction of CPTD from 1996 to 1997 was calculated using the following formula:

$$\frac{\text{(CPTD in 1996) - (CPTD in 1997)}}{\text{(CPTD in 1996)}} \times 100$$

Negative value of percentage reduction was ignored.

b. Fruit collection

Host fruits were collected every month at random from 5 municipalities. Fruits were collected from the tree (picked fruits) and ground (fallen fruits). Collected fruits were brought to the laboratory, classified according to kind, counted and weighed. These fruits were placed over sawdust for pupation of the larvae. After seven to ten days of holding, the sawdust was sifted to collect the pupae. Pupae obtained were placed in small plastic containers inside screen cages for adult emergence. The degree of fruit infestation was computed based on the number of fruits infested over the total samples and the number of pupae per kilogram of infested fruits was determined.

3. Sterile Insect Technique

Pupae mass reared at the PNRI laboratory were marked with fluorescent dye (4g/L) and placed in polyethylene plastic bags. Each bag contained about 460 g (ca. 950 mL) pupae. The polyethylene bags were packed in carton boxes (48 bags/box) and irradiated with a minimum and a maximum dose of 50 and 108.8 Gy, respectively, using the Multipurpose Gamma Irradiation Facility at the PNRI. After irradiation, ice packs were placed on top of the pupae to serve as coolant. One box contained approximately 1.6 million sterile fruit fly pupae.

Transport of sterile OFF pupae

The pupae were transported in carton boxes to Iloilo via Philippine Airlines (PAL) commercial flight. Upon arrival at Iloilo airport, the pupal boxes were loaded again to an air-conditioned vehicle and then to a hired pumpboat going to Buenavista wharf and then finally delivered to the fruit fly holding laboratory located near the Guimaras airstrip in McLain using the NMRDC vehicle. Transport of sterile pupae from PNRI to Iloilo was done in two batches at one day interval for every release schedule.

Bagging and holding of sterile pupae

About 100 g pupae were placed into each paper bag containing paper strips and sugar paper for adult diet, then the bag was folded twice and stapled securely across the top. Bagged pupae were placed in the pupal racks arranged in a uniform distance for proper air circulation. The temperature of the holding room was maintained at 23°C to 27°C.

Release

Figure 1 shows the flight course of the plane for the release of sterile flies. Aerial release was done using BPI Cessna plane with a funnel installed at the rear left side opening of the aircraft as passage for bag droppings. About 230-250 pupal bags were loaded in each flight.

Ground release of sterile flies was conducted in areas where CPTD was more than one and places with fruit infestation. This was done one day before adult emergence.

Evaluation Method for SIT

In the evaluation for the effectiveness of MAT, flies trapped were simply counted and CPTD was calculated. In SIT evaluation, captured flies are needed to determine whether the flies are sterile or wild using fluorescent dye detection method either by whole body or by head crashing detection method. In the former, a small amount of solvent (4 parts acetone: 1 part ethyl alcohol) was dropped on the body of the captured fly placed on a filter paper to dissolve the fluorescent dye and detected under a UV lamp. In the head crashing detection method, the head of the fly was crashed on the paper before dropping a small amount of solvent.

The number of flies detected with dye is named M (marked) or sterile and the number of flies without dye as U (unmarked) normal or wild.

Quality control tests

Samples of sterile pupae were taken upon arrival to Guimaras to check the quality of sterile flies to be released. Quality control tests include adult emergence rate, flight ability, sex ratio and longevity. All tests were conducted in the holding room.

On the actual date of release, the quality of sterile flies was likewise tested. One bag was marked, loaded in the plane, brought back after each release and hung under the tree. The bag was examined after 3 days.

4. Population Estimation by Mark-recapture Method

The procedure of mark-release recapture method was similar to Koyama's (Koyama, 1993, 1995). Three experimental plots (4 has./plot) were selected for this experiment covering three sites namely: commercial mango plantation , backyard area and natural vegetation. Sterile pupae sent from the PNRI were divided evenly and placed in three different cages and reared in the laboratory. The adults were provided with water sugar and protein hydrolysate.

Fully matured adults were released in each experimental plot on November 26. In each plot, cages containing the emerged adults were placed at the center of the release area and opened for 30 minutes (8:00 to 8:30 a.m.). The dead and inactive flies that remained in the cages were counted later to estimate the number of flies released.

Twenty five traps were hanged on trees in each plot at 1:00 p.m. on the same day. Three days after, the first recapture was done at around 1:00 p.m. in each plot. The second recapture

was carried out at five days after release. The flies captured in traps were counted and examined under UV lamp to determine whether they are marked flies or wild flies. Absolute densities of the Oriental fruit fly in each plot were calculated using the Lincoln Method (Lincoln, 1930) which is calculated using the following formulae:

$$\hat{U} = M_o u_1 / m_1$$

The variance is approximately estimated by:

$$\hat{V}(\hat{U}) = \frac{\hat{U}(\hat{U} - u_1)(u_1 + m_1)}{u_1 / m_1}$$

5. Information Campaign

To effectively disseminate information about the objectives of the project and obtain reactions/support from the target clienteles, a series of information campaign was conducted. This was done on the provincial, municipal and barangay level.

Results and Discussion

1. Oriental Fruit Fly Mass Production

From the 2 adult cages being maintained as stock culture, the number of adult cages increased to 10 in July to October, 13 cages in November and 20 cages in December. This is in preparation for the first island-wide sterile fly releases in Guimaras as complimentary to MAT scheduled in November 1997. The total number of 5-kg. larval diet prepared from January to March was 3,591 trays producing approximately 101 million pupae.

Results of the quality control of mass-reared fruit flies showed an average of 90.4, 99.2, 96.5, and 9389 percentage egg hatchability, pupation, adult emergence and fliers, respectively (Table 1). The average weight of pupa was 13.37 mg and sex ratio was 50.4: 49.6 (male: female). The above data show that the quality of flies produced at PNRI fall within acceptable standards set for other species of *Bactrocera* (Anonymous, 1998).

2. Male Annihilation

Ground and aerial applications were done at 50 days interval from February to November 1997. A total of 6 applications of MAT was done with 525,534 pieces of lured PBS distributed in Guimaras Island (ground-347,934 and aerial - 177,600) (Table 2a). The application of MAT by both methods, approximately covered 54% of the total land area of Guimaras. The rest of the area not covered are planted to crops which are non-target hosts of fruit flies (ricelands, fish ponds, etc.)

The efficiency of male annihilation in reducing male fruit fly population was evaluated based on monthly CPTD in 1996 when MAT was not applied and monthly CPTD in 1997 during

Table 1. Quality control data on Oriental fruit fly rearing at the PNRI (January 1997 to February 1998)

Gen.	Ave. Egg Collection/ Wk (ml)	Egg Hatch (%)	Pupation (%)	Pupal Recovery (%)	Weight of pupa (mg) (%)	Adult Emergence (%)	Fliers (%)	Sex ratio M:F (%)
11	175.80	87.33	98.70	82.75	12.80	98.70	97.30	56:44
12	202.68	89.46	99.70	79.30	13.65	96.98	93.82	46:54
13	173.97	87.79	98.67	85.38	13.19	94.83	91.42	48:52
14	199.00	90.33	100.00	78.05	12.91	96.20	93.60	47:53
15	190.28	88.70	100.00	63.66	13.22	98.60	97.60	52:48
16	147.90	89.73	99.40	75.72	13.06	96.40	94.00	53:47
17	180.53	93.40	100.00	76.47	13.80	95.00	93.00	51:45
18	204.50	91.40	97.00	65.41	13.60	97.40	97.00	46:50
19	184.63	91.60	100.00	81.40	12.85	97.20	95.80	46:50
20	219.00	89.65	99.70	88.12	13.05	93.70	92.80	53:47
21	173.82	91.80	98.55	48.90	14.28	95.00	93.07	53:47
22	204.51	93.53	98.48	57.77	14.11	96.84	87.12	50:50
23	167.80	91.98	98.15	60.29	13.46	96.05	86.60	52:48
24	164.25	89.10	97.65	50.75	12.69	98.10	85.70	48:52
	184.91	**90.41**	**99.00**	**71.00**	**13.33**	**96.50**	**92.77**	**50.4:49.6**

Table 2a. Male annihilation activities in Guimaras (February-November 1997)

Date of Application	Application Method and Number of PBS Distributed		Total PBS
	Ground	Aerial	
Feb. 27-Mar 4, 1997	78,672	32,200	110,872
Apr. 15-17, 1997	52,410	no distribution*	52,410
Jul. 7-9, 1997	52,410	31,600	84,010
Aug. 18-19, 1997	52,410	36,600**	89,010
Sep. 30-Oct. 1, 1997	59,622	40,600	100,222
Nov. 3-4, 1997	52,410	36,600	89,010
TOTAL	**347,934**	**141,000**	**525,534**

* Due to several problems during the first aerial application.
** Release conducted Aug. 26, 1997

Table 2b. Male annihilation activities in Guimaras (May-September 1998)

Date of Application	Application Method and Number of PBS Distributed		Total PBS
	Ground	Aerial	
May 13-14, 1998	29,000	62,550	91,550
June 23-24, 1998	11,600	87,600	99,200
August 10-15, 1998	72,450	no distribution	72,450
Sep. 28 - Oct. 2, 1998	9,450	85,000	94,450
TOTAL	**122,500**	**235,150**	**357,650**

the application of MAT. The monthly reduction in male fruit fly population is shown in Table 3 and Fig. 2. From March to June, a significant reduction in fruit fly population was observed. A slight fluctuation with a downward trend occurred in August. The highest percentage reduction was observed in October with 98.4. Generally, the applications of MAT at regular intervals significantly reduce male fruit fly population in the island. Hence, release of sterile flies (eradication phase) was conducted beginning November 1998 up to April 1999. However, the eradication phase was discontinued due to budgetary constraints.

For the second series of MAT application, a total of 4 replications consisting of 357,650 pieces of lured PBS were distributed throughout the island.

In April and May 1998, a low fruit fly population was observed in all areas of Guimaras. However, in June 1998, CPTD increased in all areas and a peak was observed in July 1998. This may be attributed to several factors: 1) the remaining fertile fruit flies in the field could have mated during the time interval of the last SIT application (April 4, 1998) and the first MAT application (May 13-14, 1998), 2) abundance of host fruits as well as the onset of the rainy season during this period favored the increase in fly population, 3) the scheduled MAT application in May 1998 was followed by heavy rainfall which could have lowered the effectiveness of the chemical. Continued release of lured PBS resulted to low fly catches in monitor traps in August which declined further in September to less than one CPTD. MAT implemented from May to September 1998 totalled 4 applications. A total of 357,650 pieces of PBS were distributed throughout the island (ground - 122,500 and aerial - 235,150) (Table 2b). About 35% of the total land area of Guimaras was covered per application considering the recommended application of 4 PBS/ha.

3. Sterile Insect Technique

After a significant reduction of wild population by MAT in October 1997, island-wide SIT was conducted at biweekly intervals from November 29, 1997 to April 1998 in Guimaras Province. Due to the limited resources in the mass rearing facility, only approximately less than 10 million flies could be produced for sterile fly releases. This is lower than the target production of 25 million flies per week based on the result of the mark-recapture studies by Koyama (1995). Table 4 shows the sterile insect release activities in Guimaras island from November 29, 1998 through April 4, 1999. About 91.74 million sterile pupae were sent by the PNRI to Guimaras. A total of 10 release schedules were made with dropping interval of 1 bag/5 seconds. A total of 9,600 bags or 34, 490,888 sterile flies were released by aerial applications (26 flights).

In areas where CPTD was more than 1, ground release of sterile flies was conducted. This was done one day before adult emergence. A total of 2,425 bags or 12,632,163 sterile flies were released by ground applications.

Figures 3 and 4 show the CPTD from 1996 to 1998. During the initial stage, the CPTD of marked or sterile flies as shown by a low S/N (sterile: normal or wild) ratio. This may be attributed to the insufficient number of flies released or may be due to low survival rate of flies in the field. An increase in the S/N ratio was observed from 0.37 in December 1997 to 4.19 in April 1998 (Table 5). However, the required S/N ratio of more tan 10 was not achieved since the eradication phase was discontinued as a result of budgetary constraint.

Table 3. Percentage reduction in male fruit fly population based on CPTD computed during male annihilation treatment for 1996-1997 in Guimaras.

Month	1996	1997	Reduction (1996-1997)	Reduction (%) 1996-1997/1996
January	0.26	2.83	-2.57	0.00
February	0.23	4.18	-3.95	0.00
March	0.73	0.58	0.15	20.55
April	0.72	0.37	0.35	48.61
May	1.48	0.41	1.07	72.30
June	44.45	2.95	41.50	93.36
July	18.02	1.87	16.15	89.62
August	10.06	0.84	9.22	91.65
September	14.51	0.76	13.75	94.76
October	13.11	0.23	12.88	98.25
November	6.83	0.50	6.33	92.68
December	2.36	0.16	2.20	93.22

Table 4. Sterile insect release activities in Guimaras Island (November 25, 1997-March 31, 1998)

Batch No.	Total No. of Pupae Received (Million)	Date Received	Date Released		Total No. of Bags Utilized		No. of Pupae/Bag		Brgy. Covered		No. of Flight	
			Ground	Aerial	Ground	Aerial	Ground	Aerial	Ground	Aerial	Ground	Aerial
1	3.2	11/25/97		11/29	-	484	-	6,612	-	2	-	2,613,800
2	4.3	12/09/97	12/10	12/14	36	595	16,110	6,269	11	2	487,154	3,681,191
3	7.2	12/11/97		12/16	-	1113	-	6,496	-	3	-	6,338,541
4	7.5	01/20/98	01/21	01/27	4	1105	13,405	6,703	1		45,936	1,574,596
5	8.3	01/22/98		-do-	-	1243	-	6,661	-	5	-	3,143,916
6	6.6	02/03/98		02/09	-	1066	-	6,145	-		-	4,313,830
7	8.5	02/05/98	02/09	-do-	171	1116	6,628	6,628	3	5	495,971	3,236,757
8	5.8	02/17/98		02/23	-	554	-	10,469	-		-	1,260,340
9	7.0	02/19/98		-do-	-	628	-	11,115	-	4	-	1,993,488
10	6.0	03/03/98	03/04	03/09	4	748	18,720	7,894	1		55,658	1,678,235
11	9.2	03/05/98	03/06	-do-	53	948	19,750	8,558	10	5	750,206	4,656,194
12	4.6	03/17/98	03/20	-	649	-	7,150	-	31	-	3,364,000	-
13	7.4	03/19/98	03/23	-	629	-	11,685	-	62	-	3,521,385	-
14	6.3	03/31/98	04/04	-	879	-	7,133	-	35	-	3,911,853	-
Total	**91.74**										12,632,163	34,490,888

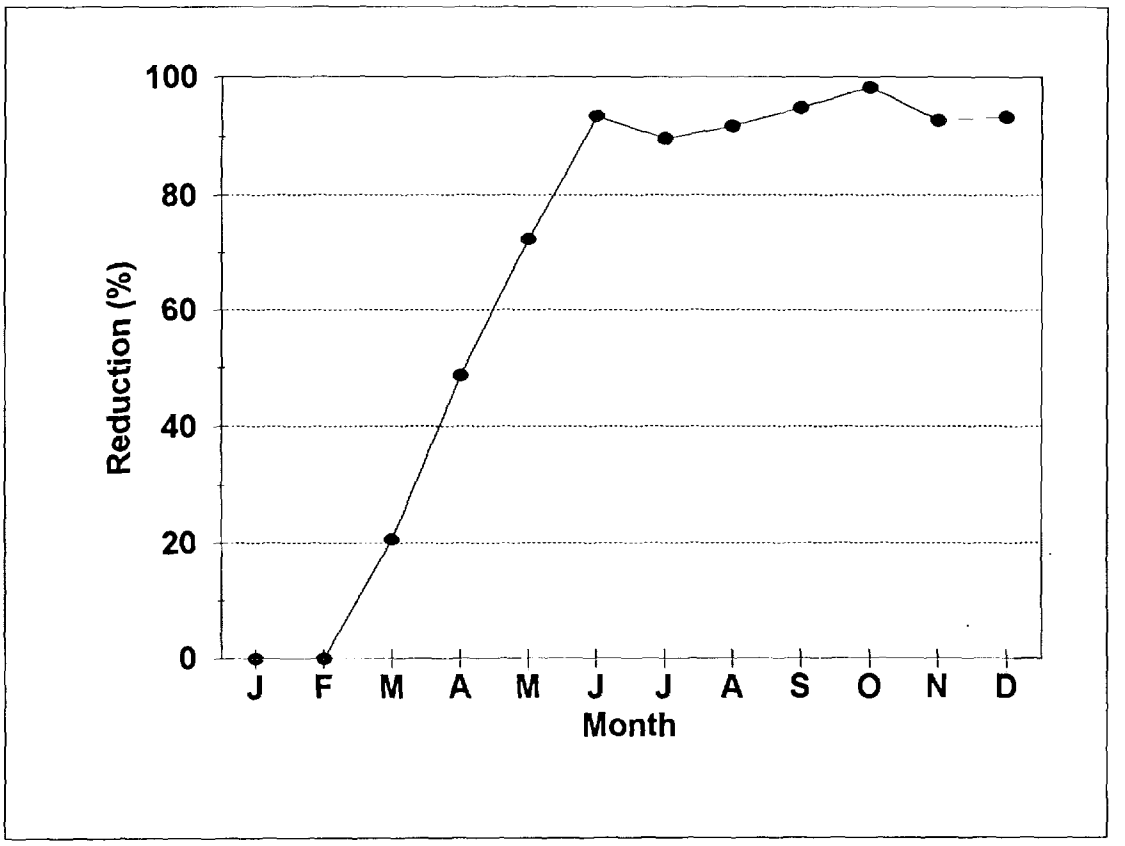


Fig 2. Percentage reduction on male fruit fly population based on CPTD computed during the male annihilation treatment (MAT) for 1996-1997 in Guimaras.

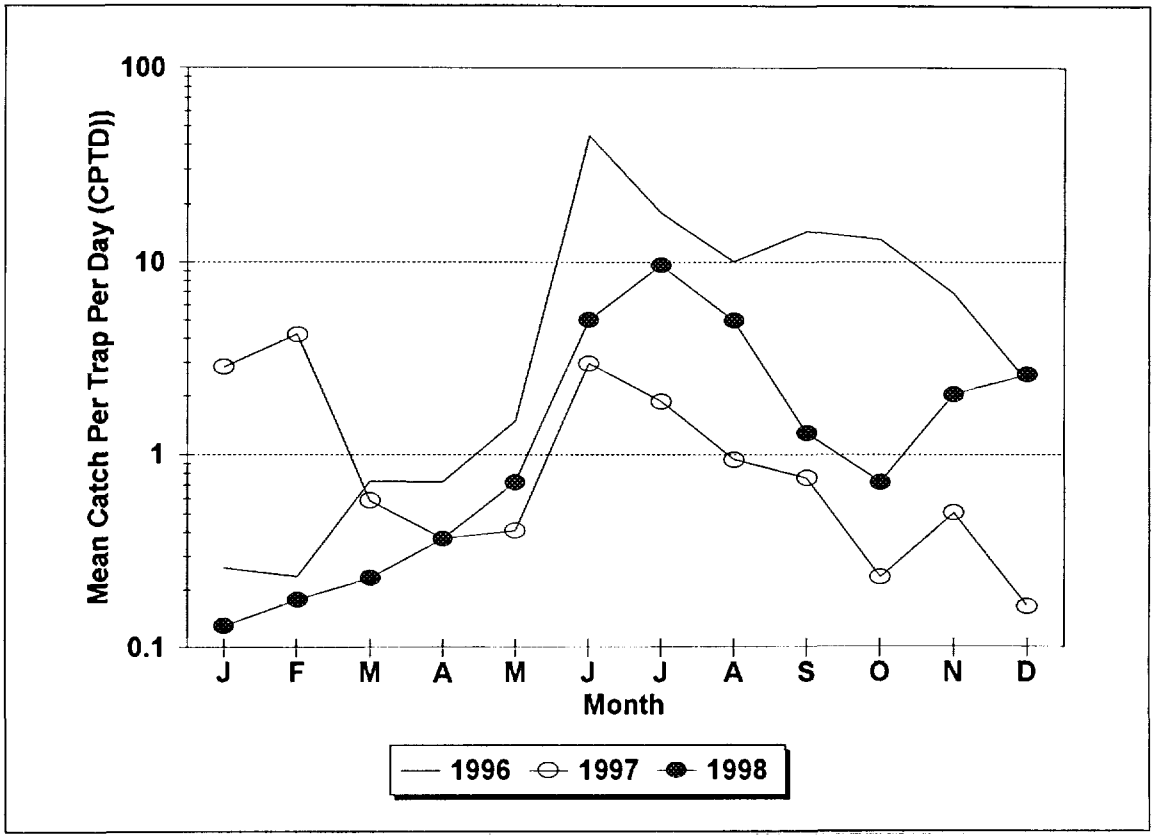


Fig 3. Monthly flactuation in Oriental fruit fly caught in monitor traps in Guimaras island from January 1996 to December 1998. Data are are shown in logarithmic scale.

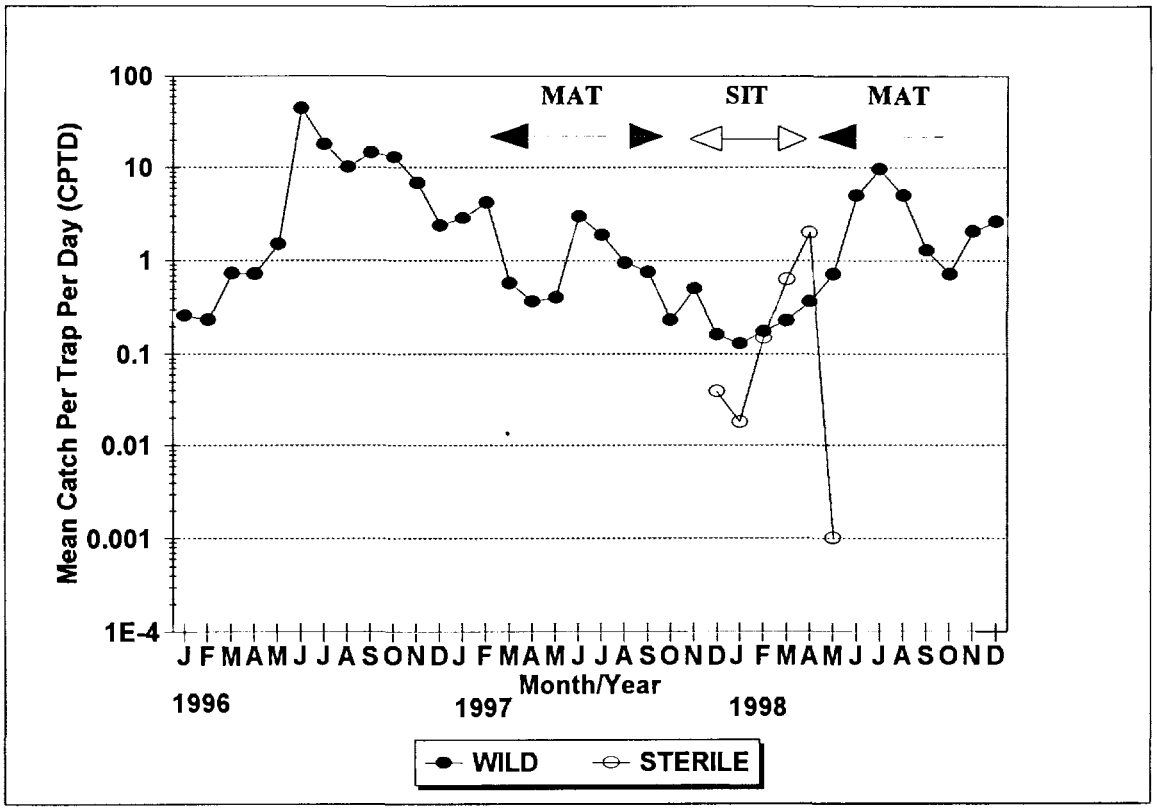


Fig 4. Monthly flactuation in Oriental fruit fly population caught in monitor traps in Guimaras Island from January 1996 to December 1998. Data are shown in logarithmic scale.

Table 5. S/N ratio for each release of sterile flies in Guimaras Island.

Date of Release	Total Marked Flies (Sterile)	Total Unmarked Flies (Normal or Wild)	S/N (Sterile: Normal) Ratio
December 1997	5.34	14.34	0.37
January 1998	2.05	12.47	0.16
February 1998	13.74	18.11	0.72
March 1998	55.79	20.95	2.66
April 1988	159.16	37.94	4.19

4. Monitoring Fruit Fly Population

The monthly monitoring of wild fly population and sterile fly recaptures is presented in Fig 4. After the fifth application of MAT, the population of wild fly recorded in October was suppressed to a low level with less than one male caught per trap per day (CPTD). A slight increase in mean CPTD was recorded in November with the highest in Sibunag (1.61) where fruiting of native guava was abundant during this period. When release of sterile flies was started in the last week of November, wild fly catches monitored in December decreased in all areas. In the succeeding months, the mean CPTD still fall below one male/trap per day indicating a low population of wild flies in the field. Sterile fly recaptures obtained in December was comparatively lower than wild fly catches as in some cases it is zero. Although the density of the sterile flies released in the field was low, the suppression of wild fly population after male annihilation followed by sterile fly releases was achieved.

5. Quality Control

Table 6 shows the results of quality control tests conducted on both laboratory and filed conditions of the sterile pupae sent to Guimaras. Under field conditions, the percentage emergence of sterile pupae were generally satisfactory except for batches 5, 7 and 9 while only batches 7 and 12 have low percentage emergence under laboratory condition. With respect to percentage fliers, 8 batches of pupae ranged from 21.26 - 57.39% and were below acceptable standards while 5 batches (1, 2, 3, 6 and 12) were observed within acceptable levels (62.39 - 98.69%) under field conditions while under laboratory conditions results were generally satisfactory. This may be attributed to several factors such as: 1) delayed release for batches 4 and 5 resulting to insufficient food supply inside the pupal bags, 2) abrupt fluctuation of temperature in the holding room (batch 7), 3) maximizing the number of flights per aerial release by increasing the volume of pupae in the bag from 100 g/bag to 200 g/bag (batches 8 and 9), and 4) handling of pupae (marking, transportation and bagging).

The sex ratio of the flies were almost 1:1 and based on longevity test, sterile flies could survive for 12-25 days after emergence with food and water.

6. Fruit Collection/Inspection

Fig. 5 shows the fruiting period of the different hosts of the Oriental fruit fly in Guimaras. The fruit infestation data from 1996 to 1998 is shown in Tables 7, 8 and 9. The number of fruit fly recovered per kilogram fruit sample was smaller in 1997 when MAT was conducted than in 1996. Despite the more than 90% reduction in CPTD (Table 3 and Fig 3), many fruits were still infested by fruit flies indicating the fact that MAT reduces only the male fruit fly density. Hence, SIT is needed to reduce the female fruit fly density. The main fruits infested included guava, starfruit, guayabano, sineguelas and mango. Tables 10, and 11 show the fruit infestation data in 1996, 1997 and 1998, respectively. Guava and starfruit have the most number of pupae per kilogram fruit sample which may be due to pest preference and their availability throughout the year. Generally, infestation was high on fallen than on picked fruits.

The monthly fruit infestation in almost areas decreased after the implementation of male annihilation followed by sterile fly release.

Table 6. Results of quality control tests done in the field and laboratory condition in Guimaras (November 1997-March 1998).

Batch No.	Total No. Received (Million)	Date Received	Date Released	Pupal Wt. (Kg.)	% Emergence		% Fliers		Sex Ratio		Longevity Test		
					Field*	Lab.	Field*	Lab.	Male	Female	Male (% Mortality)	female	Days after Emergence
1	3.20	11/25/97	11/29/97	-	91.72	93.70	89.68	89.66	1.20	1.00	not taken		-
2	4.31	12/09/97	12/14/97	64.50	99.86	88.70	98.69	84.00	1.20	1.00	68.0	64.0	18
3	7.23	12/11/97	12/16/97	111.30	94.34	95.00	87.67	92.33	1.00	1.04	77.3	58.7	16
4	7.46	01/20/98	01/27/97	99.36	89.77	90.67	21.26	85.67	1.00	1.00	58.7	22.7	21
5	8.28	01/22/98	01/27/98	110.40	79.51	86.30	37.97	83.00	1.00	1.17	54.7	29.3	25
6	6.55	02/03/98	02/09/97	85.16	93.16	90.70	65.86	73.67	1.00	1.05	62.7	30.7	23
7	8.53	02/05/98	-do-	121.90	72.44	62.30	43.76	54.67	1.00	1.04	61.3	53.3	22
8	5.80	02/17/98	02/23/98	69.84	93.14	94.00	21.73	85.67	1.00	1.03	62.7	58.7	12
9	6.98	02/19/98	-do-	86.02	76.28	96.30	28.56	77.33	1.00	1.00	61.3	46.6	14
10	5.98	03/03/98	03/09/98	74.98	91.39	92.70	28.42	74.33	1.00	1.13	56.7	45.3	16
11	9.16	03/05/98	-do-	115.90	92.39	91.00	57.39	71.67	1.34	1.00	57.3	40.0	17
12	4.64	03/17/98	03/20/98	63.00	87.76	80.67	72.50	56.33	1.04	1.00	41.3	30.7	23
13	7.35	03/19/98	03/23/98	100.70	88.87	92.33	47.91	66.33	1.00	1.02	58.7	44.0	17
14	6.27	03/31/98	04/04/98	88.32	85.60	94.33	62.39	83.33	1.07	1.00	53.3	52.0	22
Total	**91.74**			**AVG.**	**88.30**	**89.19**	**54.56**	**77.00**	**1.06**	**1.03**			

* Taken from bag samples returned after the flight and opened for one hour to allow adults to fly out from the bag.

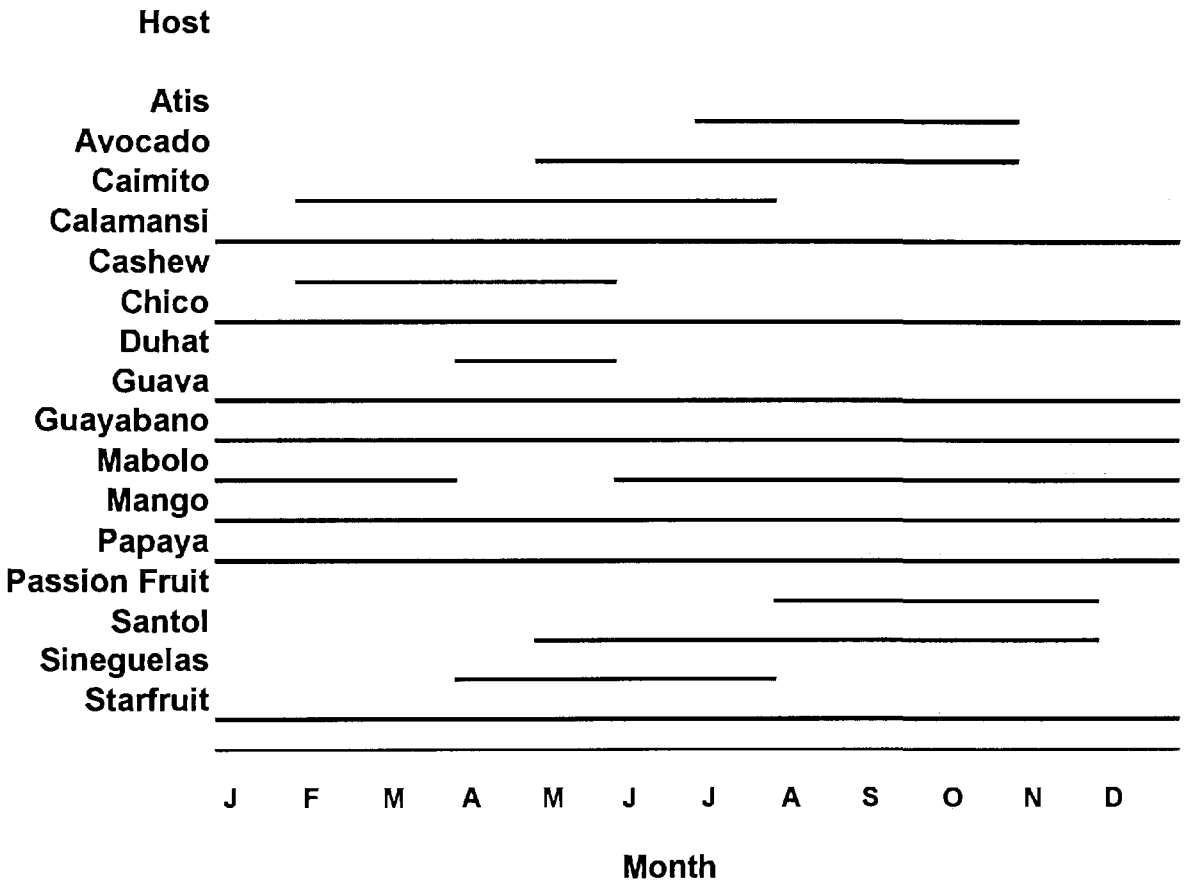


Fig 5. Fruiting period of different hosts of Oriental fruit fly.

Table 7. Fruit infestation data in 1996

Month	Fallen fruits			Picked fruits		
	Wt (kg.)	Total no. of pupae recovere	Mean no. of pupae/kg. fruit sample	Wt (kg.)	Total no. of pupae recovere	Mean no. of pupae/kg. fruit sample
January	8.5	55	6.5	14.6	18	1.2
February	91.0	1,203	13.2	2.0	0	0.0
March	59.5	2,243	37.7	43.4	15	0.3
April	280.7	4,839	17.2	64.0	89	1.4
May	234.5	3,319	14.2	3,136.1	7,965	2.5
June	4,463.7	9,181	2.1	5.8	6	1.0
July	64.4	1,928	29.9	65.4	93	1.4
August	94.0	608	6.5	70.2	350	5.0
September	22.4	1,499	66.9	26.1	564	21.6
October	71.6	481	6.7	14.4	137	9.5
November	64.8	3,721	57.4	36.5	331	9.1
December	2.3	116	50.4	43.0	1,249	29.0

Table 8. Fruit infestation data in 1997

Month	Fallen fruits			Picked fruits		
	Wt (kg.)	Total no. of pupae recovere	Mean no. of pupae/kg. fruit sample	Wt (kg.)	Total no. of pupae recovere	Mean no. of pupae/kg. fruit sample
January	31.9	1,879	58.9	11.3	0	0.0
February	31.6	3,436	108.7	29.7	15	0.5
March	203.6	3,777	18.6	18.0	0	0.0
April	238.5	4,110	17.2	35.1	3	0.1
May	249.0	926	3.7	298.6	357	1.2
June	84.9	996	11.7	5,180.7	5,587	1.1
July	297.2	1,380	4.6	1,665.6	741	0.4
August	152.7	1,942	12.7	310.8	1,628	5.2
September	5.9	18	3.1	255.4	168	0.7
October	97.2	1,717	17.7	200.9	1,204	6.0
November	90.7	6,097	67.2	336.6	7,848	23.5
December	22.0	480	21.9	314.7	1,566	5.0

Table 9. Fruit infestation data in 1998.

Month	Fallen fruits			Picked fruits		
	Wt (kg.)	Total no. of pupae recovered	Mean no. of pupae/kg. fruit sample	Wt (kg.)	Total no. of pupae recovered	Mean no. of pupae/kg. fruit sample
January	47.0	282	6.0	144.5	962	6.7
February	68.6	904	13.2	138.9	686	4.9
March	53.3	521	9.8	466.8	158	0.3
April	108.2	1,583	14.6	764.7	184	0.2
May	64.5	1,473	22.8	651.8	299	0.5
June	115.8	2,188	18.9	332.6	384	1.2
July	93.2	4,395	47.2	196.6	5,019	25.5
August	41.0	2,380	58.0	124.5	11,178	89.8
September	4.0	349	87.3	145.9	3,348	22.9
October	25.1	1,030	41.0	150.8	3,631	24.1
November	19.0	535	28.2	109.8	2,444	22.3
December	23.1	570	24.7	67.9	1,287	19.0

Table 10. Fruit fly infestation on different host fruits collected in 1997 in Guimaras. Island.

Host Fruits	Picked		Fallen		Ave. no. of pupae/kg fruit (picked and fallen)
	Weight of fruit (kg)	Ave. no. of pupae/kg.	Weight of fruit (kg)	Ave. no. of pupae/kg.	
Mango	5,073.00	1.00	863.50	11.20	6.10
Guava	487.70	18.30	171.00	44.25	31.28
Starfruit	369.40	10.10	194.00	39.50	24.80
Calamansi	199.75	0	23.60	5.80	2.90
Chico	127.30	0.40	0.90	6.70	3.55
Papaya	139.10	0.07	-	-	0.04
Santol	1,283.30	0.18	2,215.50	0.23	0.21
Sineguelas	41.70	2.40	5.14	14.60	8.50
Atis	80.30	0	-	0	0
Avocado	88.40	0	0.60	0	0
Duhat	3.70	0	-	0	0
Guayabano	54.80	0	-	0	0
Mabolo	12.50	0	1.00	0	0
Macopa	3.90	0	-	0	0
Passion fruit	13.95	0	11.50	0	0
Bignay	2.10	0		0	0
Pomelo	10.50	0	1.00	0	0

Table 11. Fruit fly infestation on different host fruits collected in 1998 in Guimaras Island.

Host Fruits	Picked		Fallen		Ave. no. of pupae/kg fruit (picked and fallen)
	Weight of fruit (kg)	Ave. no. of pupae/kg.	Weight of fruit (kg)	Ave. no. of pupae/kg.	
Mango	1,849.16	1.73	318.79	13.66	7.70
Guava	101.33	85.23	7.65	71.24	78.24
Starfruit	245.80	24.60	34.93	58.57	41.59
Calamansi	21.00	0	-	-	0
Atis	71.55	4.04	-	-	2.02
Avocado	11.70	0	-	-	0
Chico	112.65	1.78	1.10	0	0.89
Guayabano	192.60	21.55	15.40	53.51	37.53
Mabolo	-	-	-	-	-
Macopa	1.10	0	-	-	0
Papaya	90.23	0	-	-	0
Passion Fruit	-	-	-	-	-
Santol	54.70	1.54	15.15	21.58	11.56
Sineguelas	163.57	0.02	1.20	0	0.01
Caimito	43.60	0	-	-	0

6. Population Estimation By Mark-recapture Method

Table 12 shows the total number of pupae and the number of emerged and released adults in each cage while the summary of the recapture data is presented in Table 13. Following similar procedures, the results of population estimation using Lincoln method showed that the number of fruit flies per hectare obtained in 1998 (Kuba, 1998) was lower compared to those obtained in 1993 (Koyama, 1993) in all sites or areas (Table 15). This may be attributed to the MAT applications in 1997 and 1998 as well as to sterile fly releases from November 1997 to April 1998.

7. Information Campaign

A regular public information campaign about the objectives of the project was made through radio broadcasts (DYFM Bombo Radio and DYRI Gintong Ani program) and barangay meetings.

An island-wide information campaign was conducted on February 5, 1997 sponsored by the Provincial Government. A total of 198 participants including the municipal mayors or representatives, barangay captains, SK chairmen, provincial and agricultural officers, DA technicians and heads of primary and secondary schools in Guimaras and mango growers attended the campaign. The schedule of MAT and sterile fly releases were given emphasis. Likewise, the participation of concerned barangay officials in the hanging of particle board squares for the ground release was solicited. Precautionary measures to be undertaken during aerial releases as well as the participation of all students in the "Pulot dagas" (picking of dropped or fallen fruits) operation were also discussed.

Information about the project and its benefits to the environment was prepared in the dialect and printed in each pupal bags for distribution.

Table 12. Mark-release-recapture study in Guimaras Island.

Release area/ Parameters	A: Commercial orchard	B: Backyard	C: Natural Vegetation
No. of pupae	12,545	12,545	12,545.0
No. of adults emerged	11,016	10,557	10,713.0
No. of unemerged pupae	1,529	1,988	1,832.0
No. of adults released	9,397	8,837	9,152.0
No. of adults remained in the cage	1,619	1,720	1,561.0
% Emergence	87.8	84.2	85.4
No. of adults used for marking check	200	200	200.0
No. of adult males releas	4,599	4,319	4,476.0

Table 13. Summary of recapture data.

Release area	Date	No. of marked flies	No. of unmarked flies
A: Commercial	Nov. 29, 1998	232	58
	Dec. 01, 1998	42	111
B: Backyard	Nov. 29, 1998	244	98
	Dec. 01, 1998	18	225
C: Natural vegetation	Nov. 29, 1998	298	106
	Dec. 01, 1998	28	138

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