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GUAVA ARTHROPOD SEASONALITY AND CONTROL OF FRUIT FLIES IN SOUTH FLORIDA

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Abstract. **Guava production has intensified in south Florida. However, there is no existing management program for monitoring guava pests, i.e., Caribbean fruit flies, *Anastrepha suspensa*, guava mites, *Tegolophus guavae*, *Brevipalpus* sp., and leaf footed bugs, *Leptoglossus* sp, mealybugs, *Phenacoccus* spp. An unsprayed grove was surveyed for arthropod pests seasonal density from July 1996 through June 1998. Leaves, flowers and fruits of randomly selected trees were inspected weekly. Populations of Caribbean fruit fly were monitored using McPhail traps and tests of efficacy of control tactics (Spinosad, Agrimek), lures (Phloxine B, Nulure) and fruit bagging showed that fruit bagging is the best method to prevent Caribbean fruit fly infestation to guava fruits in Florida.**

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Introduction

Guava, *Psidium guajava* L., originated in tropical America, and it is now widely grown all over the tropics and subtropics. At present the major guava producing countries are southern Asian countries, Hawaiian islands, Cuba, India and South America (Bose and Mitra, 1990). Fruits are in demand for export from subtropical Florida. However, exports to California and some other ports are restricted by Caribbean fruit fly, *Anastrepha suspensa* (Loew) quarantines. A post-harvest hot water disinfestation treatment exists for guavas (Gould, 1995),

Table 1. Pests of Guava in Florida, recorded until 1999.

Order	Family	Species	Damage description
Acarina	Eriophyidae	*Tegolophus guavae* (Boczek)	This mite causes a pimple like response on the fruit epidermis; damage is followed by fruit bronzing. This mite is also found on leaves.
	Tarsonemidae	*Tarsonemus* sp.	This mite was found on fruits that show extensive bronzing.
	Tenuipalpidae	*Brevipalpus* sp.	Mite found on fruit with bronzing.
	Tydeidae	*Tydeus* spp.	Found on fruit infested with *T. guavae.*
Lepidoptera	Tortricoidea	*Epinotia* (possibly)	
	Tortricidae	*Amorbia emigratella* Busck	Worms found in the leaves of guava
	Olethreutidae	*Strepsicrates smithiana indetana* (Dyar)	Leaf-tier on guava
	Hyponomeutidae	*Argyresthia eugeniella* Busck	Guava fruit worm
Diptera	Tephritidae	*Anastrepha suspensa* (Loew)	Caribbean fruit fly
Homoptera	Pseudococcidae	*Phenacoccus* sp.	
	Coccidae	*Ceroplastes floridensis* Comstock	Florida wax scale
		Coccus hesperidum Linnaeus	Brown soft scale
		Coccus viridis (Green)	Green scale
		Eucalymnatus tessellatus (Signoret)	Tessellated scale
		Parasaissetia nigra (Nietner)	Nigra scale
		Protopulvinaria pyriformis (Cockerell)	Pyriform scale
		Pulvinaria psidii Markell	Green shield scale
		P. urbicola Cockerell	Urbicola soft scale
		Saissetia coffeae (Walker)	(Hemispherical scale)
		S. miranda (Cockerell and Parrott)	Mexican black scale
		S. oleae (Olivier)	(Black scale)
		Vinsonia stellifera (Westwood)	Stellate scale
	Diaspididae	*Hemiberlesia lataniae* (Sign.)	Latania scale
		H. rapax (Comst.)	Greedy scale
		Aonidiella orientalis (Newst.)	Oriental scale
		Aspidiotus destructor Sign.	Coconut scale
		Chrysomphalum dictyospermi (Morg.)	Dictyospermum scale
		C. ficus Ashmead	Florida red scale
		Parlatoria pergandii Comst.	Chaff scale
		Pseudaonidia clavigera (Ckll.)	Camelia mining scale
		P. duplex (Ckll.)	Camphor scale
		Pseudischnaspis bowreyi (Ckll.)	Bowery scale
		Pseudoparlatoria parlatoriodes (Comst.)	False parlatoria scale
Hemiptera	Coreidae	*Leptoglossus balteatus* (L.)	
		L. concolor (Walker)	
		L. gonagra (F.)	

but infestations must be less than 10% of the total fruit in shipment before the treatment is applicable. Guavas are typically so heavily infested with the pest in Florida that treatments are inapplicable. Currently, the arthropods most frequently observed on guavas in Florida include, besides the Caribbean fruit fly, the mites *Tegolophus guavae* (Eriophyid), *Brevipalpus* spp., *Tydeus* spp., the mealybug (*Phenacoccus* sp.), leaf footed bugs, (*Leptoglossus* spp.), and the caterpillars *Strepsicrates smithiana, Amorbia emigratela.* Other pests, such as fruit worm and scales, are observed, but their frequency appears to have been reduced during the last years (Table 1).

Any integrated pest management program should be based on the knowledge of the life history and population dynamics of the arthropods that affect a plant system. With the exception of some studies by Wolfenbarger (1954), no studies are known to us that address this issue. Moreover, since the Caribbean fruit fly continues to be the major constrain for guava production in Florida, knowledge of effectiveness of methods that reduce fruit fly infestations are urgently needed by Florida guava growers. The objectives of this study address those two questions.

Materials and Methods

Population dynamics. Ten 20 year-old guava trees located in a orchard at the Tropical Research and Education Center in Homestead were selected randomly for monthly sampling of infestations of eriophyid, tenuipalpid and tydeid mites, mealybugs, caterpillars and fruit flies. A single 15 cm terminal branch and a fruit were selected per tree and the number of mites, mealybugs and caterpillars recorded. Ten fruits were collected, their state of ripenesss recorded, and were kept in 500 ml plastic containers with vermiculite. Presence of CFF pupae or flies was assessed 1 month after collection.

Adult fruit flies were also studied by placing 6 glass McPhail traps at the orchard borders. The glass traps were placed at ¾ tree height on the exterior part of the tree canopy and baited with 10 g torula yeast plus 300 ml of water. The traps were monitored for the presence of adult flies every 15 days.

Control of CFF

Experiment 1. Tests were conducted at the Agricultural Research Service, Subtropical Horticulture Research Station in Miami, FL. The guava variety used was 'Ruby × Supreme' obtained form a commercial guava nursery at Brooks Tropicals, Homestead, FL. Trees were approximately 6 feet tall and planted 10 feet apart in rows. Trees were free of previous insecticide applications. Half gallon of material was sprayed on 4 trees. Sprayer was a hand-pump-up Solo 456, 2 gallon, hollow cone tip, 0.1 gal/min. Eleven treatments were used. The treatments were spinosad (Dowelanco, NAF-295 suspension, 22.1%AI)/nulure, margosan (Grace-Sierra, Milipitas, CA, azadirachtin 0.25%, 12.3 ml)/water, hot pepper wax (Wilder's hot Pepper Wax. Inc., New Wilmington, PA, capsaicin 3%, 59.1 ml)/kinetic/water, Guardian Spray (Guardian Spray Company, Bakersfield, CA garlic juice 99.9%, 2.37ml)/water, Phloxine B (wettable powder, D and red 28, Milton Davis, St. Louis MO, product 10-25-DA-0906, 1.77 g)/water/nulure, malathion (50%EC)/water, Guardian/kinetic/water, abamectin (Avid 0.15 EC, Merck, product 06791A, 9.96 g, 100 ppm)/water/nulure. Each treatment was applied to four trees adjacent to each other in a row. Treatments were randomized within the orchard. Treatments were applied by a hand-held 2 gallon Solo sprayer with a hollow cone tip that delivered approximately 0.1 gallons per minute. Treatments were applied in the morning weekly. There was no re-application because of rain. Round-up was sprayed to control weeds on 6/12, 7/12 and 9/12. Insecticides application dates were 6/18/96, 6/25, 7/2, 7/9, 7/16, 7/23, 7/30, 8/6, 8/13, 8/20, 8/27, 9/3, 9/10, 9/17, 9/24. Based on a 1992 commercial packinghouse fruit survey, fruit of > 55 mm diameter was infested to a high degree (5/23 37 fruit, 46 pupae, 5/26 117 fruit 155 pupae, 7/7 40 fruit 406 pupae).

To check treatment efficacy, we assessed natural infestations in fruits of 64-74 mm, knowing that they were infestable at that size. The natural infestation survey was done on two dates, 8/26 and 9/2. Four fruits were harvested from each treatment on each date. Fruits were held in aggregation on moist fine vermiculite at 68-91°F, 80%RH, and 14 hours of light in an environmental chamber. Pupae that emerged were counted after 30 days. Two McPhail traps were run weekly between 7/12 and 10/3/96 at two locations immediately adjacent to the grove to determine if natural populations of adults were present.

Experiment 2. Based on results obtained during Experiment 1., an additional test was conducted on a 6-year -old orchard, 'Ruby × Supreme' guava. Each plot consisted of approximately 1 acre where the insecticides were applied to the trees using a Solo sprayer. Chemicals were applied every week starting June 4, 1997 and ending July 2, 1997. The spray treatments were Guardian, Suredye spray, Spinosad plus Nu-

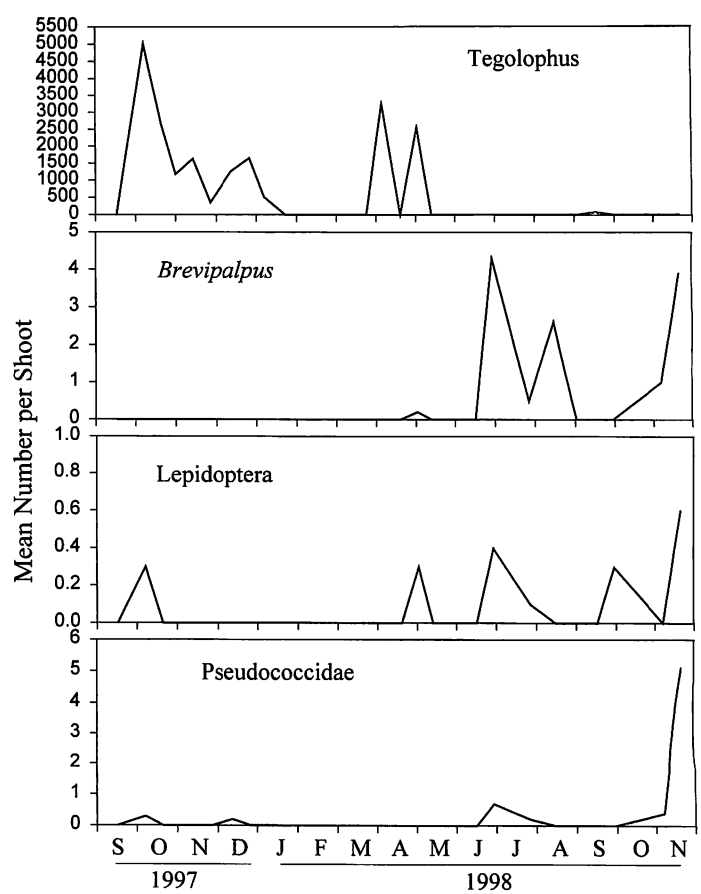

Figure 1. Seasonality of *Tegolophus guavae, Brevipalpus* sp., *Strepsicrates* sp., and *Planococcus* sp., on guava shoots between 1997 and 1998 in Homestead, FL.

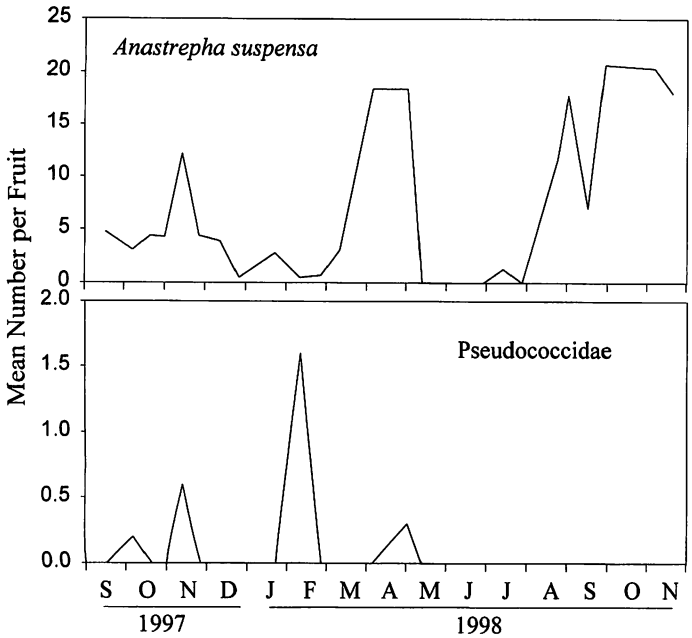

Figure 2. Seasonality of *Anastrepha suspensa* and *Planococcus* sp., on guava fruits collected from an unsprayed guava orchard between 1997 and 1998, Homestead, FL.

lure, Agrimek plus Nulure, and FC435 Oil. The physical control treatment consisted of bagging the fruit with a 14 × 20 "Delnet" bag. All the treatments were compared with an untreated control. Fruits were collected every week before treatment, placed in a plastic bag and brought immediately to the laboratory where the fruits were held for larval emergence in 500 ml containers with vermiculite.

Results and discussion

Seasonality of pests

Leaf flushes. The most common pests infesting leaves and shoots during 1997 through 1998 were the mites *Tegolophus guavae, Brevipalpus* sp., the mealybug, *Phenacoccus* sp., and the caterpillar *Strepsicrates smithiana.* Highest numbers of *T. guavae* per shoot were observed early fall through early winter and during the months of April and May. The mites were observed mostly on the tender leaves, buds, but few are observed on the fruit, causing "pimples" or deformations (Fig. 1).

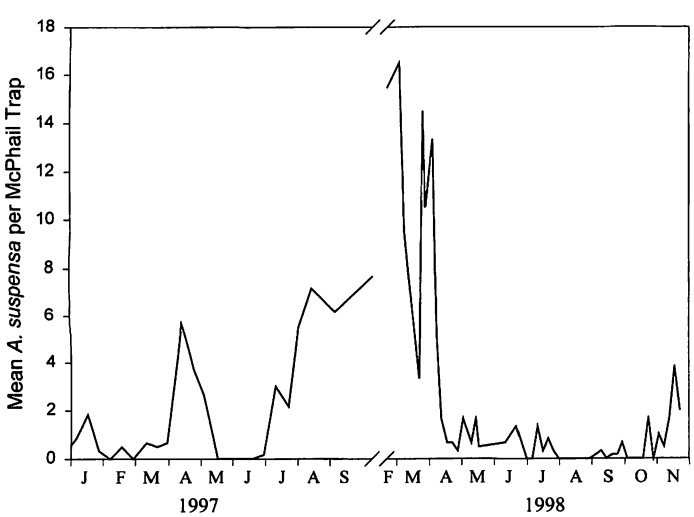

Figure 3. Mean *Anastrepha suspensa* adults captured on McPhail traps baited with Torula yeast placed in an unsprayed guava orchard between 1997 and 1998, Homestead, FL.

Table 2. Total McPhail trap catches (n = 2) of Caribbean fruit flies in guava groves during period of treatment, Miami, FL, 1996.

Date	Males	Females
July 2	7	132
July 10	11	83
July 16	15	132
July 22	18	143
July 30	72	152
August 6	5	134
August 13	5	53
August 20	9	83
August 27	9	82
September 3	5	55
September 10	12	39
September 17	11	43
September 24	8	24
October 3	19	34

Brevipalpus spp., only increased on the leaves between the Summer months and during fall. However, in Central America, *Brevipalpus californicus* (Banks) has been observed causing guava fruit to turn brown, smooth and shiny, with epidermal cracking. Symptoms on the leaves are characterized by epidermal cracking on the leaves (Ochoa et al., 1994). *S. smithiana* was periodically observed at different times of the year, without showing a definitive infestation trend. The tender leaves are webbed together by larvae of *S. smithiana* and leaf flush is devoured by small greenish caterpillars. The caterpillars pupate on the leaves. The time of their emergence is unknown.

The mealybug, *Phenacoccus* spp., was observed during the months of October, December, July and November (Fig. 1). Adult female mealybugs are white, about 3 mm long, and covered with a white, mealy wax. The mealybug shelters in leaf axils, but they also move onto fruit and settle under the calyx or between touching fruit.

Fruits. Caribbean fruit fly and *Phenacoccus* sp., were the most abundant insects observed infesting fruit during 1997 and 1998. Even though, we have observed the presence of *Brevipalpus* sp., and *Tegolophus guavae* on guava fruit, we did not observe infested fruit during this survey. A low mealybug

Table 3. Mean* (SEM) number of naturally infested Caribbean fruit fly pupae emerged from guavas under various treatments, Miami, FL 1996.

Treatment	Pupae ± SEM
Hot pepper wax/Kinetic	165 ± 1
Untreated	159 ± 42
Spinosad/Nulure	137 ± 10
Malathion/Nulure	131 ± 20
Margosan	89 ± 19
Hot pepper wax	69 ± 17
Malathion	67 ± 34
Guardian	51 ± 4**
Phloxine B/Nulure	40 ± 10**
Guardian/Kinetic	38 ± 5**
Avid/Nulure	11 ± 0***

*n = 8 fruits, 4 from each of 2 dates, August 26 and September 2, 1996.
**Means differ from blank (P < 0.05, Tukey-Kramer Test).
***Means differ from blank (P < 0.01, Tukey-Kramer Test).

Table 4. Emerged Caribbean Fruit Fly pupae from Treated and Untreated Guavas.

Treatment	Number of pupae collected from guavas						
	1DBT	15DAT	20DAT	27DAT	34DAT	41DAT	48DAT
Untreated	6.3 b	5.8 b	9.4 b	11.3 a	2.7 b	6.9 b	6.4 b
Agrimek + Nulure	11.2 b	18.3 b	25.7 a	15.0 a	6.4 ab	5.2 b	2.3 cde
Oil	10.9 b	6.4 b	21.3 ab	17.8 a	9.6 a	6.0 b	4.3 bcd
Suredye	6.4 b	6.8 b	8.3 b	7.9 a	3.6 ab	2.9 b	5.0 bc
Spinosad + Nulure	10.3 b	7.6 b	22.8 ab	16.8 a	5.7 ab	4.0 b	0.9 de
Guardian	20.8 a	35.1 a	29.0 a	16.7 a	9.0 ab	12.9 a	13.5 a
Delnet Bags	0.3 c	0.0 c	0.0 c	0.0	0.0	0.0	0.33 e
P>	0.0001	0.0001	0.008	ns	ns	0.003	0.0001

Duncan Waller

infestation on fruit was observed on October, November, January and April (Fig. 2).

With the exception of May and beginning of June, infestation of guava by CFF was almost constant. Highest infestation was observed during summer and fall (Fig. 2). Caribbean fruit fly trapping increased in April, July, August and September in 1997. However, fruit fly highest trapping (during 1998) was observed during February through March 1998, and lower peaks observed through the year during the spring, summer and fall months (Fig. 3).

Control of CFF

Experiment 1. McPhail trapping indicated that feral flies were present in the area to naturally infest fruits (Table 2). Only four treatments, Guardian, Guardian/Kinetic, Phloxine B/Nulure, and Avid/Nulure provided control significantly different from the blank. Only the Avid/Nulure treatment provided control that would permit application of the hot water treatment for export to California (Table 3).

Experiment 2. The only treatment that significantly reduced Caribbean fruit fly infestation to guava fruit was fruit bagging. Other treatments, such as Agrimek, Sure Dye, and Spinosad had a lower fruit fly infestation per fruit compared with Guardian. However, with the exception of fruit bagging, none of treatments used during this study was significantly lower than the untreated control (Table 4).

Table 5. Number of Caribbean fruit fly pupae collected from guava fruits at different stages of maturity.

Treatment	Number of pupae collected from fruits harvested at different stages of ripeness		
	Green	Green-Mature	Mature
Untreated	0.00 b	13.00 a	65.0 a
Agrimek + Nulure	4.71 b	—	—
Oil	0.00 b	16.0 a	27.4 a
Suredye	4.81 b	17.0 a	—
Spinosad + Nulure	3.49 b	0.0	2.0 a
Guardian	20.96 a	0.0	—
Delnet Bags	0.00	0.0	—
P>	0.0001	0.35	0.2

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