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COMPARISON OF FIELD OBSERVATIONS AND TRAPPING OF PAPAYA FRUIT FLY IN PAPAYA PLANTINGS IN CENTRAL AMERICA AND FLORIDA

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ABSTRACT

Papaya fruit flies, *Toxotrypana curvicauda* Gerstaecker, were observed on papaya trees in Guatemala and Costa Rica to compare with reported patterns of behavior for papaya fruit flies in south Florida. In both cases, males and females were nearly always on fruit and not on leaves. General activity of both sexes and female oviposition were highest in the morning in Central America, contrasting with the late afternoon activity period in Florida. A total of 23 mating pairs was observed in Costa Rica, all on papaya trees in late morning, compared to late afternoon to dusk in Florida. A fruit model trap baited with the pheromone 2-methyl-6-vinylpyrazine caught significant numbers of both male and female *T. curvicauda* in Costa Rica at a pheromone release rate of 1 μg/h. At this location, counts of flies in plots on papaya trees versus traps indicated a high rate of capture of both sexes of papaya fruit flies with the fruit-model sex pheromone trap.

RESUMEN

Se observo el comportamiento de las moscas *Toxotrypana curvicauda* Gerstaecker de la fruta en plantas de papaya en Guatemala y Costa Rica y se comparo dicho comportamiento con el observado en moscas de papaya en Florida. En ambos casos, los machos y las hembras fueron observados casi siempre en las frutas y no en las hojas. La actividad

de ambos sexos, y la oviposicion de las moscas en Costa Rica se observo durante la mañana en contraste con la actividad de las moscas de Florida la cual ocurre en las horas de la tarde. Un total de 23 parejas en copula fue observado en Costa Rica en horas avanzadas de la mañana, comparado con la actividad de las moscas de Florida durante el atardecer. Un modelo de trampa simulando una fruta, con la feromona 2-methyl-6-vinylpyrazyne utilizada como atrayente, y con una velocidad de dispersion de 1 ug/h, capturo un numero significativo de hembras y machos en Costa Rica. En este lugar, la captura del numero de moscas en plantas de papaya comparado con el numero de moscas capturado en las trampas, indico un numero alto de captura de moscas de ambos sexos en la trampa simulante de una fruta y utilizando la feromona como atrayente.

The papaya fruit fly, *Toxotrypana curvicauda* (Gerstaecker), occurs throughout much of the Caribbean, Central America, and South America (Wolcott 1933), where it is the principal insect pest of papaya fruit. Until recently, there was little information on the biology and behavior of this pest, and no lures or traps for monitoring or detection.

Studies have been conducted on the papaya fruit fly in South Florida on adult behavior (Landolt & Hendrichs 1983, Landolt 1984a), on the male sex pheromone (Chuman et al. 1987), and on behavioral responses to male sex pheromone (Landolt et al. 1985, Landolt & Heath 1988, Landolt et al. 1988). Suggested methods of cultural control for the papaya fruit fly have been made (Landolt 1984b) and a pheromone-baited trap was developed for monitoring and possibly control of papaya fruit flies (Landolt et al. 1988, Landolt and Heath 1990).

In the continental U.S., commercial papaya production is restricted to the southernmost area of the Florida peninsula. Papaya cultivation and infestations of papaya fruit flies are much more prevalent in Central America, northern South America and the Caribbean Islands. To determine if research findings on the papaya fruit fly in south Florida are generally applicable to papaya fruit fly infestations in other areas, observation and trapping studies were conducted in papaya plantings in Guatemala and Costa Rica for comparison. This paper reports the results of those studies.

Materials and Methods

Field observations of papaya fruit fly activities were made in three small (< 1 hectare) plantings of papaya near Retalhuleu, Guatemala, 17-23 June 1986 and 3-21 March 1987, and in a large (> 100 hectares) commercial papaya plantation near Buenos Aires, Costa Rica, 11-18 May 1988 and 1-2 February 1989. Bihourly visual surveys of papaya fruit fly activity on papaya trees were made on 4 days in June 1986, and 3 days in March 1987 in 3 small plantings totalling about 0.7 hectares near Retalhuleu, Guatemala. Fly sightings and activities were recorded from 0600 to 1800 hours, near sunrise to sunset. The sex and location of flies sighted, as well as male calling, female oviposition, fly interactions, and matings were noted. These observations were made in areas adjacent to pheromone trap plots described later. A similar study was made of papaya fruit fly behavior in a papaya plantation near Buenos Aires, Costa Rica, over 5 days in May 1988. Observations were made in a 4-row strip (5 meters) about 60 meters long, along the eastern edge of the plantation bordering the Rio Volcan. Bihourly observations were made from 0600 to 1600 hours with sunrise and sunset near 0600 and 1800 hours respectively. The sex and location of flies sighted, as well as their activities, were recorded. On 1-2 February 1989, male and female papaya fruit flies sighted were tallied per observation period with no behavioral observations made. Observed patterns of oviposition and mating in Florida were made using the methods of Landolt & Hendrichs (1983).

Trapping tests were set up in both locations to evaluate the attractiveness of the pheromone 2-methyl-6-vinylpyrazine (2,6-MVP) and efficacy of the fruit-model trap developed in Florida (Chuman et al. 1987, Landolt et al. 1988) for the papaya fruit fly in these areas. The trap used consisted of a 14-cm-diam. dark green sphere coated with Tanglefoot® (The Tanglefoot Co., Grand Rapids, MI) and baited with glass capillary lures loaded with 2,6-MVP as described by Landolt & Heath (1988). The desired release rate was obtained by using a 25 µl micropet (0.6 mm i.d.) with an air column over the pheromone reservoir. Lures were attached to spheres near the top as described by Landolt et al. (1988). Traps were hung from leaf petioles near, but not touching, fruit clusters. In Guatemala, two randomized complete blocks of 5 traps baited with dispensers providing different release rates of 2,6-MVP were originally set up on 3 March, 1987, in 2 separate plantings. Estimated release rates of the 5 treatments were 0, 80, 160, 320, and 1060 ng/h. These two blocks were maintained and checked daily until 12 March. Another block of 5 treatments was set up and maintained 10-12 March in a third papaya planting, and a fourth block was maintained from 12-21 March. Traps in all blocks were placed in papaya trees about 5 meters apart. In Costa Rica, a trapping experiment was set up on 13 January 1989 adjacent to the observation area described comparing unbaited traps to traps with pheromone lures releasing 1 µg/h. Five pairs of pheromone-baited and unbaited traps were set up in a N-S line, along the eastern edge of the papaya plantation. Traps were placed about 5 meters apart. Traps were checked and captured flies removed on 31 January and 1-2 February, at 1600 hours. Trap catch data from the Costa Rica test were analyzed using a paired t-test (Steel & Torrie 1960).

Results and Discussion

The papaya fruit fly observed near Retalhuleu, (and also San Jose de Puerto) in Guatemala and near Buenos Aires, Puntarenas, Costa Rica, differed in appearance from those collected, observed, and trapped in Dade County, Florida. All papaya fruit flies seen in Central America during this study were brown and yellow in color, compared to the brown and darker orange-yellow of those in Florida. Knab & Yothers (1914) noted the papaya fruit fly resemblance in size, form, color, and behavior, to *Polistes* wasps, which may be Batesian mimicry (Bates 1862). In this study, the color patterns observed were similar to vespid social wasps collected in the respective areas. In Dade County, Florida, the coloration is similar to that of *Mischocyttarus mexicanus* (Saussure), *Polistes dorsalis* (Fab.), and a local race of *Polistes exclamans* Vierick. In Guatemala *Mischocyttarus* sp. and *Stelopolybia areata* (Sat) were common in the study area, with coloration similar to that of the local papaya fruit fly.

General diel activity patterns observed in both Guatemala and Costa Rica were quite different from those observed in Florida. Near Retalhuleu, Guatemala, most fly sightings on papaya trees were from 0800 to 1400 hours, with males preceding females somewhat (Fig. 1). In Costa Rica near Buenos Aires, most sightings occurred from 1000 to 1200 hours (Fig. 1). During these studies 34 male and 19 female papaya fruit flies sighted at the Guatemala site and 334 males and 160 females were sighted at the Costa Rica site. In both locations, these observations differed from pattens exhibited by papaya fruit flies studied in Dade County, Florida, where fly activity was concentrated principally in the 2 h preceding sundown (Landolt & Hendrichs 1983). Temperatures recorded during peak periods of activity were 22-25°C in Dade Co., Florida (February), 33-36°C at the Guatemala study site and 28-34°C at the Costa Rica study site. Shifts in diel activity patterns are possibly due to responses to temperature differences. However, in subsequent field experiments in Florida in June, 1987, with daytime temperatures ranging up to 29°C, papaya fruit fly activity was still concentrated near dusk (unpublished observations).

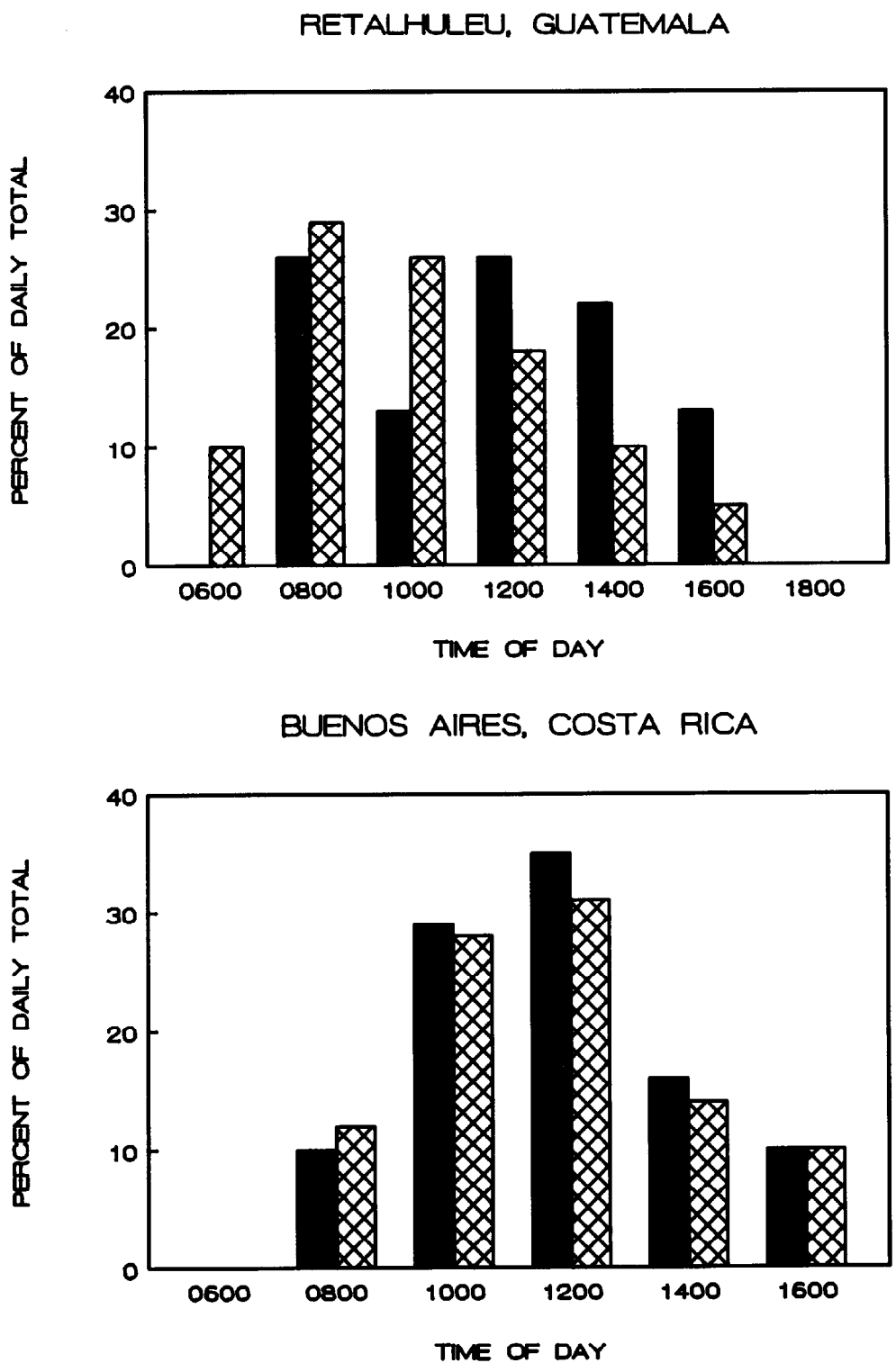

Fig. 1. Percentages of daily totals of male and female papaya fruit flies observed in papaya groves at bihourly intervals. Solid bars are for females, cross hatched bars are for males. Retalhuleu, Guatemala and Buenos Aires, Costa Rica.

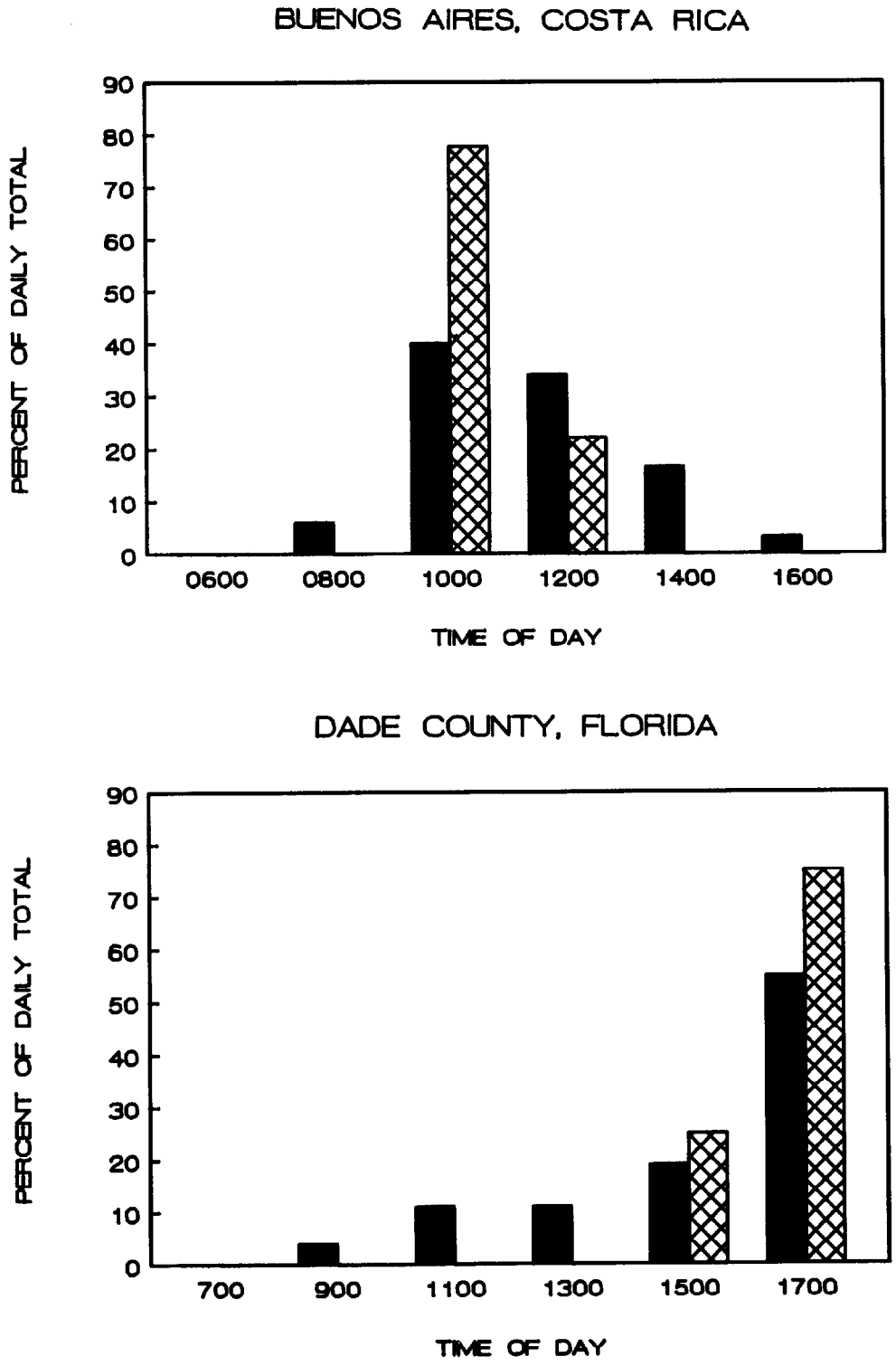

Fig. 2. Percentages of daily totals of ovipositing females and mating pairs of papaya fruit flies sighted in a papaya plantation at bihourly intervals. Solid bars are for ovipositions, cross hatched bars are for matings. Buenos Aires, Costa Rica and Dade County, Florida.

The diel pattern of female oviposition at the Costa Rica study site was distinct with most ovipositions observed in late morning (1000-1200 hours) (Fig. 2). In Dade Co., Florida most ovipositions were observed in the last 2 h of daylight, but with lesser numbers occurring throughout the day (Landolt & Hendrichs 1983). The few ovipositions observed in Guatemala were not recorded.

Mating pairs of papaya fruit flies were observed on papaya trees at both the Guatemala and Costa Rica sites. At the Guatemala sites, 3 mating pairs of papaya fruit flies were observed in June 1986. All 3 were near fruit clusters but on the trunk or on leaf petioles, and were sighted at 1400, 1430, and 1500 hours. These sightings were not made during systematic observations. A total of 23 mating pairs of papaya fruit flies were sighted in 5 days of bihourly observations made at the Costa Rica site in May 1988. All were recorded from 1000 to 1200 hours, with most at 1000 hours (Fig. 2). Again, the time of day of mating in papaya groves differed from that observed in Florida. Of 13 matings observed during the study of *T. curvicauda* activity in the field in Florida (Landolt & Hendrichs 1983), all were from 1400 to 1700 hours.

A total of 37 papaya fruit flies were trapped in Guatemala with fruit model traps baited with 2-methyl-6-vinylpyrazine (19 females, 18 males). Most flies (15 females, 12 males) were found in traps with the 2 highest release rates (320-1060 ng/h) (Table 1). A total of 196 papaya fruit flies was caught in traps in Costa Rica, (140 males and 56 females) in 3 days using a 2,6-MVP release rate of about 1 μg/h. Catches of both males and females on these pheromone-baited traps were significantly higher than on unbaited control traps (Table 1). In trapping tests conducted in Florida, highest trap catches were obtained with pheromone release rates of 140 to 900 ng/h.

We conclude from these studies that the pheromone-baited fruit-model trap developed in Florida for the papaya fruit fly is efficacious in Central America for trapping papaya fruit fly males and females. Although the trap is probably useful for monitoring general activity patterns, additional research is necessary to develop an understanding of the relationship between trap catches and population levels. At the Costa Rica study site on 1-2 February 1989, numbers of papaya fruit flies sighted in bihourly observations (total of 48 females, 81 males) were comparable to the number trapped (42 females, 77

TABLE 1. MEAN NUMBERS (±SD) OF MALE AND FEMALE PAPAYA FRUIT FLIES CAUGHT PER TRAP PER DAY IN TRAPS BAITED WITH 2-METHYL-6-VINYLPYRAZINE RELEASED FROM GLASS CAPILLARY DISPENSERS AT DIFFERENT RATES. N = 20 FOR GUATEMALA, N = 15 FOR COSTA RICA.

	Release Rate (ug/h)				
	0	.08	.16	.32	1.06
Guatemala					
Females	0.0	0.1	0.1	0.3	0.5
Males	0.1	0.1	0.1	0.4	0.2

	Release Rate (ug/h)	
	0	1.0
Costa Rica		
Females	1.5 ± 1.4	2.8 ± 2.7[1]
Males	2.9 ± 1.8	6.8 ± 4.3[1]

[1]Significantly greater than unbaited (0 dose) traps by paired T-test at $p < 0.01$. For catches of females, $t = 4.91$, d.f. = 13. For catches of males, $t = 4.81$, d.f. = 13.

males), suggesting the possibility of trapping out the papaya fruit fly with a suitable trap density. The papaya fruit fly is easily spotted on papaya because it is a large, colorful tephritid which remains principally on the large exposed papaya fruit and not on foliage. Most papaya fruit flies in a papaya grove can be spotted and counted in a row by row walkthrough.

Previously, we recommended (Landolt 1984b) that information on diel activity patterns of the papaya fruit fly be used to maximize efficacy of control methods used, such as pesticide applications directed at this insect. The present results show the timing of such treatments in Guatemala and Costa Rica should be much earlier in the day (late morning) than that recommended for south Florida (late afternoon).

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Mention of a proprietary product does not constitute an endorsement by the USDA.

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