ANASTREPHA SUSPENSA (LOEW) (DIPTERA: TEPHRITIDAE) McPHAIL TRAPS FOR SURVEY AND DETECTION

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ABSTRACT

Modifications of McPhail traps used for survey and detection of fruit flies were evaluated for the Caribbean fruit fly, *Anastrepha suspensa* (Loew). Traps containing 2 pellets of hydrolyzed torula yeast-borax bait (HTY) dissolved in water attracted as many Caribbean fruit flies as traps containing 6 pellets. Traps containing 2 pellets attracted significantly fewer miscellaneous species of flies that contaminate traps used for fruit fly survey and detection. Clear glass McPhail traps attracted as many Caribbean fruit flies as did traps that had been painted arc yellow. None of the alternative baits tested were significantly more attractive than HTY. Significantly more Caribbean fruit flies responded to McPhail traps, where they enter from the bottom, than to bucket traps, where they enter from the side. Although significant differences were observed in fly response to traps at different locations, these differences could not be demonstrated as consistently due to host species in which the traps were placed.

RESUMEN

Se evaluaron trampas de McPhail modificadas para el reconocimiento y la detección de la mosca del Caribe de las frutas, *Anastrepha suspensa* (Loew). Las trampas que contenían 2 polotillas de cebo (torula-borax-"HTY") sirvieron egual como las de 6 pelotillas en atraer las moscas del Caribe, per las de 2 pelotillas atrayeron menos moscas miscelaeas contaminantes. Las trampas claras atrayeron moscas del Caribe egual como las trampas amarillas. Ningun cebo alternativo fue más atractivo que "HTY". Significativamente más moscas del Caribe respondieron a las trampas de McPhail, en las cuales se entran por abajo, que a las trampas de balde, en las cuales se entran por el lado. Aunque se observaron diferencias significativas enu la reacción de las moscas a las trampas en diferentes sitios, no se podía demonstrar que estas diferencias se debian a las especies de hospederas en donde se colocaron las trampas.

The so-called Caribbean fruit fly, *Anastrepha suspensa* (Loew), has been found in Florida since 1965. During that period, the only trap available for survey and detection of this species has been the McPhail trap. This type of trap has been used by inspectors from the USDA Animal and Plant Health Inspection Service (APHIS), Plant Protection and Quarantine (PPQ) and the Florida Department of Agriculture and Consumer Services, Division of Plant Industry (DPI), for detection of incipient infestations of the Mexican fruit fly, *Anastrepha ludens* (Loew) and other species of fruit flies

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(Anonymous 1976) as well as to monitor populations of the Caribbean fruit fly.

McPhail traps have been operated on a weekly basis in Dade County, FL and elsewhere in the state for over 25 years. Steyskal (1977) found that Dahl reported use of a bell-shaped glass fly trap in 1896. McPhail (1937) had used the invaginated clear glass trap in evaluating various proteinaceous or ammonium baits for Mexican fruit fly. Newell (1936) reported that McPhail traps baited with a mixture of citrus juice and brown sugar were used in Florida to indicate progress being made during 1933 and 1934 to eradicate an infestation of *Anastrepha acidusa*[2] and *A. suspensa* in Key West.

Several improvements have been made to facilitate use of the McPhail trap for survey and detection of fruit flies. Sodium borate was found to inhibit decomposition of protein hydrolysates (Lopez and Hernandez Becerril 1967) which had been found more attractive to flies than the protein mixtures previously used by McPhail (1939) and others. A pelletized formulation of cottonseed protein hydrolysate (CTPH) and borax was developed to facilitate handling and mixing the materials used as a bait for survey and detection of fruit flies (Lopez et al. 1968). Subsequently a hydrolyzed torula yeast (HTY) formulation was found to be a more effective attractant for the Caribbean fruit fly than was the CTPH (Lopez et al. 1971).

Prokopy and Economopoulos (1975) reported that coating the exterior of McPhail traps with Bird Tanglefoot® or painting the traps daylight fluorescent yellow improved their effectiveness in capturing olive flies, *Dacus oleae* (Gmelin), or Mediterranean fruit flies, *Ceratitis capitata* (Wiedemann), under some conditions. Greany et al. (1978) found that sticky board traps attracted more Caribbean fruit flies when painted arc yellow, which they reported produced a sharp reflectance peak at ca. 590 nm. The objective of this study was to determine if the effectiveness of McPhail traps for survey and detection of Caribbean fruit flies could be improved by painting, use of various baits as attractants, or other modification.

Methods

The standard operating procedure for using McPhail traps in Florida is given in the Florida Fruit Fly Detection Manual as revised (Anonymous 1976). The traps were filled with water and torula yeast borax pellets (4 parts HTY and 5 parts borax by weight) added. The traps were serviced at 7-day intervals. In these studies, traps were placed in one or more of the 5 guava orchards available for our use or in selected individual trees located in cooperators' yards.

In our experiments, we selected trees that were hosts of the Caribbean fruit fly. Where we selected different species as hosts, we rotated traps from one host tree to the next or we placed paired traps in a host and rotated their locations in the tree according to the compass direction.

Comparisons were made to determine the efficiency of traps containing 2 vs. 6 pellets, traps painted with arc yellow alkyd enamel fluorescent paint (Day-Glo Color Corp #26-67-016-4 Cleveland, Ohio) vs. clear glass, and traps containing alternative baits to HTY. Generally, the attractant bait

[2]Specimens reported as *Anastrepha acidusa* Walk. actually were *A. mombinpraeoptans* Sein (Stone 1939). This species name is now know as *A. obligua* (Macquart) (Steyskal 1975).

was placed in the trap containing ca. 300 ml of water, and the trap was swirled until the bait dissolved. The number of Caribbean fruit flies responding to each trap was determined at weekly intervals. Since individual trap catch ranged from 0 to 475 flies/week, the data were transformed to log (x+1) for statistical analysis, calculation of means and Duncan's new multiple range test. Usually a split plot analysis of variance was used.

Results and Discussion

Number of Pellets per Trap. The trapping efficiency of McPhail traps containing 2 pellets of HTY-borax lure was compared with that of 6 pellets. Each trap was placed in a host tree at 10 different locations. Treatments were rotated between locations and replicated 5 times. The number of Caribbean fruit flies and miscellaneous species of flies in each trap was determined at weekly intervals for 23 weeks. These data (transformed to log (x + 1)) showed that the mean number of Caribbean fruit flies caught in traps baited with 2 pellets was 1.5 flies/trap/week compared with 1.3 flies for those with 6 pellets and that the treatment means did not differ significantly. However, analysis of transformed data for species of flies other than the Caribbean fruit fly showed that there were significantly fewer miscellaneous flies (various species, primarily Tachinidae, Muscidae and Calliphoridae) caught when 2 pellets were used (35.3 flies/trap/week) than when 6 pellets were used (67.5).

Earlier tests conducted by a DPI inspector, W. H. Pierce (letter to C. Poucher, dated May 12, 1972), reported that 10 traps containing 5 pellets/trap caught an average of 29.8 Caribbean fruit flies/trap/week during a 5-week period compared with 17.5 for traps containing 2 pellets. The data given by Pierce, when transformed and analyzed by the t-test, were not statistically different.

At the time of this research, 197 McPhail traps were being operated in Florida. Use of 2 pellets/trap would result in reduced cost of material as well as reduced time required to separate the fruit flies from the miscellaneous species of flies found in the trap.

Painted Traps. Since research by Greany et al. (1978) had shown that sticky board traps attracted more Caribbean fruit flies when painted are yellow than white or other colors tested, a study was undertaken to determine if McPhail traps painted are yellow would attract more Caribbean fruit flies than unpainted traps. McPhail traps were painted as follows: (1) solid (all surfaces accessible from the outside were painted); (2) top (outer surface accessible when trap was placed on a flat surface was painted); (3) throat (lower portion of trap and entrance to opening in bottom of trap was painted), or (4) unpainted. Two HTY pellets were placed in each trap as bait.

Efficiency of painted McPhail traps was determined in the field by placing single traps in potential host trees located in southern Dade County and rotating each of the 4 types of traps between the trees, or by placing one of each of the 4 types of traps in a host tree and rotating the traps on the compass points. The former were operated for 16 weeks from December until April, and the latter were operated for 10 weeks from April through June. Each treatment was replicated 5 times within each experiment and design. Results from these 2 experiments (Table 1) showed that differences

TABLE 1. MEAN RESPONSE OF CARIBBEAN FRUIT FLIES TO CLEAR AND PAINTED MCPHAIL TRAPS.

Location	Test interval (dates)	Clear traps	Painted traps[1]		
			Solid	Top	Throat
S. Dade	XII/20/76-IV/21/77	0.4 a	0.5 a	0.5 a	0.5 a
S. Dade	IV/21/77-VI/30/77	1.1 a	1.0 a	1.2 a	1.0 a
AREC	X/26/78-XII/29/78	4.0 a	3.9 a	—[2]	—
Kendall A	X/26/78-XII/29/78	1.1 a	0.5 b	—	—
Kendall B	X/24/78-XII/29/78	16.5 a	6.2 a	—	—

[1]Data were transformed to log (x+1) for analysis of variance, calculation of means and separation of means by Duncan's new multiple range test. Values in a horizontal line followed by the same letter are not significantly different at the 5% level.
[2]— indicates not tested.

in response of Caribbean fruit flies to traps painted as indicated were not statistically significant at the 5% level.

Efficiency of McPhail traps painted solid using arc yellow paint was subsequently compared with clear traps in guava plantings at the Florida Agricultural Research and Education Center (AREC), Homestead, FL and at 2 guava plantings operated by Kendall Groves. These traps were operated from mid-October through December, 1978, and were replicated 4 times at each of the 3 locations. Results from these tests (Table 1) also failed to show consistent differences in response of flies to clear and painted McPhail traps. This is consistent with findings by Prokopy and Economopoulos (1975) and Prokopy et al. (1975) that painting a clear McPhail trap did not enhance the effectiveness of traps containing Rodia-borax bait. This experiment did demonstrate that there were significant differences between response of Caribbean fruit flies to McPhail traps baited with HTY pellets during the season, within each orchard (Table 2). These differences generally were consistent for both clear and painted McPhail traps, as well as for the 3 guava groves in which the experiments were conducted.

ALTERNATIVE BAITS. As noted above, Lopez had found that HTY was superior to CTPH as an attractant for the Caribbean fruit fly. At the request of cooperators, we tested 3 other proteinaceous baits as attractants for Caribbean fruit flies. Amber BYF Series 50x, a water-soluble fraction of antolyzed brewers yeast, was supplied by Amber Laboratories, Milwaukee, WI, 53209. Zitan 85® and Nasiman 73®, hydrolized proteins, were supplied by Osem Export Ltd (Tamogan Ltd), Tel Aviv, Israel. In the first experiment, traps were rotated between locations over a 6-week period. In the second experiment, they were tested for 11 weeks.

Results of these tests are given in Table 3. They show that in one experiment the Zitan 85 was inferior to HTY, but in the other tests there were no differences between baits. Amber BYF was more attractive to miscel-

TABLE 2. SEASONAL ACTIVITY OF CARIBBEAN FRUIT FLIES TO MCPHAIL TRAPS IN 3 ORCHARDS.

Week	Orchard location[1]		
	AREC	Kendall A	Kendall B
Oct. 26	10.9 ab	3.3 a	254.1 a
Nov. 2	19.6 a	2.4 a	87.1 b
Nov. 9	5.0 b	4.2 a	125.1 ab
Nov. 16	6.1 b	0.1 b	8.1 c
Nov. 23	24.6 a	0.3 b	15.9 c
Nov. 30	6.0 b	0.3 b	8.9 c
Dec. 7	1.1 c	0.1 b	1.9 d
Dec. 14	1.1 c	0.2 b	1.0 de
Dec. 21	0.1 c	0.4 b	0.3 de
Dec. 29	0.0 c	0.1 b	0.0 e

[1]Data were transformed to log (x+1) for analysis of variance, calculation of means and separation of means by Duncan's new multiple range test. Values in a column followed by the same letter are not significantly different at the 5% level.

laneous other species of flies than the Nasiman 73 and Zitan 85 baits. HTY was more consistent as a bait than was Amber BYF. Most of the Caribbean fruit flies responding to the latter trap did so in a 1-week period.

TRAP DESIGN. White bucket traps containing a liquid protein bait have been used for fruit flies in Hawaii (Nakagawa et al. 1975). The principle of operation is similar to the McPhail trap except that the flies enter the buckets from the side, instead of from the bottom as in the McPhail trap. McPhail and bucket traps, each containing 2 HTY pellets dissolved in ca. 350 ml water, were placed in guava trees at the Mannheimer Primatological Foundation near Florida City. The traps were operated for 17 weeks, from August to December 1979, and treatments were replicated 4 times.

Analysis of variance for these data, transformed to log (x+1), showed that significantly more Caribbean fruit flies responded to the McPhail traps (3.0 flies/trap/week) than to the bucket traps (0.8 flies/trap/week).

TRAP-HOST SELECTION. The Florida Fruit Fly Detection Manual (Anonymous 1976) recommends that McPhail traps should be placed in preferred hosts

TABLE 3. COMPARISON OF FLY RESPONSE TO BAITS IN MCPHAIL TRAPS.

Bait	Amount/ trap	Mean number of flies/trap per week[1]		
		Caribbean fruit flies		Other flies[2]
		1977	1978	1978
HTY	2 pellets	3.0 a	2.6 a	258.0 ab
Amber BYF	3 ml	1.9 ab	2.3 a	378.1 a
Nasiman 73	3 ml	0.9 b	1.4 a	129.6 b
Zitan 85	3 ml	0.5 b	1.1 a	101.7 b

[1]Data were transformed to log (x+1) for analysis of variance, calculation of means and separation of means by Duncan's new multiple range test. Values in a column followed by the same letter are not significantly different at the 5% level.
[2]Various species, primarily Tachinidae, Muscidae and Calliphoridae.

of the species of fruit fly being trapped. Von Windeguth et al. (1973) reported that the most important hosts of the Caribbean fruit fly in Key West, Florida, included guava (*Psidium guajava* L.), loquat (*Eriobotrya japonica* (Thunb.) Lindl.), Surinam cherry (*Eugenia uniflora* L.), tropical almond (*Terminalia catappa* L.) and sapodilla (*Achras zapota* L.).

In one of our experiments we compared response of flies over a 16 week period from January through April to traps placed in different hosts. Analysis of these data, using a t-test, showed that there was no difference in response of flies to traps in a loquat tree (4.9 flies/trap/week) compared to a nearly guava tree (1.4 flies/trap/week). Similarly, there was no difference in response to traps in a sapodilla tree (7.0 flies/trap/week) and a nearby guava tree (4.4 flies/trap/week).

Conclusions

The research reported in this paper has demonstrated that McPhail traps baited with 2 pellets of HTY were as effective as those with 6 pellets, when used to survey for the Caribbean fruit fly. More miscellaneous species of flies, that had to be separated from the fruit flies, were found in the latter. This research did not indicate the potential for improving response of Caribbean fruit flies to the McPhail traps by painting them arc-yellow, use of other baits or use of a bucket instead of an invaginated, liquid bait trap. Differences in response of fruit flies to McPhail traps could only be attributed to seasonal variation in population abundance.

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