Spinosad as an Organophosphate Alternative for Areawide Fruit Fly Control in Hawaii and Production of Organic Fruits & Vegetables

R. I. Vargas[1], N. W. Miller[1], R. J. Prokopy[2, 4], and R. F. L. Mau [3]

[1]United States Department of Agriculture, Agricultural Research Service,
Pacific Basin Agricultural Research Center, P.O. Box 4459, Stainback Highway, Hilo, HI 96720, (808) 959-4329,
Fax: (808) 959-5470, rvargas@pbarc.ars.usda.gov, http://pbarc.ars.usda.gov

[2]University of Massachusetts, Department of Entomology, Fernhald Hall, Amherst, MA 01003

[3]University of Manoa, Department of Plant and Environmental Protection Services
College of Tropical Agriculture and Human Resources, 3050 Maile Way, Room 310, Honolulu, HI 96822
(808) 956-7063, Fax: (808) 956-5888, maur@ctahr.hawaii.edu

[4] Deceased, 14 May 2004

Bactrocera cucurbitae
(Coquillett)

Bactrocera dorsalis
(Hendel)

Abstract:

Protein bait sprays and the highly attractive male kairomone lures methyl eugenol and cue-lure have been used in conjunction with organophosphate insecticides in area-wide fruit fly campaigns worldwide. An effective spinosad protein bait spray (GF-120) without an organophosphate insecticide has recently been developed for area-wide control of oriental fruit fly and melon fly in Hawaii. In addition a male annihilation spinosad treatment has been developed for area-wide suppression of oriental fruit fly and melon fly. These treatments offer environmentally friendly alternatives to present organophosphate formulations for eradication or suppression of fruit flies not only in Hawaii, but throughout the world. Many cooperators in the Hawaii Area-Wide Pest Management Program have employed these techniques to produce organically certified fruits and vegetables.

Introduction:

Historically, protein bait sprays and the highly attractive male kairomone lures methyl eugenol (4-allyl-1, 2-dimethoxybenzene-carboxylate) and cuelure [4-(*p*- acetoxyphenyl)- 2- butanone] have been used in conjunction with organophosphate insecticides in area-wide fruit fly campaigns (Vargas et al. 2001, 2002, 2003). Overuse of organophosphate insecticides has been implicated in secondary pest outbreaks, negative effects on beneficial insects, environmental contamination, and adverse effects on human health (Carson 1962, Hoy & Dahlsten 1984, Dow Elanco 1994). Concerns with the use of these toxicants in insect eradication programs have been repeatedly voiced by community organizations in the U.S.A. Recently spinosad, an insecticide derived from metabolites from the soil bacterium, *Saccharopolyspora spinosa*, has shown promise as an alternative to traditional toxicants. Spinosad demonstrates lower mammalian and environmental toxicity with reduced risk to humans and wildlife than traditional insecticides (Dow Elanco 1994). Unlike traditional toxicants spinosad has limited contact toxicity and low volatility and thus must be ingested by insects to be effective. For this reason we began researching methods for the use of spinosad against Oriental Fruit Fly (*Bactrocera dorsalis* (Hendel)), Mediterranean fruit fly (*Ceratitis capitata* (Wiedemann)), and Melon Fly (*Bactrocera cucurbitae* (Coquillett)) in the Hawaiian Islands.

Materials and Methods:

Field Plot Trials of GF-120 Fruit Fly Bait for Melon Fly

Three types of fields with sorghum borders were simultaneously evaluated: a plot with sprayed borders, a plot with unsprayed borders, and a plot without borders. Plots were one hectare with cut cucumbers placed inside (fig. 1).

Sprayed plots were treated with GF-120 NF fruit fly bait diluted to contain 80 ppm spinosad (fig. 2). 50 ml of this mixture was applied in a 50 cm swath around the entire perimeter of the plot using a backpack sprayer with a coarse nozzle setting.

Protein fed (egg-bearing) and protein starved female melon flies were marked and released at each field site. Twenty-five females of each physiological state were released from each side of the field plot during the morning of each trial.

Cucumbers were checked for arriving female flies every half hour for 8 hours each day. Arriving females were removed and recorded.

Fig. 1. Experimental field plot with sorghum border used to test GF-120 fruit fly bait against melon fly.

Table 1. Mean % melon fly arriving on cucumber

State	Field	Mean % Flies	Stnd Dev ±	
P - Fed	Sprayed	11	6	B
	Clean	31	11	A
	Open	28	5	A
P - Starved	Sprayed	0	0	C
	Clean	6	4	BC
	Open	2	2	C

Values in each column followed by letters are not significantly different at the 0.05 level (LSD, Proc GLM, SAS).

Male Annihilation Studies with Oriental Fruit Fly and Melon Fly

Naled and malathion are the standard insecticides used in male annihilation treatments.

Plastic 1 liter bucket traps (fig. 3) containing cotton wicks with either cuelure (10 ml) or methyl eugenol (10 ml) with various toxicants were weathered in the field on Kauai Island.

Toxicants tested included spinosad, naled, malathion, DDVP, and permethrin. Solutions were mixed that contained 5% (ai) of each liquid toxicant and placed on a cotton dental wick. Ten ml of each solution was put on each wick. Two gm cubes of DDVP were placed in baskets with 10ml of lure (cuelure or methyl eugenol).

Flies were removed from traps and counted each week.

Fig. 2. GF-120 NF fruit fly bait.

Table 2. Cuelure male annihilation captures

Weeks	Toxicant	Mean	SEM ±	
1 -5	Naled	100.63	22.07	A
	DDVP	90.79	21.40	AB
	Malathion	67.89	18.93	AB
	Spinosad	49.78	15.50	BC
	Permethrin	3.58	0.54	C
16 - 20	Malathion	1251.10	315.70	A
	Spinosad	1167.30	270.47	A
	DDVP	826.25	212.27	AB
	Naled	453.05	103.58	BC
	Permethrin	23.80	4.63	C

Values (weeks 1-5 or 16-20) in each column followed by letters are not significantly different at the 0.05 level (LSD, Proc GLM, SAS).

Results:

Field Plot Trials of GF-120 Fruit Fly Bait for Melon Fly

Significantly more egg-bearing female melon flies where able to reach cucumbers in the open and unsprayed plots (table 1).

No starved flies arrived to cucumber in the plots sprayed with GF-120 (table 1).

Few starved flies were attracted to cucumber (table 1).

Male Annihilation Studies with Oriental Fruit Fly and Melon Fly

In cuelure tests spinosad kill compared with malathion during weeks 1-5 (table 2).

In cuelure tests spinosad kill compared with naled and malathion during weeks 6-10 (table 2).

In methyl eugenol tests spinosad wicks showed kill similar to naled and malathion for up to 10 weeks (table 3).

Fig. 3. Plastic 1 liter bucket trap used for male annihilation trials.

Table 3. Methyl eugenol male annihilation captures

Weeks	Toxicant	Mean	SEM ±	
1 -5	DDVP	1522.30	234.22	A
	Spinosad	1418.10	223.31	AB
	Naled	1382.45	155.08	AB
	Malathion	1030.85	134.29	B
	Permethrin	238.80	32.47	C
16 - 20	Naled	2557.35	288.30	A
	Malathion	1827.00	168.40	B
	DDVP	1703.75	224.20	B
	Spinosad	1369.55	197.80	B
	Permethrin	527.00	46.57	C

Values (weeks 1-5 or 16-20) in each column followed by letters are not significantly different at the 0.05 level (LSD, Proc GLM, SAS).

Conclusions:

An effective protein bait spray without an organophosphate insecticide has been developed for area-wide control of not only Mediterranean fruit fly but also for oriental fruit fly and melon fly. An organic formulation (GF-120 NF) is now available.

In addition a male annihilation spinosad treatment without an organophosphate insecticide has been developed for area-wide suppression of oriental fruit fly.

A moderately successful male annihilation spinosad treatment without an organophosphate insecticide has been developed for melon fly.

GF-120 NF and passive MAT treatments have allowed many growers in the Hawaii Fruit Fly AWPM Program to market organic fruits and vegetables in Hawaii.

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