Evaluation of Reduced Risk Insecticide for Olive Fruit Fly Control

By

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The olive fruit fly (OLFF), *Bactrocera oleae* (Diptera; Tephritidae), is one of the most significant pests of olives throughout the Mediterranean (Sharaf 1980, Michelakis and Neuenschwander 1983, Kapatos and Fletcher 1984). OLFF larvae develop in the olive fruit, causing premature fruit drop and reducing fruit quality for canning or oil production. The OLFF appeared in California in 1998 and has now spread throughout the state where it can cause considerable damage (Collier and Van Steenwyk 2003 and Rice et al. 2003).

In California OLFF control relies on repeated applications of GF-120, a combination of the reduced risk insecticide spinosad and a new fruit fly bait developed by Dow AgroSciences. Standard practice in the San Joaquin and Sacramento valleys is to apply GF-120 every 1-2 weeks from pit hardening to harvest. GF-120 is currently registered on olives under an emergency registration (Section 18). An IR-4 project is underway to gather residue data needed to establish tolerance for spinosad in olives for future Section 3 registration of GF-120.

We have developed field and laboratory efficacy data on GF-120 for OLFF control. From these data, it appears that GF-120 provides excellent control of low OLFF populations. However, control of large or dispersive populations of OLFF by GF-120 in a timely manner is problematic. The registration of another insecticide, e.g. pyrethroid or foliar applied neonicotinoid, would provide a fast acting alternative for large or dispersive OLFF populations. A pyrethroid or neonicotinoid insecticide could suppress large OLFF populations and then allow repeated applications of GF-120 to maintain the OLFF population within acceptable levels. In addition, the registration and use of a pyrethroid or neonicotinoid insecticide may slow or prevent the development of resistance to spinosad by OLFF. Here we report on initial investigations of the relative efficacy of several pyrethroid, neonicotinoid and other insecticides in the laboratory for control of OLFF. From this information, we will select of the most efficacious insecticide for field evaluations and subsequent registration through the IR-4 process. The selection of the insecticide to pursue for registration will be made after consultation with the manufacturer, stakeholders (e.g. California Olive Committee) and IR-4 program, and will be based on a number of factors, e.g. manufacturer's willingness to support registration and field research, material meeting reduced risk criteria, etc.

Plans and Procedures:

Preliminary OLFF insecticide efficacy trials were conducted in the laboratory to evaluate a large number of registered and unregistered insecticides including six pyrethroids, four neonicotinoids, avermectins and avermectin analogs and other potential insecticides most at both a high and low application rate. In general, the high field rate of each insecticide was evaluated first and if significant mortality was observed, then a low field rate was evaluated. Each insecticide and application rate except GF-120 was combined with NuLure at 3 pt/100. Three ml of final spray solution was applied to 10 olive leaves per replicate using a Potter spray tower. The GF-120 was applied in 20 ul droplets to five leaves per replicates. Each insecticide and application rate was replicated four times. After the insecticides were applied to the leaves, the leaves were allowed to dry (1 hr) and were placed into a 4-liter cage with 25 adult OLFF. The flies were reared in the laboratory on olives. The OLFF were pre-fed a 3:1 (sugar:yeast) diet. Mortality was determined at 1/2 and 1 days of exposure (DOE). The experiment was conducted at about 70°F.

Results and Discussion:
OLFF mortality resulting from various insecticides is shown on Table. 1. In Table 1, the insecticides are grouped by class and rate while the determination of significance among the insecticides was evaluated regardless of class or rate. The data was transformed and presented as mean percent corrected mortality using Abbott's formula (Abbott 1925). The control mortality was 3.0 percent or less in all trials except for the trial containing Mesa, Agri-Mek and Proclaim. In this trial control morality was 11.7%. The high and low rate of each insecticide was selected based on currently registered field rates on another food crops. This amount of insecticide would be the expected rate to receive registration.

The mean percent corrected mortality of the insecticides shows a great deal of variation among the different classes as well as rates. The only insecticides registered on olive (Sevin and Supracide) performed poorly while Malathion, which is not registered, produced good but quite variable results in two different trials. Malathion was included to provide a grower standard since Malathion has been the insecticide previously used in various fruit fly eradication programs before the development of GF-120. Thus the currently registered materials, Sevin or Supracide performed poorly and are not viable alternatives for OLFF control. GF-120, the current grower standard is as effective or more effective than Malathion. The different dilutions of GF-120, i.e. 4 to 1 or 1.5 to 1, made little difference in the efficacy of the material. However, concentration of GF-120 may be important in longevity of the product in the field when rehydration of the material from dew or humidity is possible.

The all pyrethroid insecticides show good efficacy with the high rate of Brigade as effective as Malathion or GF-120. The low rate of Baythroid and Warrior were not as effective as the low rates of Asana, Danitol or Brigade particularly at 1/2 DOE. Only one rate (middle) of Decis was evaluated because the manufacture was uncertain about its status and was unlikely to support further study of the product. Thus of the pyrethroid insecticides Brigade is the most promising. The spot or alternate row treatment of a pyrethroid insecticide combined with NuLure bait might provide acceptable control without the secondary pest outbreaks that has been associated with their full coverage usage of the pyrethroids in the past.

The neonicotinoid insecticides showed little promise for OLFF control with the exception of the high rate of Actara. However, the high rate of Actara provided only marginally control. In a related study, Provado and presumably Actara provide larval control of walnut husk fly within the fruit (Van Steenwyk and Coates 2001). Thus in the future Actara might provide a rescue treatment to suppress OLFF infestation after oviposition.

Avermectin and avermectin analogues provided surprising results. Agri-Mek at the high rate of application provided control similar to the pyrethroid insecticides. Proclaim at a high field rate of 0.015 lb(ai)/100 provided marginal control while Mesa provided no control. Also Avaunt provided no control. Agri-Mek at the rate of 0.023 lb(ai)/100 gal is very expense that would cause grower resistance to it use. Another promising result was that the use of a low rate of Success (spinosad) at 0.016 lb(ai)/100 gal resulted in control similar the pyrethroid insecticides and Agri-Mek. The efficacy of Success might increase to the level of Malathion or Brigade with an increase in the amount of Success. However, using large amounts of Success would not provide an alternative chemistry and thus accelerate potential resistance problems. The current IR-4 project to registered GF-120 (spinosad plus bait) will establish a tolerance for spinosad on olives and the registration of Success could use this tolerance and thus require less work.

Conclusions:
Asana, Brigade and Success show promise as future IR-4 candidates. The high rate of Agri-Mek, Baythroid, Danitol and Warrior also show some promise as potential candidates while Actara, Assail, Avaunt, Calypso, Mesa and Proclaim show limited or no efficacy against OLFF.

Table 1. Laboratory Efficacy of Sprayed Registered and Unregistered Insecticides plus NuLure for OLFF Control

Treatment		Rate	Percent Corrected Mortality		Control
Trade Name	Chemical Name	lb ai/100 gal	1/2 DOE	1 DOE	Mortality
		OP and Carbamate Insecticides			
Sevin 80WP	carbaryl	7.520	1.9 ab	8.6 ab	1.0
Supracide 2EC	methidathion	0.500	6.8 abc	19.7 bc	1.0
Malathion 8EC	malathion	3.000	80.2 mn	88.2 klm	0.0
Malathion 8EC	malathion	3.000	33.7 ef	52.1 de	3.0
		Pyrethroids Insecticides			
Asana XL 0.16EC	esfenvalerate	0.015	54.5 ij	68.5 fghi	1.0
Asana XL 0.16EC	esfenvalerate	0.050	66.2 hl	80.6 ijklm	1.0
Baythroid 2E	cyfluthrin	0.025	16.4 cd	48.4 d	1.0
Baythroid 2E	cyfluthrin	0.050	55.4 ij	74.9 hij	1.0
Brigade 10WP	bifenthrin	0.019	63.4 jkl	76.9 ijkl	2.0
Brigade 10WP	bifenthrin	0.038	69.9 lm	82.3 jklm	1.0
Brigade 10WP	bifenthrin	0.100	81.3 n	89.0 lm	2.0
Danitol 2.4EC	fenpropathrin	0.200	47.4 ghi	60.4 def	1.0
Danitol 2.4EC	fenpropathrin	0.400	54.1 hij	78.9 ijkl	1.0
Decis 0.2EC	deltamehtrin	0.195	53.4 hij	70.9 fghij	0.0
Warrior 1CS	Lambda-cyhalothrin	0.015	21.0 d	53.1 de	1.0
Warrior 1CS	Lambda-cyhalothrin	0.025	54.0 hij	73.7 ghij	0.0
Warrior 1CS	Lambda-cyhalothrin	0.030	33.1 e	75.4 hijk	1.0
		Neonicotinoid Insecicides			
Calypso 4SC	thiacloprid	0.250	1.0 ab	1.0 a	1.0
Provado 1.6F	imidacloprid	0.100	4.1 ab	7.3 ac	1.0
Assail 70WP	acetamiprid	0.101	4.8 ab	8.7 ab	1.0
Actara 25WG	thiamethoxam	0.031	11.5 bcd	27.9 c	1.0
Actara 25WG	thiamethoxam	0.086	37.1 efg	51.7 de	1.0
		Avermectins, Analoges & Others			
Mesa 0.078EC	milbemectin	0.015	0.0 a	0.0 a	11.7
Agri-Mek 0.15EC	abamecin	0.012	35.1 ef	63.1 efgh	11.7
Agri-Mek 0.15EC	abamecin	0.023	43.9 fgh	72.6 fghij	11.7
Proclaim 5WG	emamectin benzoate	0.015	47.9 hi	61.0 defg	11.7
Avaunt 30WG	indoxacarb	0.047	0.0 a	0.0 a	1.0
Avaunt 30WG	indoxacarb	0.113	1.0 ab	1.9 a	1.0
Success 2SC	spinosad	0.016	58.8 jk	73.2 fghij	1.0
GF-120 (4:1)	spinosad		83.1 n	93.1 m	0.0
GF-120 (1.5:1)	spinosad		82.1 n	93.2 m	0.0

Means followed by the same letter within a column are not significantly different (Fisher's protected LSD, $P \leq 0.05$). All insecticides combined with 3 pt Nulure/100 gal

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