LABORATORY TOXICITY OF INSECTICIDE RESIDUES TO *ORIUS INSIDIOSUS* and *GEOCORIS PUNCTIPES*

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Abstract

Adults obtained from laboratory cultures of the insidious flower bug, *Orius insidiosus* (Say), and big-eyed bug, *Geocoris punctipes* (Say) were exposed to ten insecticides, including three newer insecticides with novel modes of action, using a residual insecticide bioassay. There was considerable variation in response among both species tested to the insecticides. Spinosad was less toxic than other insecticides tested on both species.

Introduction

Primary pest release and resurgence, and increases in populations of secondary pests, may occur as a result of the selective destruction of beneficial arthropods by chemical pesticides. Even the newly developed biorational pesticides, which are based on natural products, and are more host- or pest-specific, can have profound side effects (Croft 1990). Pest release and resurgence have been widely reported as a consequence of pesticide use or over-use (Michelbacher et al. 1946, Doutt 1948, DeBach and Bartlett 1951, Lingren and Ridgway 1967, Flint and van den Bosch 1981).

One of the first definitive studies on the effects of pesticides on beneficial arthropods was reported by DeBach and Bartlett (1951). These authors noted that adverse effects of chemical control treatments on natural enemy populations in citrus were produced in three ways: through direct toxicity, through toxicity or repellent action of chemical treatments considered inert, and through elimination of beneficial populations by removal of host species.

In addition to direct impact, pesticides often disrupt relationships of associated species in the community, including competitors, hyperparasites, and alternate hosts or prey of natural enemies (Croft 1990). The concept of integrated pest management (IPM) was developed as a consequence of the incompatibility of pesticides and biological control.

Integrated pest management practice in cotton production recommends the preservation of beneficial insects for control of various insect pests. Emphasis on IPM is especially important in early season cotton, when beneficials are capable of maintaining some pests below economic thresholds. Chemical insecticidal sprays become necessary, however, as the growing season progresses and numbers of pest insects increase and plant fruiting structures become more susceptible to attack. Information on the toxicitites of various cotton insecticides to several key beneficial species is therefore important in selection of compounds that will minimize mortality of these species.

The insidious flower bug, *Orius insidiosus* (Say), and the big-eyed bug, *Geocoris punctipes* (Say) are important predators of several economic pests of cotton (Sterling et al. 1989). Field application of pyrethroid and organophosphorus insecticides significantly reduced the *Heliothis* spp. predator complex in cotton, compared with an untreated check (Roach and Hopkins 1981). Field testing of dimethoate, fenvalerate, and flucythrinate significantly reduced populations of most beneficial arthropods when applied to early season cotton in Mississippi (Scott et al. 1986). Leggett (1992) found that predaceous arthropods in Arizona cotton were reduced after application of ULV malathion, but populations completely recovered two weeks after treatment.

Several other studies document the toxic effect of cotton insecticides on beneficials (Pape and Crowder 1981, Yokoyama and Pritchard 1984, Yokoyama et al. 1984, Butler and Las 1983, Scott et al. 1983, Rajakulendran and Plapp 1982). The effects of four new compounds at field rates on populations of beneficials: spinosad (Tracer), fipronil (Regent), chlorfenapyr (Pirate), and imidacloprid (Provado) have been tested on cotton beneficials (Pietrantonio and Benedict 1999, Sparks et al. 1997, England et al. 1997, Peterson et al. 1996, Murray and Lloyd 1997). The objective of this study was to determine some of the lethal and sublethal effects of selected insecticides on *O. insidiosus* and *G. punctipes*.

Materials and Methods

The *O. insidiosus* and *G. punctipes* cultures were originally collected from cotton near Weslaco, TX, in September 1996. Adults were maintained on green beans as an ovipositional substrate. All colonies were provided *Helicoverpa zea* (Boddie) eggs as food and moistened cotton wicks as a water source. Adults were maintained in 14.5cm x 2.5cm ventilated plastic petri dishes, with 40-60 insects per dish. All species were held at 26 ± 2^0 C, 55-60% RH, and a 14L:10D photoperiod. Adults were less than one-week old when tested.

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Formulated insecticides tested were fipronil [Regent 2.5 emulsifiable concentrate (EC); Rhone-Poulenc Agric. Co., Research Triangle Park, NC], spinosad [Tracer 4 suspension concentrate (SC); Dow AgroSciences, Indianopolis, IN], chlorfenapyr [Pirate 3 (SC); American Cyanamid Co., Parsippany, NJ], imidacloprid [Provado 1.6 flowable (F); Bayer, Inc., Kansas City, MO], cyfluthrin [Baythroid 2 (EC); Bayer, Inc., Kansas City, MO], tebufenozide [Confirm 2 (F); Rohm and Haas, Philadelphia, PA], endosulfan [Phaser 3 (EC); AgrEvo USA Co., Wilmington, DE], profenofos [Curacron 8 (EC); Novartis, Greensboro, NC], azinphos-methyl [Guthion 3 (F); Bayer, Inc., Kansas City, MO], and malathion [Fyfanon 9.79 ultra low volume (ULV); Cheminova, Inc., Wayne, NJ].

Spray Chamber

Helicoverpa zea eggs were treated with insecticides using a laboratory spray chamber (DeVries Mfg., Hollandale, MN). The sprayer was calibrated to deliver 56 liters per hectare using one TX-4 nozzle at 1.7kg/cm² and 4.8km/h. For ULV application of malathion, the compressed-air system was replaced with a modified ULVA+ spinning disk atomizer head (Dramm Corp., Manitwoc, WI; Elzen unpublished). Rates of formulated insecticides applied were selected by referring to an appropriate control guide (Norman and Sparks 1997) or from manufacturer's recommendations (in the case of non-registered materials).

Bioassays

Helicoverpa zea eggs were treated with insecticides in 6 replicates using the spray chamber. Eggs were previously frozen at -70°C for 1h to prevent hatching. Thirty mg of eggs were exposed to 6 male and 6 female *O. insidiosus* adults (8 days old) in 11 cm diameter petri dishes per replicate in 6 replicates. Replicates were supplied with a water-moistened cotton wick and one green bean (6 cm long). Mortality was determined at 72-h post-treatment. This bioassay was repeated using the same parameters for *G. punctipes*.

Insects were held at 26 ± 2^0 C, 55-60% RH, and a 14L:10D photoperiod. Mortality was determined by failure of insects to move when prodded by a probe. Control mortality was never greater than 10.0%; data were corrected for control mortality using Abbott's (1925) formula. Percentage mortalities were arcsine transformed and analyzed by analysis of variance; means were separated by least significant differences [$P \leq 0.05$ (SAS Institute 1988)].

Results and Discussion

Few significant differences were found in insecticide toxicity among treatments to male *O. insidiosus*. Toxicity ranged from a low of 21.7% (tebufenozide) to a high of 62.5% (malathion). Tebufenozide and cyfluthrin were significantly less toxic to males than malathion (Table 1). Toxicity of the insecticides to female *O. insidiosus* ranged from a low of 19.8% (tebufenozide) to a high of 62.7% (imidacloprid). Tebufenozide was also significantly less toxic than malathion to females (Table 1).

For *G. punctipes* males, imidacloprid, tebufenozide, and spinosad were significantly less toxic than chlorfenapyr, endosulfan, and fipronil (Table 1). Spinosad, tebufenozide, and azinphos-methyl were significantly less toxic to female *G. punctipes* than fipronil and endosulfan (Table 1).

Pietrantonio and Benedict (1999) rated chlorfenapyr as slightly harmful (causing 25-50% mortality) to *O. insidiosus*. They also reported that spinosad was harmless (causing <25% mortality) to *O. insidiosus*. We found similar mortality to *O. insidiosus* exposed to chlorfenapyr; however, spinosad produced much higher mortality in *O. insidiosus* in our tests (Table 1). Schoonover and Larson (1995) reported that spinosad was 450-fold less toxic to *O. insidiosus* than cypermethrin. England et al. (1997) found 76% mortality in *O. insidiosus* exposed to endosulfan treated cotton leaves [0.57 kg(AI)/ha] 24 h after exposure; we observed lower mortality to endosulfan [1.7 kg(AI)/ha] 72 h after exposure. They also reported that malathion ULV caused 100% mortality; at the same rates we observed lower mortality with malathion (Table 1).

Tillman and Mulrooney (1997) reported higher mortality in *G. punctipes* treated with the same rate of ULV malathion as in our study, but they reported similar mortality with the same rate of fipronil (although applied ULV). Fipronil was more toxic to *G. punctipes* than to *O. insidiosus* (Table 1), which was overall more sensitive to insecticides, perhaps due to its much smaller size. Mizell and Sconyers (1992) observed 77.6% mortality to *G. punctipes* exposed to 127.4 ppm of imidacloprid; we also found high mortality in most cases (Table 1). Their method was based upon dipping plastic petri dishes or diet cups with lids into pesticide solutions; thus, the entire arena would have been coated with insecticide, whereas in our tests, only eggs were exposed to insecticide.

There was considerable variability in response of the two species tested to the insecticides selected. However, the lower toxicity of spinosad to *G. punctipes* is consistent with the study of Murray and Lloyd (1997) who reported that spinosad was not disruptive to predator populations in Australian cotton and suggested that the product has an important role in integrated management programs. Further, Hendrix et al. (1997) reported that spinosad was softer on beneficials than chlorfenapyr, deltamethrin (Decis), *lambda*-cyhalothrin (Karate), or acephate (Orthene), and Pietrantonio and Benedict (1999) rated spinosad as harmless (causing <25% mortality) to *Cotesia plutellae* (Kurdjumov) in laboratory studies.

Cotton IPM is highly complex and relies on many factors, including the selectivity of pesticides. Data on the selectivity of newer insecticides with novel modes of action are useful, because these may replace conventional insecticides. Unlike most insecticides which are very toxic to beneficials (or equally toxic to pests and beneficials), we have presented here examples of insecticides which are less toxic to beneficial insects. Therefore they should fit very well into IPM programs.

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Table 1. Toxicity of Selected Insecticides to *O. insidiosus* and *G. punctipes* Adults Supplied with Insecticide Treated *H. zea* eggs for 72-h.

		% Mortality			
		O. insidiosus		G. punctipes	
Treatment	**Kg(AI)/ha**	**Males**	**Females**	**Males**	**Females**
Azinphos -methyl	0.28	27.5ab	25.0ab	44.5ab	44.5bc
Imidacloprid	0.052	47.8ab	62.7c	11.1a	50.0bcd
Spinosad	0.099	47.8ab	54.6bc	16.7a	11.1a
Tebufenozide	0.28	21.7a	19.8a	11.1a	16.7ab
Fipronil	0.056	38.8ab	53.9bc	88.9c	94.5d
Endosulfan	1.70	45.8ab	60.0c	77.8c	94.5d
Chlorfenapyr	0.39	57.5bc	31.8abc	61.1bc	66.7cd
Cyfluthrin	0.056	28.4a	43.7abc	44.5ab	22.2ab
Profenofos	0.28	45.4ab	44.3abc	44.5ab	33.3abc
Malathion ULV	1.0	62.5bc	52.8bc	38.9ab	66.7cd

Means within a column followed by the same letter are not significantly different ($P \geq 0.05$; least significant difference [SAS Institute 1988]).