TOLERANCE OF NATURAL ENEMIES TO SELECTED INSECTICIDES APPLIED AT ULTRA LOW VOLUMES

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Abstract

The tolerance of two natural enemies, *Geocoris punctipes* (Say), the big-eyed bug which is a general predator of several lepidoptera species, and *Cardiochiles nigriceps* Vierick, a host-specific parasitoid of the tobacco budworm, to residues of malathion, fipronil, and cyfluthrin applied ultra low volume (ULV) was determined for 0, 24, and 48 HAT (hours after treatment). Toxicity to the target pest, *Anthonomus grandis* Boheman, the boll weevil, also was evaluated. Exposure to malathion residues at 0 HAT resulted in highest mortality for the three insects. Cyfluthrin was less toxic than malathion at 0 HAT for all insects. Toxicity of malathion residues decreased sharply at 48 HAT for all three insect species. Toxicity of fipronil remained the same for the boll weevil from 0 to 24 HAT, but was lower for the two natural enemies at 24 HAT compared to 0 HAT. Also, fipronil was less toxic to *C. nigriceps* than to big-eyed bugs at 24 HAT. Fipronil was the only insecticide which had continued toxicity to the boll weevil at 48 HAT. Toxicity to the boll weevil was much lower with cyfluthrin than malathion and fipronil at 24 HAT. However, cyfluthrin was more toxic to the two natural enemies than to the boll weevil at 24 HAT.

Introduction

Malathion currently is being applied ultra low volume (ULV) for the control of boll weevils in cotton by the Boll Weevil Eradication Program. Fipronil and cyfluthrin have been considered as possible alternative insecticides for control of boll weevils. Insecticides which are highly toxic to beneficial arthropods can disrupt populations of these natural enemies of potential pest insects causing outbreaks of secondary pests. Falcon et al. (1971) and Eveleens et al. (1973) demonstrated that heavy outbreaks of beet armyworms can be generated by insecticide treatments used to suppress the plant bug, *Lygus hesperus* Knight in cotton in California. Our research goal was to determine the tolerance of two natural enemies, the big-eyed bug, a general predator of many lepidoptera species, and *Cardiochiles nigriceps* Vierick, a host-specific parasitoid of the tobacco budworm, to insecticides applied ULV for boll weevil control by the Boll Weevil Eradication Program.

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Materials and Methods

An air assisted ultra low volume (ULV) spraying system mounted on a John Deere 600 high cycle was used to apply the following treatments on field plots on July, 17, 1996: 1) malathion at 12 oz/A, 2) fipronil at 0.05 lbs/A, and 3) cyfluthrin at 0.033 lbs/A. Total volume of the ULV applications was 16 oz/A with once refined cottonseed oil as diluent. A randomized complete block design was used. Plots were 4 (40") rows x 200' (0.06 A). Each treatment was replicated 4 times. Bioassays were conducted in the laboratory using insects in petri dishes. A single insect was placed in a petri holding one treated leaf. Ten treated leaves per replicate were collected at 0, 24 and 48 HAT (hours after treatment). Mortality was determined after 24 hours of exposure.

Boll weevils and *C. nigriceps* used in this test were young adults reared at the USDA, ARS Gast Rearing Laboratory at Mississippi State, MS. Big-eyed bugs were collected from a cotton field near Brooksville, MS.

Mortality data were corrected for control mortality using Abbott's formula (Abbott 1925). Percentage mortality data were converted to arcsine values and analyzed by analysis of variance (ANOVA) (SAS 1988). Means were separated by a least significant differences test (LSD).

Results and Discussion

Exposure to malathion residues at 0 HAT resulted in high mortality for the three insects at 0 and 24 HAT (Table 1). Toxicity of malathion residues decreased sharply at 48 HAT for all three insect species. The high levels of toxicity of malathion to natural enemies has been well documented. High mortality was reported for *Aphytis lignanensis* Compere [Aphelinidae], *Metaphysus luteolus* (Timberlake) [Encyrtidae], *Spalangia drosophilae* Ashmead [Pteromalidae], *Leptomastix dactylopii* Howard [Encyrtidae], *Cryptolaemus montrouzieri* Mulsant [Coccinellidae], *Lindorus lophanthae* (Blaisdell) [Coccinellidae], *Rodolia cardinalis* (Mulsant) [Coccinellidae], and *Stethorus picipes* Casey [Coccinellidae] (Bartlett 1963), *Chrysopa carnea* Stephens [Chrysopidae] (Bartlett 1964), *Camploletis sonorensis* (Cameron) [Ichneumonidae], *Hippodamia convergens* Guérin-Meneville [Coccinellidae], *Meteorus leviventris* (Wesmael) [Braconidae], *Brachymeria intermedia* (Nees) [Calcididae], and *Chelonus blackburni* (Cameron) [Braconidae] (Wilkinson et al. 1975), *Microplitis croceipes* (Cresson) [Braconidae] (Powell et al. 1986), *Catolaccus grandis* (Burks) [Pteromalidae] (King et al. 1993), and *Cotesia marginiventris* (Cresson) [Braconidae] (Ruberson et al. 1993) when exposed to malathion either topically or conventionally applied.

Toxicity of fipronil residues remained the same for the boll weevil from 0 to 24 HAT, but was lower for the two natural enemies at 24 HAT compared to 0 HAT. Also, this insecticide was less toxic to *C. nigriceps* than to big-eyed bugs at 24 HAT. Fipronil was the only insecticide which had continued toxicity to the boll weevil at 48 HAT. Further studies should be conducted on selectivity of this insecticide.

Cyfluthrin was less toxic than malathion at 0 HAT for all insect species. Mortality of the boll weevil was much lower for cyfluthrin than for malathion and fipronil for the boll weevil at 24 HAT. However, this insecticide was more toxic to the two natural enemies than to the boll weevil at 24 HAT. The effectiveness of cyfluthrin for control of the boll weevil probably should not be evaluated only on physiological death of an adult. Even though cyfluthrin may not kill the adult boll weevil, it debilitates the adult to such an extent that it does not move very much unless stimulated by an external source. Ovipositional and feeding behavior and the impact of predator populations need to be evaluated in the field to better understand the effectiveness of this insecticide in the field.

Overall, malathion was the most toxic insecticide to the natural enemies. Fipronil appeared to have some level of selectivity to the boll weevil. The two natural enemies were less susceptible to cyfluthrin than to malathion at least at 0 HAT. Further evaluation of selectivity of fipronil and cyfluthrin along with oxamyl and endosulfan, two other insecticides used by the Boll Weevil Eradication Program, needs to be done.

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Table 1. Mortality of boll weevils (BW), big-eyed bugs (BB), and *Cardiochiles nigriceps* (CN) exposed to residues of malathion (MA), fipronil (FI), and cyfluthrin (CY) applied at ultra low volumes.

			% Mortality[1]		
Chemical	Rate	Insect	0 HAT[2]	24 HAT	48 HAT
MA	12	BW	96.7 A,1,a	92.5 A,1,a	5.0 A,1,b
	oz/A	BB	94.4 A,1,a	85.0 A,1,a	2.5 A,1 b
		CN	100.0 A,1,a	87.5 A,1,a	0.0 A,1,b
FI	0.05	BW	80.0 A,1,2,a	78.9 A,1,a	45.0 A,2,b
	lb/A	BB	86.0 A,1, 2,a	45.9 B,2,b	7.5 B,1,c
		CN	78.3 A,1,2,a	10.0 C,2,b	0.0 B,1,b
CY	0.033	BW	70.0 A,2,a	24.9 B,2,b	10.0 A,1,b
	lb/A	BB	65.0 A,2,a	69.5 A,1,a	10.0 A,1,b
		CN	67.5 A,2,a	72.5 A,1,a	10.0 A,1,b

[1]Mortality is corrected for control mortality using Abbott's (1925) formula. Values within a column followed by the same capital letter are not significantly different ($P > 0.01$) between species for a single chemical. Values within a column followed by the same number are not significantly different ($P > 0.01$) between chemicals for a single species. Values within a row followed by the same lower case letter are not significantly different ($P > 0.01$). Comparisons were based on LSD. All data were transformed by arc-sine before analysis.
[2]Hours after treatment