LETHAL AND SUBLETHAL EFFECTS OF SELECTED INSECTICIDES AND AN IGR ON THE BOLL WEEVIL ECTOPARASITOID *CATOLACCUS GRANDIS*

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Abstract

A laboratory culture of the boll weevil ectoparasitoid, *Catolaccus grandis*, was exposed to lethal and sublethal doses of insecticides and an insect growth regulator (IGR) using a spray chamber bioassay. Insecticides tested were Guthion, Phaser, Regent, Fyfanon, Baythroid, Cygon, Tracer, Methyl parathion, Orthene and Vydate. At full rates, Tracer was significantly less toxic to female *C. grandis* than other treatments except Phaser; Regent and Fyfanon were significantly more toxic than other treatments. Most of the chemicals tested were highly toxic to male *C. grandis*; Tracer was numerically less toxic. At sublethal rates, most of four selected chemicals tested were low in toxicity to *C. grandis*; no *C. grandis* pupae developed from parasitism during a 24 h treatment period with Fyfanon or Tracer. Sex ratio of progeny appeared to be unaffected by the treatments.

Introduction

The effectiveness of the ectoparasitoid *Catolaccus grandis* (Burks) as a biological control agent against the boll weevil, *Anthonomus grandis grandis* Boheman, has been established (Morales -Ramos and King 1991, Summy et al. 1992, 1994, 1995; Morales-Ramos et al. 1994, 1995; King et al. 1995). The technical feasibility of mass producing *C. grandis* in an insectary was demonstrated by Morales-Ramos et al. (1992) and Roberson and Harsh (1993). King et al. (1995) reported the successful use of inoculative/augmentative releases in commercially managed cotton fields in South Texas to suppress boll weevil.

Little knowledge exists regarding the tolerance of *C. grandis* to insecticides used to control insects pests of cotton, or, more specifically, those insecticides targeted for boll weevil control. The present study documents the lethal and sublethal effects of selected compounds on *C. grandis* using a spray chamber bioassay.

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Materials and Methods

Insects

Catolaccus grandis were reared on boll weevil larvae as described by Cate (1987). The boll weevil larvae were produced at the R. T. Gast Rearing Laboratory, Mississippi State, MS. Adult wasps were kept in plexiglass cages as described by Morales-Ramos et al. (1992). Adults were 9-10 days old when used in bioassays.

Insecticides

Formulated insecticides tested were fipronil [Regent emulsifiable concentrate (EC); Rhone-Poulenc Agric. Co., Research Triangle Park, NC], spinosad [Tracer 4 suspension concentrate (SC); DowElanco, Indianopolis, IN], chlorfenapyr [Pirate 3 SC; American Cyanamid Co., Parsippany, NJ], tebufenozide [Confirm 2 flowable (F); Rohm and Haas, Philadelphia, PA], imidacloprid [Provado 1.6 (F); Bayer, Inc., Kansas City, MO], cyfluthrin [Baythroid 2 (EC); Bayer, Inc., Kansas City, MO], oxamyl [Vydate 2.76 concentrated low volume (CLV); E. I. Dupont de Nemours & Co., Wilmington, DE], endosulfan [Phaser 3 emulsifiable concentrate (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

A laboratory spray chamber (DeVries Mfg., Hollandale, MN; Elzen et al. in press) was used to apply formulated insecticides in bioassays. The sprayer was calibrated to deliver 56 liters per hectare using one TX-4 nozzle at 1.7kg/cm5 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; G. W. Elzen unpublished).

Direct Toxicity Bioassays

Rates of formulated insecticides applied were selected by referring to an appropriate control guide (Norman and Sparks 1997). Cotton plants, *Gossypium hirsutum* L. (>Sure-Grow 125'), grown in 11cm diameter plastic pots in a greenhouse, were used to obtain cuttings (10-14 cm stem with three to four small leaves and buds), which were placed in florist's water picks. Cuttings were treated with formulated insecticides using a spray chamber as described above. Each treatment consisted of 12 replicates of one terminal each. Controls were treated with water only. Four female or male *C. grandis* were placed on each cutting 30 min after spraying and confined to each cutting with a 590-ml ventilated paper cup. Adults exposed to each compound were held for 72 hours at 26 ± 2^0 C, 55-60% RH, and a 14L:10D photoperiod. Data were taken at 24-h after exposure; mortality was assessed by failure of movement 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 difference [$P \tilde{} 0.05$ (SAS Institute 1988)].

Sublethal Bioassays

Boll weevil pupae (60-70 per replication) were placed in an uncovered plastic petri dish (3.5 inch diameter) and treated with formulated malathion, spinosad, endosulfan, or tebufenozide at 25% of the full rate using the spray chamber as described above. Each treatment was replicated 6 times. After 30 min, boll weevil pupae were encapsulated singly in parafilm sheets and 20 male and 50 female *C. grandis* were exposed to each replicate for 24 h in a ventilated one gallon tupper ware cage. Insects were fed honey throughout the experiment. At the end of 24 h, percentage mortality of males and females was determined, percentage parasitism (by parasitoid eggs laid per boll weevil pupae) was determined, percentage development of parasitoid eggs to pupae and sex ratio of offspring were determined. Fresh, untreated para film sheets containing boll weevils were supplied to the previously exposed *C. grandis* for an additional 24 h and the same parameters as described above were again determined. Three F_1 males and five females from the above bioassays were exposed to untreated boll weevil pupae in para film sheets for 24 h periods (fresh sheets every 24 h) for a total time of 72 h. Each 24 h, percentage mortality, percentage parasitism (as defined above), and sex ratio of developed F_2 progeny were determined.

Results and Discussion

At full rates, Tracer was significantly less toxic to female *C. grandis* than other treatments except Phaser; Regent and Fyfanon were significantly more toxic than other treatments (Table 1). Most of the chemicals tested were highly toxic to male *C. grandis*; Tracer was numerically least toxic (Table 1).

At sublethal rates, most of the four chemicals tested were low in toxicity to *C. grandis*. However, Fyfanon produced 66.3 percent mortality in females (Table 2). No *C. grandis* pupae developed from parasitism during a 24 h treatment period with Fyfanon or Tracer (Table 3). We do not as yet have an explanation for these results. Sex ratio of progeny appeared to be unaffected by the treatments (Table 4).

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. The body of literature concerning the devastating effects of insecticides to populations of natural enemies and beneficial insects is considerable (Croft and Brown 1975, Croft and Morse 1979, Croft 1990, Elzen 1989, Jepson 1989). However, scientific methods must be refined so that the risks posed by insecticides to natural enemies can be predicted reliably (Stark et al. 1995).

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Table 1. Toxicity of selected insecticides to *Catolaccus grandis* adults at full field rates.

		% Mortality	
Insecticide	Lb(ai)/a	Females	Males
Guthion	0.25	56.3bcd	81.2abc
Phaser	1.5	37.5ab	83.3bc
Regent	0.05	89.6e	87.5bc
Fyfanon	0.92	91.7e	89.6bc
Baythroid	0.05	43.8bc	75.0ab
Cygon	0.25	72.7cde	79.2abc
Tracer	0.089	18.8a	64.6a
Methyl parathion	0.5	56.3bcd	72.9ab
Orthene	0.25	64.6bcd	79.2abc
Vydate	0.25	81.3de	89.6bc

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

Table 2. Toxicity of selected insecticides to *Catolaccus grandis* adults at 25% of full field rate.

		% Mortality			
Insecticide	Lb(ai)/a	24 h/Exposure		24h/Post-treatment	
		Males	Females	Males	Females
Phaser	0.38	0.00a	0.00a	0.00a	0.00a
Fyfanon	0.22	3.52a	66.27c	0.22a	8.06b
Tracer	0.02	1.67a	2.06b	0.00a	0.97a
Confirm	0.06	1.67a	0.33a	0.00a	0.00a

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

Table 3. Parasitism of boll weevil pupae by *C. grandis*.

		% Parasitism			
Insecticide	Lb(ai)/a	4 h/Exposure		24 h/Post-treatment	
		Cells	Pupae	Cells	Pupae
Phaser	0.38	72.37bc	72.96bc	87.12c	72.18a
Fyfanon	0.22	27.06a	0.00a	31.25a	86.38a
Tracer	0.02	82.09c	0.00a	80.93c	85.87a
Confirm	0.06	48.43b	57.71b	69.76b	71.82a
Control	----	58.25b	85.15c	76.50bc	74.37a

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

Table 4. Sex ratio of *C. grandis* progeny from insecticide treated adults.

		% Progeny			
		24 h/Exposure		24 h/Post-treatment	
Insecticide	Lb(ai)/a	Males	Females	Males	Females
Phaser	0.38	34.16b	65.84c	57.62cd	42.34a
Fyfanon	0.22	0.00a	0.00a	60.32d	27.05a
Tracer	0.02	0.00a	0.00a	32.34a	67.67c
Confirm	0.06	38.64b	44.69b	49.91c	50.09ab
Control	----	39.41b	55.64bc	44.35b	65.94b

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