TOXICITY OF SEVERAL INSECTICIDES TO CATOLACCUS GRANDIS (BURKS) AND SELECTION WITH MALATHION

Dan A. Wolfenbarger
USDA, ARS, SPA
Crop Insects Research Unit
Weslaco, TX
Shoil M. Greenberg
USDA, ARS, SPA, Biological Control of Pests
Weslaco, TX

Abstract

LC_{50}'s of oxymal and malathion to male Catolaccus grandis (Burks) were 513 and 57 fold greater than LC_{50} to female parasites, respectively. LC_{50}'s of profenofos to female parasites was 13 fold greater than LC_{50} of male parasites. Endosulfan was comparatively nontoxic to both sexes. We were unable to select for resistance to malathion against either sex during 16 months.

Introduction

Insecticides are applied to cotton for control of hemipterous (Lygus sp. and Pseudoletra) and homopterous (Aphis gossypii and Bemisia argentifolii) pests at the same time that releases of adult parasites, Catolaccus grandis (Burks), are made for suppression of the boll weevil, Anthonomus grandis (Boh.). Summy et al. (1994) showed that two carbamate insecticides killed 90% or more of this parasite >14 days.

Toxicity of several insecticides was determined to find a selective insecticide against one of the sexes of C. grandis. We attempted selecting for resistance to malathion because it was used in a area wide eradication program against the boll weevil in the Lower Rio Grande of Texas in 1995.

Materials and Methods

Bioassay. Technical amitraz and buprofezin (AgrEvo Inc., Wilmington, DE), azinphosmethyl and imidacloprid (Miles, Inc. Kansas City, KS), bifenthrin, cypermethrin and endosulfan (FMC Corporation, Princeton, NJ), malathion and methyl parathion (Cheminova, Denmark), oxamyl (Dupont, Wilmington, DE) and profenofos (Ciba-Giegy, Goldsboro, NC) were tested in the laboratory in 1992 and 1993 with a strain of C. grandis maintained in another laboratory.

Glass vial bioassays were conducted separately against males and females using the vial coating method of Wolfenbarger et al (1994). Doses of 0.000125 to 500 µg insecticide per vial were tested. Not all doses were tested with all insecticides. An untreated check was used with each bioassay. Insecticides were diluted in acetone and 0.625 ml were coated onto the entire glass surface of a vial (13 mm millimeter diameter x 100 mm long). After drying for 1 h four to 15 parasites of one sex (4 to 10 days of age) were placed in each vial. Three or more replicates were used with each dose of each insecticide (1 vial = 1 replicate). Females and males were allowed to mate prior to bioassay.

Dead plus moribund and live adults in all tests were determined after 3 h. Dead remained on the bottom of the vial and did not move while moribund adults moved but remained on the bottom of vial. Live adults remained on the side of the vial.

LC_{50}, its 95% Confidence Interval, slope ± standard error were determined by SAS (1984). When 95% confidence intervals did not overlap LC_{50}'s were significantly different. Shown are the number of insects treated; mortalities were corrected by check for each sex. When $\leq$ 1.96 was determined from slope/SE of slope regression was equal to 0 and thus not significant.

Selection for resistance of C. grandis. Following the evaluation of these insecticides a selection experiment was initiated with malathion from a sample of 100 males and females of the same laboratory strain and conducted for 16 months. In each generation each surviving female and male was treated with 0.00625, 0.0625, or 0.625 µg/vial and mortalities were determined after 3 and 24 h. After the 3 h exposure the parasites were placed in a modified plastic 24 h bioassay. Sexes were maintained separately and fed honey waster after the 3 h bioassay. Chamber measured 15 cm diameter with a circular screened (nylon) window 5 cm diameter on top.

Thereafter, mated females of each dose were confined in modified petri dishes (1 per dish) for exposure to a host. Parasitoids were maintained in laboratory at 26 ± 1°C, 65 ± 5% RH, and a photoperiod of 12:12 (L:D) h. Morales-Ramos et al. (1992) and Greenberg et al (1994 and 1995). Parasitized larvae of boll weevil were encapsulated in Parafilm; larvae of parasite were allowed to develop to the adult stage inside a cylindrical paper carton (18 by 16 cm) modified with an exit hole on top connected to a large (15 cm diameter) petri dish. Two weeks after exposure, the emerging male and female wasps of the next generation were allowed to mate for 3 to 7 days and collected for bioassay with the 3 doses. Male and female parasites were divided into 3 equal groups and treated with the three doses. Then we showed mortalities of female parasites by the greatest dose tested after 24 h to determine if we could select for resistance.

On days 233, 250 and 297 number of females emerged/female were determined when bioassayed at

Reprinted from the *Proceedings of the Beltwide Cotton Conference*
Volume 2:1305-1310 (1997)
National Cotton Council, Memphis TN

0.00625, 0.0625 and 0.625 µg/vial. Mortalities were then determined after 24 h.

Results and Discussion

The LC_{50} of oxamyl against males was 513 fold greater than for female parasites (Table 1). The LC_{50} of malathion against males was 57 fold greater than LC_{50} for females.

LC_{50} of profenofos to female was 13 fold greater than shown for male parasites. This is the opposite result shown for oxamyl and malathion. LC_{50}'s of females and males exposed to cypermethrin and methyl parathion were not significantly different.

Males were not killed when treated with amitraz, buprofezin and imidacloprid at 6.25 to 500 µg/vial. Imidacloprid had the greatest LC_{50} against females. Bifenthrin was as toxic to males as was methyl parathion but mortalities were variable for females at 0.000625 to 0.625 µg/vial.

Endosulfan was comparatively nontoxic to both sexes of C. grandis. Concentrations of 25 to 250 µg/vial killed 0 to 33% of female and 0 to 42% of male after 3 hr. A nonsignificant regression is also shown for azinphosmethyl; mortalities ranged from 10 to 30% for concentrations of 25 to 250 µg/vial.

We were unable to select for resistance to malathion against either sex during the 16 months of selection (Table 2). All LC_{50}'s of both sexes were equal (Table 2) to LC_{50}'s in the initial bioassay (Table 1).

The 24 h mortalities decreased when females were exposed to 0.625 µg malathion/vial (Table 3). This was the greatest dose tested with this insecticide. Perhaps this time should be used to determine if we can select for resistance.

On the last three sample days number females/treated female were not reduced by exposure to malathion by any of the three doses when mortalities were determined after 24 h (Table 4).

References Cited

Greenberg, S. M., J. A. Morales-Ramos, and E. G. King. 1994. Correlation between pupal weight and fecundity of Catolaccus grandis (Burks). pp. 965-967 IN Cotton Research Conference. Cotton Insect Research and Control Conference.

Greenberg, S. M., J. A. Morales-Ramos, E. G. King, K. R. Summy and M. G. Rojas. 1995. Biological parameters for mass propagation of Catolaccus grandis. Environ. Entomol. 24: 1322-1327.

Summy, K., J. A. Morales-Ramos, E. G. King, D. A. Wolfenbarger, R. J. Coleman, S. M. Greenberg, A. W. Scott, Jr., and J. V. French. 1994. Integration of boll weevil parasite augmentation into short-season production system of the Lower Rio Grande Valley. pp. 953-958 IN Cotton Research Conferences. Cotton Insect Research and Control Conference. 4. Morales-Ramos, J. A., K. R. Summy, J. Roberson, J. R. Cate and E. G. King. 1992. Feasibility of Mass Rearing Catolaccus grandis, pp. 725-726 IN Proceedings, Beltwide Cotton Conferences, National Cotton Council of America, Memphis, TN.

Wolfenbarger, Dan A., R. G. Riley, D. H. Akey and W. A. Jones. 1994. Endosulfan and bifenthrin in alternate applications and mixture against B-strain whitefly. pp. 901-904 IN Cotton Research Conferences. Cotton Insect Research and Control Conference.

Table 1. Toxicity after 3 h by dead and moribund of insecticides to gender of laboratory strain of Catolaccus grandis by vial bioassay. Weslaco, TX. 1993-1994.

Insecticide	Sex	Treated No.	Slope ± SE	LC_{50} (µg/vial)	(95% C.I.)
Buprofezin	F	276	2.7±0.85	15.84	(7.9-8.58)
	M	297	0.17±0.13[a/]		
Imidacloprid	F	218	0.38±0.13	5206.0	(413.33 - $9.8x10^{11}$)
	M	224	-0.013±0.14[a/]		
Amitraz	F	447	0.46±0.21	538.47	(59.9-1.1 x 10^{82})
	M	397	1.16±1.47[a/]		
Methyl	F	397	0.58±0.29	0.15	(∞ - ∞)
Parathion	M	441	1.63±0.41	0.097	(0.037-0.22)
Endosulfan	F	383	0.55±0.58[a/]		
	M	368	0.73±0.66[a/]		
Azinphosmethyl	F	253	2.46±2.17[a/]		
	M	313	0.18±0.18[a/]		
Oxamyl	F	461	0.37±0.10	0.00039	($5.4x10^{-8}$-0.0054)
	M	520	0.36±0.13	0.2	(0.0013-13.47)
Profenofos	F	150	2.15±0.38	7.9	(5.6-12.29)
	M	161	0.59±0.17	0.62	(0.012-747.14)
Malathion	F	515	0.41±0.19	0.038	(∞ - ∞)
	M	323	1.56±0.44	2.15	(0.79-5.89)
Cypermethrin	F	510	0.99±0.24	0.031	(0.0032-0.11)
	M	357	1.21±0.36	0.18	(0.038-0.77)
Bifenthrin	F	119	0.99±0.68[a/]		
	M	116	1.51±0.44	0.07	(∞ - ∞)

[a/] Ratio slope/SE of regression was not significantly different from 0.

Table 2. Toxicity of Catolaccus grandis with malathion after 3 h for 16 months 1993-1995.

Sex Treated	Number Insects Treated	Slope ± SE	LC_{50} µg/vial)	(95% C.I.)
		Day 346, 1993 to Day 298, 1994		
Female	1308	1.55±0.59	0.12	(∞ - ∞)
Male	957	1.36±0.62	0.87	(∞ - ∞)
		Day 313		
Female	273	2.42±0.26	0.24	(0.19 - 0.31)
Male	142	1.25±0.24	0.91	(0.48 - 2.75)
		Day 341		
Female	498	0.99±0.1	0.013	(0.0094-0.018)
Male	247	0.86±0.23	0.32	(∞ - ∞)
		Day 4, 1995		
Female	155	0.80±0.34	0.085	(∞ - ∞)
Male	25	0.90±0.63		
		Day 33		
Female	129	1.64±1.08		
Male	41	0.89±0.34	0.64	(0.17 - 555.0)
		Day 67		
Male	90	1.47±0.30	2.53	(1.52 - 4.61)
		Day 114		
Female	214	0.09±0.59[a]		
Male	57	0.35±0.46[a]		
		All days from Day 313, 1994 to Day 114, 1995		
Female	1376	0.76±0.01	0.053	(0.012 - 0.19)
Male	618	0.67±0.16	1.25	(∞ - ∞)

[a] Ratio slope/SE of regression was not significantly different from 0.

Table 3. Mortality after 24 h following exposure to malathion at 0.625 µg/vial of female Catolaccus grandis. 1994.

Day(s)	Number Tested	Mortality (%)
69	160	99
89 to 98	118	68
129	17	65
145 - 159	17	82
172 - 215	26	19
233 - 265	40	78
284	12	8
297	17	35

Table 4. Mortality of Catolaccus grandis after 24 h and females/female tested, 1994.

Day(s)	Dose (µg/vial)	Number Females Tested	Mortality (%)	Ratio Females/Female Tested
233	0.00625	26	15	2.0
	0.0625	12	25	7.7
	0.625	26	19	2.3
250	0.00625	10	50	4.2
	0.0625	10	50	7.0
	0.625	3	0	4.0
297	0.00625	29	52	1.1
	0.0625	6	50	5.0
	0.625	37	84	3.2