RESPONSE OF BEET ARMYWORM FROM MEXICO, LOUISISANA AND GEORGIA, U. S. A. TO INSECTICIDES

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Abstract

Methomyl was significantly more toxic to beet armyworm, Spodoptera exigua (Hbn.), in eastern Mexico than western Mexico. There was no significant difference in LD50 of methomyl by strains (in 1991, 1993 and 1994) in eastern Mexico and a susceptible strain. All pyrethroids, i. e. bifenthrin, cypermethrin, cyfluthrin, esfenvalerate, fenvalerate, lambda cyhalothrin, permethrin and tralomethrin, were more toxic to the susceptible strain than any field collected strain in eastern and western Mexico, Louisiana or Georgia.

Introduction

In the United States the beet armyworm, Spodoptera exigua (Hbn.), is more susceptible to insecticides on the west coast state of California than the east coast states of Florida and Georgia in the United States (Wolfenbarger & Brewer 1993). No information is available on response of this insect to various insecticides in the northern third of eastern and western Mexico. Particular reference is made to toxicity of methomyl which is considered to be a standard insecticide against this insect in the United States and Mexico.

For this reason response of other insecticides was compared to methomyl from 1991 1994 in eastern Mexico and from 1981 to 1989 in western Mexico. These results were compared to response of strains from Louisiana and Georgia in 1990. Response by these field strains was compared to Zenaca-Dow laboratory strain which was considered to be susceptible to insecticides. Results are presented here.

Methods and Materials

Technical abamectin (Merck, Inc., Three Rivers, NJ), azinphos-methyl (Bayer, Inc.., Kansas City, KS), cypermethrin (FMC, Inc., Princeton, NJ), deltamethrin and tralomethrin (AgroEvo, Inc., Wilmington, DE), chlorpyrifos DOW, Inc., Indianapolis, IN), cyfluthrin (Bayer, Inc., Kansas City, KS), lambda cyhalothrin (Zenaca, Inc., Richmond, CA) methomyl, fenvalerate and esfenvalerate (DuPont, Inc., Wilmington, DE), methyl parathion (Cheminova, Inc., Denmark, permethrin and endosulfan (FMC, Inc., Princeton, NJ) PROFENOFOS (Ciba, Inc., Goldsboro, NC) and sulprofos (Bayer Inc., Kansas City, KS) were tested.

Insects were collected from cotton (10-40 larvae) in Valle de Yaqui in western Mexico each year from 1981 to 1989 and near Estacion Cuauhtemoc in southern Tamaulipas in eastern Mexico each year in 1991, 1993 and 1994. Larvae (10-14) were collected from cotton near Tifton, GA and Monroe, LA in 1990 and treated in indicated generations.

Zenaca-Dow laboratory strain of beet armyworm was susceptible to insecticides in 1990 (Wolfenbarger & Brewer 1993). Strain was reared continuously since collection with no introduction of field collected insects for 25+ years.

Pupae from each field and laboratory strain (20 to 50 of each sex0 were placed in 3.78 liter plastic-lined cardboard containers for moth emergence and oviposition A 5% sucrose solution was included as food for moths.

Individual neonate larvae were placed in 30 ml. Plastic cups containing 12-15 ml. Artificial diet (Shaver & Raulston 1971). Methods used to topically teat larvae from Zenaca-Dow weighing 15 $\pm$ 6 mg. with 1 µl acetone were described by Wolfenbarger & Brewer 1993. In eastern Mexico, Louisiana and Georgia, U.S.A. larvae were treated at 25 $\pm$ 3 mg. and in western Mexico they were treated at 35 $\pm$ 8 mg.

Doses (range listed as µg/larvae) tested for each insecticide were abamectin (20 to 0.0775), azinphosmethyl (40 to 0.78), bifenthrin (10 to 0.00625), chlorpyrifos (40 to 0.195), cyfluthrin (10 to 0.00625), cypermethrin (100 to 0.0155), deltamethrin (5 to 0.0031), endosulfan (40 to 0.1), esfenvalerate (50 to 0.195), fenvalerate (200 to 0.39), lambda cyhalothrin (10 to 0.0625), methomyl (100 to 0.195), methyl parathion (100 to 0.195), permethrin (200 to 0.00775), profenofos (25 to 0.0975), sulprofos (50 to 0.0975), and tralomethrin (10 to 0.00625). All insecticides were serially diluted (50%) from the greatest to lowest dose, but not all doses were tested against all strains.

In eastern Mexico mortalities were determined after 24 H (1991), 48 H (1993) and 72 H (1994). In western Mexico, Tifton, GA and Monroe, LA mortalities were determined after 48 H. mortalities of Zenaca-Dow were determined after 72 H. Only larvae with no movement following gentle probing were counted as dead.

LD50 values, slope $\pm$ standard error and 95% confidence interval were determined by Probit Analysis (SAS 1989).

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Significant differences between LD50 values were indicated by non-overlapping confidence intervals. Where slope/SE rations were $\geq$ 1.96 the regression was not significantly different from zero.

Results and Discussion

LD50's from 1 to 0.1 for a susceptible strain of beet armyworm were determined for chlorpyrifos, methyl parathion and methomyl (Table 1). The macrolactone abamectin was not toxic to beet armyworm of this susceptible strain. LD50 for fenvalerate was significantly greater than shown for the halogenated cyclopropane pyrethroids with the cyano moiety, i.e. bifenthrin, deltamethrin, cyfluthrin, lambda cyhalothrin and cypermethrin. These pyrethroids had LD50's which ranged from 0.0013 to 0.013, a 10-fold difference and all were significantly more toxic than the non-cyano pyrethroid permethrin.

From 1981 to 1989 deltamethrin, cyfluthrin and cypermethrin had LD50's which ranged from 0.28 to 0.7 µg/larva from western Mexico (Table 2). Not all LD50's for these three pyrethroids were significantly alike, but when arrayed (0.28, 0.35, 0.37, 0.41, 0.46, 0.47, 0.54, 0.7) from low to high the next LD50 (the LD50 above and the LD50 below) was alike. From 1986 and 1987 the cholinesterase inhibitors were less toxic than the pyrethroids, and chlorpyrifos was significantly more toxic than methyl parathion and methomyl.

Methomyl was the most toxic insecticide in 1991, 1993 and 1994 in eastern Mexico (Table 3). It was significantly more toxic to beet armyworm in eastern compared to western Mexico; LD50's were <0.6 on the east coast and >10 on the west coast. LD50 for endosulfan, a cyclodiene insecticide, indicated susceptibility by this insecticide in eastern Mexico. LD50 for sulprofos in 1993 was 30 to 98-fold greater than shown in 1991 and 1994. In eastern Mexico methyl parathion showed equal LD50's while azinphosmethyl showed variable LD50 in 1991 and 1994; in 1993 slope value was non-significant indicating it did not differ from zero. In 1967, LD50 of methyl parathion was 0.026 µg/larva (Wolfenbarger et al 1970). The LD50 for methyl parathion at the same location in 1991 and 1993 was about 75 to 100-fold greater, respectively, than in 1967. LD50 for permethrin increased 7-fold during the same years. However, the LD50 for permethrin in eastern Mexico in 1993 and 1994 were significantly greater than those shown in 1986-1987 in western Mexico, but LD50's were equal at the two locations in 1986-1987 and 1991.

In 1994, LD50's were determined from Altamira, Mante and Ebano (Table 4) and the cyano containing pyrethroids, i.e. cypermethrin and deltamethrin, were significantly more toxic than the non-cyano pyrethroid permethrin. Cypermethrin and deltamethrin were equally toxic to methomyl; LD50's were <0.3. Profenofos was significantly more toxic than sulprofos, methyl parathion and azinphosmethyl.

LD50's of cypermethrin against beet armyworms collected from Tifton, GA were not significantly different after 4 generations of selection (Table 5). Difference in LD50 were <5 from generation 3 to 7. Beet armyworm from Monroe, LA were susceptible to cypermethrin; differences in LD50 were 16 to 100 fold less in Monroe, LA and Tifton, GA. Regardless, LD50's from Monroe, LA and Tifton, GA were significantly greater than shown for Zenaca-Dow.

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Table 1. Toxicity of insecticides to beet armyworm larvae of Zenaca-Dow laboratory strain. 1990.

Insecticide	Number Treated	Slope ± SE
Fenvalerate	294	1.40 ± 0.20
Methyl Parathion	359	0.88 ± 0.11
Methomyl	359	1.33 ± 0.23
Chlorpyrifos	324	1.53 ± 0.24
Permethrin	414	1.55 ± 0.14
Esfenvalerate	150	0.49 ± 0.25
Cypermethrin	248	0.99 ± 0.16
Deltamethrin	87	1.15 ± 0.33
Cyfluthrin	72	1.13 ± 0.33
Bifenthrin	60	1.24 ± 0.38
Lambda Cyhalothrin	59	1.50 ± 0.45
Abamectin	176	0.98 ± 0.29

Table 1. Toxicity of insecticides to beet armyworm larvae of Zenaca-Dow laboratory strain. 1990.

Insecticide	LD50 (μg/larva)	(95% Confidence Limits)
Fenvalerate	0.037	(0.028 - 0.048)
Methyl Parathion	0.16	(0.11 - 0.25)
Methomyl	0.80	(0.62 - 1.02)
Chlorpyrifos	0.48	(0.24 - 0.75)
Permethrin	0.0086	(0.00062 - 0.011)
Esfenvalerate	(non-significant regression)	
Cypermethrin	0.013	(0.0051 - 0.015)
Deltamethrin	0.0034	(0.00065 - 0.0065)
Cyfluthrin	0.0044	(0.00099 - 0.0086)
Bifenthrin	0.0013	(0.00018 - 0.0029)
Lambda Cyhalothrin	0.0091	(0.0052 - 0.025)
Abamectin	14.91	(4.67 - 9453)

Table 2. Toxicity of different insecticides to beet armyworm larvae from Valle De Yaqui, Sonora, Mexico. 1981-1989.

Year of Collection	Number Treated	Slope ± SE	LD50 (mg/larva)
		Deltamethrin	
1981	380	2.13 ± 0.23	0.54
1983	150	1.57 ± 0.24	0.37
1986	250	1.86 ± 0.23	0.47
1987	350	1.45 ± 0.21	0.46
1989	250	2.20 ± 0.20	0.41
		Cypermethrin	
1986	250	2.26 ± 0.49	0.35
1987	250	2.17 ± 0.25	0.7
		Permethrin	
1986	250	2.41 ± 0.25	1.76
1987	300	1.73 ± 0.18	1.38
		Cyfluthrin	
1987	250	2.07 ± 0.24	0.28
		Methyl Parathion	
1986	250	3.61 ± 0.44	35.37
1987	300	1.95 ± 0.24	26.34
		Chlorpyrifos	
1987	250	2.33 ± 0.25	2.3
1989	250	1.56 ± 0.23	0.7
		Methomyl	
1986	300	1.68 ± 0.23	26.14
1987	300	1.59 ± 0.22	12.72
1989	250	1.24 ± 0.23	10.12

Table 2. Toxicity of different insecticides to beet armyworm larvae from Valle De Yaqui Sonora, Mexico. 1981-1989.

Year of Collection	Number Treated	(95% Confidence limits)	
		Deltamethrin	
1981	380	(0.44	0.66)
1983	150	(0.23	0.53)
1986	250	(0.37	0.58)
1987	350	(0.34	0.6)
1989	250	(0.35	0.89)
		Cypermethrin	
1986	250	(0.15	0.72)
1987	250	(0.57	0.49)
		Permethrin	
1986	250	(1.46	2.1)
1987	300	(1.1	1.72)
		Cyfluthrin	
1987	250	(0.23	0.35)
		Methyl Parathion	
1986	250	(31.27	39.51)
1987	300	(20.9	31.84)
		Chlorpyrifos	
1987	250	(1.91	2.76)
1989	250	(0.61	0.98)
		Methomyl	
1986	300	(19.96	32.37)
1987	300	(9.51	15.97)
1989	250	(7.63	13.43)

Table 3. Toxicity of insecticides to beet armyworm larvae from Estacion Cuauhtemoc, Tamaulipas, Mexico. 1991 and 1993.

Insecticide	Number Treated	Slope ± SE	LD_{50} (μg/larva)
		1991[1/]	
Methomyl	360	1.7 ± 0.36	0.16
Permethrin	360	1.06 ± 0.25	0.5
Methyl Parathion	400	1.4 ± 0.21	2.0
Sulprofos	400	1.7 ± 0.28	3.38
Profenofos	240	2.14 ± 0.24	5.37
Azinphosmethyl	320	1.71 ± 0.35	5.63
		1993[2/]	
Methomyl	320	1.67 ± 0.2	0.56
Profenofos	320	2.77 ± 0.38	3.25
Cypermethrin	280	0.96 ± 0.1	3.4
Permethrin	280	1.21 ± 0.12	3.71
Methyl Parathion	240	1.49 ± 0.16	5.77
Sulprofos	280	0.67 ± 0.16	318.68
Azinphosmethyl	250	0.27 ± 0.15	3/
Deltamethrin	300	0.35 ± 0.29	3/

1/ Taken after 24 H
2/ Taken after 48 H
3/ Non-significant regression

Table 3. Toxicity of insecticides to beet armyworm larvae from Estacion Cuauhtemoc, Tamaulipas, Mexico. 1991 and 1993.

Insecticide	Number Treated	(95% Confidence Limits)
	1991[1/]	
Methomyl	360	(0.071 - 0.28)
Permethrin	360	(0.13 - 1.43)
Methyl Parathion	400	(1.01 - 3.71)
Sulprofos	400	(1.93 - 5.95)
Profenofos	240	(4.16 - 7.07)
Azinphosmethyl	320	(1.96 - 11.73)
	1993[2/]	
Methomyl	320	(0.12 - 1.54)
Profenofos	320	(0.96 - 6.73)
Cypermethrin	280	(0.8 - 13.01)
Permethrin	280	(2.26 - 6.04)
Methyl Parathion	240	(2.28 - 13.36)
Sulprofos	280	(∞ - ∞)
Azinphosmethyl	250	3/
Deltamethrin	300	3/

1/ Taken after 24 H
2/ Taken after 48 H
3/ Non-significant regression

Table 4. Toxicity of insecticides to beet armyworm larvae from Estacion Cuauhtemoc, Tamaulipas, Mexico, 1994.

Insecticide	Source	Number treated	Slope ± SE
Methyl Parathion	Altamira	360	2.41 ± 0.26
	Mante	210	1.33 ± 0.22
	Ebano	280	2.76 ± 0.3
Azinphos-methyl	Altamira	380	2.03 ± 0.59
Profenofos	Altamira	660	2.52 ± 0.34
	Ebano	480	2.61 ± 0.59
Sulprofos	Altamira	360	1.55 ± 0.14
	Mante	270	1.41 ± 0.14
	Ebano	360	1.57 ± 0.16
Methomyl	Mante	520	0.78 ± 0.09
Endosulfan	Mante	560	0.61 ± 0.06
Permethrin	Mante	300	1.11 ± 0.11
Cypermethrin	Altamira	520	0.94 ± 0.14
	Mante	320	1.11 ± 0.13
	Ebano	360	1.46 ± 0.14
Deltamethrin	Altamira	400	1.21 ± 0.18
	Ebano	270	1.58 ± 0.21

Table 4. Toxicity of insecticides to beet armyworm larvae from Estacion Cuauhtemoc, Tamaulipas, Mexico, 1994.

Insecticide	Source	LD50 (μg/larva)
Methyl Parathion	Altamira	2.91
	Mante	2.42
	Ebano	2.49
Azinphos-methyl	Altamira	6.07
Profenofos	Altamira	0.92
	Ebano	1.08
Sulprofos	Altamira	1.13
	Mante	3.79
	Ebano	3.88
Methomyl	Mante	0.06
Endosulfan	Mante	0.44
Permethrin	Mante	1.40
Cypermethrin	Altamira	0.10
	Mante	0.3
	Ebano	0.59
Deltamethrin	Altamira	0.26
	Ebano	0.22

Table 4. Toxicity of insecticides to beet armyworm larvae from Estacion Cuauhtemoc, Tamaulipas, Mexico, 1994.

Insecticide	Source	(95% Confidence Interval)
Methyl Parathion	Altamira	(2.35 - 3.51)
	Mante	(0.57 - 4.65)
	Ebano	(1.65 - 3.44)
Azinphos-methyl	Altamira	(∞ - ∞)
Profenofos	Altamira	(0.60 - 1.27)
	Ebano	(0.60 - 1.50)
Sulprofos	Altamira	(0.66 - 1.87)
	Mante	(2.47 - 5.74)
	Ebano	(2.04 - 6.4)
Methomyl	Mante	(0.02 - 0.13)
Endosulfan	Mante	(0.11 - 1.16)
Permethrin	Mante	(0.95 - 2.01)
Cypermethrin	Altamira	(0.01 - 0.21)
	Mante	(0.18 0.44)
	Ebano	(0.4 - 0.83)
Deltamethrin	Altamira	(0.12 - 0.43)
	Ebano	(0.14 -0.33)

Table 5. Toxicity of cypermethrin to beet armyworm larvae from Tifton, Georgia and Monroe, Louisiana, U.S.A. 1990.

Generation From Collection	Number Treated	Slope ± SE
	Tifton, GA	
3	120	0.65 ± 0.20
4	120	0.79 ± 0.18
5	180	1.26 ± 0.17
6	100	1.73 ± 0.52
7	150	1.74 ± 0.35
	Monroe, LA	
3	120	1.82 ± 0.44
4	126	2.86 ± 0.80

Table 5. Toxicity of cypermethrin to beet armyworm larvae from Tifton, Georgia and Monroe, Louisiana, U.S.A. 1990.

Generation From Collection	LD50 (µg/larva)	(95%Confidence Limits)
	Tifton, GA	
3	11.39	(0.54 - 53.07)
4	8.41	(1.05 - 29.30)
5	14.05	(7.58 - 23.54)
6	15.12	(∞ - ∞)
7	41.76	(18.23 - 68.60)
	Monroe, LA	
3	0.45	(0.14 - 0.83)
4	0.41	(0.19 - 0.57)