RESPONSE TO THE BEET ARMYWORM FROM SOUTHERN TAMAULIPAS, MEXICO TO INSECTICIDES

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Abstracts

Beet armyworm resistance to insecticides monitoring program has been conducted since 1991 in Southern Tamaulipas, Mexico. DL_{50} values incremented from 1991 to 1993; but from 1994 to 1995 this trend was the opposite. In relation with the susceptible colony, the resistance relationship (RR) fluctuated from 196,150x to 30,050x for Endosulfan; 49.9x to 7.8x for Methyl Parathion; 306,364.5x to 419.5x for Azinphos-Methyl; 18,527.5x to 3,175.8x for Profenofos; 15,700 at 14,500x for Chlorpyrifos and 721.6x at 111.3x for Methomyl. In relation to tue Pyrethroids, the resistance relationship was of 14,824x to 703x for Permethrin and 16,204.7x to 566.6x for Cypermethrin.

Introduction

The Beet Armyworm has been traditionally considered as a pest on a wide range of crops in the tropical and sub-tropical regions (Metcalf and Metcalf 1992). However, heavy infestations have been observed on cotton in some Mexican and United States regions (Douse and McPherson 1991, Headley 1988, Smith 1989, Burris *et al*, 1994, and Smith 1994).

In the Southern region of Tamaulipas, Mexico, specifically in the region called Mante, heavy damage was observed. In 1994 this region noticed an extremely high population affecting more than 10,000 ha, which a very heavy defoliation was experienced. In the US in 1995, 44.4% of the cotton area was infested by the Beet Armyworm and 2.6 million acres needed insecticide treatment. Heavy infestations occurred in the areas covered by the Boll Weevil Eradication Program as well as areas not included in this program (Elzen 1996). In Texas, 2.9 of the 5.2 million acres were infested (Carter 1996).

The Beet Armyworm has demonstrated tolerance to many of the frequently recommended insecticides (Wolfenbarger and Brewer 1993) and this is related to the susceptibility of the populations to active ingredients of these products.

Due to this problem, since 1991 a program was launched in Suothern Tamaulipas to monitor the level of resistance of different populations.

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Materials and Methods

This study was conducted in the entomology laboratory of the Campo Experimental Sur de Tamaulipas located in km 55 carretera Tampico-Mante.

During 1991 and 1993, in Southern Tamaulipas 100-200 larvae were collected on cotton during October-November and in 1994 and 1995 at Mante and Altamira regions.

In 1995 a susceptible strain, Zeneca-Dow (Wolfenbarger and Brewer 1993) was used as comparison to the field populations. The susceptible strain has been kept continuously for 25 years without the introduction of any individuals from the field.

Larvae collected in 1991 and 1993 were fed cotton leaves in petri dishes and in 1994 and 1995 were fed with artificial diet (Southland Products Incorporated) in 1.0 oz dishes with 2 ml of diet and placed at the laboratory until the pupal stage was reached. Pupae were placed in 3.0 l glass jars in order to obtain adults which were maintained with a 10% sugar solution and moved to a different jar every other day.

Larvae emerged in 1991 and 1993 were placed in groups of 10 in petri dishes with cotton leaves, the leaves were changed every other day. In 1994 and 1995 groups of 5 larvae were placed in plastic cups with artificial diet. Bioassays were performed with third instar larvae of ± 25 mg of the third generation after the field collection. Larvae were treated topical with 1.0 µl of the acetone solution deposited at the dorsal part of the thorax.

Evaluated insecticides were Endosulfan, Methyl Parathion, Azinphos-Methil, Profenofos, Chlorpyrifos, Methomyl, Permethrin, Cypermethrin, and Deltamethrin of technical grade.

For each strain and evaluated insecticide, the response range was determined each year with a preliminary bioassay in which the logarithmic concentrations were 0.000, .0001 to 10%. At least eight dosis in which 0 and 100% mortality was obtained, with four replications and ten larvae per replication were evaluated. Mortality was determined 24 hours after the application in 1991 and 48 hours later in 1993, 1994, and 1995.

The LD_{50} value, thes slope ± standard error and the confidence limits were determined by Probit analysis in 1991; for the other year Polo PC program was used.

Results and Discussion

In 1991 Methomyl was the treatment that exhibited the lowest LD_{50}, followed by Permethrin. The highest values were obtained with Profenofos and Azinphos-Methyl (Table 1). For 1993 LD_{50} values for all insecticides were incremented as compared with 1991, except for Profenofos where a reduction of the LD_{50} value was observed (Table 2).

In 1994, LD_{50} values diminished as compared with 1993 and among the two evaluated strains; Cypermethrin was the only treatment that showed statistical differences (Table 3).

In 1995 Altamira's colony exhibited an increment of tolerance to Endosulfan with respect to 1994 value.

For Methyl Parathion, its value in 1995 was lower than in 1994 but only statistically different for the Altamira colony; these values are not statistically different from 1991 and 1993. For Azinphos-Methyl, in 1995, the strain of Altamira was more tolerant than the Mante strain and statistically different (Table 4). From 1991, 1993 and 1994 no statistical differences were found for the LD_{50}.

Values of Profenofos in 1995 are very similar among the two colonies as well as the 1994. The numbers of 1995 and 1994 are lower than in 1993 but not statistically different. But if compared with the highest value obtained in 1991, statistical differences can be observed. For this insecticide a diminishing trend of the LD_{50} was observed between 1991 and 1995 which can be an indicator of the resistance dilution.

For Methomyl in 1995 no differences were found among two evaluated strain and the value is similar than the one found in 1993, and statistically different of the lower values found in 1991 and 1994. The response to Methomyl throughout the time does not indicate a clear tendency due to the fact that the values have moved inconsistently from 0.157 to 0.7 µg/larva in 1995 in the Altamira strain.

The LD_{50} values observed in 1995 indicate that the strains of Altamira and Mante are different on their response to Cypermethrin, and the strain of Altamira is more resistant (Table 4). In 1994 the values of the Altamira's strain had an increased, the values of 1994 and 1995 are statistically different. In 1994 these two strains were not statistically different. The value of 1993 is very similar to the Altamira's of 1995 (Table 2). However, the lowest observed value was in 1991, and this is an indicator that the population in Southern Tamaulipas tends to increase.

Cypermethrin, which was evaluated from 1993 on and this year obtained its highest value (Table 2). No differences were found on the Mante's strain between 1994 and 1993 but different to Altamira in all the years (Table 3). In 1995 a change in the two strains is observed; Altamira strain present an increment as compared with 1994. Mante strain behaved the opposite, higher value in 1994 than in 1995. Both strains in both years were statistically different.

In 1993 Deltamethrin obtained its highest value (Table 2). In 1994 a diminished number was obtained and in 1995 a statistically difference and even lower value was observed.

Table 5 shows LD_{50} values of the susceptible strain and they are lower than any obtained by the strains from Southern Tamaulipas. When these are compared (Table 6), very high resistance values can be observed for each of the insecticides. The Altamira's strain exposed to Endosulfan had a LD_{50} 196,150 times higher in 1994, while the Mante's strain was 18,900 times higher in 1994 and this proportion increased to 30,050 in 1995.

Methyl Parathion exhibited lower differences. In 1993 had a resistance relation of only 47.9 and this decreased in 1995 to 8.2 and 7.8 for Altamira and Mante respectively.

The greatest resistance relation between the susceptible and field strains was obtained in 1993 with Azinphos-Methyl (Table 6). Later on a decrease of this value was noticed. Profenofos, in 1991, was 18,527.5 times higher than the susceptible strain, but later a decrease was also noticed.

Chlorpyrifos, the most commonly used insecticide to control Beet Armyworm during 1994 and 1995, showed in 1995 a resistance relation of 14,500 and 15,700 for Altamira and Mante strains respectively.

Contrary to the rest of the insecticides, Methomyl showed a increasing tendency. The greatest value was observed in 1995 (Table 6). This can be explained in part to the lack of effectiveness of the product and it use in tank mixes or by itself and all these have been increasing the resistance level.

With the Pyrethroids, the greatest difference was observed with Permethrin in 1993 (Table 6), but in 1994 and 1995 it was observed a decreasing tendency getting a 704 value for the Mante strain in 1995. Cypermethrin behaved similary, its greatest values were obtained in 1993 and in 1994 when both strains exhibited lower numbers.

It is probable that the observed tendency of almost all the insecticides to lower values can be explained primarily to the migration that the Beet Armyworm has experienced throughout the region, and the consequence of this is the dilution of resistance. The first outbreaks of this pest in Southern Tamaulipas were observed in Mante. In 1994 very high number were experienced and the migration to adjacent regions.

Even though a diminishing trend has been observed in all the insecticides, its effectiveness in the field has not increased. For the contrary, products such as Methomyl and Chlorpyrifos have demonstrated a lower performance.

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Table 1. Toxicity of insecticides to beet armyworm from Southern of Tamaulipas, Mexico in 1991. CESTAM-INIFAP.

Insecticide	Insect. test	Slope±SE	LD50* µg/larva	Confidence limits 95%
Methyl Parathion	400	1.393± .206	2.009	1.011- 3.713
Azinphos-Methyl	320	1.707± .345	5.631	1.964-11.726
Profenofos	240	2.139± .238	5.373	4.163- 7.065
Methomyl	360	1.698± .355	0.157	0.071- 0.282
Permethrin	360	1.062± .245	0.501	0.129- 1.432

* 24 hrs. after aplication.

Table 2. Toxicity of insecticides to beet armyworm from Southern of Tamaulipas, Mexico in 1993. CESTAM-INIFAP.

Insecticide	Insect test	Slope±SE	LD50* µg/larva	Confidence limits 95%
Methyl Parathion	240	1.487± .164	5.766	2.122-13.356
Azinphos-Methyl	250	0.270± .146	612.729	∞ - ∞
Profenofos	280	2.774± .382	3.252	0.956- 6.732
Methomyl	320	1.696± .213	0.563	0.115- 1.537
Permethrin	280	1.210± .118	3.706	2.261- 6.045
Cypermethrin	280	0.959± .099	3.403	0.796-13.005
Deltamethrin	300	0.345± .097	8.066	∞ - ∞

*48 hrs. after aplication.

Table 3. Toxicity of insecticides to beet armyworm from Southern of Tamaulipas, Mexico in 1994. CESTAM-INIFAP.

Insecticide	S	Insect test	Slope±SE	LD50 µg/larva	Confidence limits 95%
Endosulfan	M	560	0.630± .068	0.756	0.156- 2.166
M-Parathion	A	360	1.972± .203	3.029	2.188- 3.952
	M	210	1.528± .242	3.258	1.097- 5.843
A-Methyl	A	380	2.005± .590	6.074	∞ - ∞
Profenofos	A	660	2.517± .342	0.923	0.595- 1.270
Methomyl	M	520	0.749± .096	0.108	0.051- 0.190
Permethrin	A	360	1.494± .137	1.881	1.413- 2.472
	M	300	1.232± .120	2.185	1.337- 3.477
Cypermethrin	A	520	0.915± .133	0.119	0.039- 0.241
	M	320	1.395± .148	0.489	0.350- 0.654
Deltamethrin	A	400	1.024± .113	0.221	0.131- 0.339

*48 hrs. after aplication.
S= Strain A= Altamira M= Mante

Table 4. Toxicity of insecticides to beet armyworm from Southern of Tamaulipas, Mexico in 1995. CESTAM-INIFAP.

Insecticide	S	Insect test	Slope±SE	LD50 µg/larva	Interval limits 95%
Endosulfan	A	260	1.247± .190	7.846	3.128-14.341
	M	280	0.824± .110	1.202	0.297- 2.924
M-Parathion	A	320	1.806± .166	0.976	0.683- 1.371
	M	320	2.068± .232	0.929	0.705- 1.176
A-Methyl	A	240	2.243± .284	4.518	3.583- 5.603
	M	360	1.354± .220	0.839	0.392- 1.349
Profenofos	A	360	2.644± .421	0.921	0.624- 1.180
	M	280	2.770± .365	0.904	0.692- 1.110
Chlorpyrifos	A	240	2.293± .308	0.290	0.233- 0.353
	M	280	1.972± .281	0.314	0.210- 0.430
Methomyl	A	240	1.640± .215	0.700	0.300- 1.371
	M	240	2.493± .281	0.540	0.447- 0.645
Permethrin	A	230	3.158± .524	3.528	2.675- 4.312
	M	280	2.806± .336	1.983	1.455- 2.536
Cypermethrin	A	280	1.961± .229	0.765	0.590- 0.990
	M	440	1.586± .190	0.176	0.128- 0.231
Deltamethrin	A	320	1.702± .240	0.794	0.339- 1.278
	M	360	1.578± .263	0.162	0.083- 0.244

*48 hrs. after aplication.
S= Strain A= Altamira M= Mante

Table 5. Toxicity of insecticides to strain beet armyworm susceptibility (Zeneca-Dow). CESTAM-INIFAP, 1996.

Insecticide	Insect test	Slope±SE	LD50* µg/larva	Confidence limits 95%
Endosulfan	240	2.635±.465	0.00004	0.00003-0.00006
M-Parathion	270	2.427±.454	0.119	0.055-0.171
A-Methyl	280	2.508±.301	0.002	0.001-0.003
Profenofos	240	2.304±.305	0.00029	0.000024-0.00036
Chlorpyrifos	400	1.447±.123	0.00002	0.0001-0.00002
Methomyl	240	4.023±.498	0.00097	0.00056-0.00139 **
Permethrin	240	2.503±.307	0.00025	0.00016-0.00038
Cypermethrin	240	3.306±.100	0.002	0.002-0.002

*48 hrs. after aplication.
**90%

Table 6. Relative resistance to beet armyworm of Southern of Tamaulipas, Mexico, with respect a susceptible strain (Zeneca-Dow) CESTAM-INIFAP.

Insecticide	Strain	Year	LD50 µg/larva	R.R.
Endosulfan	Susceptible	-	0.00004	-
	Altamira	1994	7.846	196150.0
	Mante	1994	0.756	18900.0
		1995	1.202	30050.0
M-Parathion	Susceptible	-	0.119	-
		1991	2.009	16.8
		1993	5.706	47.9
	Altamira	1994	3.029	25.4
		1995	0.976	8.2
	Mante	1994	3.258	27.37
		1995	0.929	7.8
A-Methyl	Susceptible	-	0.002	-
		1991	5.631	2815.5
		1993	612.729	306364.5
	Altamira	1994	6.074	3037.0
		1995	4.518	2259.0
	Mante	1995	0.839	419.5
Profenofos	Susceptible	-	0.00029	-
		1991	5.373	18527.5
		1993	3.252	11213.8
	Altamira	1994	0.923	3182.7
		1995	0.921	3175.8
Chlorpyrifos	Susceptible	-	0.00002	-
	Altamira	1995	0.290	14500.0
	Mante	1995	0.314	15700.0
Methomyl	Susceptible	-	0.00097	-
	S.T.	1991	0.157	161.8
	S.T.	1993	0.563	580.4
	Altamira	1995	0.700	721.6
	Mante	1994	0.109	111.3
Permethrin	Susceptible	-	0.00025	-
		1991	0.501	2004.0
		1993	3.706	14824.0
	Altamira	1994	1.881	7524.0
		1995	0.794	3160.0
	Mante	1994	2.185	8740.0
		1995	0.176	704.0
Cypermethrin	Susceptible	-	0.00021	-
		1993	3.403	16204.7
	Altamira	1994	0.119	566.6
		1995	0.765	3642.8
	Mante	1994	0.489	2328.5
		1995	0.176	838.1

*48 hrs. after aplication.
R.R. = Resistence relationship.