INSECTICIDE RESISTENCE OF TOBACCO BUDWORM IN SOUTHERN TAMAULIPAS, MEXICO

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Abstracts

Cotton is one of the most important crops of southern Tamaulipas, Mexico. In the last two years the crop area reached 55,000 ha. The tobacco budworm (*Heliothis virescens*), cotton boll weevil (*Anthonomus grandis*), and lately the beet armyworm (*Spodoptera exigua*), are the most important pests of this area. Lately, a tendency of the tobacco budworm population towards resistance has been noticed, especially to pyrethroids.

In 1991 the level of resistance to permethrin was 1.9x and 2.7x in 1994. The levels for cypermethrin were 1.1x in 1991 and 8.4x in 1994. Deltamethrin levels were 3.8x and 8.6x respectively. The LD_{50} for methyl parathion was lower than the susceptible strain. In the case of profenofos a lower value was observed between 1991 and 1994.

Introduction

In northeastern Mexico, the cultivation of cotton was a determining factor for the opening of land to agriculture. In 1960, 400,000 ha in the northern area and about 230,000 ha in the southern part of Tamaulipas were planted (Vargas, et al. 1979). In the late 60's southern Tamaulipas experienced a big disaster due to the resistance of the tobacco budworm, *Heliothis virescens*, to insecticides (Bujanos-Muñiz, 1984), and as a result, the area was almost abandoned for cotton activities. In the 80's, cotton started to gain importance again and the growing area in 1983 reached 12,000 ha. In the last two years, the growth of cotton has climbed to 55,000 ha.

In Mexico and in some other countries the tobacco budworm is one of the most important pests, as well as the cotton boll weevil, *Anthonomus grandis*. In the last years the beet armyworm *Spodoptera exigua* has gained importance.

In order to control the pests that attack cotton, nearly 15 applications of insecticides per season it is necessary, of which in at least 6 of them products are included to eliminate the tobacco budworm.

The first reports of the resistance to methyl parathion in tobacco budworm in southern Tamaulipas were in 1969 (Adkinsson, 1969; Wolfenbarger and McGarr, 1970). Since then, some researches have determinated the LD_{50} by using the topical method (Brazzel, 1970). Since 1969 until 1973, the values of the LD_{50} stayed very high, from 460 to 5152 µg/g. In 1979 these values went down to 264 µg/g and in 1980 the value increased to 506 µg/g (Wolfenbarger, et al. 1981). Besides the resistance to methyl parathion, the tobacco budworm had very high levels of resistance to other insecticides (Wolfenbarger, 1973).

Pyrethroids are effectives to control tobacco budworm, but it has been also found some resistance to them. The first determination of the LD_{50} with a pyrethroid in tobacco budworm in southern Tamaulipas was done in 1974 and this value was 5.4 µg/g for permethrin (Davis, et al. 1974). In 1977 it was 0.82 µg/g, 6.38 µg/g in 1978, 2.44 µg/g in 1980, and 5.2 µg/g in 1983 (Wolfenbarger, et al. 1981, Bujanos-Muñiz, 1983).

The constant observation of the LD_{50}, allows to observe changes in the susceptibility of insect populations to insecticides, so it is easier to plan the appropriate way to manage resistance. With that purpose, in 1991 I began a constant monitoring of resistance to insecticides in tobacco budworm populations in cotton in southern Tamaulipas, Mexico.

Materials and Methods

The research was carried out in the entomology laboratory of Campo Experimental del Sur de Tamaulipas (INIFAP).

Larvae from southern Tamaulipas were collected during September to November, 1991 and 1994 in cotton fields. The laboratory colony (susceptible) came from Ciudad Obregon, Sonora, Mexico. A strain of 98 generationes in laboratory was used in the bioassay in 1993.

The larvae were placed on plastic cups (30 ml of capacity) with aproximately 4 ml of artificial diet (Leon, 1978). Larvae were placed in a room at 25 ± 2°C, relatively humedity 60 to 80% and a 12:12 photoperiod until they molted to pupae. The pupae were transfered into glass jars of 3 l, in a sex ratio 1:1, for adult emergence. Once the adults emerge, the glass jars were covered with a paper towel, and so adults oviposited on them. Adults were kept on sugar solution at 10%. The adults were changed to another jar every two days. Larvea were placed on artificial diet again.

The insecticides evaluated were: methyl parathion, profenofos, permethrin, cypermethrin and deltamethrin 90% pure, except methyl parathion 80% pure. The bioassays method was topical application (Brazzel, 1970). Larvae of third instar of weight 25 ± 3 mg were topically treated with 1 µl of acetone solution applied to the dorsal surface of the thorax. In every strain evaluated and for each one of the insecticides, the range of response was determinated by a preliminary bioassay, in which

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logaritmic concentrations of 0.00001 to 10% were used. In that bioassay the appropriated concentration to get 0 and 100% mortality was determined. Once these values were found, for each insecticide evaluated, a minimum of 7 dosis with 4 replications with 10 larvae each were evaluated. Mortality was determinated 48 hrs after application.

The slope ± standard error, LD_{50} and the confidence interval were deter-minated in 1991 using SAS and in 1993 and 1994 by POLO PC programs.

Results and Discussion

The LD_{50} for methyl parathion in southern Tamaulipas varied from 1.88 µg/larva in 1991 to 1.93 µg/larva in 1994, observing a small increased in 1994 compared with 1991. Although those values compared to the suceptible strain were lower (Table 1), it can be concluded that in 1994 populations of tobacco budworm were suceptible to methyl parathion; even though in the 60's the values were very high (Wolfenbarger, et al. 1981).

Values of LD_{50} for profenofos were 0.611 µg/larva in 1991 and 0.42 µg/larva in 1994 (Table 1); statistically these values are not different due to the fact that the confiance interval overlaps. Compared to the LD_{50} of the suceptible strain, the level of resistance to that product was 2.3x in 1991, decreasing to 1.6x in 1994.

In relation to pyrethroids, which are the most commonly used products in this region for the control of tobacco budworm, an increase in the LD_{50} value has been observed. For permethrin its highest value was in 1994 (Table 1), with a level of resistance of 2.7x. In 1991 the LD_{50} value was 0.28 µg/larva and a level resistance of 1.9x. Of the three pyrethroids evaluated, this is the least toxic and it also had the lowest level resistance in 1994; this can obey to the fact that formulated products with this insecticide generally are not used in cotton.

In relation to cypermethrin an increase in the LD_{50} values was observed. In 1991 it was 0.08 µg/larva and a level of resistance of 1.1 times compared to the susceptible strain (Table 1). In 1994 the LD_{50} values was 0.62 µg/larva and a level of resistance of 8.4 times. For deltamethrin, the LD_{50} values in 1991 were of 0.03 µg/larva and 0.08 µg/larva in 1994, and a level of resistance of 3.8x and 8.6x respectively.

In 1994 an strategy for the management of resistance was proposed; this strategy restricted the use of pyrethroids during September 15 to October 30, that is the period of time when the tobacco budworm appears in higher numbers. In that year, although this strategy was suggested, the level of resistance for cypermethrin and deltamethrin was the highest compared to the susceptible strain 8.4x for cypermethrin and 8.6x for deltamethrin.

In summary, the values obtained indicate a tendency of the tobacco budworm populations of southern Tamaulipas towards resistance to pyrethroids. During 1995, many deficiencies were observed in controlling the tobacco budworm with pyrethroids, caused perhaps by resistance to these insecticides; but this can not be confirmed until I get information from the population collected in late 1995, for which the bioassays are still in progress.

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Table 1. Toxicity of various insecticides against tobacco budworm *Heliothis virescens* in southern Tamaulipas. México. INIFAP-CIR Noreste-CESTAM.

Insecticide	Year	Insect test	Slope ±SE	LD50[1/] µg/ larvae	95% confidence interval	RR
Methyl	Susc.	320	1.63±.17	3.95	∞-∞	-
Parathion	1991	210	2.76±.40	1.88	1.39-2.42	-
	1994	210	2.09±.42	1.93	.60-3.19	-
Profenofos	Susc.	280	1.19±.36	0.26	.14- .38	1.0
	1991	270	1.50±.37	0.61	.21-1.68	2.3
	1994	280	4.07±.65	0.42	.35- .49	1.6
Permethrin	Susc.	280	3.51±.41	0.14	.10- .22	1.0
	1991	270	1.73±.21	0.28	.20- .38	1.9
	1994	210	1.20±.16	0.39	.04-1.06	2.7
Cypermethrin	Susc	320	2.24±.25	0.07	.05- .09	1.0
	1991	360	0.80±.16	0.08	.02- .36	1.1
	1994	300	0.94±.10	0.62	.34-1.17	8.4
Deltamethrin	Susc.	280	2.02±.20	0.01	.007-.01	1.0
	1991	240	2.32±.46	0.03	.02- .05	3.8
	1994	330	1.60±.17	0.08	.06- .11	8.6

[1/] 48 hrs after aplication.

$$\text{RR = Level of Resistance} = \frac{LD_{50}\ \text{of that year}}{LD_{50}\ \text{of susceptible strain}}$$

Susc. = Suseptibility strain.