EFFECT OF COMMERCIALLY PLANTED Bt COTTON ON THE RESISTANCE OF TOBACCO BUDWORM TO INSECTICIDES IN SOUTHERN TAMAULIPAS, MEXICO

A. P. Terán-Vargas
Campo Experimental Sur de Tamaulipas-CIR Noreste-INIFAP
Est. Cuauhtémoc, Tam., Mexico

Abstract

Cotton is an important comodity in Southern Tamaulipas, Mexico. It was in 1994 and 1995 when this crop reached its peak planted area; however, in 1995 the highest Tobacco Budworm (*Heliothis virescens*) LD_{50} values were found: Profenofos 5.34x, Permethrin 4.46x, Cypermethrin 6.12x, Deltamethrin 18.25x, and 14.0x for Lambda-cyhalothrin. In 1997 an important decrement of this pest's LD_{50} values were observed for the above mentioned insecticides. This can be attributed to two factors: a) the use of Bollgard® cotton and, b) a reduction in the number of insecticide applications to control this pest, since it is not necessary when using this cotton. Some of these pesticides quickly regained LD_{50} values similar to those of the reference colony.

Introduction

Cotton is one of the crops where pest resistance to insecticides is of great importance. Very serious difficulties in controlling pests have been experienced in countries in South and Central America, in the US., Mexico, Turkey, Egypt, and many others. One of the reasons is the intense application of a variety of insecticides for a very long period of time, in some cases sprays are made on a weekly basis or even more often. One indicator of the selection pressure is reflected on the fact that 40% of the insecticides in the US was used in cotton (Eichers 1981).

In Northeast Mexico cotton played an important role in opening great land extensions for agriculture (Bujanos-Muñiz 1984). In 1960, the cotton area in Northern Tamaulipas reached 400,000 hectares, and 230,000 on its Southern part (Vargas et al. 1979). Towards the end of the 1960s Southern Tamaulipas cotton suffered its most severe crisis due to the high level of resistance of the Tobacco Budworm (*Heliothis virescens*) to chlorate, phosphorate and carbamate insecticides. During this period of time cotton farming was completely abandoned. Since the 1980s this crop has made a comeback reaching 50,000 hectares in 1994-1995.

Cotton comeback was made possible in part to the introduction of pyrethroids. However, due to its high effectiveness and the lack of alternative insecticides, on the one hand, the overuse of pyrethroids helped increase the crop area (Table 1), but, on the other, control problems were once more quickly apparent.

In 1991 a population of Tobacco Budworm was 2.3x more resistant to Profenophos than a population from Ciudad Obregón with more than 100 generations in the laboratory without insecticide applications. A population in Southern Tamaulipas was 1.9x more resistant to Permethrin, and 1.1x and 3.8x more resistant to Cypermethrin and Deltamethrin respectively. In 1994 the LD_{50} for Profenofos was 1.6x greater, while the values for Permethrin, Cypermethrin and Deltamethrin were 2.7x, 8.4x, and 8.6x respectively (Terán-Vargas 1996).

Materials and Methods

In 1995 and 1997 larvae of the Tobacco Budworm were collected in cotton fields. The captures took place in conventional cotton in 1995 and in 1997 in Bt cotton refuges.

Larvae were placed in 30 ml plastic cups with artificial diet (Southland Products Inc.) and kept at room temperature (25 ± 2°C), 60-80% relative humidity, and a photoperiod of 12:12 h. Pupae were transferred to 3.0 l glass jars for adult emergence, copulation and egg lay. Adults were fed with a 10% sugar solution.

The reference colony, which has been maintained for 108 generations without insecticides, was obtained from Ciudad Obregón, Sonora, Mexico.

Evaluated insecticides were Methyl Parathion, Profenofos, Permethrin, Cypermethrin, Deltamethrin and Lambda-Cyhalothrin. The bioassay method was topical application to third instar larvae (25 ± 3 mg), and mortality was evaluated 48 h after application.

Results and Discussion

Table 1 shows the planted cotton area in the last decade. In 1994 and 1995 cotton reached its greatest area; however, it is during this period of time when the LD_{50} values were higher. The resistant population was 4.46x, 61.12x, 18.25x, and 14.0x than the susceptible one for Permethrin, Cypermethrin, Deltamethrin and Lambda-Cyhalothrin respectively (Table 2). With this resistance scenario lack of Tobacco Budworm control was observed in the fields, leaving behind 50% of the larvae alive after each application. This caused that the number of applications to control this insect increased to 6-8, rising production costs and losses due to control deficiency.

By 1996 the cotton area was reduced 96.5% (Table 1). Of the area planted in 1996 (2,103 ha), 57% had Bollgard® cotton. Southern Tamaulipas was the second area in the

Reprinted from the *Proceedings of the Beltwide Cotton Conference*
Volume 2:1243-1244 (1999)
National Cotton Council, Memphis TN

world with this type of crop, after the US. Due to the success in its introduction Bollgard area increased 379% in 1997 (Table 1).

Using Bollgard cotton aliviated the need for insecticide applications for the Tobacco Budworm, and this in turn, made it possible to reduce the LD_{50} for Methyl Parathion to a level even lower than the susceptible population, although not significantly different. For Profenofos the situation was similar, significant lower LD_{50} values in 1997 than in 1995 (Table 2).

Similar trends were also observed with pyrethroids, except for Lambda-Cyhalothrin that had a non-significant increase of 14.0x to 23.5x. Permethrin values in 1997 were three times lower than in 1995 (non-significant), a significant 43x reduction from 1995 to 1997 for Cypermethrin, and a significant 5.7x reduction for Deltamethrin (Table 2).

The reduction of the LD_{50} values can be attributed in part to the Bollgard plants, the reduction of the insecticide applications, and the reduction of selective pressure towards resistance. All these in turn can bring back insect susceptibility to insecticides to a level where commonly used products can be effective again. This scenario could also bring the possibility of switching the 96:4 Bollgard planting option to 60:40 in order to reduce the selection pressure that this type of cotton has on the Tobacco Budworm and thus maintain the effectiveness of this technology for a longer time.

With the advent of new insecticides without cross resistance into the market, such as Tracer®, Intrepid® and Steward®, the options for Mexican farmers to grow cotton have increased.

Acknowledgment

To Carlos Blanco Montero for assistance in the preparation of this manuscript.

References

Eichers, T.R. 1981. Farm Pesticide Economic Evaluation, 1981. USDA Economic and Statistics Service, Agri: Econ. Rep. No. 464.

Bujanos-Muñiz, R. 1983. Susceptibilidad a insecticidas en *Heliothis* Spp. (Lepidoptera: Noctuidae) del Sur de Tamaulipas, México, Tesis de Maestría en Ciencias. Colegio de Postgraduados.

Vargas-C.J.E.; Villarreal, F., y E. Salgado S. 1979. Líneas de algodonero resistentes al ataque del complejo bellotero *Heliothis* Spp. En el Sur de Tamaulipas. Agric. Tec. Mex. Vol. 6 (1):11-19.

Terán-Vargas, A.P. 1996. Insecticide Resistence of Tobacco Budworm in SouthernTamaulipas, México. 1996 Proceedings Belwide Cotton Conferences, Nashville, TN. P. 784-786.

Table 1. Cotton Area in Southern Tamaulipas, Mexico During 1990-1998.

Year	Planted area in ha*	
	Bollgard**	Conventional
1990	0	17817
1991	0	30455
1992	0	20013
1993	0	18412
1994	0	54398
1995	0	48402
1996	1200	903
1997	7982.4	-
1998	15822.15	-

*Distrito de Desarrollo Rural 162 González y 161 Mante, SAGDR
**Monsanto Comercial, S.A. de C.V.

Table 2. Insecticide Toxicity for The Tobacco Budworm (*H. virescens*) in Southern Tamaulipas, Mexico. INIFAP-CIR Noreste-CESTAM.

Insecticide	Year	Insect Test	Slope ± SE	LD_{50} µg/larvae	95% Confidence Interval	RR
Methyl Parathion	Susc.	280	2.28±0.24	1.46	1.19-1.75	-
	1995	360	1.79±0.16	1.63	1.32-2.02	1.11 x
	1997	210	1.63±0.19	1.03	0.45-2.19	-
Profenofos	Susc.	280	1.83±0.18	0.12	0.08-0.19	-
	1995	320	2.24±0.32	0.68	0.46-0.93	5.34 x
	1997	210	2.76±0.38	0.20	0.15-0.26	1.60 x
Permethrin	Susc.	360	2.63±0.23	0.17	0.14-0.20	-
	1995	360	1.49±0.13	0.78	0.60-1.01	4.46 x
	1997	210	1.36±0.20	0.25	0.04-0.56	1.46 x
Cypermethrin	Susc.	320	1.95±0.11	0.01	0.01-0.02	-
	1995	320	1.33±0.14	0.98	0.52-1.76	61.12 x
	1997	210	1.47±0.19	0.30	0.19-0.41	18.75 x
Deltamethrin	Susc.	240	3.14±0.34	0.00	0.00-0.00	-
	1995	320	1.24±0.14	0.07	0.04-0.11	18.25 x
	1997	210	1.84±0.22	0.05	0.02-0.10	12.50 x
Lambda-Cyhalothrin	Susc.	280	2.53±0.30	0.00	0.00-0.00	-
	1995	290	1.16±0.14	0.02	0.00-0.05	14.0 x
	1997	210	1.52±0.21	0.04	0.02-0.06	23.5 x

RR= LD_{50} of strain/LD_{50} Susceptible strain.