DIFFERENCES IN HELIOTHIS VIRESCENS RESISTANCE DEVELOPMENT AFTER LABORATORY SELECTION WITH PROFENOFOS, THIODICARB AND CYPERMETHRIN

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Abstract

A selection experiment was conducted in Colombia using a field population of the tobacco budworm *Heliothis virescens*. Profenofos, thiodicarb, cypermethrin and α-cypermethrin were applied to third instar larvae for 13 generations. Bioassays were conducted to measure the development of resistance. The resistance factors after a 13 generation pressure were respectively 2 for profenofos, 21 for thiodicarb, 748 for cypermethrin and over 2000 for α-cypermethrin.

Introduction

Insecticide resistance is a major concern for the cotton farmer and for the Chemical Industry. Experimental induction of insecticide resistance is recognized as a possible method to assess the risk of resistance development to an insecticide (Brown&Payne 1988). The major selection experiments have been conducted with dipterous pests which are easier to rear and treat in large numbers than phytophagous insects such as the tobacco budworm, *Heliothis virescens.*

The project was initiated in 1993 by Ciba-Geigy and Federalgodon. The objective of the project was to evaluate the "resistance development risk", towards the tobacco budworm, of Ciba's main cotton insecticide CURACRON (profenofos). Others major classes of insecticides (thiodicarb, cypermethrin, α-cypermethrin) were included in the experiment for comparison.

Methodology and Experimental Design

The Jaime Mor Laboratory of Federacion Nacional de Algodoneros located in EL Espinal (Tolima, Colombia) was our testing and rearing location for the experiment. The basic methodology was the same as described by Rendon et al (1992). The base *Heliothis virescens* population was collected in cotton fields during the cotton season having already some selection pressure from commercial applications.

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This basic population was divided into 4 substrains (one substrain for each of the 4 insecticide treatments). The lines were maintained and multiplied in the laboratory using an artificial diet similar to the one proposed by Patana (1969). Each of the four substrains were subjected to one selection pressure per generation. To limit the workload, bioassays of each substrain were done each second generation.

The dose for the selection pressure was the approximate LD50 value determined in the bioassays. Third instar larvae with an average weight of 15 mg (± 2 mg) were used for both inducing selection pressure and measuring levels of resistance. Larvae were topically treated using a Hamilton PB 600 dispenser with 1µl of an acetone insecticide solution.

For applying selection pressure samples of more than 1000 larvae were used.. Bioassays used between 5 to 8 doses and between 40 to 80 larvae per dose, using the ESA method (Anonymous, 1970). The mortality was assessed after 48 hours. Moribund larvae were counted as dead. Data were subjected to probit analysis to obtain LD 50 values and the other relevant parameters. Resistance Factors (RF) were calculated by dividing the LD 50 obtained for a given generation by the LD50 of the basic population collected in the field.

Results

The results are shown in table 1 to 4. The results for the selection pressure are expressed in % mortality at the given dose in ng per larvae. The number of larvae to which selection pressure has been applied is given for each generation. The LD50 value from the bioassay is expressed in ng per larvae. The resistance factors are expressed as the quotient of F(n)/F0.

Discussion

The results demonstrated the possibility of insecticide resistance induction by using an artificial selection pressure in a well designed laboratory experiment. The level of resistance induced is different according to the characteristics of the insecticides.

Differences between insecticides from the same class such as cypermetrhin and α-cypermethrin with RF factors of 750 and >2000 after a 13 generations selection pressure were not expected. The reason maybe be explained by the difference in number and ratio of isomers. This phenomenon once more demonstrates the difficulty to generalize resistance assumptions for classes of insecticides. Insects treated with thiodicarb were less affected and reached a RF of about 20 after being pressured for 13 generations.

Profenofos, with an RF of 2 is outstanding and did not show any increase after the exposure during 13 generations.

This tendency with profenofos has also been confirmed by our world-wide bollworm resistance monitoring activities. The reasons for the low level of resistance development to profenofos in the population of tobacco budworm are not known and need more investigation.

Experimentation for predicting resistance is still a matter of debate, although it gives a useful indication combined with the field experience. However, the need to use a resistance management strategy is obvious. The differentiation between low and high risk may be used in a similar way as for the fungicide resistance management strategy where products of different mode of action are applied in mixture according their estimate risk of resistance.

References

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Table 1: Results of profenofos selection

Generations	Dose ng/lv	Number treated	Mortality in %	LD50 ng/lv	Resist. Factors
F0	---	---	---	124	---
F1	110	1017	50%	---	---
F2	110	1177	70%	152	1
F3	152	1305	82%	---	---
F4	152	1250	62%	211	2
F5	180	1136	70%	---	---
F6	180	1203	56%	198	2
F7	182	1147	57%	---	---
F8	182	1493	44%	214	2
F9	200	1170	44%	---	---
F10	200	1402	54%	176	1
F11	224	1149	49%	---	---
F12	224	1427	51%	202	2
F13	240	1484	65%	----	---
F14	---	---	---	295	2

Table 2: Results of thiodicarb selection

Generations	Dose ng/lv	Number treated	Mortality in %	LD50 ng/lv	Resist. factors
F0	---	---	---	416	---
F1	300	1640	58%	---	---
F2	300	1565	47%	1015	2
F3	930	1111	47%	---	---
F4	930	1339	42%	1625	4
F5	1500	1133	44%	---	---
F6	1500	1044	39%	2078	5
F7	2000	1292	50%	---	---
F8	2000	1669	32%	2680	6
F9	2300	1145	39%	---	---
F10	2300	1263	42%	---	---
F11	5500	1283	52%	---	---
F12	5500	2133	74%	7065	17
F13	7940	1203	57%	---	---
F14	---	---	---	8920	21

Table 3: Results of cypermethrin selection

Generations	Dose ng/lv	Number treated	Mortality in %	LD50 ng/lv	Resist. factors
F0	---	---	---	203	---
F1	190	1266	62%	---	---
F2	190	1335	29%	297	1
F3	360	1061	61%	---	---
F4	360	1666	31%	502	2
F5	470	1514	55%	---	---
F6	470	1255	43%	1400	7
F7	1120	656	54%	---	---
F8	1120	2036	54%	3610	18
F9	2000	1337	59%	---	---
F10	2000	1091	33%	18110	89
F11	15850	1343	44%	---	---
F12	15850	1836	42%	44070	217
F13	44670	1322	54%	---	---
F14	---	---	---	152000	748

Table 4: Results of α-cypermethrin selection

Generations	Dose ng/lv	Number treated	Mortality in %	LD50 ng/lv	Resist. factors
F0	---	---	---	158	---
F1	178	1268	33%	---	---
F2	178	1474	36%	280	2
F3	251	802	46%	---	---
F4	251	1100	39%	462	3
F5	501	1536	47%	---	---
F6	501	1318	46%	1450	9
F7	1122	317	44%	---	---
F8	1122	1636	28%	1950	12
F9	2000	1643	66%	---	---
F10	2000	1810	53%	6890	44
F11	10000	1145	38%	---	---
F12	10000	1281	18%	200000	>1000
F13	260000	1500	42%	---	---
F14	---	---	---	338000	2140