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EFFECTS OF PLANT EXTRACTS ON PYRETHROID RESISTANCE IN THE CONTROL PROGRAME OF THE COTTON LEAFWORM *SPODOPTERA LITTORALIS* BOISD (LEPIDOPTERA : NOCTUIDAE)

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ABSTRACT

Our results clearly indicated that most field strains developed remarkably high levels of resistance, (average RR 50.9 - 6667.7 fold, RR of 142.5 - 1738.8 fold) from a susceptible strain treated with seven tested synthetic pyrethroids: Alphamethrine, Deltamethrine, Cis-cyfluthrin, Cypermethrin, Fenpropathrin, Fenvalerate and Lamdacyhalothrin. However, least resistance was detected for Fenvalerates and lamdacyhalothrin. Appreciable decline in tolerance rates of Downythorn apple, Santonicae and worm wood increased by 9.7, 4.3 and 4.0 fold for Fenpropathion, Deltamethrin and Cypermethrine, respectively. Average RR for Deltamethrin was 925.6 despite the fact that it was one of the most potent pyrethroids tested against the laboratory susceptible strain.

INTRODUCTION

The cotton leaf worm, *Spodoptera littoralis*, has long been recognized as the most serious and wide spread economic pest in Egypt and in nearly all cotton growing areas. Chemical control of this pest is still adopted as one of the major techniques since 1950. The extensive and continuous application of organic insecticides against this pest induced serious problems such as resistance. Alternative larvicides in general and ovicides in particular have been recomended to alter or overcome the problems of resistance.

The synthetic pyrethroids have been found to possess significantly greater activity than organophosphorus and carbamate compounds against many of destructive agricultural pests, especially Lepidopterous insects such as *Heliothis virescens* ***(Davis et al., 1977 and Wolfenbarger et al., 1977)*** and *Plutella xylostella* ***(Ming Yie Lin et al., 1981).***

Pyrethroid resistance has been a major concern of cotton producers because of reported pyrethroid resistance in insects. Many investigators previously worked on strains of *S. littoralis* selected for pyrethroid resistance in the laboratory ***(Riskallah et al., 1983; El-Guindy et al., 1982 and Fahmy et al., 1985)*** worked on field population. Others ***(El-Guindy et al., 1985; Issa et al., 1985 and Ayad and El-Dakroury, 1985)*** have observed high LD_{50}'s in bioassayed strains collected from field populations.

However some authors were reluctant to classify these observations as resistance because they were not acquainted with control failures in the field.

The aim of the present work is to investigate the possible development of resistance and however, we tend to develop these methods by testing the joined effect of pyrethroids with some botanical extracts.

MATERIAL AND METHODS

Rearing technique :

The stock culture of susceptible strain of *S. littoralis* used in the present work was reared in laboratory of the Entomology Dept., under constant conditions of 27 ± 2°C and 60 - 65% RH.

Bioassay :

To measure the relative susceptibility of *S. littoralis* strain to either the recommended synthetic pyrethroids and the candidate plant extracts.

Pyrethroid insecticides used were; Alphamethrin, Delta methrin, Cis-cyfluthrin, cypermethron and fenpropathrin.

Tested plants used are shown in Table (1); caraway, devil's apple, downythorn apple, beadtree, Santonicae and worm wood.

Fourth instar larvae were obtained from those raised in from the colony. The bioassay procedure based on exposing the larvae to cotton leaves treated with a minimum of five to eight concentrations of each insecticidae. Each treatment was replicated for a minimum of five times using 10 larvae in each replicate.

Cotton leaves were treated by the leaf - dipping technique for 3 seconds in test solution and left to dry in the air for 15 min. before offering them to the test larvae in glass vials. These vials were held at room temperature (27± 2°C) and the mort lity was observed and recorded 24 h after treatment. Water treatments were used as controls. Control mortality was less than >5% and all mortality data were corrected for control mortality ***(Abbott, 1925).*** Based on previous studies with these insecticides, it was assumed that total mortality was equal to the combined number of dead and moribund larvae observed. The data were subjected to probit analysis ***(Finney, 1971)*** to estimate the median lethal concentration (LC_{50}) values.

Insecticides :

Commercial formulated synthetic pyrethoids were used as supplied by the manufacturers. The tested formulations included deltamethrin (Decis 2.5% EC), cypermethrin (Ripcord 30 % EC), Fenpropathrin (Menothrin 20% EC), fenvalerate (sumicidin 20% EC), alphamethrin (Fastac 10% Ec), lamdacy - halothrin (Kendo 5% EC) and cis - cyfluthrin (Boldock 2.5 % EC).

Plant extraction procedure :

Plants used are tabulated in table (1). Dry seeds of Devil's apple, downythron apple and beadtree; fruits of caraway; whole plants without roots of worm wood; dried unexpanded flower head of santonica and fresh whole plants without roots of budding grass were used in preparing the extraction. All plants or parts of plants used were free from any insecticidal residues. Tested plants were extracted according to the procedure of ***Gayar and Shazli (1968) and Teotia and Pandey (1979).***

RESULTS AND DISCUSSION

Table (2) includes slopes of regression lines, estimated LC_{50} values and derived resistance factors for a laboratory susceptible strain of *S. littoralis*.

Among the 7 compounds tested, the synthetic pyrethroids Alphamethrin (Fastac) and Cis - cyfluthrin (Baldock) were more toxic to the susceptible strain only than all other pyrethroids, whereas fenvalerate (Sumicidin) and Lamdacyhalothrin (kendo) were the least toxic. Of the six plant extracts tested, four were almost fully resistant to pyrethroids.

The estimated resistance factors (RR) demonstrated that high resistance levels were detected for alphamethrin and cis - cyfluthrin in all tested plants, ranging from 1333.3 to 11470 (average = 6667.7 -fold) for the former and from 656.6 to 7323.3 (average = 4749.9- fold) for the latter. On the other hand, the least resistance factors were recorded (18.6-fold) for lamdacyhalothrin and (25.5 fold) for fenvalerate. However, no resistance was detected for both compounds when beadtree was used (RR = 2.9 for lamdacyalothrin) and when caraway was used (RR = 7.0 for Fenvalerate). Moderate to low levels of resistance were recorded for Deltamethrin (Avg. RR = 737.6), cypermethrin (Avg. RR = 160.4) and Fenpropathrin (Avg. RR = 50.9).

In general, worm wood followed by downythorn apple were only slightly resistant to the sever tested pyrethroids, recording an average RR of 33.3 and 132-fold, respectively. Rather high resistance levels to all pyrethroids tested were exhibited by caraway treatments followed by those of Santonicae and devil, s apple treatments as shown by average RR of 2798.4, 1720.2 and 1544.9-fold, respectively.

Differences in levels of resistance could be easily detected for the tested pyrethroids in most plants extracts (Table 3).The highest slope values detected in Devil's apple and Santonicae treatments were 2.9 and 2.25, respectively for cypermethrin, and in Downy thorn apple treatments and 2.25 for fenpropathrin, indicating moderate degrees of heterogeneity of response. However, slope values of the same populations decreased to 1.62 and 0.66, respectively, revealing an increase in the heterogeneity of both selected populations. This decrease in slope values was evident for the above mentioned treatments. The slope pattern is in agreement with ***Hopkins and Gordon (1956)*** who reported that development of true resistance is characterised by regression lines becoming shallower as chemical control was applied and becoming finally steeper again as resistant genotypes prevail in the new population.

Generally, the least resistance levels were again exhibited for lambacyhalothrin and fenvalerate, recording average RR 18.1 and 28.0-fold, respectively. Similar resistance ratio values were discussed by indicated a good approximation of the degree of resistance present ***(Hinkle et al., 1985).*** However, no resistance was detected for either fenvalerate in each of caraway (RR = 9.1- fold), downythorn apple (RR = 4.4 -fold) and beadtree (RR=4.6 fold) or for cypermethrin in beadtree (RR = 0.18). On the other hand, the highest resistance levels were recorded for alphamethrin in downythorn apple (averages RR = 1330). Average RR for

Detlamethrin was 925.6 despite the fact that it was one of the most potent pyrethroids tested against the laboratory susceptible strain.

Based on the average resistance ratios (RR) of each specific plant extract, we concluded that the cotton leaf worm population in beadtree treatments seems to be more susceptible to pyrethroids. On the other hand downythorn apple, Santonicae and caraway treatments exhibited remarkably high resistance levels.

Data in Table (4) demonstrate a considerable and significant increase in tolerance of downythorn apple and Santonicae populations to deltamethrin by 3.82 X and 4.33 X, respectively, while tolerance rates increased by 4.06 X for cypermethrin in worm wood population, by 9.74 X for fenpropathrin in downythorn apple population and by 3.32 X and 3.75 for fenvalerate in devil's apple and worm wood populations. In contrast the cotton leaf worm population of beadtree showed remarkable decline in tolerance rate. ***Brown et al. (1982)*** found that the reversion of pyrethroid tolerance observed in tobacco budworm, *Heliothis virescens* (F), field strains could be explained by the selection for survival being linked to reproductive incapacity as has been observed with DDT selection ***(Lineva, 1955 and Brown, 1981).*** Pyrethroid - selected individuals may not be able to compete reproductively with moths, resulting in increased pyrethroid susceptibility.

El-Guindy et al. (1982) found that resistance to pyrethroids had already been established in field strains of *S. littoralis* in most of the Egyptian Governorates. They added that the different levels of significant resistance to pyrethroids exhibited by the field strains are the result of cross resistance with other groups of insecticides and not due to intensive or prolonged applications of these newly used materials. Our results are in agreement with those obtained in cotton field of Arizona and California ***(Crowder et al., 1979 and Twine and Reynolds, 1980).***

It is apparent from the present study and from those of others that after using pryethroids in cotton control program, pyrethroid - specific resistance in *S. littoralis* becomes widespread. Pyrethroid resistance detected is most probably a result of cross resistance with other insecticides prevously used. However, in view of such serious resistance situation in the insect, immediate measures, such as using pyrethroids in appropriate sequence, must be under taken to prolong the potentiality of the available compounds.

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Table (1): Information about the six plant species used in the present study.

No.	Family	Scientific name	English name	Arabic name
1	Umbelliferae	*Carum Carvi L.*	Caraway	Karawya, Kammun armani
2	Solanaceae	*Datura stramonium L.*	Devil's apple,	Taturah, Nafir
3	Solanaceae	*Datura metel L.*	Metel, Downy thorn apple	Gawz mathil
4	Leguminoseae	*Abrus precatorius L.*	Bead tree, wild liquorice	Ayneddike, Shashm
5	Compositae	*Artemisia santonicum L.*	Santonica	Shihh khursani, Qayssum anthi
6	Compositae	*Artemisia herba alba L.*	Worm wood	Shihh.

Table (2): Concentration mortality data and resistance ratios of different synthetic pyrethroids when combined with different plant extracts (at concentration of 20 ppm) tested by leaf dipping technique against *Spodoptera littoralis* larvae. (susceptible strain).

Insecticides		Insecticide only %	Mortality data of indicated plant extracts plus pyrethroids						
			Caraway	Devil's apple	Downythorn apple	Beadtree.	Santionica	Worm wood	Average RR
Deltamethrin	LC_{50}	0.086	102.32	26.08	34.7	133.17	20.93	-----	----
(Decis)	RR		1189.7	303.2	403.4	1548.4	243.3	-----	737.6
Cypermethrin	LC_{50}	0.27	51.27	72.46	27.0	44.25	47.84	17.05	
(Record)	RR		189.9	268.3	100.0	163.8	177.1	63.1	160.4
Fenpropathion	LC_{50}	1.01	13.02	26.49	126.94	71.43	56.94	14.4	
(Meothrin)	RR		12.8	26.2	125.6	70.7	56.3	67.77	59.9
Fenvalerate	LC_{50}	2.95	20.82	45.75	37.48	244.63	35.94	22.9	
(Sumicidin)	RR		7.0	15.5	12.7	82.9	12.1	----	26.04
Alphamethrin	LC_{50}	0.003	34.41	4.0	---	---	21.6	----	
(Fastac)	RR		11470.0	1333.0	---	---	7200	----	6667.7
Lamdacyhalothrin	LC_{50}	2.71	63.4	---	50.68	8.0	79.93	----	
(Kendo)	RR		23.3	---	18.7	2.9	29.4	----	18.6
Ciscyfluthrin	LC_{50}	0.009	60.27	65.91	---	5.91	38.91	----	
(Boldock)	RR		6696.6	7323.3	---	656.6	4323.3	----	4749.9
Average	RR		2798.4	1544.9	132.0	216.62	1720	33.3	

Table (3) : Concentration mortality data and resistance ratio of different synthetic pyrethroids when combined with different plant extracts (at concentration of 20 ppm) tested by leaf dipping technique against *Spodoptera littoralis larvae* (field strain).

Insecticides		Insecticide only %	Mortality data of indicated plant extracts plus pyrethroids						
			Caraway	Devil's apple	Downythorn apple	Beadtree.	Santionica	Worm wood	Average RR
Deltamethrin	LC_{50}	0.086	79.37	49.93	132.63	10.42	90.71	114.55	---
	RR		922.90	580.5	1542.50	121.1	1054.7	1331.90	925.6
Cypermethrin	LC_{50}	0.270	9.98	80.65	23.93	0.05	47.05	69.31	
	RR		36.90	298.70	88.60	0.18	174.20	259.00	142.50
Fenpropathion	LC_{50}	1.010	10.00	18.36	1236.70	---	31.10	5.02	
	RR		9.90	18.10	1224.4	---	30.70	4.90	257.60
Fenvalerate	LC_{50}	2.950	26.90	152.20	13.03	14.62	34.64	245.50	
	RR		9.10	51.50	4.40	4.60	11.70	86.20	28.00
Alphamethrin	LC_{50}	0.003	2076.60	---	3.99	---	5.43	---	
	RR		---	---	1330.00	---	18.10	---	1738.80
Lamdacyhalothrin	LC_{50}	2.710	---	---	49.1	---	---	---	
	RR		---	---	18.1	---	---	---	18.10
Cis-cyfluthrin	LC_{50}	0.009	---	---	3.08	---	---	---	
	RR		---	---	342.2	---	---	---	342.2
Average	RR		611.00	237.20	649.90	42.0	616.20	419.90	

Table (4): Tolerance rates of *Spodoptera littoralis* (susceptible and field strains) of different plant extracts to synthetic pyrethroids insecticides.

Insecticides	Tolerance Rate (T.R.)						
	Caraway	Devil's apple	Downythorn apple	Bead tree.	Santionica	Worm wood	Mean
Deltamethrin (Decis)	0.77	1.91	3.82	0.078	4.33	---	2.18
Cypermethrin (Repcord)	0.19	1.11	0.88	0.001	0.98	4.06	1.20
Fenpropathion (Meothrin)	0.76	0.69	9.74	---	0.54	0.35	1.62
Fenvalerate (Sumicidin)	1.29	3.32	0.34	0.059	0.96	3.75	0.21
Alphamethrin (Fastac)	0.18	---	---	---	0.25	---	0.96
Lamdacyhalothrin (Thrin)	---	---	0.96	---	---	---	---
Cis-Cyfluthrin	---	---	0.73	---	---	---	---
Average	0.638	1.758	3.148	0.046	1.364	2.72	

تأثيرات المستخلصات النباتية على مقاومة البيروثيرويدات فى برنامج المكافحة لدوده ورق القطن

فاتن فريد أبو الدهب
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أظهرت نتائجنا بوضوح أن معظم السلالة الحقلية لدودة ورق القطن ينمـــو بداخلـــها أعلـــى مستوى من المقاومة بمتوسط (RR 50.9 – 666-7-7 Fold) للسلالة الحساسة و RR 142.5- 1738.8 للسلالة المقاومة عند معالجتها بالبيرويثرويدات التخليقية الأتية :

Alphamethrine, Deltamethrine, Cis-cyfluthrin, Cypermethrin, Fenpropathrin, Fenvalerate and Lamdacyhalothrin.

وظهرت أقل مقاومة لهذه البيروثيرويدات عند خلطها بالمستخلصات النباتية من نبـــات الداتورا والشيح، والشيح البابنونج•

وقد لوحظ زيادة فى متوسط التحمل للمبيدات بفروق 9.7, 4.3 and 4.0 Fold للمبديات الأتية :

Fenpropathrin, Deltamethrine, Cypermethrin • معدل التحمل Deltamethrine يوضح الحقيقة أن هذا المبيد اظهر أعلى درجة من تحمـــل الحشـــرات الحساسة المختبرة للبيروثيرويبدات•