Egypt. J. Agric. Res., 79 (3), 2001.

MONITORING FOR INSECTICIDE RESISTANCE IN BOLLWORMS FIELD POPULATIONS USING VIAL RESIDUE ASSAY TECHNIQUE

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(Manuscript received September 2000)

Abstract

A glass vial technique was developed to estimate the insecticidal activities of some organophosphorus, carbamate, pyrethroid and (OP + IGI) insecticides to both pink and spiny bollworms. Also, monitor of field populations for resistance to tested insecticides was followed. Responses of susceptible strain were compared with those collected from the fields at Kafr El-Dawar , El-Bouheira Governorate during 1997 and 1998 . Data indicated high resistance levels to the pyrethroid fenvalerate, the OP chlorpyrifos and the carbamate thiodicarb and to the two insecticides\IGI mixtures namely delfos and empire in pink bollworm field strain showing a: 34.84, 101.4, 105.5, 104.6 and 129.58 fold, of resistance, respectively. While spiny bollworm was in the tolerant stage with : 3.31, 2.81, 2.75, 3.89 and 3.45 folds, respectively. The calculated LC_{90} from Lc-p lines were used as discriminating concentration to determine resistance in both PBW and SBW in 1998.

Key words: Insecticides, resistance, bollworm, monitoring, vial technique, discriminating concentration.

INTRODUCTION

Development of resistance to insecticides in insect pest is a severe problem in many crops (Kanga and Plapp1995). Strategies to slow the development of resistance all emphasize the need to develop accurate and rapid monitoring techniques to detect resistance before a control failure occurs (Schouest & Miller 1988).

Traditionally, monitoring for resistance has been time consuming and complex since large sample sizes are usually required to establish precise probit regressions, while new resistance monitoring techniques for the assessment of resistance in the field now can rapidly monitor weekly LC_{50} variations within a single population (Plapp *et al.,* 1990; Kanga and Plapp, 1995).

The vial residue assay technique would be an excellent resistance monitoring method, it is a simple, reliable, inexpensive, quick technique and can be done by crop consultant after minimal training (Plapp *et al.,* 1990; Elzen *et al.,* 1992).

This technique was developed to supplement monitoring data for larvae of adult resistance to provide timely and accurate resistance data for the stage when the insect is an actual pest. (Ferbeck *et al.,* 1998).

The vial can be used for resistance monitoring and resistance detection as an aid in management decisions and document control failures resulting from resistance. In the same respect, Mink and Boethel (1992) concluded that, the use of the vial discriminating dose technique is a valid test for monitoring and detecting resistance in field population, this method provides the user with results quickly, does not require that insects be reared, and is more practical than the topical application bioassay.

MATERIALS & METHODS

1. Insect pests used

Pink bollworm (PBW) : *Pectinophora gossypiella* (Saunders) [Lepidoptera: Gelechiidae]

a. Field male moth population of PBW: A field culture of PBW was collected locally from cotton fields in Kafr El-Dawar District, El-Bouheira Governorate, Egypt, through 1997-1998 using a modified pheromone baited live traps. These traps were distributed around the cotton fields by a rate of one trap/ 5 feddans and were fixed higher than the foliage by 20-30 cm. All the traps were installed before sunset and collected quickly in the following morning before sunrise (dawn) and transferred directly to the laboratory to obtain live moths.

b. Susceptible strain of PBW: The susceptible colony of PBW was supplied by the Bollworm Research Department, Plant Protection Research Institute, Agricultural Research Center, Dokki, Giza, Egypt, where it has been reared for several years in conditioned laboratory without exposure to insecticides. The rearing procedure was adopted as that recorded by Abdel- Hafez *et al.* (1982) .

Spiny bollworm (SBW): *Earias insulana* (Boisd.) [Lepidoptera: Noctuidae]

a. Field male moth population of SBW: A field culture of SBW was collected locally from cotton fields in Kafr El-Dawar District, El-Bouheira Governorate, Egypt, through 1997-1998 using a modified pheromone baited live traps. These traps were distributed around the cotton fields by a rate of one trap/ 5 feddans and were fixed higher than the foliage by 20-30 cm. All the traps were installed before sunset and collected quickly in the following morning before sunrise (dawn) and transferred directly to the laboratory to obtain live moths.

b. Susceptible strain of SBW: The stock colony was obtained from the Boll-worm Research Department, Plant Protection Research Institute, Agricultural Research Center, Dokki, Giza, Egypt, where it has been reared for several generations in conditioned laboratory without exposure to insecticides. The culture was reared in the laboratory on semi-artificial diet according to (Abdel- Hafez *et al.* 1982) rearing technique.

2. insecticides used

a. Pyrethroid (Fenvalerate): EC 20%, Application rate: 600 ml/fedden.

b. Organophosphorus: (Chlorpyrifos): EC 48%, Application rate: 1 liter/fedden.

c. Mixtures

- Delfos: Mixture of Chlorpyrifos (48%) + Hexaflumuron (2%).
: EC 50%, Application rate: 1 liter/fedden.
- Empire: Mixture of Chlorpyrifos 48% + Diflubenzuron 3%
: FL 51%, Application rate: 1 liter/fedden.

d. Carbamate: Thiodicarb :WG 80%, Application rate : 0.5 kg/fedden

3. Procedure of Vial Residue Assay Technique (VRAT): It is an alternative method for resistance monitoring was perfected by Plapp 1971 and Plapp *et al.* 1990. This technique was used for larvae and adults of bollworms as described in the following steps:

1. Freshly coated vials were prepared in the following steps:
   a. The desired insecticides were diluted with acetone into many appropriate concentrations.
   b. Only one ml. of each concentration was pipetted into the labeled vials to design the desired series.
   c. The uncapped vials were placed in the coating tray and the coating devise was moved until dryness.
2. The live pheromone moth traps were placed at the desired locations within 10 feet of the field. The traps were left overnight and moths were collected in the following morning before sunrise and were moved to the laboratory as quickly as possible.
3. One teaspoon of sugar was solubled in one cup of warm water, then small pieces of cotton (approximately 0.5 cm in size) were dipped in the sugar solution and

squeezed to remove all excess liquid and placed one wick into each vial.

4. Five live moths were inserted in each coated vial including the control vial, then the vials were plugged with cotton and incubated at fixed temperature of 25°C.

5. After 12 hr. and 24 hr., mortality data were recorded and subjected to probit analysis according to Finney (1971).

4. STATISTICAL ANALYSIS

a. Regression equation and confidence limits: Regression equation and confidence limits were calculated according to (Finney 1971) probit analysis computer program .

b. Toxicity Index (T.I.): was calculated for each insecticide according to Sun (1950) as follow:

$$\text{Toxicity Index (T.I.)} = \frac{LC_{50} \text{ of the most toxic insecticide}}{LC_{50} \text{ of the tested insecticide}} \times 100$$

c. Relative Toxicity (R.T.): R.T. values were measured according to the equation of Metcalf (1967) as follow:

$$\text{Relative Toxicity (R.T.)} = \frac{LC_{50} \text{ of the lowest toxic insecticide}}{LC_{50} \text{ of the tested insecticide}} \text{ (Fold)}$$

d. Resistance Ratio (R.R.): Resistance ratio (RR) values were calculated according to the following equation:

$$\text{R.R.} = \frac{LC_{50} \text{ of the field strain}}{LC_{50} \text{ of the susceptible strain}} \text{ (Fold)}$$

e. Developed Resistance Ratio (DRR): These values were calculated according to (Shekeban , 2000)

$$\text{DRR} = \frac{\text{calculated mortality \% of the discriminating concentration}}{\text{observed mortality \%}} \times \text{R.R.}$$

RESULTS

1. Assaying PBW male moths resistance levels to different insecticides

Data at 24hr. assessment indicate that, fenvalerate was the most toxic insecticide against susceptible strain (LC_{50}= 0.062 ppm), while thiodicarb was the lowest toxic one (LC_{50}= 0.10 ppm).Whereas the LC_{50} values of chlorpyrifos and its mixtures delfos and empire were: 0.072, 0.087 and 0.071 ppm, respectively, Table 1.

Data at 12 hr. assessment in late season 1997 indicate that, the LC_{50} values of fenvalerate, chlorpyrifos, delfos, empire and thiodicarb were : 3.86, 19.88, 30.1, 30.97 and 29.8 ppm, respectively, Table 2, while the corresponding LC_{50} values of these insecticides at 24 hr. assessment were : 2.16, 7.3, 9.1, 9.2 and 10.55 ppm, respectively, Table 3.

The previous data pointed to high resistance ratios as follow : 34.84, 101.4, 104.6, 129.58 and 105.5 fold for fenvalerate, chlorpyrifos, delfos, empire and thiodicarb, respectively, Table 7.

2. Assaying SBW male moths resistance levels to different insecticides

Results from 24hr. assessment indicate that, fenvalerate was the most effective insecticide against susceptible strain (LC_{50}= 0.59 ppm), while The LC_{50}'s for chlorpyrifos, delfos, empire and thiodicarb were : 3.1 , 2.8 , 2.9 , and 3 ppm, respectively, Table 4.

Data at 12 hr. assessment in late season 1997 indicate that, the LC_{50} values of fenvalerate, chlorpyrifos, delfos, empire and thiodicarb were : 3.4 , 21.9 , 18.2 , 20.3 and 45.4 ppm, respectively, Table 5, while the corresponding LC_{50} values of these insecticides at 24 hr. assessment were : 1.95 , 8.7 , 10.9 , 10.0 and 8.1 ppm, respectively, Table 6.

Comparing field and susceptible strains data show that, the field strains has different tolerant levels and the resistance ratios were: 3.89 fold to delfos, 3.45 fold to empire, 3.31 fold to fenvalerate, 2.81 fold to chlorpyrifos and 2.75 fold to thiodicarb, Table 7.

3. Discriminating concentration (DC) and resistance development

The calculated LC_{90}'s from Lc-p lines were used as discriminating concentrations to determine resistance in both PBW and SBW male moths. The PBW observed mortality % of the corresponding DC were: 90%, 69%, 66.7%, 90% and 85.8 % for fenvalerate, chlorpyrifos, delfos, empire and thiodicarb, respectively. The developed resistance ratios (DRR) against these insecticides were: 34.84, 131.8, 141.21, 129.58 and 107.61 fold, respectively.

The SBW observed mortality % of the corresponding DC were: 85%, 75%, 76.7%, 80% and 74.5% for fenvalerate, chlorpyrifos, delfos, empire and thiodicarb, respectively, while the matching developed resistance ratios (DRR) were: 3.51, 3.62, 4.55, 3.9 and 3.33 fold, respectively.

DISCUSSION

The high efficiency of the pyrethroid fenvalerate against PBW adult moths is in agreement with Campanhola and Plapp 1989 who found that, the principal alternatives to pyrethroids (organophosphates & carbamates) are not as toxic to *Heliothis virescens* and *H. zea* as pyrethroids . So, it is suggested to direct the insecticide treatments for bollworms control against the adult moths to get an efficient treatment, decrease the cotton losses and increase the cotton area.

Data also, indicate the interior toxicity of thiodicarb in this respect, the superior of pyrethroids for PBW control because of their knockdown effect. Accordingly, every control action should be directed against adult of bollworms not against larvae which are highly protected inside the green cotton bolls.

The resistance ratio results pointed out to the fact that PBW male moths field strain population had developed high resistant level to different insecticide groups. Sun *et al.* (1995) mentioned a very high level of insecticide resistance in diamondback moth, (>1761 fold) against deltamethrin, (>874 fold) with fenvalerate and (246 fold) with methomyl .

Xianchun *et al.* (1997) reported that four field strains of *Pectinophora gossypiella* had developed 185 - , 6.7-, 698- and 249- fold resistance to deltamethrin.

Attempts have been made to develop bioassay techniques to document insects resistance to insecticides based on a discriminating concentration (an approximate LC_{70-99}). A technique using liquid scintillation vials treated with diagnostic concentrations of several synthetic insecticides was used for resistance studies with different insects (Campanhola and Plapp, 1989; Plapp *et al.*, 1990; Elzen *et al.*, 1992), their findings are in agreement with that of our results to use the discriminating concentration (LC_{90}) for easy, quickly and efficient way to detect insecticide resistance in cotton insect populations under field conditions.

Table 1. Toxicity of different insecticides against PBW male moths, susceptible strain at 24 hr. assessment, using VRAT.

Insecticides	Regression Equation Y= a+ bx	LC_{50} (ppm) [Confidence Limits]	LC_{95} (ppm) [Confidence Limits]	(1) R.T.	(2) T.I.
I. Fenvalerate (pyrethroid)	Y= 0.94 + 0.78 X	0.062 (0.089 – 0.043)	8.07 (1922 – 3.85)	1.61	100
II. Chlorpyrifos (O.P.)	Y= 1.26 + 1.11 X	0.072 (0.093 – 0.055)	2.21 (3.73 – 1.37)	1.39	86.1
III-a Delfos (Mixture)	Y=1.12 + 1.05 X	0.087 (0.11 – 0.066)	3.17 (6.26 – 1.71)	1.15	71.3
III-b Empire (Mixture)	Y=1.08 + 0.94 X	0.071 (0.096 – 0.052)	3.95 (7.52 – 2.24)	1.41	87.3
IV. Thiodicarb (Carbamate)	Y=0.85 + 0.86 X	0.1 (0.14 – 0.073)	8.37 (18.04 – 4.33)	1	62

Table 2. Toxicity of different insecticides against PBW male moths, field strain at 12 hr. assessment in late season of 1997, using VRAT.

Insecticides	Regression Equation Y= a+ bx	LC_{50} (ppm) [Confidence Limits]	LC_{95} (ppm) [Confidence Limits]	R.T.	T.I.
I. Fenvalerate (pyrethroid)	Y= -2.49 + 4.24 X	3.86 (4.17 – 3.59)	9.45 (11.31 – 7.95)	8.02	100
II. Chlorpyrifos (O.P.)	Y= -6.27 + 4.83 X	19.88 (21.58 – 18.32)	43.56 (53.19 – 35.72)	1.56	19.42
III-a Delfos (Mixture)	Y=-4.93 + 3.33 X	30.1 (33.46 – 27.09)	93.84 (120.01 – 73.56)	1.03	12.82
III-b Empire (Mixture)	Y=-3.36 + 2.24 X	30.97 (36.02 – 26.67)	167.48 (254.49 – 110.99)	1.00	12.46
IV. Thiodicarb (Carbamate)	Y=-3.79 + 2.57 X	29.8 (34.48 – 25.79)	129.78 (183.82 – 92.2)	1.04	12.95

Table 3. Toxicity of different insecticides against PBW male moths, field strain at 24 hr. assessment in late season of 1997, using VRAT.

Insecticides	Regression Equation Y= a+ bx	LC_{50} (ppm) [Confidence Limits]	LC_{95} (ppm) [Confidence Limits]	R.T.	T.I.
I. Fenvalerate (pyrethroid)	Y= -1.07 + 3.18 X	2.16 (2.35 – 1.99)	7.11 (8.66 – 5.93)	4.88	100
II. Chlorpyrifos (O.P.)	Y= -2.2 + 2.55 X	7.3 (8.12 – 6.57)	32.22 (41.38 – 25.21)	1.45	29.59
III-a Delfos (Mixture)	Y=-3.57 + 3.72 X	9.1 (9.9 – 8.43)	25.16 (29.84 – 12.20)	1.16	23.7
III-b Empire (Mixture)	Y=-4.53 + 4.7 X	9.2 (9.9 – 8.6)	20.6 (23.4 – 18.1)	1.15	23.47
IV. Thiodicarb (Carbamate)	Y=-2.27 + 2.22 X	10.55 (11.83 – 9.41)	58.22 (79.97 – 42.67)	1.00	20.47

Table 4. Toxicity of different insecticides against SBW male moths, susceptible strain at 24 hr. assessment, using VRAT .

Insecticides	Regression Equation Y= a+ bx	LC_{50} (ppm) [Confidence Limits]	LC_{95} (ppm) [Confidence Limits]	R.T.	T.I.
I. Fenvalerate (pyrethroid)	Y= 0.34 + 1.48 X	0.59 (0.71 – 0.48)	7.7 (12.4 – 5.4)	5.25	100
II. Chlorpyrifos (O.P.)	Y= -1.24 + 2.52 X	3.1 (3.5 – 2.8)	14 (17.5 – 11.2)	1.00	19.00
III-a Delfos (Mixture)	Y=-1 + 2.26 X	2.8 (3.1 – 2.4)	14.8 (19.2 – 11.6)	1.11	21.1
III-b Empire (Mixture)	Y=-1.18 + 2.57 X	2.9 (3.2 – 2.6)	12.6 (15.6 – 10.3)	1.07	20.3
IV. Thiodicarb (Carbamate)	Y=-1.19 + 2.51 X	3 (3.3 – 2.7)	13.4 (17.7 – 10.4)	1.03	19.7

Table 5. Toxicity of different insecticides against SBW male moths, field strain at 12 hr. assessment in late season of 1997, using VRAT.

Insecticides	Regression Equation Y= a+ bx	LC_{50} (ppm) [Confidence Limits]	LC_{95} (ppm) [Confidence Limits]	R.T.	T.I.
I. Fenvalerate (pyrethroid)	Y= -0.64 + 1.44 X	3.4 (4.2 -2.8)	56.1 (148.5 - 24.8)	13.35	100
II. Chlorpyrifos (O.P.)	Y= -2.33 + 1.74 X	21.9 (26.2 - 18.4)	194.2 (318 - 120.6)	2.07	15.5
III-a Delfos (Mixture)	Y=-2.73 + 2.17 X	18.2 (21.8 - 15.2)	104.6 (193.1 - 57.5)	2.49	18.7
III-b Empire (Mixture)	Y=-2.12 + 1.62 X	20.3 (26.4 - 15.7)	209.3 (593.3 - 76.1)	2.24	16.7
IV. Thiodicarb (Carbamate)	Y=-2-05 + 1.23 X	45.4 (59.1 - 35.1)	968.1 (2360.2 - 409.1)	1	13.4

Table 6. Toxicity of different insecticides against SBW male moths, field strain at 24 hr. assessment in late season of 1997, using VRAT.

Insecticides	Regression Equation Y= a+ bx	LC_{50} (ppm) [Confidence Limits]	LC_{95} (ppm) [Confidence Limits]	R.T.	T.I.
I. Fenvalerate (pyrethroid)	Y= -0.71 + 2.43 X	1.95 (2.17 - 1.74)	9.24 (12.3 - 7.13)	5.59	100
II. Chlorpyrifos (O.P.)	Y= -2.18 + 2.31 X	8.7 (9.9 - 7.7)	45 (58.7 - 34.8)	1.25	22.4
III-a Delfos (Mixture)	Y=-2.37 + 2.28 X	10.9 (12.2 - 9.8)	57.3 (79.2 - 41.7)	1	17.9
III-b Empire (Mixture)	Y=-1.98 + 1.98 X	10 (11.3 - 8.8)	67.3 (98.8 - 46.3)	1.09	19.5
IV. Thiodicarb (Carbamate)	Y=-1.5 + 1.65 X	8.1 (9.5 - 6.9)	81 (121.9 - 54.7)	1.35	24.1

Table 7. LC_{50} values of different insecticides against PBW and SBW field and susceptible strains and the resistance ratio (R.R) values using VRAT.

Insecticides	PBW			SBW		
	LC_{50} Susc. strain (ppm)	LC_{50} Field strain (ppm)	R.R. (Fold)	LC_{50} Susc. strain (ppm)	LC_{50} Field strain (ppm)	R.R. (Fold)
I. Fenvalerate (pyrethroid)	0.062	2.16	34.84	0.59	1.95	3.31
II. Chlorpyrifos (O.P.)	0.072	7.3	101.4	3.1	8.7	2.81
III-a Delfos (Mixture)	0.087	9.1	104.6	2.8	10.9	3.89
III-b Empire (Mixture)	0.071	9.2	129.58	2.9	10	3.45
IV. Thiodicarb (Carbamate)	0.10	10.55	105.5	3.0	8.1	2.75

$$R.R. = \frac{LC_{50} \text{ of field strain}}{LC_{50} \text{ of susceptible strain}} \text{ Fold}$$

Table 8. Observed mortality % of different insecticides against PBW and SBW male moths, field strain and the corresponding developed resistance ratio values (DRR) using VRAT.

Insecticides	PBW			SBW		
	Calculated LC_{90} (ppm)	Observed Mortality %	D.R.R. (Fold)	Calculated LC_{90} (ppm)	Observed Mortality %	D.R.R.
I. Fenvalerate (pyrethroid)	5.5	90	34.48	6.6	85	3.51
II. Chlorpyrifos (O.P.)	23.7	69	131.8	32.5	75	3.62
III-a Delfos (Mixture)	23.4	66.7	141.21	39.5	76.7	4.55
III-b Empire (Mixture)	17	90	129.58	46	80	3.90
IV. Thiodicarb (Carbamate)	41	85.8	107.61	55	74.5	3.33

$$D.R.R. = \frac{\text{Calculated mortality \% of the discriminating concentration}}{\text{Observed mortality \%}} \times R.R.$$

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استكشاف مقاومة عشائر ديدان اللوز الحقلية للمبيدات باستخدام طريقة الأثر الباقي على السطح الداخلي للزجاجات

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١- تقييم مستوى مقاومة ذكور دودة اللوز القرنفلية للمبيدات المختلفة:

أوضحت النتائج بعد ٢٤ ساعة من التعرض أن الفنفاليرات هو أكثر المبيدات سمية ضد السلالة الحساسة (ت ق ٥٠= ٠,٠٦٢ جزء فى المليون) بينما كان الثيوديكارب هو الأقل سميه (ت ق ٥٠ = ٠,١ جزء فى المليون) وكانت قيم ت ق ٥٠ للامبير والكلوربيرفوس والديلفوس هى ٠,٠٧١، ٠,٠٧٢، ٠,٠٨٧ جزء فى المليون ، على التوالى.

أظهرت نتائج الدراسة انه بعد ١٢ ساعة من التعرض للمبيدات على السلالة الحقلية كان الفنفاليرات هو الأكثر فاعليه يليه الكلوربيرفوس ثم الثيوديكارب ثم الديلفوس وأخيرا الامبير بينما بعد ٢٤ ساعة كان الفنفاليرات هو الأكثر سميه (ت ق ٥٠ = ٢,١٦جزء فى المليون) ويليه الكلوربيرفوس فالديلفوس فالامبير وأخيرا الثيوديكارب بقيم ت ق ٥٠= ٧,٣ و٩,١ و٩,٢ ثم ١٠,٥٥ جزء فى المليون على التوالى وعند مقارنة السلالة الحساسة والحقلية وجدت نسب مقاومة عالية وهى ٣٤,٨٤ ضعف للفنفاليرات، ١٠١,٤ للكلوربيرفوس ،١٠٤,٦ ضعف للديلفوس ،١٢٩,٥٨ ضعف للامبير وأخيرا ١٠٥,٥ ضعف للثيوديكارب.

٢- تقييم مستوى مقاومة ذكور دودة اللوز الشوكية للمبيدات المختلفة:

أوضحت النتائج بعد ٢٤ ساعة من التعرض أن الفنفاليرات كان اكثر المبيدات سميه لكل من السلالة الحساسة والسلالة الحقلية (ت ق ٥٠ = ٠,٠٥٩ و١,٩٥ جزء فى المليون على التوالى) بينما كانت القيم لباقى المبيدات كالتالى: كلوربيرفوس(٣,١ و٨,٧ جزء فى المليون على التوالى) والديلفوس (٢,٨ و١٠,٩ جزء فى المليون على التوالى) والامبير (٢,٩ و١٠ جزء فى المليون على التوالى) وأخيرا الثيوديكارب (٣ و٨,١ جزء فى المليون على التوالى) وبمقارنة نتائج السلالتين معا أظهرت السلالة الحقلية درجات من التحمل لها قيم نسبة مقاومة كانت كالتالى: الديلفوس ٣,٨٩ ضعف يليه الامبير ٣,٤٥ ضعف ثم الفنفاليرات ٣,٣١ ضعف ثم الكلوربيرفوس ٢,٨١ وأخيرا الثيوديكارب ٢,٧٥ ضعف.

٣- التركيزات الوصفية (DC) وتطور المقاومة:

لقد استخدمت قيم ت ق ٩٠ المحسوبة من خطوط السميه للسلالة الحقلية فى بداية موسم ١٩٩٦ كتركيزات وصفية وذلك لتقدير مستوى المقاومة فى كل من ذكور دودة اللوز القرنفلية ودودة اللوز الشوكية.

أ- أعطت الجرعة الوصفية نسب موت فى ذكور دودة اللوز القرنفلية كالتالى: ٩٠٪ للفنفاليرات و٦٩٪ للكلوربيرفوس و٦٦,٧٪ للديلفوس و٩٠٪ للامبير و٨٥,٨٪ للثيوديكارب وبناء على هذه النتائج كانت قيم المقاومة المتطورة كالأتى ٢٤,٨٤ و١٣١,٨ و١٤١,٢١ و١٢٩,٥٨ ثم ١٠٧,٦١ ضعف ضد كل من الفنفاليرات ، الكلوربيرفوس، الديلفوس ، الامبير ثم الثيوديكارب على التوالى.

ب- أعطت التركيزات الوصفية نسب موت فى ذكور دودة اللوز الشوكية كالتالى: ٨٥٪ للفنفاليرات و٧٥٪ للكلوربيرفوس و٧٦,٧٪ للديلفوس و٨٠٪ للامبير و٧٤,٥٪ للثيوديكارب وبناء على هذه النتائج كانت قيم المقاومة المتطورة كالأتى: ٢,٥١ و٣,٦٢ و٤,٥٥ و٣,٩ ثم ٣,٣٣ ضعف ضد كل من الفنفاليرات ،الكلوربيرفوس،الديلفوس ،الامبير ثم الثيوديكارب على التوالى.