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COMPARATIVE STUDIES BETWEEN LONG-TERM BIOASSAY AND DISCRIMINATING DOSAGE AS MEANS FOR MONITORING RESISTANCE IN *S. littoralis larvae*

By

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ABSTRACT

The results of monitoring resistance through long-term bioassay (topical application) showed that, El-Beheira field strain of the cotton leafworm *Spodoptera* littoralis had resisted a wide range of the tested insecticides (including organophosphates, carbamates and pyrethroids) except for malathion. The LD_{50} values of El-Beheira field strain were greater than that of the laboratory-susceptible one for the most of the tested insecticides indicating different ranges of R/R values. For organophosphate insecticides the highest level of resistance was obtained for pirimiphos-methyl (R/R = 443.53), while moderate resistance was obtained for chlorpyrifos and chlorpyrifos-methyl. In the meantime a low level of tolerance was observed to profenofos. Moreover, El-Beheira field strain was slightly changed from susceptibility to malathion (R/R = 1.04). For carbamate insecticides El-Beheira field strain was moderately resistant to methomyl while thiodicarb was extremely high in inducing resistance. For synthetic pyrethroid insecticides, El-Beheira field strain was extremely resistant to deltamethrin (R/R = 571.4), while a slight tolerance was achieved for cypermethrin. Moreover, this strain was

moderate resistant to fenvalerate. The discriminating dosage technique was used by estimating one dosage (LD_{99} of the laboratory – susceptible strain) for the tested insecticides to monitor for resistance in *S.littoralis* field strain. The data showed, that the field strain was resistant to eight out of the ten tested insecticides or had survivor percent value of more than 50% (these insecticides were deltamethrin, pirimophos-methyl, fenvalerate, thiodicarb, profenophos, chlorpyriphos-methyl, and chlorpyrifos). In contrast, for malathion the percent of survivors was 0.33. So, the field strain revealed susceptibility for this insecticide. The discriminating dosage technique is a simple, inexpensive and discriminate well between resistant and susceptible populations. The data of discriminating dosage for the tested insecticides against El-Beheira field strain of *S. littoralis* confirmed the long-term bioassay data in which high level of resistance was obtained for deltamethrin and pirimiphos-methyl, since a hundred percent of the tested insects were survived. In the meantime El-Beheira field strain of *S. littoralis* exerts susceptibility to malathion. The results suggest the discriminating dosage technique for monitoring insecticide resistance in field populations. Moreover, this technique gave quick informations about resistance level provide a simple and quick test for distinguishing between the resistant and susceptible populations. Therefore, this technique is useful to monitor resistant species and thus contribute to their control. Generally the long-term bioassay technique need long time and large numbers of insects but it provides an accurate information about the level of resistance.

INTRODUCTION

The Egyptian cotton leafworm *Spodoptera littoralis* (Boisd) has in the past been the most serious pest of cotton in Egypt and it remains, potentially at least a key pest. It is extremely polyfagous feeding on wide range of field vegetable crops (FAO, 1994). Prolonged exposure of pest population to high dosages and frequent applications of insecticides is well known to cause resistance, cross-resistance and multiple-resistance. Populations of *S. littoralis* have developed resistance to insecticides which severely limits their practical to usefulness. Several investigators have dealt with resistance phenomenon in *S. littoralis* (El-Sebae *et al.*, 1973, Moustafa *et al.*, 1977, 1980 a,b, Shawir 1983, Moustafa & Abu-Elamayem 1986, Abd El-Rahman 1986, Shawir *et al.*, 1991, Mourad *et al.*, 1992 and Abou El-Saad *et al.*, 1998). Detection of susceptibility changes in field populations can facilitate use of alternative control measures including the use of synergists, rotation to different insecticides, reduction in the number of insecticide applications or reduced rate of application. The most used ways to monitor resistance is through bioassay and many of these methods such as topical application, dipping.. etc. are useful in determining resistance levels in the laboratory. Large numbers of insects or long periods of time are required to obtain results, which even then difficult to understand especially when resistance is leight and populations is heterogeneous (Campanhola and Palpp 1989). In such instance, a simple bioassay monitoring method (discriminating dosage) for resistance is particularly valuble. Omer *et al.*, 1992 and Cahill *et al.*, 1996 used discriminating dosage technique to monitor for resistance in whitefly *Bemisia* spp. this technique is simple and practically. The aim of our work is to compare between long-term bioassay and discriminating dosage techniques as monitoring methods for *S. littoralis* field populations.

MATERIALS AND METHODS

Insects : A laboratory susceptible strain (LS) of the Egyptian cotton leafworm *Spodoptera Littoralis* (Boisd) was reared in the laboratory at least for three years according to (El-Defrawi *et al.*, 1964) on castorbean leaves. This strain was considered as a reference strain. A field strain of *S.littoralis* was collected as egg masses from cotton fields in El-Beheira governorate the hatched larvae were reared in the laboratory on castorbean leaves for one generation.

Insecticides Organophosphorus: Chlorpyriphos [0,0-diethyl-0-(3,5,6-trichloro-2-pyridinyl) Phosphorothiate], a technical grade (96% a.i) was obtained from DOW Chemical Co., Chlorphyrifos-methyl [0,0-dimethyl-0-(3,5,6-trichloro-2-pyridinyl)] phosphorothioate, a technical grade (94% a.i) obtained from DOWC chemical Co., Malathion. [diethyl (dimethoxyphinthioyl)thio]butanedioat, a technical grade (85.4% a.i) Pirimiphos-methyl (0-2-diethylamino-6-methylpyrimidin-4-yl 0,0-dimethyl phosphorothioate], a technical grade (91.4% a.i) obtained from ICI Plant Protection Division, Profenofos: 0-(4-bromo-2-chlorophenyl)-0-ethyl-S-propyl-phosphorothioate, a technical grade (93.4% a.i) obtained from Ciba-Geigy Co., Carbamates Methomyl: (methyl N [((methylamino) carbonyl) oxy] ethanimidithioate), a technical grade (99% a.i) obtained from DU Pont de Nemours, Thiodicarb: (dimethyl N-N-[thiobis (methylimino carbonyloxy)] bis [ethanimidothioate]), a technical grade (95% a.i) obtained from Union Carbide. Syunthetic Pyrethroids Cypermethrin: [(RS)-∝-cyano-3phenoxybenzyl (1RS, 3RS; 1RS, 3SR)-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropane carboxylate], a technical grade (96.62% a.i) obtained from Roussl., Deltamethrin: [1R-[1∝(S*), 3∝]]-cyano(3-phenoxyphenyl) methyl 3-(2,2-dibromoethenyl)-2,2-dimethylcyclopropane Carboxylate], a technical grade (98% a.i) obtained from Roussel, Fenvalerate: (RS)- ∝-cyano-3-phenoxy benzyl (RS)-2-(4-chlorophenyl)-3-methylbutyrate],a technical grade (92.9% a.i) obtained from Sumitomo Chemical Co. Ltd. Osaka Japan.

Monitoring of resistance through bioassay: The fourth instar larvae of *S. littoralis* (susceptible and field strains) were topically treated by one microliter of acetone solution of the tested insecticides. Arnold Hand Microapplicator (Bukard) was used. A series of 6-8 concentrations for each tested insecticide were used, each concentration was replicated three times. Ten larvae were used for each replicate. The treated insects were kept under controlled conditions at 27 $\pm$ 1°C and 70 – 85% RH inside adjusted room. Mortality were counted after 24 h. A computer program for probit analysis (Finney 1971) was used to estimate the LD_{50}, expected LD_{99} and slope values. The fold of resistance (resistance ratio R/R) was calculated at LD_{50} level as follows.

$$R/R = \frac{LD_{50} \text{ value of El-Beheira field strain}}{LD_{50} \text{ value of the laboratory-susceptible strain (reference)}}$$

Monitoring of resistance through discriminating dosage: The expected LD_{99} and associated 95% confidence limits of the susceptible strain of *S. littoralis* were estimated by probit analysis and used to estimate a discriminating dosage (diagnostic dosage). For each insecticide based on considerations discussed by Roush & Miller (1986) and Halliday & Burnham (1990) the dose which reliably caused ≈ 99% mortality of susceptible strain was estimated and adjusted practically. The fourth instar larvae of susceptible strain were treated topically by one microliter of acetone solution of the tested insecticides as described before. A series of 6-8 concentrations ranging between LD_{90} and LD_{99} (expected) were used for each insecticide, each concentration was replicated three times. Data for three or four tests for each insecticide at each of three concentrations chosen according to the suggestions of Robertson *et al.*, (1984) were used to adjust the discriminating dose. The actual mortality at the discriminating dosage was evaluated for each insecticide against the susceptible and El-Beheira field strain for monitoring resistance. A hundred larvae of each strain were used and replicated three times, then the mortality response for each insecticide was determined. The response will ranged between 100% and zero % which means full susceptibility and high resistance for the susceptible and field strain, respectively.

RESULTS

Monitoring of resistance through long-term bioassay: The susceptibility of El-Beheira field strain to the main groups of insecticides (organophosphates, carbamates and pyrethroids) was compared with a laboratory-susceptible one of *S. littoralis*. The log dose probit lines (Ld-p line) were drown for the tested insecticides of both strains in comparative manner, while, LD_{50} values were deduced and tabulated in Tables (1 & 2) with their confidence limits at 95% level and slope values. The resistance ratios (R/R) at LD_{50} level are also tabulated. The data in (Table 1) show that, organophosphate insecticides (Ops) had a wide range of toxicity against the laboratory-susceptible strain. The most toxic insecticide was chlorpyrifos, while the least toxic one was malathion. The other tested Ops showed moderate toxicity against this strain. For carbamate insecticides, methomyl was about ten times more toxic than thiodicarb. The toxicity of pyrethroid insecticides against the same strain in a descending order was deltamethrin, cypermethrin and fenvalerate. Generally, deltamethrin and methomyl as pyrethroid and carbamate insecticides were the most toxic insecticides against the laboratory-susceptible strain. In contrast, malathion and profenofos were the least toxic insecticides against that strain. The other tested insecticides showed moderate toxicity, since the toxicity in descending order was cypermethrin, chlorpyrifos, thiodicarb, pirimiphos-methyl, fenvalerate and chlorpyriofs-methyl. The data in (Table 2) show that again Ops had large range of toxicity against El-Beheira field strain. The most toxic insecticide was chlorphyrifos, while pirimiphos-methyl was the least toxic one. The other tested Ops showed moderate toxicity against this strain. For the tested carbamate insecticides methomyl was about 16.6 times more toxic than thiodicarb against the Field strain. The toxicity of pyrethroid insecticides against that strain in a descending order was cypermethrin, deltamethrin and fenvalerate. Generally, methomyl and cypermethrin as carbamate and pyrethroid insecticides were the most toxic insecticides against the Field strain. In contrast pirimiphos-methyl

Table (1):Toxicity data of certain insecticides for the laboratory-susceptibile strain of *S. littoralis*.

Insecticides	LC_{50} µg / larvae	Confidence limits at 95% level	Regression of N. S. D response (Y) on log dose (X)
Chlorpyrifos	0.0125	0.011 – 0.01420	Y = 4.166 + 2.189 X
Chlorpyrifos-methyl	0.119	0.0064 – 2.2200	Y = 0.938 + 1.016 X
Malathion	14.890	12.68 – 17.5100	Y = -2.087 + 1.780 X
Pirimiphos – methyl	0.0680	0.054 – 0.08500	Y = 1.080 + 0.930 X
Profenofos	0.4100	0.3200 – 0.5300	Y = 3.820 + 9.960 X
omyl	0.0033	0.0019 – 0.0057	Y = 3.940 + 1.589 X
Thiodicarb	0.0338	0.0240 – 0.0470	Y = 1.505 + 1.023 X
Cypermethrin	0.0104	0.00920 – 0.012	Y = 3.290 + 1.660 X
Deltamethrin	0.0008	0.00018 – 0.0035	Y = 5.170 + 1.670 X
Fenvalerate	0.0840	0.0700 – 0.1000	Y = 1.860 + 1.730 X

Table (2): Toxicity data of certain insecticides for El-Beheira field strain of *S.littoralis*.

Insecticides	LD_{50} ug/larva	Confidence limits at 95% level	Regression of N. S. D response (Y) on log dose (X)	*R/R
Chlorpyrifos	0.14	0.124 – 0.158	Y = 3.63 + 4.33 X	11.2
Chlorpyrifos-methyl	1.031	0.340 – 3.110	Y = - 0.020 + 1.530 X	8.6600
Malathion	15.51	13.79 – 17.44	Y = -2.740 + 2.310 X	1.0400
Pirimiphos – methyl	30.16	22.31 – 40.59	Y = -1.560 + 1.059 X	443.53
Profenofos	1.785	1.352 – 2.301	Y = -0.394 + 1.580 X	4.3500
Methomyl	0.058	0.047 – 0.072	Y = 1.320 + 1.069 X	17.580
Thiodicarb	6.760	5.220 – 8.760	Y = 1.710 + 2.060 X	200.59
Cypermethrin	0.091	0.079 – 0.110	Y = 1.820 + 1.750 X	8.7500
Deltamethrin	0.480	0.290 – 0.790	Y = 0.330 + 1.050 X	571.40
Fenvalerate	5.350	4.702 – 6.080	Y = -1.929 + 2.640 X	63.690

$$*R/R = \text{(Resistance Ratio)} = \frac{LD_{50}\ \text{of El-Beheira field strain}}{LD_{50}\ \text{of laboratory – susceptible strain}}$$

and malathion were the least toxic insecticides.. The other tested insecticides showed moderate toxicity.

Considering the confidence limits of LD_{50} values at 95% level, all LD_{50} values for the tested insecticides of the Field strain were outside the range of the confidence limits of the LS strain except for chlorphyrifos-methyl, cypermethrin and malathion. Overlapping between the LS and Field strains confidence limits was observed, meaning of LD_{50} values inside the confidence limits and thus tolerance might be developed rather than resistance. On the other hand significant differences in confidence limits of LD_{50} values of the other tested insecticides against the two tested strains was observed.

Estimated LD_{50}'s were always higher for the Field strain than for LS one. Accordingly the R/R values could be classified into four categories, the first category, low level of resistance or tolerance (from 2 to 10 folds), the second category moderate level of resistance (from 10 to 100 fold), the third, high level of resistance (from 100 to 200 fold) and the fourth, extremely high level (> 200 fold). Generally the resistance level through mortality bioassay reflect that the Field strain showed the wider range of susceptibility level for Ops. The strain was still susceptible to malathion with R/R value of 1.04 fold on the contrary, pirimiphos-methyl was extremely high in inducing resistance (estremely high resistance), the Field strain was 443.53 times more resistant than the LS one. While the field strain was moderately resistant to chorypyrifos (11.2 times). Slight tolerance was achieved for both profenofos and chlorpyrifos-methyl (low resistance or tolerance) with R/R values of 4.35 and 8.66, respectively. Generally, the resistance level through mortality bioassay reflect that, pirimiphos methyl > chlorphyrifos > chlorpyrifos-methyl > profenofos > malathion. The strain was moderately resistant (17.58) to methomyl,

Table (3)The response of El-Beheira field strain of *S. littoralis* to the discriminating dosages for certain insecticides.

Insecticides	Dis-criminating dosage µg/larva	No. of tested insects	No. of dead insects	No. of survivor insects	% of dead insects ± SD	No. of survivor insects	R/R* value
Chlorpyrifos	0.060	300	119	181	39.67 ± 1.00	60.33	11.20
Chlorpyrifos-methyl	0.600	300	193	107	64.33 ± 2.52	35.67	8.660
Malathion	49.00	300	299	1.00	99.67 ± 2.31	0.330	1.040
Pirimiphos -- methyl	0.125	300	0.00	300	0.000 ± 0.00	100.0	443.5
Profenofos	0.500	300	78.0	222	26.00 ± 3.46	74.00	4.350
Methomyl	0.047	300	116	184	38.68 ± 4.16	61.33	17.58
Thiodicarb	1.992	300	42.0	258	14.00 ± 1.00	86.00	200.59
Cypermethrin	0.050	300	96.0	204	20.00 ± 3.61	68.00	8.750
Deltamethrin	0.0199	300	0.00	300	0.000 ± 0.00	100.0	571.4
Fenvalerate	1.590	300	15.0	285	5.000 ± 1.00	95.00	63.69

while thiodicarb was estremely high in inducing resistance (extremely high, since the Field strain was 200.59 times more resistant than LS one. The Field strain showed wide range of susceptibility level for pyrethroid insecticides. The strain was extremely high resistant to deltamethrin, since the resistance ratio was 571.4. Howwever, slight tolerance was achieved for cypermethrin. Moreover, this strain was moderately resistant to fenvalerate with R/R value of 63 fold.

Monitoring of resistance through discriminating dosage: The discriminating dosage which discriminate between susceptible and field or genetic variant populations was used as monitoring technique for resistance. The mortality bioassay was used as described in Materials and Methods to estimate discriminating dosages (LD_{99}) of LS strain of *S. littoralis* for the tested insecticides. These dosages were consistently affected killed approximately 99% of susceptible larvae in contrast with less than 99% for all the tested response of the tested insects which could be classified into three categories: susceptible, intermediate and resistant. Susceptible insects have no survivors at LD_{99}, the category intermediate means that, substantial proportion of test insects, but less than 50% survive, the category "resistant" when 50% or more of exposed insects survive (Sawroop 1966). The data in Table (3) show that, the field strain was resistant (survivor percentage more than 50% survive), to eight out of the ten tested insecticides (deltamethrin, pirimiphos-methyl, fenvalerate, thiodicarb, profenofos, cypermethrin, methomyl and chlorpyrifos). In contrast, for malathion the percent of survivors was 0.33. So this strain revealed susceptibility for that insecticide. Moreover, this strain showed intermediate resistance toward chlorpyrifos-methyl. These data suggest that, the field strain had developed resistance or tolerance to all tested insecticides except malathion. The observed data are in about consistent parallel with those obtained in long term bioassay for the tested insecticides. Since deltamethrin and pirimiphos-methyl had the highest fold of resistance (571.4 and 443.53, respectively) in the meantime they also had the highest percent of survivors (100%) at the discriminating dosages. While malathion which enhanced susceptibility gave negligible percent of survivors at the discriminating dosage. For the other tested insecticides percent of survivors at the discriminating dosages were corresponding to the fold of resistance. However there are some deviations especially at low level of resistance or tolerance. The data suggest that, the discriminating dosage technique provides a simple and quick test for monitoring of insecticide resistance in *S. littoralis* field populations. This technique might be useful in routine susceptibility test.

DISCUSSION

Results of monitoring resistance through long-term bioassay showed that El-Beheira field strain of *S. littoralis* had resisted a wide range of the tested insecticides (organophosphates, carbamates and pyrethroides) except for malathion, since the LD_{50} values of El-Beheira field strain were greater than that of the laboratory-susceptible for most of the tested insecticides indicating different ranges of RR values. The development of resistance or tolerance in the field population might be due to the intensive use of different insecticides to control cotton pest complex, thus it is a cause of multiple-resistance. Within each group the concerned difference in the level of resistance might be due to differences in chemical structure, for instance the difference between cypermethrin and deltamethrin, also the difference between methomyl and thiodiocarb.

For organophosphate insecticides the highest level of resistance was obtained for pirimiphos-methyl (which was recommended for whitefly control in cotton since 1989), while moderate resistance was obtained for chlorpyrifos and chlorpyrifos-methyl. In the meantime a low level of tolerance was observed to profenofos. This finding is in agreement with that reported by Moustafa *et al.*, (1980 a) in which *S.*

littoralis did not acquiried resistance toward profenofos compared with the other tested insecticides. Moreover, El-Beheira field strain was slightly changed from susceptibility to malathion, which is not recommend for *S. littoralis* control in cotton for a long time, this indicated that the resistance is related to exposure to chemicals used for control of cotton pests (Prabhaker *et al.,* 1985). For carbamate insecticides El-Beheira, field strain was moderately resistant to methomyl, while thiodicarb was extremely high in inducing resistance, which indicated cross-resistance between the two insecticides, that might be due to the extensive use of methomyl. In the meantime thiodicarb was not recommended to control cotton pests for long time. Moreover, the high level of resistance for thiodicarb might be due to the chemical structure of this insecticide. For synthetic pyrethroid insecticides, El-Beheira field strain of *S. littoralis* was extremely resistant to deltamethrin, while slight tolerance was achieved for cypermethrin. Moreover, this strain was moderately resistant to fenvalerate, which indicated that the resistance is related to the exposure to chemicals used for control of cotton pest complex. Because of deltamethrin was recommended for cotton bollworm control, the field strain of *S. littiralis* was exposed for selection and so it developed high resistance level to this insecticide. Moreover, the extensive use of deltamethrin to control whitefly in vegetable crops might be enhanced the development of resistance.

The results of monitoring resistance through long-term bioassay is in agreement with those reported by El-Deeb (1984), Abed-El-Rahman (1986), Shawir *et al.,* (1991), Mourad *et al.,* (1992), Arms *et al.,* (1997), Charalambous & Iordanow (1997), Abou-El-Saad *et al.,* (1998) and Mascarenhas (1998). The discriminating dosage technique was also used to monitor for resistance in El-Beheira field strain of *S. littoralis.* The results showed that, El-Beheira field strain had developed resistance to eight out of the ten tested insecticides (has survivors percent more than 50), while this strain was susceptible to malathion (had survivors percent of 0.33). The data of this technique confirmed the long-term bioassay data in which high level of resistance was obtained for deltamethrin and pirimiphos-methyl. In the meantime a hundred percent of the tested insects were survived, while the field strain was susceptible to malathion which gave the lowest percent of survivor insects. The discriminating dosage technique is a simple, inexpensive and useful to differentiate between resistant and susceptible populations. Sanderson & Roush (1992), Cahill *et al.*,(1995) and (1996) used discriminating dosage bioassay technique to distinguish between the susceptible and field or resistant populations of whitefly and suggest that, this technique provides simple and rapid way to monitor insecticide resistance. Generally the long-term bioassay technique is time consuming and need large numbers of insects in one assay but it provides an accurate information about the level of resistance. While the discriminating dosage technique gave quick informations about resistance and provides a simple test for discriminating between the susceptible and resistant populations. Therefore it may be useful to use this technique in routine work to monitor for resistance in field populations, because time becomes a limiting factor here.

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الملخص العربى

دراسات مقارنة بين إستخدام التقييم الحيوى المطول والجرعة المفرقة كطرق لرصد المقاومة فى يرقات دودة ورق القطن

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رصد المقاومة من خلال التقييم الحيوى المطول:

أوضحت نتائج رصد المقاومة من خلال التقييم الحيوى المطول (طريقة المعاملة السطحية) أن سلالة البحيرة من دودة ورق القطن قد كونت مدى واسع من المقاومة لكل المبيدات المختبرة (والتى تشمل مجاميع المبيدات الفسفورية العضوية ، الكاربامات ، البيروثريدات المخلقة) حيث كانت قيم LD_{50} لسلالة البحيرة أكبر من تلك القيم المتحصل عليها للسلالة الحساسة المعملية لمعظم المبيدات المختبرة مما يشير إلى قيم مختلفة لمستوى المقاومة (R/R بالنسبة لمجموعة المبيدات الفسفورية العضوية، كانت أعلى درجة مقاومة تم تسجيلها للبرميفوس–ميثايل (R/R = ٤٤٣ر٥٣) ، بينما تكونت مقاومة متوسطة لكل من الكلوربيريفوس والكلوربيريفوس– ميثايل وفى نفس الوقت تكون مستوى تحمل بسيط للبروفينوفوس علاوة على ذلك أظهرت سلالة البحيرة حيود بسيط عن الحساسية للملاثيون (R/R = ١ر٤٠)، وبالنسبة لمجموعة الكاربامات أظهرت سلالة البحيرة مقاومة متوسطة للميثوميل ، بينما كانت هناك درجة عالية من المقاومة للثيوديكارب – أما بالنسبة لمجموعة البيروثريدات المخلقة فقد أظهرت سلالة البحيرة درجة عالية من المقاومة للدلتامثرين (R/R = ٥٧١ر٤) بينما كان هناك درجة ضعيفة من التحمل للسيبرمثرين علاوة على ذلك فقد أظهرت سلالة البحيرة درجة متوسطة من المقاومة للفنفاليرات .

رصد المقاومة من خلال الجرعة المفرقة :

تم إستخدام طريقة الجرعة المفرقة بإستنتاج جرعة واحدة من خط السمية للمبيدات المختبرة للسلالة الحساسة المعملية وذلك لرصد المقاومة فى السلالة الحقلية من دودة ورق القطن. ولقد أشارت النتائج أن سلالة البحيرة كانت مقاومة لثمانية من العشرة مبيدات المختبرة بمعنى آخر كانت نسبة الحشرات الغير متأثرة بهذه الجرعة أعلى من ٥٠% وهذه المبيدات هى الدلتامثرين والبيروميفوس – ميثايل والفنفاليرات والثيوديكارب والبروفينوفوس