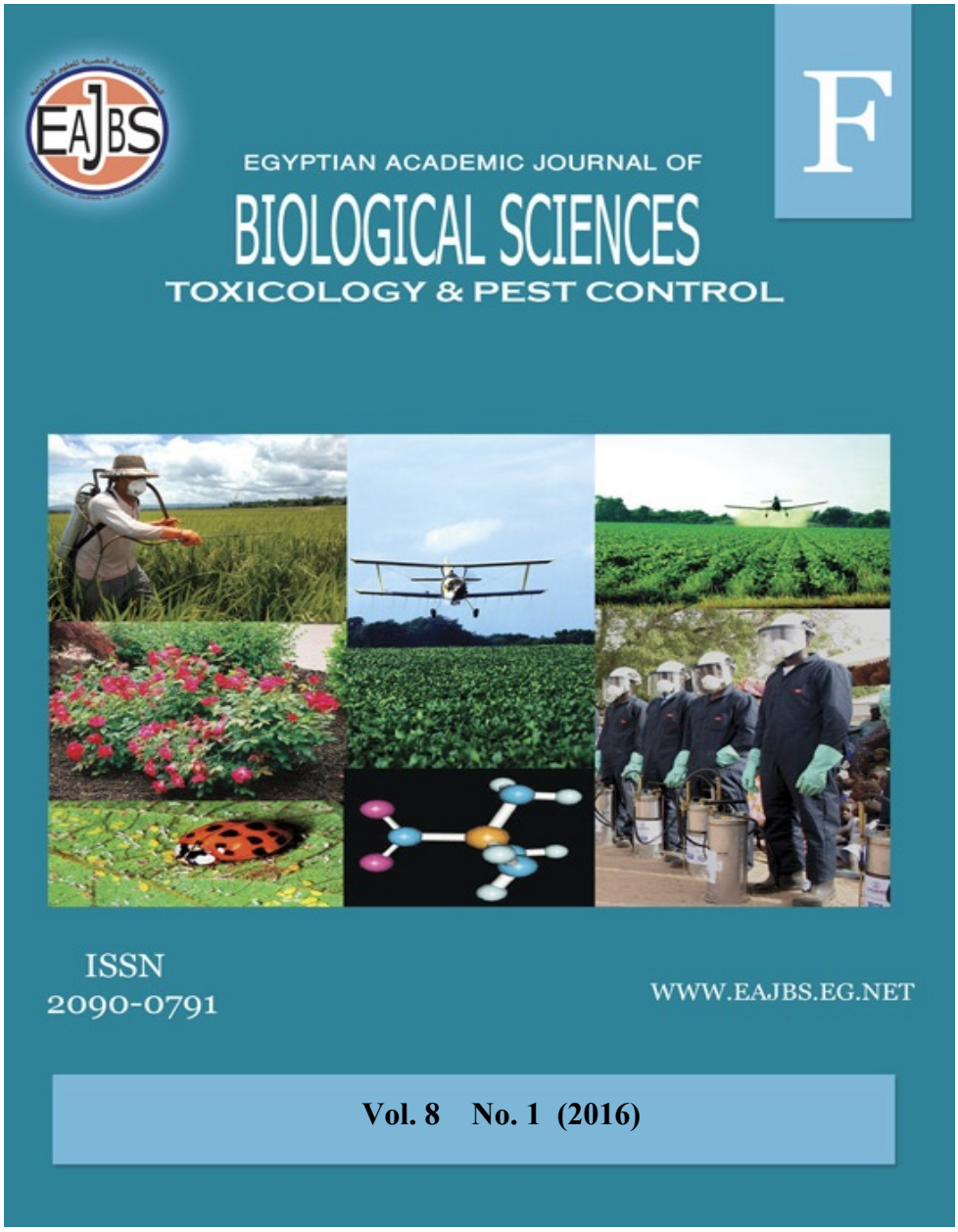

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Pyrethroids Resistance Mechanism in Egyptian Cotton Leafworm *Spodoptera littoralis* (Boisd.)

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ABSTRACT

Synthetic pyrethroids have been developed with the aim to improve the specificity and activity of the natural insecticide pyrethrum. The pyrethroids are a functional toxin, causing adverse effects in a secondary way, as a consequence of neuronal hyper excitability. This is demonstrated by the lack of anatomo-pathologic injuries in the central nervous systems, even after repetitive acute intoxications (Parker *et al*., 1985). Development of resistance to pyrethroids (Lambda cyhalothrinon) in *Spodoptera littoralis* laboratory strain by selection pressure was studied under laboratory condition. This led to significant changes in biological (larval duration, pupal duration, adult longevity, fecundity and fertility) and biochemical aspects (total carbohydrates, total protein and total lipid contents) of treated larvae. It also caused significant changes in the main enzymes activities of the treated larvae.

INTRODUCTION

The Egyptian cotton leafworm, *Spodoptera littoralis* (Boisd.) is one of the most notorious and destructive phytophagous insect pests in Egypt, not only to cotton, but also to other field crops and vegetables (Kandil *et al*., 2003). These caterpillars are very polyphagous, causing important economic losses in both greenhouses and open field on a broad range of ornamental, industrial and vegetable crops. Besides many populations have acquired resistance towards most insecticide groups (Alford, 2000). Chemical insecticides are an effective mean for the control and prevention of major damage caused by this insect pest. However, the extensive and continuous use of traditional insecticides creates environmental contamination and could lead to development of insect resistance. Resistance to insecticides is the development of ability in a strain of insects to tolerate doses of toxicants which would prove lethal to the majority of individuals in normal population of the same species (O'Brine, 1967). Synthetic pyrethroids have been developed with the aim to improve the specificity and activity of the natural insecticide pyrethrum.

The pyrethroids are a functional toxin, causing adverse effects in a secondary way, as a consequence of neuronal hyper excitability. This is demonstrated by the lack of anatomo-pathologic injuries in the central nervous systems, even after repetitive acute intoxications (Parker *et al*., 1985). The pyrethroids display high affinity to Na+-channels and evoke their toxic effects through changes in the functions of these channels. The binding of pyrethroids to Na+-channels causes a prolonged channel opening (Narahashi, 1996; Narahashi *et al*., 1995; Vijverberg and Van den Bercken, 1990). At high pyrethroid concentrations the blockage of the inactivation tail current may cause a complete depolarization of the nervous membrane with blockage of the neuronal excitability (Narahashi, 1992). However, at low concentrations the tail current is sufficient to obtain a repetitive excitatory activity. Thus, hyper excitability is the basis of the majority of pyrethroid intoxications (Narahashi, 1992, 1996). It is demonstrated that alteration of only 1% ofthe total Na+-channels is sufficient to induce the described hyper excitability (Narahashi, 1996;Narahashi *et al*., 1995).

MATERIALS AND METHODS

Insects rearing technique:

The basis of the culture designed to provide cotton leafworm, *S. littoralis* used in the present work was obtained from freshly collected eggs masses supplied from the Cotton Leafworm Department, Plant Protection Research Institute, Dokki, Egypt. Larval stages were reared on caster bean leaves (*Ricinus communis*) which were provided daily. The formed pupae were collected and placed in clean Jars with moist saw dust placed at the base to provide the pupation site. Adults were provided with 10% sugar solution. All stages of *S. littoralis* were cultured and tested at 27±2°C and 70± 5 % R.H.

Tested Insecticide:

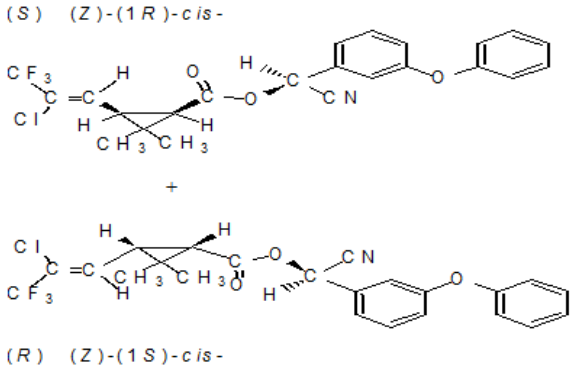
Synthetic pyrethroids have been developed with the aim to improve the specificity and activity of the natural insecticide pyrethrum.

Common name: Lambda-cyhalothrin

Trade name: Kaput (5% EC)

Chemical name: lambda-cyhalothrin (BSI, draft E-ISO); lambda-cyhalothrine ((f) draft F-ISO).

Chemical Structure:



Selection Pressure Procedures for Resistance:

The leaf-dipping bioassay method was used to determine the median lethal concentration (LC_{50}) values. Serial concentrations of Spinetoram were prepared. For each concentration, caster bean leaves were dipped for 30 seconds then allowed to dry at room temperature before being offered to newly ecdysed 4th instar *S. littoralis* larvae. Each considered concentration comprised 10

larvae and was replicated 5 times (i.e. 50 larvae / treatment). A similar number of larvae were considered as a control in which larvae were offered castor oil leaves immersed in distilled water. For each concentration larvae were allowed to feed on treated leaves for 24 hours.

The dead larvae were recorded after 24 hours post–treatment. The mortality percent was determined and corrected after 24 hours using the Abbott formula (Abbott, 1925) for correction wherever required. Results were illustrated graphically as log/probit regression lines using Sigma Plots software for Windows (version 11) depending on (Finney (1972). Mortality data were subjected to probit analysis using the Statistical Analysis System Version 9.1 program PROC PROBIT (SAS Institute 2003) and statistical values of LC_{25}, LC_{50}, LC_{80} and LC_{90} weredetermined to reflect the efficiency of the tested insecticides. When comparing between LC_{50} values, a failure of 95% confidence limits to overlap was used as a measure to determine significant differences between treatments. Resistance Ratio (RR) and Relative Resistibility values were used to measure the difference in resistance between strains and were calculated as follow:

Resistant ratio= LC_{50} of the selected strain / LC_{50} of susceptible strain.

Relative resistibility = LC_{50} of the selected generation - LC_{50} of anterior generation.

Homogeneity inside strain = LC_{50} of the strain / LC_{90} of the samestrain.

Biological studies

Newly ecdysed 4th instar *S. littoralis* larvae were offered castor bean oil leaves treated with Spinetoram at the first determined LC_{50} (Parent) for 24 hours after which time larvae were offered untreated leaves. Each test comprised 100 larvae and was replicated 5 times (i.e. 500 larvae / treatment). The same numbers of larvae were considered as a control, these larvae were offered castor oil leaves immersed in distilled water. The following parameters were recorded:

Larval instars duration, from the initial treated instar up to pupation.

Percentage of pupation.

Male life span.

Female life span (pre-oviposition – oviposition – post-oviposition)

Mean number of deposited eggs/ female

Incubation period.

Hatchability percentage.

Biochemical studies:-

After 24 hours following the feeding of 4th instar *S. littorralis* larvae on castor bean oil treated with Spinetoram at the parent determined LC_{50}, any surviving larvae exhibiting toxic symptoms were selected. Total carbohydrates were extracted and prepared for assay according to Crompton and Birt (1967). Total carbohydrates content were estimated in acid extract of sample by the phenol-sulphuric acid reaction of Dubois *et al.*, (1956). For other biochemical measurements; the surviving larvae exhibiting toxic symptoms were anaesthetized and rinsed with 5 ml acetone to remove surface residues, the larvae were weighed then homogenized in phosphate buffer (pH 7) using a Teflon tissue homogenizer surrounded by crushed ice. The homogenates were centrifuged at 8000 rpm for 20 min at 4^0 C and the supernatant was used directly for the determination of the following:

The total protein content of the total body was determined according to Bradford (1976).

Total lipids were estimated by the method of Knight *et al*. (1972).

Glutathione-S-transeferase activity was determined according to the method of Habig *et al.* (1974).

Non-specific α and β esterase activity was measured as described by Van Asperen (1962).

Acetyl choline-esterase (AChE) activity was determined using acetylcholine bromide (AChBr) as substrate according to the method described by Simpson *et al.* (1964).

Acid and alkaline phosphatase activity was measured from the larval hemolymph as described by Powell and Smith (1954).

Mixed Function Oxidase (MFO) activity was determined according to the method of Hansen and Hodgson (1971).

Statistical analysis:-

The statistical analysis of data on mortality was subjected to the Abbott formula (Abbott, 1925) for correction wherever required. Probit analysis was determined to calculate LC_{50} (Finney, 1972), through software computer program. The significance of the main effects was determined by one way analysis of variance (PROC. GLM). The significance of various treatments was evaluated by Tukey's multiple range tests ($p< 0.01$). All analyses was made using the Statistical Analysis System Version 9.1 program PROC PROBIT (SAS Institute 2003).

RESULTS AND DISCUSSION

Development of resistance of *S. littoralis* to Lambda-cyhalothrin:

The resistance spectrum towards Lambda-cyhalothrin was investigated in different generations of *S. littoralis* lab strain. The toxicity regression lines were graphically illustrated in Fig. (1) and the calculated LC_{50} values of Lambda-cyhalothrin to the different generations of *S. littoralis* during two generation of selection were presented in Table (1). The results clearly indicated that LC_{50} values were increased gradually from 6.2 to 267.4 ppm for parent and second (G2) generations, respectively. This mass selection with Lambda-cyhalothrin caused increasing in resistance levels to 43fold in the second generations compared with the standard susceptible parent strain (Table 1). Homogeneity values of the parent and G2 generations were 6.3 and 4.4, respectively.

Table 1: Development of resistance in *S. littoralis* to Lambda-cyhalothrinduring selection for two generation.

Selection generation	LC_{50} (ppm)	LC_{90} (ppm)	Slop	r^2	Resistance Ratio(fold)	Relative resistibility	Homogeneity LC_{90}/LC_{50} ratio
Parent	6.2	38.9	1.5	0.93	-	-	6.3
G2	267.4	1174	1.9	0.95	43	261.2	4.4

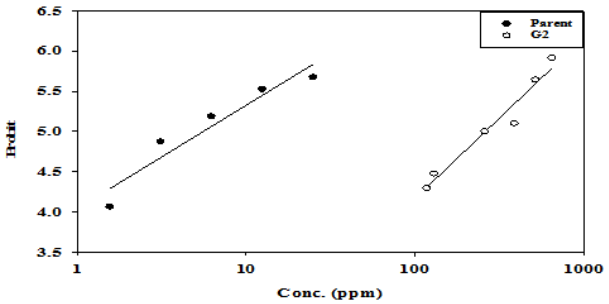


Fig. 1: Lambda-cyhalothrintoxicity lines of different *S. littoralis* generations.

As shown in Table (1) and Fig. (1) the toxicity regression lines were characterized by slight fluctuations in the slope values. The slope values were comparatively height and nearly close to each other. In this respect Hoskins and Gordon (1956) pointed out that the development of true resistance was characterized by regression line becoming shallower as it moves to the right, finally it becomes steeper again as

resistance genotypes comes to characterize the new populations.

Biological studies on resistance of *S. littoralis*:

Biological aspects of parent strain (K/P) as affected by treatment with the first calculated Lambda-cyhalothrin LC_{50} level are presented Table (2).

The obtained results following treatment showed that; the larval duration from initial treated instar up to pupation recorded highly significant increase to 15.60 days compared to 10.90 days for the untreated. Aziza Mohamady (2005) indicated that the larval duration was prolonged in treatment with Beta-cyfluthrin compared with the untreated.

Table 2: Biological aspects of treating *S. littoralis* 4th instar larvae with LC_{50} of Lambda-cyhalothrin.

Biological Aspect	**Untreated**	**Treated**
Duration of larval stage (days ± S.E)	10.90±0.10	15.60*** ±0.18
Mean total pupal duration (days ± S.E)	14.00*** ±0.00	9.19±0.12
Male life span (days ± S.E)	10.67±0.67	15.33* ±1.33
Female moth life span (days ± S.E)	9.00 ns±1.00	11.00 ns ±1.53
Pre-oviposition period days ± S.E	2.00 ns±0.00	2.33 ns ±0.67
Oviposition period days ± S.E	5.33 ns ±1.20	6.33 ns±1.45
post-oviposition period days ± S.E	1.67 ns±0.33	2.33 ns ±0.67
Mean no. deposited egg / ♀ ± S.E	1789***+28.52	258.67±96.01
Incubation period days ± S.E	3±0.35	5.22*** ±0.67
% Egg hatchability	94%	9%

* means significant (p of t≤ 0.05),
** means moderately significant (p of t≤ 0.01),
*** means highly significant (p of t ≤ 0.001 and ns means non-significant. (SAS T-test).

This may be attributed to the low and /or slow metabolic rate of larvae treated with the sub-lethal concentration of insecticide. The results also agree with that obtained by Hewady (1990), who reported that the pyrethroid Fenopropathin proved latent harm effect on the larval development of the spiny bollworm *E. insulana*. On the other hand the pupal duration was significantly decreased by approximately 4.81 day when the 4th instar larvae were treated. This finding is in accordance with the results obtained by Radwan (1992) and Mohamady (2000) who mentioned that, the treatment of 4th instar larvae of *S. littoralis* LC_{50} of Fenvalerate reduced the pupal duration. Aziza Mohamady (2005) proposed that; this decreased may be due to the reduction of feeding appetite of larvae.

As seen in Table (2), the life span of an adult female moth emerged from 4th instar larvae treated with LC_{50} of K/P was 11.00 days which was non-significant elevated than their control by 2.00 days and presented by a mean of 2.33, 6.33and 2.33days for a pre-oviposition, oviposition and post oviposition period while in the untreated control, the life span of an adult female moth was a mean of 9.00 days, presented by a mean of 2.00, 5.33and 1.67days for a pre-oviposition, oviposition and post oviposition periods, respectively. Likewise, the results displayed that a significant increased occur in male life span than control, whereas; it was 15.33 days in treated larvae compared to 10.67 in the untreated.

The reproduction potential of moths emerging from treated larvae was also highly significantly decreased, (Table 2). Total number of deposited eggs per female emerged from treated larva was 258.67 eggs with 9% egg hatchability. Untreated females deposited 1789 eggs/ female with 94 % egg viability. This result agreement with that obtained by Aziza Mohamady

(2005), who reported that treatment with LC_{50} of Beta-cyfluthrin on 4th instar larvae reduced egg production in the resulting female moths. With regard to hatchability our result also agree with Aziza Mohamady (2005), who reported that the highly decrease in hatchability refer to the decrease in sterility percentage (male fertility). It is obvious that Beta-cyfluthrin was the most effective compound in producing sterility compared with other compounds and this indicates that the effect of this compound persisted long from treating the 4th instar larvae up till the adult stage. According to Georghio (1965)treatment with insecticides may be resultin either an increase or a decrease in egg production, and may also affect egg fertility. A large number of factors and / or processes may be involved. Also, Amer (1997)mentioned that Esfenvalerate gave a slight reduction in fecundity of *E. insulana* asnewly hatched larvae. Ayad *et al.* (1983) reported that fenvalerate decreased the percentage of emergence, fecundity and hatchability of eggs of *S. littoralis*. The same effects were recorded by Radwan (2001).

Biochemical studies on resistance of *S. littoralis*:

Treated 4th instar *S. littoralis* larvae with their calculated LC_{50} values for parent and G2 generations of Lambda-cyhalothrin resistance strain were analyzed biochemically in order to determine the biochemical changes resulting these treatments.

Effect on main contents:

Total carbohydrates, total protein and total Lipids are major necessary components for any organism development, growth, performance and its vital activities. As seen in Table (3), treatment of 4th instar *S. littoralis* larvae with the calculated LC_{50s} for K/P and K/G2 generations of Lambda-cyhalothrin resistant strains caused marked non-significant increase in the total carbohydrates from 11.47 in untreated to 13.43mg/ ml for K/P and significantly reduction in the total carbohydrates from 11.47 in untreated to 8.30mg/ ml for K/G2 giving 17.08 % increasing than their value in the untreated and -27.63% decrease than their value in the untreated. This result were agreement with Gamil (2012) showed that LC_{50} of indoxacarb, pyridalyl and spinetoram had the highest impact on carbohydrates, protein or lipid content of treated 4th instar *S. littoralis* larvae instar. Total carbohydrate content in untreated 4th instar *S. littoralis* larvae 17.3 mg/ml, respectively which was reduced by 56.1, 63.5 and 85.9 % for the respective mentioned tested insecticides. Determination of total soluble protein content in treated K/P and K/G2 fourth *S. littoralis* instar larvae with their Lambda-cyhalothrin corresponding LC_{50} values were 15.10and 12.37(mg/ml) respectively, compared with 13.43 mg/ml in untreated. It was slightly elevated in K/P strain by 8.93% than untreated, while it recorded reduction in K/G2 by 7.89 % for the K/G2 than untreated (Table 3). The reductions in food intake and in the ability to convert food into biomass would eventually have extended the development time of the larvae. The decrease in protein content might be due to a mechanical lipoprotein formation which will be used to repair damaged cells, tissues, and organs (Saravana and Geraldine, 2001; Ribeiro *et al*., 2001; Mosleh *et al.*, 2003) or might be referred to mobilization of amino acids during insecticide stress to meet the energy. Also, the reduction of protein level might be due to the destructive effect on some of the cerebral neurosecretory cells of the brain responsible for secretion of the protein of the treated larval instars of *S. littoralis* (Hamouda and Dahi, 2008). The obtained observation was agreement with Elbarky *et al.* (2008) and Rashwan (2013), they indicated that the reduction

in protein content may be due to inhibition of DNA and RNA Synthesis.

Table 3: Total carbohydrates, protein and lipid content in 4thinstar*S.littoralis* larvae selection generations 24 hours post treatment with their LC_{50s} of Lambda-cyhalothrin.

Selection Generation	Carbohydrates (mg/ml)	Protein (mg/ml)	Lipid (mg/ml)
K/P	13.43^{a} ±0.35 (17.08)*	15.10^{a}±0.32 (8.93)*	7.57^{a} ±0.33 (34.45)*
K/G2	8.30^{b} ±0.06 (-27.63)*	12.37^{b}±0.47 (-7.89)*	5.40^{b} ±0.15 (-4.08)*
Untreated	11.47^{a} ±0.58	13.43^{ab} ±0.19	5.63^{b} ±0.23
LSD	2.503	2.1898	1.5746

- Means have the same letter vertically are insignificant.

* %Increase or decrease than control = $\frac{\text{Treated - Control}}{\text{Control}}$ X 100

Obtained results in Table (3) also declare that treating the K/P and K/G2 with their corresponding LC_{50} concentrations caused significant increase in their lipid contents as compared with untreated insects. It was highly elevated in K/P strain by 34.45% than untreated, while it recorded reduction in K/G2 by -4.08 % for the K/G2 than their untreated. Lipids are essential structural component of cell membrane and cuticle. They provided a rich source of metabolic energy. The great reduction in total lipids might be due to breaking down lipids to simpler moieties that could be utilized as a carbon source for growth. Bennett and Shot well, (1972) suggested that the treated larvae might produce enzyme that utilizes lipids for energy requirement.

Enzyme assay:

Many species of insect have developed resistance to insecticides. Several enzymes have shown to be involved resistance.

Effect on Acetyl Choline- esterase, Glutathione-S-transeferase and Mixed Function Oxidase (MFO) activity:

Data in Table (4) explained that acetyl choline esterase activity in untreated 4th instar *S. littoralis* larvae was 62.27 µg AChBr / ml/ min which was significantly lower than that recorded in 4th instar *S. littoralis* larvae treated with the Lambda-cyhalothrinLC_{50} for K/P was 56.90µg AChBr/ ml/ min, while; the enzyme activity after treatment in K/G2 recorded highly decreasing by -24.04% than untreated.

AChE has a key role in neurotransmission by hydrolyzing the neurotransmitter acetylcholine in cholinergic synapses of the nervous system and is the target site of several neurotoxic insecticides. Pyrethrins attack the nervous system of insects. These compounds impact the sodium channels by blocking them in an open position by the inhibition of the voltage-dependent inactivation (Casida, 1973). The result of this blockage is a significant release of acetylcholine at the synapse level. This over-abundance of neurotransmitters causes the desensitization of postsynaptic receptors and then triggers, through negative feedback on the pre-synaptic receptors, an inhibition of acetylcholine release.

Table 4: Acetyl Choline- esterase, Glutathione S-transeferase and Mixed Function Oxidase (MFO) activities in 4th instar *S. littoralis* larvae of selection generation 24 hours post treatment with their LC_{50s} of Lambda-cyhalothrin.

Selection Generation	AChE *(µg AChBr /min/g.b.wt)*	GST *(m mole sub. conjugated/min/g.b.wt)*	MFO *(n mole sub oxidized/min/g.b.wt)*
K/P	56.90 ^{ab}±2.50 (-8.62)*	140.00 ^{b}±2.52 (-5.61)*	32.10 ^{b}±1.51 (-11.00)*
K/G2	47.30 ^{b}±1.37 (-24.04)*	251.00 ^{a}±12.06 (69.22)*	48.07 ^{a}±0.97 (33.26)*
Untreated	62.27 ^{a} ±2.64	148.33 ^{b} ±9.82	36.07 ^{b} ±1.86
LSD	14.214	57.577	9.4678

- Means have the same letter vertically are insignificant.

* %Increase or decrease than control = Treated - Control X 100 / Control

The synaptic transmission is then blocked, which leads to the paralysis of the insect followed by its death.

Glutathione S-transferases (GSTs) activity showed marked difference in between untreated 4th instar larvae and treated selection generations being 148.33mol/ min. for untreated and following the treatment with the calculated LC_{50s} of the respective mention generations, activity of (GSTs) enzyme was slight decrease to 140.00 mol/min. for K/P and was significantly increased to 251.00 mol / min. for K/G2 (Table 4). Meanwhile; (GSTs) activity in K/P generation showed slightly decreased by -5.61% for K/P generation than untreated and showed highly increase by 69.22 % for K/G2 generation than untreated. GSTs are a diverse family of enzymes found ubiquitously in aerobic organisms Enayati *et al.* (2005) . They play a central role in the detoxification of both endogenous and xenobiotic compounds and are also involved in intracellular transport, biosynthesis of hormones, and protection against oxidative stress Ortelli *et al.* (2003). GSTs can metabolize foreign compounds by facilitating their reductive dehydrochlorination or by conjugation reactions with reduced glutathione, to produce water-soluble metabolites that are more readily excreted. In addition, they contribute to the removal of toxic oxygen free radicals produced through the action of pesticides. GSTs are known to exist in dimers (homo- or heterodimers) Vanhaelen (2004). A significant increase in GST activity was found for deltamethrin resistant strain of *P. gossypiella* compared with susceptible strain Hemat (2005). Similar findings were recorded by Ibrahim *et al.* (1996) which showed that GST activity was greater in pyrethroid resistant strain than in susceptible strain of tobacco bud worm *H. virescens*. Martin *et al.*(2002) found that GST activity of the deltamethrin selected strain was significant higher than in the susceptible strain in the cotton bollworm *H. armigera*.

Data presented in Table 4 explained the specific activity of Mixed Function Oxidase (MFO) for the selection generation (K/P and K/G2) of *S. littoralis*. The obtained results indicated that; the estimated (MFO) activity was fluctuated between selection generations, whereas; it recorded slightly decreased than the untreated in K/P by 11.00%. Meanwhile; it elevate than the untreated by 33.26%in K/G2. MFO or monooxygenase systems like Cytochrome P-450 is known to occur in many groups of animals, as well as plants and micro-organisms. It occurs in a number of forms and fills a variety of functions. In insects cytochrome P-450 has been demonstrated in midgut, fat

body and malpighian tubules of several different developmental stages, with the midgut being generally, but not always, the site of greatest activity Hodgson (1983).

Effect on Non–specific esterase activities:

The Non–specific esterase activities (α-esterases and β-esterases) in 4th instar*S. littoralis* larvae of the selection Lambda-cyhalothrinresistant generations are displayed in Table (5).

Table 5: Non- specific esterase activities (α-esterases and β-esterases) in 4th instar *S. littoralis* larvae of selection generation 24 hours post treatment with their LC_{50s} of Lambda-cyhalothrin.

Selection Generation	α-esterases *(µg α-naphthol/min/g.b.wt)*	β-esterases *(µg α-naphthol/min/g.b.wt)*
K/P	419.33[a]±16.90 (538.54)	654.00[a]±17.47 (6.80)
K/G2	43.67[b]±1.86 (-33.50)	538.67[a]±17.68 (-12.02)
Untreated	65.67[b] ±3.48	612.33 [a] ±30.15
LSD	63.417	142.82

- Means have the same letter vertically are insignificant.

* % Increase or decrease than control = Treated - Control X 100 / Control

The result pointed to α-esterase activity was highly significant increased than untreated in the K/Pabout 419.33 µg α-naphthol/min/g.b.wt and slight decreased than untreated in the K/G2 about 43.67µg α-naphthol/min/g.b.wt (i.e., 538.54 and -33.50 % elevation).

As seen in Table (5), β-esterases enzyme activity recorded slight increased than untreated (i.e. 6.80 %) for K/P and slight decreased than untreated (i.e. -12.02% reduction) for K/G2 .General esterases are a large and diverse group of hydrolases that hydrolyze numerous substances including esters and certain non-ester compounds. Numerous studies have demonstrated that esterases play an important role in conferring or contributing to insecticide detoxifications in insect and arthropod species (Motoyama and Dauterman, 1974; Mouches *et al*., 1986; Saleh *et al*., 1986). Esterases are hydrolyzing enzymes,which split ester compounds with the addition of water to yield alcohol and acids (Shaurub *et al.,* 1999). The general decrease in the activity of the studied enzymes (alpha-esterase, beta- esterase) in the present work may indicate that general esterases are not involved in the detoxification process of Lambda-cyhalothrin.

Effect on Acid and alkaline phosphatases activities:

Data in Table 6 presented acid and alkaline phosphatase activitiesin 4th instar *S. littoralis* larvae of Lambda-cyhalothrinselection generations. The results estimated that; acid phosphatase activity generally increased than untreated. Highly increased than untreated by 118.23% in K/P and slightly increased than untreated by 21.63%.

On the other hand, alkaline phosphatase activity was recorded significant increased than untreated by 38.83% in K/P and slight reduction percentage than untreated by -1.94% in K/G2. These observations are in conformity with the finding of Hemat (2005) who reported that no correlation between acid and alkaline phosphatase activity and resistance level to daltamethrin.In this respect, Farag (1978) found that activity of acid and alkaline phosphatase showed marked differences during the development of

resistance to insecticides. On the other hand the alkaline phosphatase showed slight decreased in resistance rather than susceptible strain of *S. littoralis* (Afifi 1988 and Amin 1992).

Table 6: Acid and alkaline phosphatase activities in 4th instar *S. littoralis* larvae of selection generation 24 hours post treatment with their $LC_{50s}$of Lambda-cyhalothrin.

Selection Generation	Acid phosphatase *(U x103/g.b.wt)*	Alkaline phosphatase *(U x103/g.b.wt)*
K/P	1220.67^{b} ±25.83 (118.23)*	238.33^{a} ±11.39 (38.83)*
K/G2	680.33^{a} ±11.20 (21.63)*	168.33^{b} ±4.18 (-1.94)*
Untreated	559.33^{a} ±10.90	171.67^{b} ±4.63
LSD	48.437	47.472

- Means have the same letter vertically are insignificant.
- * % Increase or decrease than control = Treated - Control X 100 / Control

Generally, it should be pointed out that; study the bullied up of resistance in *S. littoralis* lab strain to lambda- cyhalothrinby selection pressure led to significant changes in biological and biochemical aspects of treated *S. littoralis* larvae extended to the subsequent generations.

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ARABIC SUMMERY

ميكانيكية مقاومة دودة ورق القطن للبيريثرويدات

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تم تطوير البيريثرويدات الصناعية بهدف تحسين نوعية ونشاط البيريثريم الطبيعى. والبيريرثرويدات هى سموم وظيفية تتسبب فى احداث تأثيرات ضارة ثانوية نتيجة احداثها لإستثارات عصبية. ويتضح ذلك من عدم وجود إصابات مرضية تشريحياً فى الجهاز العصبى المركزى حتى بعد حالات التسمم الحاد المتكررة (باركر و اخرون ١٩٨٥). تم دراسة تطور صفة المقاومة للبيريثرويدات (لامبادا - ثيهالوثرين)على السلالة المعملية لدودة ورق القطن سبودوبترا ليتورالس عن طريق الضغط الإنتخابى تحت الظروف المعملية. أدى ذلك الى تغيرات بيولوجيه معنويه فى كل من طول العمر اليرقى وطول فترة التعذير وخصوبة كل من الإناث والذكور. و الى تغيرات بيوكيميائية فى المحتوى الكلى للكربوهيدرات والبروتينات والدهون. وايضا ادى ذلك الى تغيرات فى نشاطات الإنزيمات الرئيسية لليرقات المعاملة.