Egypt. Acad. J. Biolog. Sci., 12(1): 197-206 (2020)

Egyptian Academic Journal of Biological Sciences
F. Toxicology & Pest Control
ISSN: 2090 - 0791
http://eajbsf.journals.ekb.eg/

Field and Biochemical Studies of Bio- and Chemical Pesticides on the Cotton Leafworm, *Spodoptera littoralis* (Boisduval) on Sugar Beet

Dalia E. Lotfy[1] and El-Sayed M. Embaby[2]
1- Plant Protection Research Institute, Agriculture Research Centre, Cairo, Egypt
2- Plant Pathology Dept., National Research Centre, Cairo, Egypt.
Email: lomshahd@yahoo.com

ARTICLE INFO
Article History
Received:15/5/2020
Accepted:28/6/2020
Keywords:
Sugar Beet**,** *S. littoralis*, *B. thuringiensis,* Hamer®, Jasper®, field efficacy, GST, AChE.

ABSTRACT

Cotton leafworm, *Spodoptera littoralis* (Boisd.) is a serious lepidopterous pest affecting several economic plant families leading to lowering in crop yields as well as crop quality through its larval stages Efficacy of Dipel 2x®as bio-insecticide and Hamer® and Jasper® as biorational insecticides were investigated against *S. littoralis* larvae under field conditions in Egypt throughout two seasons August 2018 and 2019 on Sugar Beet. Results showed that the population of *S. littoralis* larvae during both seasons reduced after insecticide application. The highest reduction in infestation percentages was recorded with Jasper® followed by Hamer® then Dipel 2x®. It recorded 96.30%, 90.06%, 80.32%, 78.70% and 68.52%, 67.31% with Jasper, Hamer and Dipel 2x® during 2018 and 2019, respectively. The overall reduction in infestation percentages was 87.78%, 86.46%, and 64.76%, 60.71 % and 53.67%,49/.10% for Jasper, Hamer, and Dipel 2x® during 2018 and 2019 Sugar Beet growing seasons, respectively. The activity of acetylcholinesterase (AChE) and Glutathione *S*- transferase (GST) enzymes play an important role in insect immune response compared to control against susceptibility of field strain 3rd instar larvae of *S. littoralis* was determined. Our results revealed that Dipel 2x® was the most potent bioinsecticide in both crop yields and quality due to its larval activity followed by Hamer® then Jasper® among the selected insecticides. The present work discusses the role of biorational and biological insecticides application in integrated pest management and biochemical studies were carried out on 3rd instar larvae of *S. littoralis* (Field strain) to determine AChE and GST enzyme activity.

INTRODUCTION

Sugar beet, *Beta vulgarias* L.(Chenopodiaceae) is considered as the second most important source of sugar production In Egypt after Sugar cane. Kafr El-Sheikh Governorate represents the utmost producing source of Sugar beet; including more than 50% of the sugar beet -cultivated area (Abou El-Kassem, 2010). Crop importance and uses relies on the high sugar content of root (Rashid, 1999), making it a commercial source of sugar as well as ethanol production in temperate countries (BSRI, 2005). Egyptian Cotton leafworm, *Spodoptera littoralis* (Boisduval) (Lepidoptera :Noctuidae) is a major (quarantine) pest affecting economic important plant families leading to lowering in crop yields as well as crop quality (OEPP/EPPO 1981). Among the crops infested by this insect is the Sugar beet, *Beta vulgaris* L. (Chenopodiaceae). During the growing season that starts from mid -August, the average recorded temperature one month later (during September) assisted in the infestation of Sugar beet seedlings by *S. littoralis* larvae causing great losses and resulting in forming bare areas in the field in case of heavy infestation (El-Mahalawy, 2011). The infestation rate is considered critical when reaching 20%. Concerning pest management on edible crops, it is of major concern to consider both pest killing efficiency, environmental contamination, wildlife, and public health concerns, as well as food safety (El-Geddawy *et al*. 2014). Moreover, the indiscriminate use of insecticides results in increasing insecticide resistance, hence the need for biologically safe insecticide affording environmental sustainability is a must. Integrated pest management includes applying both biological and chemical control measures with special focusing on those non- conventional (bio-rational) insecticides (Pedigo 1996). The best candidate tactic for lowering resistance is using biocides and insecticides with novel modes of action. The entomopathogenic bacteria *B. thuringiensis* ,var *kurstaki*, has been widely used efficiently against laboratory and field populations of lepidopterous pests (Obeng-Ofori and Sackey, 2003; Said *et al.*, 2012; Abd El-Kareem and Ibrahim, 2015; Fetoh, *et al*. 2015; Hamama *et al.*, 2015; Darabian and Yarahmadi, 2017, Yasmin, El Fargany,2019). The field efficacy of emamectin benzoate and thiacloprid was evaluated against many lepidopteran pests as *Cydia pomonella* (Brunner *et al.*, 2005), *Pieris rapae* (Muthukumar *et al.*, 2007 and Said *et al.*, 2012). *S. litura (*Tong *et al.*, 2013) *S. littoralis (*Fetoh *et al.*, 2015).

Acetylcholiesteras (AChE) enzyme is a key enzyme in the insect nervous system that hydrolyzes acetylcholine neurotransmitter to terminate nerve impulses. (AChE) known to play a major part in insecticide resistance (Zhu *et al.*, 2000, Russell *et al*. 2004). Glutathione *S*- transferase (GST) enzymes have attracted attention in insects because of their involvement in the defense towards insecticides (Clark *et al.* 1986; Grant &Matsumura 1989; Reidy *et al.* 1990; Fournier *et al.* 1992). Rumpf *et al.* (1997) observed that there is a correlation between the degree of acetylcholinesterase AChE and GST inhibition and corresponding mortality caused by insecticide in lacewings.

The present work discusses the role of biorational and biological insecticides application in integrated pest management and biochemical studies were carried out on 3rd instar larvae of *spodoptera littoralis* (field strain), to determine AChE and GST enzyme activity.

MATERIALS AND METHODS

The suppressive effect of Hamer® (Thiacloprid**),** Jasper® (Emamectin benzoate), and Dipel 2x® *(B. thuringeinsis*) commercial insecticide against *S.littoralis* larval population were evaluated in sugar beet field with early infestation during 2018 and 2019**.**

Insecticides:

1- Dipel 2x®, *B. thuringeinsis* var. *kurstaki*, (32, 258 Potency I.U. / mg) WP, rate= 200 g/feddan, obtained from the Bio-insecticide Production Unit, Plant Protection Research Institute, Agriculture Research Centre, Giza, Egypt.

2- Hamer®, Thiacloprid 480 g/l S.C., Chloro-nicotinoid. 480 g/l S.C., China.

3- Jasper®, Emamectin benzoate, Avermectin, 480 g/l S.C., China.

Fied Application:

The field experiments were constructed in sugar beet fields infested with *S.*

littoralis at Talaat-El Agamy experimental farm, henno, Kafr El-Sheikh, Egypt. Studies covered two successive growing seasons during 2018 and 2019. 1/100 feddan was used for experimental application applying a complete randomized block design. Each treatment was applied to an area of about 42 m^2, four plots per treatment as well as untreated (control) area sprayed with water only. Separating vegetation between plots of 2 rows of sugar beet plants were left untreated. Application insecticides were applied at sunset using knapsack motor sprayer (20L capacity). 10 plants/plot/treatment were examined before insecticide application, and the data were recorded after 1,3 and 5 days of chemical insecticide application and after 2, 3, 5 days after bacterial insecticide treatments. The numbers of *S. littoralis* larvae found were recorded and the percentage of infestation reduction was calculated according to Henderson and Tilton's formula. (Henderson and Tilton, 1955) as follows:

$$\text{Reduction } \% = \left\{1 - \frac{n \text{ in } Co \text{ before treatment } x \; n \text{ in } T \text{ after treatment}}{n \text{ in } Co \text{ after treatment } x \; n \text{ in } T \text{ before treatment}}\right\} \times 100.$$

N: Insect population, T: treated, Co: control

Biochemical Analysis:

Biochemical studies were done to examine the (AchE) acetylcholinesterase and Glutathione S-Transferase (GST) enzymes of treated insects.

1-Field Strain:

Field strain of 3^{rd} instar larvae of *S. littoralis* was collected from Syngenta localities in Qulaubyia Governorate, Egypt, and treated with quarter recommended concentration of each insecticide for further biochemical analysis. Leaf of castor bean was dipped in biorational insecticides; Hamer®, Jasper®, and bio-insecticide Dipel 2x® for 10 sec. and left to dry under laboratory conditions. Leaves were put on the bottom of plastic cans covered with a sieved lid, then 30 larvae released in 3 replicates for each pesticide, while control leaves dipped in distilled water only. The live larvae were collected after 24 h for pesticide and 48 h for biopesticide in open dwarf at -20^0c for use in biochemical analysis.

2-Sample Preparation of Insects for Analysis: -

The insects were prepared as described by Amin (1998). Sample insects were homogenized in distilled water (50 mg /1 ml), then centrifuged at 8000 r.p.m. for 15 min at 2 ºC in a refrigerated centrifuge. The deposits were discarded and the supernatants, which are referred to as enzyme extract, stored at least one week without appreciable loss of activity when stored at 5^0C.

3-Enzyme Assay:

a-AchE (acetylcholinesterase) activity was measured according to the method described by Simpson *et.al*. (1964).

b-Glutathione S-Transferase (GST) catalyzes the conjugation of reduced glutathione (GSH) with 1-chloro 2,4-dinitrobenzene (CDNB) via the -SH group of glutathione. The conjugate, S-(2,4-dinitro-phenyl)-L-glutathione could be detected as described by the method of Habig *et al*.(I974).

4-Statistical Analysis:

Data were presented as the mean number of collected larvae per treatment and percent reduction in the infestation. Statistical analysis was followed by the analysis of variance (ANOVA) at p= 0.05 using Minitab v. 16 software and the results of biochemical analysis were pooled from triplicate determinations by using costat statistical software (cohort software, Berkeley). When the ANOVA statistics were significant ($P < 0.01$), the means were compared by Duncan's multiple range test.

RESULTS AND DISCUSSION

Field Studies:

Effect of Tested Insecticides on *S. littoralis* Larval Population in 2018:

The suppressive effects of Hamer®, Jasper®, and Dipel 2x® against the larval population of *S. littoralis* were evaluated in the sugar beet field with early infestation during 2018 and 2019. Under normal, (control plot), the larval population increased gradually during the first 4 days then increased after 5 days during the two studied growing seasons (Tables 1 & 2). Treatment with bacterial insecticide, Dipel 2x®, the application showed a significant reduction in the mean numbers of larvae compared to the control after 48h post-treatment reached to 40.84%, then increased to 68.52% after 5 days post-treatment. Both chemical insecticides, Jasper® and Hammer®, significantly reduced larval population 24hr post-treatment, in comparison with larval counts before treatment. The suppressive effect extended to 5 days post-treatment. The reduction in larval population showed fast promising effect of Jasper® recording 79.96 % reduction in 1 day, while Hamer® was slower in its effect causing only 46.88%, the reduction in the larval population increased to 80.32% in case of Hamer® and 96.30% in case of Jasper® after 5 days post-treatment (Table 1).

Tables 1: Mean reduction of *S.littoralis* larvae population in treated and untreated plots of Sugar beet field in 2018. 1st Season

Treatment	Untreated Area	Days after treatments							
		1 DAY		2 DAYS		3 DAYS		5 DAYS	
	Mean ±S.D.	Mean ±S.D.	Reduction %	Mean ±S.D.	Reduction %	Mean ±S.D.	Reduction %	Mean ±S.D.	Reduction%
Dipel 2x®	13.00± 2.16 a			9.50± 1.91 ab	40.84	8.75± 2.21 b	51.65	6.50± 1.29 b	68.52
Hammer®	12.00± 1.63a	7.00± 1.82b	46.88			5.50± 1.29 b	67.08	3.75± 1.70b	80.32
Jasper®	12.50 ± 2.08 a	2.75 ± 1.25 b	79.96			2.25 ±0.95 b	87.07	0.75± 0.50 b	96.30
Control	12.75± 1.70 b	14.00± 1.41 b		15.75± 3.77ab		17.75±3.09 ab		20.25± 2.75a	

Means in the same raw followed by different letters are significantly different, P≤0.05

Effect of Tested Insecticides on *S. littoralis* Larval Population in 2019:

The same pattern was observed in the second season (2019) with a lower magnitude of the reduction. Results presented in table (2) showed also that Jasper® 24h post-treatment caused the highest larval mortality compared with the control. The reduction in larval population showed a fast-promising effect of Jasper® recording 90.06 % reduction in 5 days, while Hamer® was slower in its effect causing only 78.70% after the same period. Also, it is noticed that the reduction in larval numbers caused by Dipel 2x® started to increase after 48h post-treatment reached 27.14% and 67.31% after the 5th-day post-treatment.

Tables 2: Mean reduction of *S.littoralis* larvae population in treated and untreated plots of Sugar beet field in 2019. 2nd Season

Treatment	Untreated Area	Days after treatments							
		1 DAY		2 DAYS		3 DAYS		5 DAYS	
	Mean ±S.D.	Mean ±S.D.	Reduction %	Mean ±S.D.	Reduction %	Mean ±S.D.	Reduction %	Mean ±S.D.	Reduction %
Dipel 2x®	10.75± 2.21a			9.50± 2.64ab	27.14	7.25± 2.63ab	50.76	5.50± 2.08b	67.31
Hammer®	10.50±1.29 a	7.75± 2.5 ab	34.71			4.5 ± 2.64 b	68.71	3.50 ± 1.29b	78.70
Jasper®	11.25± 2.21a	2.25± 0.95b	82.31			2.00± 0.81b	87.02	1.75± 1.95 b	90.06
Control	11.50± 1.91b	13.00± 0.81ab		14.00± 3.65 ab		15.75± 4.34ab		18.00± 2.16a	

Means in the same raw followed by different letters are significantly different, P≤0.05

The overall reduction in infestation was 87.78%, 86.46% with Jasper®, 64.76%, 60.71% with Hamer®, and 53.67%, 49.10% with Dipel 2x®, during 2018 and 2019 seasons respectively. (Table 3). The field effect of bacterial insecticides on lepidopteran pests as *S. littoralis* and *Sesamia cretica* population reduction proved its efficiency using commercial formulations like Xentari®, Dipel 2x®, Agerin® and protecto® (El –Zoghbey *et al*., 2003; Radwan *et al*., 2004; Salem, 2011; Said *et al.*, 2012 and Abd El-Kareem and Ibrahim, 2015). Also, our results agree with Jat, *et al. (*2017) who found that *B. thuringiensis* caused a reduction of larval population by 56.09 and 55.24% during 2013,2014 on cabbage crops. During the investigation, the data revealed better efficacy of emamectin benzoate and this agrees with Nukala, *et al. (*2015) who investigated bioefficacy of nine modern insecticides under field conditions against *S.litura* and revealed that emamectin benzoate, chlorpyriphos, Cypermethrin, and Chlorantraniliprole were found most effective. (Muhammad, *et al*.,2018). Emamectin benzoate was proved to be safer for parasitoid, which caused 18% mortality after 48 hrs exposure during laboratory assessment. Emamectin benzoate is the salt of emamectin effects on the nervous system of arthropods by increasing chloride ion flux at the neuromuscular junction, resulting in irreversible paralysis. Also, it affects the glutamate-gated chloride channel agonist (Dunbar *et al.*, 1998). It is observed that Emamectin benzoate is a safer insecticide for Trichogramma. Looking at the efficacy of all the insecticides emamectin benzoate, Thiacloprid, and the *Bacillus thuringiensis* kurstaki can be suggested to the farmers for the management of *S. littoralis* sugar beet. The present and previous studies support the benefit of using bacterial insecticides as a part of integrated pest management (IPM) for being an effective and environmentally safe control agent.

Tables 3: Overall reduction of *S.littoralis* larvae in seasons 2018 and 2019 in sugar beet field.

Treatment	Overall reduction In Season 2018%	Overall reduction In Season 2019%
Dipel 2x®	53.67%	49.13%
Hammer®	64.76%	60.71%
Jasper®	87.78%	86.46"%

Biochemical Studies:

Effect of Treating 3rd Instar Larvae of *S. littoralis* (field strain) With Bioinsecticide and Insecticisdes On Glutathione S-transferase and Actylcoliesterase Studied:

a-Acetylcholinesterase (AChE):

Treatment of the 3rd instar larvae (field strain) with Hamer®, Jasper®, and Dipel 2x® resulted in a significant increase in Acetylcholinesterase (AChE) enzyme activity with Dipel 2x® in comparison to control. Dipel 2x® treated larvae showed significantly higher enzyme activity but decreased in the case of Jasper® followed by Hamer® treatment after 24 h post-treatment in comparison to control (Table 4).

b- Glutathione S-transferase (GST) Activity:

Bioinsecticides Dipel 2x® treated larvae significantly increased the GST enzyme activity after 48 h post-treatment in comparison to control. But treatment with insecticides higher enzyme activity in Hamer® followed by Jasper® in comparison to control (Table 4).

Obtained results showed a significant increase in the enzyme activity of (AChE) after 48 h exposure to Dipel 2x® 421 μg ACh Br/min/ml compared with control 400 μg Ach Br/min/ml. But in case of both insecticides (Jasper® and Hamer®) decreased in

AChE enzyme activity was observed 310.6 and 357 µg ACh Br/min/ml), respectively compared with control 394.5 µg ACh Br/min/ml., after 24 h exposure. The obtained results are in agreement with those found by Abo Elghar (2005) who stated that AChE enzyme activity decreased in field strains than that of the susceptible strain against cotton leafworm. Generally, AChE from the field strain exhibited a higher insensitivity to the organophosphorus insecticides than the carbamate insecticides. The present study disagreement with those found by (Nour El-Hoda, *et, al,.2012*) showed significantly higher AChE enzyme activity in chlorpyrifos and profenophos-treated field strain than the (Lab-susceptible) strain.

Table 4: AChE and GST enzyme activity in 3rd instar larvae of *S. littoralis* (Field strain) using bioinsecticids and insecticides compounds

Tested Compounds	AChEactivity (µg Ach Br/min/ml) (Mean ±S.D)	GST activity (µmole/min/ml) (Mean ±S.D)
Dipel 2x®	421±14.7^{a}	77.6 ± 6.2^{b}
Control*	400.66 ±12.35^{a}	50.6 ± 4.25^{c}
Jasper®	310.6 ± 3.5^{c}	70.6 ± 4.1^{b}
Hammer®	357 ± 9.3^{b}	111.6 ±1.2^{a}
Control**	394.6 ± 7.4^{a}	69.6 ± 3.2^{b}
F values	25.39***	49.73***
L.S.D.	29.0399	11.780

-Means of the same column followed by different letters are significantly different, P≤0.05.
*after 48 hours ** after 24 hours

Glutathione S-transferase (GST) is a group of soluble detoxification enzymes that catalyze the conjugation of reduced glutathione with various compounds containing an electrophilic center, including insecticides (Wilce and Parker, 1994). The present study showed a significant increase in the enzyme activity of (GST) after 48 h exposure to Dipel 2x® 77.6 µmole/min/ml compared with control of 50.6 µmole/min/ml. Insecticides (Jasper® and Hamer®) caused a significant increase in the GST enzyme activity after 24h post-treatment 70.6 and 111.6 µmole/min/ml., respectively compared with control 69.6 µmole/min/ml. The obtained results are agreement with those found by (Nour El-Hoda, *et al.*, 2012). Higher activity of glutathione-S-transferase (GST) has been observed in chlorpyrifos and profenophos- treated field strains, over that of the lab-strain of PBW larvae. The obtained results are in disagreement with those found by Wang *et al.* (2009) found that GST might be not important in conferring spinosad resistance in the *S. exigua* field population. Results are disagreement with Hamama and Fergani (2019) who recorded a decrease in GST enzyme activity after treatment of 3rd instar larvae laboratory to thiacloprid, indoxacarb, and *Bacillus thuringiensis*, Emamectin benzoate did not affect GST enzyme activity.

CONCLUSION

The outcome of these studies may help in proper insecticide selection for better insecticide resistance management.

REFERENCES

Abd El-Kareem, S. M. and Ibrahim, A. A. (2015). Evaluation of Protecto® and Lannate® against the Greater Sugar-cane Borer, *Sesamia cretica* Lederer (Lepidoptera:

Noctuidae) in Corn Fields in Egypt. *Egyptian Journal of Biological Pest Control*, 25(1), 183-184.

Abou- El-ghar,G.E, Zeinab,A.E; Adel, G.Y and Hany,A.E (2005) Monitoring and Characterization of Insecticide Resistance in the Cotton Leafworm, Spodoptera littoral is (Boisd.) (Lepidoptera: Noctuidae). *Journal of Asia-Pacific Entomology* 8(4):397-410

Abou-El-Kassem, A. B. (2010). Ecological and biological studies on some insects of sugar beet plants at Kafr El-Sheikh governorate. Ph.D. Thesis, Faculty of Agriculture, Kafr El-Sheikh University., pp. 221.

Amin, T.R. (1998). Biochemical and physiological studies of some insect growth regulators on the cotton leafworm, Spodoptera littoralis (Boisd.). Ph.D. thesis, Faculty of science, Cairo Univ.

Brunner,J.F; Beers, E. H; Dunley, J. E.; Doerr, M. and Granger,K(2005): Role of neonicotinyl insecticides in Washington apple integrated pest management. Part I. Control of lepidopteran pests**.** *Journal of Insect Science*. 2005; 5: 14.

BSRI. (2005). Sugar beet cultivation in Bangladesh. Bangladesh Sugarcane Research Institute, Ishurdi. . P. 10.

Clark A.G., Shamaan N.A., Sinclair M.D., Dauter-man W.C. (1986): Insecticide metabolism by multiple glutathione S-transferases in two strains of the house fly Musca domestica (L.). *Pesticide Biochemistry and Physiology*, 25: 169–175

Darabian,K. and Yarahmadi , F.(2017). (2017): Field Efficacy of Azadirachtin, Chlorfenapyr, and *Bacillus thuringensis* against *Spodoptera exigua* (Lepidoptera: Noctuidae) on Sugar Beet Crop. *Journal of the Entomological Research Society.*, 19(3): 45-52.

Dunbar, D.M.; D. S. Lawson; S. M. White; P. N. Dugger and D. Richter, (1998). Emamectin benzoate control of *Heliothis* complex and impacton beneficial arthropods. In: Belt wide cotton conference, San Diego, California, Proceedings, USA.V2, PP. 1116-1118.

El-Geddawy, A. M. H.; Ahmed, M. A. I.; Mohamed, S. H. (2014). Toxicological evaluation of selected biopesticides and one essential oil in comparison with Indoxacarb pesticide on cotton leafworm, *Spodoptera littoralis* (Boisd.) (Lepidoptera: Noctuidae) under laboratory conditions. *American- Eurasian Journal of Sustainable Agriculture*, 8 (2): 58–64.

El-Mahalawy, N. A. (2011). Ecological and biological studies on some sugar beet insects. M. Sc. Thesis, Facultyof Agriculture., Tanta University. 178pp.

El-Zoghbey, A. A., F. A. Atalla and A. H. Mesbah. (2003). Effect of two biocides in controlling Cassida vittata (Vill.) and Spodoptera littoralis (Boisd.) infesting sugar beet plants. *Annals of Agricultural Science Moshtohor*. 41(1): 335-342.

Fetoh, B E. A.; Mohamed, S. A and Seleman, L. E. M. (2015): Field and semifield applications for bio and chemical pesticides on cotton leaf worm, *Spodoptera littoralis* (BOISD.) (Lepidoptera: Noctuidae). *Journal of Plant Protection and Pathology.*, *Mansoura University*., Vol. 6 (11): 1471 – 1478.

Fournier D., Bride J.M., Poirie M., Berge J.B., Plapp F .W.(1992): Insect glutathione S-transferases: Biochemi-cal characteristics of the major forms from houseflies susceptible and resistant to insecticides. *The Journal of Biological Chemistry*, 267: 1840–1845.

Grant D.F., Matsumura F. (1989): Glutathione S-trans-ferase 1 and 2 in susceptible and insecticide resistant Aedes aegypti. *Pesticide Biochemistry and Physiology*, 33: 132–143

Hamama, H. M.; Hussein, M. A.; Fahmy, A. R.; Fergani, Y. A.; Mabrouk, A. M. and

Farghaley, S. F. (2015). Toxicological and biochemical studies on use of neonicotinoids and bioinsecticides against the Egyptian cotton leaf worm. *Spodoptera littoralis* (Boisduval) (Lepidoptera: Noctuidae). *Egyptian Journal of Biological Pest Control.* 25(3): 525-533.

Hamama, H.M., and Fergani,Y.A.(2019).Toxicity and oxidative stress induced in *Spodoptera littoralis* (Boisduval) (Lepidoptera:Noctuidae) treated with some insecticides. *African Entomology*,27(2):523-531.

Henderson, C. F. and Tilton, E. W. (1955). Tests with acaricides against the brown wheat mite. *Journal of Economic Entomology.* 48: 157-161.

Habig, W.H.; M.J.Pabst and W.B.Jakoby (I974). Glutathione S-transferase. the first enzymatic step in mercapturic acid formation. *Journal of Biological Chemistry.*,249:7130-7139.

Jat, G.C. , Swaminathan, R., Yadav,P.C, Swati, Deshwal, H.L, Suman Choudhary and Suresh Kumar Yadav.2017.Relative Efficacy and economics of bio pesticides against *S.litura*(Fab.) on Cabbage.*International Journal of Current Microbiology and Applied Sciences*.6(6):1853-1866.

Muhammad, Q.; Dilbar, H, Saif, U. I, Habib, A, Waqar I, Mubasher, H, Fangfei, W and Liande, W (2018). Effectiveness of Trichogramma chilonis Ishii against spiny bollworm in Okra and susceptibility to insecticides. *Journal of entomology and zoology studies.* 6(1): 1576-1581.

Muthukumar, M.; Sharma, R. K. and Sinha, S. R. (2007) Field efficacy of biopesticides and new insecticides against major insect pests and their effect on natural enemies in cauliflower. *Pesticide Research Journal*,19 (2):190-196.

Nour El-Hoda A. Zidan, Jehan B. El-Naggar, Safwat A. Aref and Madeha E. El-Dewy (2012): Field Evaluation of Different Pesticides against Cotton Bollworms and Sucking Insects and Their Side Effects. *Journal of American Science*, 8(2):128-136 http://www.americanscience.org

Nukala, N. K; Acharya, M. F.; Srinivasulu, D. V. and Sudarshan, P. (2015): Bioefficacy of Modern Insecticides against *Spodopteralitura* Fabricius on Groundnut. *International Journal of Agriculture Innovations and Research*, Volume 4, Issue 3, ISSN (Online) 2319-1473

Obeng-Ofori, D. and Sackey,J.(2003):Field evaluation of non-synthetic insecticides for the management of insect pests of okra abelmoschus esculentus(L.) moench in Ghana, Faculty of Science, Addis Ababa University,SIENT: *Ethiopian Journal of Science*,26(2),145-150.

OEPP/EPPO (1981): Data sheets on quarantine organisms.EPPO list A2. Quadraspidiotus perniciosus (Comstock). *Bulletin OEPP*: 111:1-4.

Pedigo L.P. (1996): Entomology and Pest Management. 2nd Ed. Englewood Cliffs, Prentice-Hall.

Radwan, M.A., Abu-Elamayem, M.M., Kassem, Sh.M.I and El –Maadawy, E.K.,(2004). Management of *Medoidogyne incognita*, root knot nematode by integration of *Bacillus thuringiensis* with either organic amendments or carboofuran. *Pakistan Journal of Nematology*, 22:135-142.

Rashid, M. M. (1999). Sabji Biggan (in Bengali), Rashid Publishing House, 94, Old DOHS, Dhaka. P. 455.

Reidy G.F., Rose H.A., Visetson S., Murray M. (1990): Increased glutathione S -transferase activity and glu-tathione content in an insecticide-resistant strain of Tribolium castaneum(Herbst). *Pesticide Biochemistry and Physiology*, 36: 269–276.

Rumpf, S., Hetzel, F., Frampton, C. (1997). Lacewings (Neuroptera: Hemerobiidae and

Chrysopidae) and inte-grated pest management: enzyme activity as biomarker of sublethal insecticide exposure. *Journal of Economic Entomology*, 90: 102–108.

Russell, R. J.; Claudianos, C.; Campbell, P. M.; Horne, I.; Sutherland, T. D. and Oakeshott J. G. (2004). Two major classes of target site insensitivity mutations confer resistance to organophosphate and carbamate insecticides. *Pesticide Biochemistry and Physiology* 79: 84-93.

Said, A. A. A., Shaheen, F. A. H. ;Sherief, E. A. H; and Fouad, H. A. M (2012). Estimation of certain compound against cotton leafworm, *spodoptera littoralis* (Boisd.) on sugar beet plants. *Journal of Plant Protection* and *Pathology Mansoura Univ.*, 3 (12): 1321 – 1330.

Salem, S. A. R. (2011). Studies on the effect of *Bacillus thuringiensis* as a microbial control agent against the greater sugar-cane borer, *Sesamia cretica* (Lederer). M. Sc. Thesis, Fac. Sci. (Qena), South Valley Univ., 122pp.

Simpson, D.R.; D.L. Bulland D.A. Linquist (1964): A semimicrotechnique for estimation of cholinesterase activity in boll weevils. *Annals of the Entomological Society of America.*, 57: 367-371.

Tong, H; Qi, S;and Zhou,X. (2013) Field resistance of *Spodoptera litura* (Lepidoptera: Noctuidae) to organophosphates, pyrethroids, carbamates and four newer chemistry insecticides in Hunan, *China Journal of Pest Science* (2013) 86:599–609.

Wang, D.; X.Qiu; X. Ren; F. Niu and K. Wang (2009). Resistance selection and biochemical characterization of spinosad resistance in *Helicoverpa armigera* (Hübner) (Lepidoptera: Noctuidae). *Pesticide Biochemistry and Physiology* , 95 (2): 90–94.

Wilce, M. C. and W. Parker (1994). Structure and function of glutathione S-transferases. *Biochimica et Biophysica Acta*., 1205(1): 1-18.

Yasmin, E.F. (2019): Field evaluation of selected oxadiazine insecticide and bacterial bio-insecticides against cotton leaf worm, *Spodoptera littoralis* (Boisduval) (Lepidoptera:Noctuidae) infesting sugar beet (Beta vulgaris L). *Egyptian Journal of Agricultural.*, 97 (1):137-145.

Zhu, K.Y.; Gao, J.R. and Starkey, S.K. (2000). Organophosphate resistance mediated by alterations of acetyl cholinesterase in resistant clone of the green bug, Schizaphis graminum (Homoptera: Aphididae), *Pesticide Biochemistry* and *Physiology*., 68:138–147.

ARABIC SUMMARY

الدراسات الحقلية والبيوكيميائية للمبيدات الحيوية والكيميائية على دودة ورق القطن علي بنجر السكر

داليا السيد محمد لطفي[١]- السيد اسماعيل امبابي[٢]
١- معهد بحوث وقايه النباتات- مركز البحوث الزراعيه – الدقى - الجيزة
٢-المركز القومي للبحوث- قسم امراض النبات – الدقى - الجيزة

تعتبر دودة ورق القطن من آهم آلآفآت الحلقية الخطيرة آلتي تؤثر على العديد من النباتات الاقتصادية وقد تم استخدام دايبل تواكس كمبيد حشري حيوي والهامر والجاسبر كمبيدات كيميائية لمكافحة هذة الافة خلال الموسمين ٢٠١٨- ٢٠١٩علي نبات بنجرالسكر بكفر الشيخ. أظهرت النتائج أن عدد يرقات دودة ورق القطن خلال كلا الموسمين انخفض بعد استخدام المبيدات الكيميائية. حيث تم تسجيل أعلى نسبة انخفاض في الإصابة مع جاسبر يليه هامر ثم دايبل تواكس وسجلت ٩٦,٣٠ ٪ ، ٩٠,٠٦ ٪ ، ٨٠,٣٢ ٪ ، ٧٨,٧٠ ٪ و ٦٨,٥٢ ٪ ، ٦٧,٣١ ٪ مع جاسبر ، هامر و دايبل تواكس خلال عامي ٢٠١٨ و ٢٠١٩ ، على التوالي. كان الانخفاض الكلي في نسب الإصابة ٨٧,٧٨ ٪ ، ٨٦,٤٦ ٪ ، و ٦٤,٧٦ ٪ ، ٦٠,٧١ ٪ و ٥٣,٦٧ ٪ ، ٤٩ / .١٠ ٪ جاسبر وهامرو دايبل تواكس خلال مواسم زراعة بنجر السكر ٢٠١٨ و ٢٠١٩ ، على التوالي. كان لنشاط إنزيم الأسيتيل كولينستراز وأنزيم الجلوتاثيون دورًا مهمًا في الاستجابة المناعية عند معاملة السلالة الحقلية ليرقات ا لعمر الثالث لحشرة دودة ورق القطن، حيث كشفت النتائج ان دايبل تواكس كان المبيد الحيوي الأكثر تاثيرا علي الحشرة يلية مركب الهامر ثم الجاسبر بين المبيدات الحشرية محل الدرسة.