International Journal of Agriculture and Plant Science
www.agriculturejournal.in
Online ISSN: 2664-7664, Print ISSN: 2664-7656
Received: 15-12-2024, Accepted: 14-01-2025, Published: 29-01-2025
Volume 7, Issue 1, 2025, Page No. 100-103

Effect of using some chemical control methods and plant extract on response of three soybean genotypes to *Spodoptera littoralis* (Boisd) infestation, in Dakahlia Governorate, Egypt

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Abstract
This study focused on evaluating three soybean genotypes (Giza 35, Giza111 and Crawford) to infestation with *spodotera littoralis* and the effectiveness of lemongrass plant extract, compared with chemical and biological insecticides against *S. littoralis* larval instar under field condition. Results showed that when treating the second instar larvae of *S. littoralis* the efficiency of the chemical insecticide was (86%) and bio insecticide was (55.53%) respectively after the first day of treatment, compared to the repellent effect of lemongrass extract (43.11%), while after the third day of spraying, the effect of lemongrass extract increased to (70.46% respectively) which gave repellent effect on the (2^{nd} and 4^{Th}) instar larval, compared with biological insecticide (Agerin) in all varieties of soybeans under study. The results clearly showed that there were significant variations for the effect of either Soybean varieties or insecticides sources in the percentage of *S. littoralis* mortality. For the effect of the interaction between insecticides sources and Soybean variety there was moderate significant variation in percentage of *S. littoralis* mortality and repellent effect.

Keywords: Soybean genotypes, *Spodoptera littoralis*, lemongrass extract, insecticides

Introduction
Soybean is one of important Egyptian agricultural crops in terms of food and industry, it containing about 40% of protein which is similar in its nourishing value to the animal protein and 30% of cholesterol free oil (El Agroudy and Mokhtar 2011). This plant was attacked by several insects such as aphids, spider mites, cotton leaf worm and many other pests but *Spodoptera littoralis* (Boisd) (Lepidoptera: Noctuidae) is considered the major pest throughout its growing season (Kandil *et al.*, 2003) [10]. An environment and different organisms have many problems caused by chemical insecticides at present time, one of the solutions to reduce the use of pesticides and over the past 40 years is the natural control, the intensive use of broad-spectrum insecticides against the cotton leaf worm had led to the development of resistance to many of them (Smagghe *et al*., 1999 [16]; Aydin and Gurkan, 2006 and Rizk *et al*., 2010) [14]. Many researchers have demonstrated that many plants are rich in resources that can be used as pest control agents. Some plant extract can be used as insect repellents, toxic substances and as regulators, growth regulators and Antifeedant for many pests, including cotton leafworm (Arivudainambi, 2001 [1]; El-Kholy and Shaheen, 2004 []; El-Sinary *et al*., 2008 [6]; Ragaei and Sabry, 2011; El-Zoghby *et al*., 2011) [7]. This study aimed to evaluate the toxic effect of lemongrass extract compared with chemical and biological insecticides against *S. littoralis* larval instar under field condition.

Materials and Method
1. Field experiments
This study was conducted at Taj A-Ezz Research station in Dakahlia governorate during the season 2022. The soybean varieties were sown on March and April in 2022 summer season, respectively. An area about tow Fadden was cultivated with three soybean genotypes. An area of about 700M^2 was chosen of each cultivar to evaluate the bio and pesticides. Planting of each cultivar was chosen in three replicates; one replicate was free from any pesticide treatment (Control). Alive larvae were recorded in check and treatments area before application and reduction percentage was evaluated according to Henderson and Tilton formula, (1955) after1, 3, 5 and 7 days from spraying for *S. littoralis* by assigned treatments according to the formula:

$$\text{Reduction (\% mortality)} = \frac{[(\text{Cb X Ta}) - 1]}{Ca \text{ X } Tb} \text{ X } 100$$

Where:
Cb= number of alive pest individuals in control before treatment.
Ca= number of alive pest individuals in control after treatment.
Ta= number of alive pest individuals after treatment.
Tb= number of alive pest individuals before treatment.

L.S.D. values were calculated by Costat program (Costat Software, 1990) [3]. Spraying was carried out at seedling and vegetative stages and directed to the plants at the morning hours in season. The aim of the present study was to evaluate three soybean varieties (Giza 111, Giza 35 and Crawford) to *S. littoralis* infestation and its control by using three treatments of two insecticides a chemical (Indoxacarb) 30% WG and biological (Agerin) 6.5 % (*Bacillus thuringiensis* var) in addition to using lemongrass extract as one of the honest natural control methods beside water as control.

2. Preparation of plant extracts lemongrass
Lemongrass leaves were dried at room temperature for one month and then grinded by an electric grinder. The plants powder was soaked in a roughly a week in an equal mixture

hexane, acetone and ethanol solvents proportion (1:1:1) before the flask was shaken and its contents were filtered. The solvents were then removed under decreased pressure and the crude extract was weighted and stored in a deep freezer until used.

3. Preparing the stock solution the tested plant extracts

Convenient stock quantities of extract were made with tween 80 (0.1%) as emulsifier basis on the measured plant weight and the volume of the distilled water (w/v). The stock concentration was kept in glass bottles with stoppers and refrigerated store. These stock solutions were created on a regular basis. There were three replicates for concentration for plant extract.

Results and Discussion

1. Toxicity Effect of some insecticides and treated Lemongrass extract on *Spodoptera littoralis* under field condition

The study clear indicated the efficiency of the chemical and bio insecticides after the first day of treatment, compared to the effect of lemongrass extract, while after the third day of spraying, the effect of lemongrass extract was significantly increased compared with biological insecticide (Agerin) in all varieties of soybeans when treating the second instar larvae of *S. littoralis* according to Table (1). The study demonstrated that the efficiency of the chemical insecticide was (86%) and bio insecticide was (55.53%) after the first day of treatment, respectively compared to the effect of lemongrass extract (43.11%), while after the third day of spraying, the repellent effect of lemongrass extract was observed increased (70.46% respectively), compared with biological insecticide (Agerin) in all varieties of soybeans under study. Data in Table (1) showed that mortality increased with increasing days after treatment with pesticides meanwhile, the repellent effect to lemongrass extract had also increased after the third day of treatment. The obtained results in Table (1) also illustrated that there were highly significant in total mortality percentage for the second instar larvae of *S. littoralis* for Indoxacarb, Agerin and lemongrass extract it was 95.23%, 70.21% and 58.36% respectively. The genotype Giza 111 percentage of total mortality after one, three, five and seven days for treatments were 66.54%**,** 80.60%**,** 82.30% and 79.90% respectively, followed by Giza 35genotype which was 63.00%, 80.10%, 79.83 % and 79.86% respectively. Meanwhile**,** the lowest total mortality for Indoxacarb, Agerin and repellent effect of lemongrass extract was Crawford genotype it was 55.10%, 77.16 %, 73.40% and 77.43% respectively. Also, there were significant effects between the different varieties in average percentage of mortality. On the basis of 2-way ANOVA analysis, the data in Table (1) indicated that there were significant differences for the effect of either Soybean varieties or insecticides sources in percentage of mortality in *S. littoralis* (F= 3193.32, df=2, P= 0.000*** for Insecticides sources, F=104.717, df=2, P=0.000*** for Soybean variety). For the effect of the interaction between insecticides sources and Soybean variety there was moderate significant variation in percentage of *S. littoralis* mortality (F= 6.3563, df= 4, P=0.0023**).

Table 1: Corrected mortality percentage of the second instar *S. littoralis* treated with two insecticides and lemongrass extract under the field condition on three soybean genotypes

Insecticides sources	Soybean variety	Mortality (%)				Average (%) in the first season
		One day	Three days	Five days	Seven days	
Indoxacarb 30% WG	Giza 111	88.00	99.10	100	100	96.70
	Giza 35	85.10	98.50	100	100	95.90
	Crawford	84.90	94.10	94.60	98.70	93.10
Mean		86 c	97.23 b	98.20 ab	99.57 a	95.23 A
Agerin 6.5% Wp	Giza111	64.60	71.30	78.20	80.00	73.52
	Giza35	59.50	70.50	78.60	80.00	72.15
	Crawford	42.50	68.70	71.40	77.30	64.97
Mean		55.53 c	70.16 b	76.06 ab	79.1 a	70.21 B
Lemongrass extract 10%	Giza 111	47.04	71.40	68.80	59.90	61.78
	Giza 35	44.40	71.30	60.90	59.60	59.05
	Crawford	37.90	68.70	54.20	56.30	54.27
Mean		43.11 d	70.46 a	61.30 b	58.60 c	58.36 C
Average of soybean variety	Giza111	66.54 A	80.60 A	82.30 A	79.90 A	77.33
	Giza 35	63.00 A	80.10 A	79.83 A	79.86 A	75.69
	Crawford	55.10 B	77.16 B	73.40 B	77.43 B	70.77
2-way ANOVA		Df	III SS	F	P	
L.S.D.5% Insecticides source		2	6386.655	3193.32	0.000***	
L.S.D.5% Soybean variety		2	209.4352	104.717	0.000***	
L.S.D. 5%Interaction		4	25.425	6.3563	0.0023**	

ns= non- significant

*=significant

***=highly significant

Means followed by the same capital letter in a column between the different Soybean varieties and between the different averages of insecticides mortality while the same small letter in a row between the different mortality averages in days

The obtained results in Table (2) showed that the total mortality percentage of the fourth instar larvae of *S. littoralis* treated with Indoxacarb, Agerin and lemongrass extract was highest in Giza 111 genotype it was 95.05 %, 67.52% and 57.5% respectively, followed by Giza 35 genotype it was 94.5%, 65.92% and 56.1% respectively Meanwhile, the lowest total mortality for Indoxacarb, Agerin and the repellent effect lemongrass extract was recorded for Crawford genotype as it was 93.2%, 64.57% and 52.82 % respectively. From the data illustrated in tables

(2) it became clear that Giza 111genotype was highly significant in mortality percentage of fourth instar to cotton leafworm *S. littoralis* it was 73.19% followed by Giza 35 variety it was 71.68%, while the Crawford variety is lost in average percentage of mortality to the cotton leafworm it was 69.89% respectively. Also, the date in tables (2) indicated that the chemical insecticide Indoxacarb had the highest total mortality 94.25%, followed by the biological insecticide Agerin, 66 %, while the lemongrass extract gave a repellent effect 55.47%.

Table 2: Corrected mortality percentage of the fourth instar larvae *S. littoralis* treated with two insecticides and lemongrass extract under the field condition on three soybean varieties

Insecticides sources	Soybean variety	Mortality (%)				Average (%)
		One day	Three days	Five days	Seven days	
Indoxacarb 30% WG	Giza 111	85.10	95.10	100	100	95.05
	Giza 35	83.70	94.50	100	100	94.50
	Crawford	83.80	94.70	94.60	100	93.20
Mean		84.20 c	94.77 b	98.20 a	100 a	94.25 A
Agerin 6.5% Wp	Giza111	53.60	68.50	72.20	75.80	67.52
	Giza35	50.60	66.10	71.60	75.40	65.92
	Crawford	48.80	65.60	70.40	73.50	64.57
Mean		51.00 d	66.73 c	71.4 b	74.9 a	66.00 B
Lemongrass extract 10%	Giza 111	44.70	68.40	59.1	57.80	57.5
	Giza 35	43.70	67.30	57.1	56.30	56.1
	Crawford	43.80	62.70	52.9	51.90	52.82
Mean		44.07 c	66.13 a	56.36 b	55.33 b	55.47 C
Average of soybean variety	Giza111	60.47 A	77.33 A	77.10 A	77.86 A	73.19
	Giza 35	57.33 B	75.96 A	76.23 A	77.23 A	71.68
	Crawford	57.47 B	74.33 A	72.63 B	75.13 A	69.89
2-way ANOVA		Df	III SS	F	P	
L.S.D.5% Insecticides source		2	7237.154	3618.577	0.0000***	
L.S.D.5%Soybean variety		2	45.87926	22.93963	0.0000***	
L.S.D. 5%Interaction		4	7.241533	1.810383	0.1708 ns	

Means followed by the same capital letter in a column between the different Soybean varieties and between the different averages of insecticides mortality while the same small letter in a row between the different mortality averages in days

On the basis of 2-way ANOVA, the data in Table (2) clearly indicated that there were significant variations for the effect of either Soybean varieties or insecticides sources in percentage of mortality in *S. littoralis* fourth instar (F= 3618.577, df=2, P=0.0000*** for Insecticides sources, F=22.93963, df=2, P=0.0000*** for Soybean variety). For the effect of the interaction between insecticides sources and Soybean variety there was no significant variation in percentage of *S. littoralis* fourth instar mortality (F=1.810383, df=4, P=0.1708 ns).

Closed to the results of mortality to different insecticide sources, these results are in agreement with Rajapaksa and Ratnasekera (2008) who used some plant oils obtained from leaves of lemongrass and they were used to protect stored legumes against cowpea weevil and bean seed weevil and it caused a significant adult mortality and reduce egg production. Ghoneim *et al.,* 2012 [8] and Reda *et al.,* 2013 [13] proved that the *S. littoralis* could be affected by plant extracts and their active ingredients. Shenoda (2013) [15] mentioned that the lemongrass extract in water at 10% conc. on the 2nd larval instar and lantana extract in water at 10% conc. on 4th larval instar were the highest in efficacy as antifeedants, the highest mortality percentage was attained from the lemongrass extract in acetone 10% treatment against both the 2nd and 4th larval instars, respectively. Walaa *et al.,* 2023 [17] indicated that *S. littoralis* could be affected by plant extracts under field condition.

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