International Journal of Applied and Pure Science and Agriculture
ISSN Online - 2394-5532 Impact Factor: 3.762 by SJIF ISSN Print - 2394-823X

Population Fluctuation Of *Earias insulana* (Lep. Noctuidae) Infesting Three Cotton Varieties Under Sprayed And Unsprayed Conditions

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Abstract

This experiment was conducted on cotton Gossypium barbadense L. on two localities in Behira and Beni-Sueif governorates through the period from June to September of two successive cotton seasons 2014 & 2015 to evaluate the performance of sex pheromone and light traps for studying the population of Earias insulana under insecticide application. The tested varieties were Giza 70 and Giza 88 at Behira governorate and Giza 80 at Beni-sueif governorate. Data revealed that the larval population density increased during August on both check and treated plants through the two seasons in the two governorates. Larval population density was higher in check plants than on treated ones. Also data clearly showed that the moth population density was higher in the pheromone traps than in the light traps in spite of the moths were male only. The highest adult population density was recorded in Giza 80 at Beni-sueif governorates at 29.3 °C & 48 % R.H in 2014 season and 31.5 °C & 52.8 % R.H in 2015 season. Statistical analysis revealed significant differences among the cotton varieties, where the lowest larval population density was recorded on Giza 88 (12.9) followed by Giza 70 (14.8) in Behira governorate at an average of 24.1°C & 65 R.H in 2015 season.
Keywords: Bollworms, cotton varieties, Earias spp, sex pheromone.

I. Introduction

Cotton (*Gossypium* spp.) (Malvaceae) is the most important industrial crop worldwide with an area of 33.1 million hectares planted in 2013-14 [1][2]. The cotton varieties differ significantly among themselves with regards to the infestation of insect pests [3] [4] [5] [6] [7] [8] [9]. In Egypt, cotton plants like most field crops are attacked by a lot of lepidopterous pests [10]. The spiny bollworm, *Earias insulana* Boisduval. (Lep.: Noctuidae) causes a threat to cotton and is considered as mid-late season pest [11]. The larvae mainly feed on fruiting parts of the cotton plant, the soft and growing tissues especially the terminal buds and cause "top boring" and later on they attack the flower buds and bolls which ultimately shed [12] [13], resulting in considerable losses in quantity and quality [14].

The *Earias* spp are a devastating pest which reduces cotton yield up to 40 % as seed cotton and qualitatively up to 50 % by staining lint [15]. Most of the control strategies are directed to bollworms [16] [17] [18]. Various insecticides belonging to different classes, including organophosphate, pyrethroid and novel chemical are used to manage *Earias* spp infestations [19] [20] [21] [22] [23]. However, the extensive use of these insecticides has led to many serious problems like development of insecticide resistance, destruction of beneficial fauna and environmental pollution] 24] [25] [26] [27]. In order to counter these problems [28] devised an IPM strategy that controlled early and mid-season boll worm complex with two applications of a combination of endosulfan and dimethoate and *Pectinophera gossypiella* by mating disruption. They observed increase in beneficial insects and mid-season insecticide applications were sufficient to control *Heliothis armigera* and the *Earias* spp. However, significant reductions in pesticide applications were not achieved due to the need to control other cotton pest's complex particularly spiny bollworm, *E. insulana* and spotted bollworm, *E. vittella* [29] Critchley *et al*., 1991).

Sex Pheromone was used for monitoring and controls the spiny boll worm[30]. The attraction of *E. insulana* male moths to sex attractant was demonstrated by [31]. Following the identification and synthesis of the female sex pheromones of *E. insulana* [32] and *E. vittella* [33] small plot trials in

Pakistan indicated that all three bollworm species could be controlled by mating disruption by a single, early season application of their combined pheromones **[**34**]**. Also the sex pheromone of *E. insulana* was used as monitoring and control tools by mass trapping this insect in Syria **[**35**]**. The pheromones of *Earias* spp., (*E, E*)-10, 12-hexadecadienal, and the recent upsurge in prominence of pesticide resistant *Helicoverpa armigera* **[**36**]**.

The present study aims to investigate the population density and fluctuation of larvae and moths of the spiny bollworm, *E. insulana* at two governorates Behira and Beni-Sueif through two successive cotton seasons 2014 & 2015 using two varieties Giza 70 and Giza 88 at Behira governorate and Giza 80 at Beni-sueif governorate.

Light and pheromone traps were evaluated as tools of study the population of *E. insulana.* In addition, observation on the effect of temperature and relative humidity on the population of larvae adult moths in the studies localities under sprayed and unsprayed conditions.

II. Material and Methods

Field experiments were carried out at Beni-Suef (middle Egypt) and Behira (North-West of Delta) governorate in cotton fields. At Beni-Suef governorate Giza 80 Cultivar was used while at Behira governorate, Giza 70 and Giza 88 varieties were used. Each was cultivated in mid-March for two successive seasons (2014 & 2015) each in 1/2 feddan. This area was divided into two plots, one was treated by the recommended pesticides, pest pan, Tilton and sumi-gold and the other was untreated. Hundred cotton bolls were taken weekly at random from each plot. These samples were transferred to the laboratory in order to investigate the larval number. Rate of infestation *E. insulana* was calculated on the three tested cultivars throughout the two seasons, 2014 & 2015.

1- Stekam sex pheromone and light traps:

The Stekam sex pheromone traps containing pheromone [E (10) E (12) hexadecane dienal or E (10) (7) hexadecane dienalacerate] were used. Traps were situated 30 cm above the crop canopy height and they were distributed in cotton field 250 m apart. Pheromone capsules were replaced with fresh ones every 15 days. The captured moths were weekly counted and removed from the traps.

One ultraviolet light trap **(Robinson and Robinson** 250 watt) was utilized per experimental area from June till September. It was set on the roof of a village house at about 4 meters above the ground level. The collected moth's catches were counted at weekly intervals to determine the population density of the bollworm, *E. insulana* moths.

2- Certain weather factors:-

The weather factors considered in the present search were temperature and relative humidity, which were provided by the metrological Department at Agricultural Research center (ARC) at Dokki, Giza during the experiment period at seasons 2014 & 2015 to study the effect of them on the population fluctuations of the bollworm, *E. insulana*.

Statistical Analysis

The statistical analysis was carried out using ANOVA with two factors under significance level of 0.05 for the whole results using SPSS (ver. 19) and complete randomized design were used according to **[37]**. Multiple comparisons were carried out applying LSD.

III. Result and Discussion

Two techniques, sex pheromone and light trap have been applied to monitor the adult population and their response towards both techniques. The effect of treatment by insecticide on the population of larvae and adult moths was studied.

Data presented in Tables (1-3) revealed that during the two studying seasons (2014 & 2015) the larval population density of *E.insulana* was generally higher in 2014 season than 2015. In addition, the mean number of moths captured by sex pheromone traps was higher than those captured by the light trap during the two successive seasons, in Table (1) although the trapped moths were only males.

Data of the larvae and adult population of the cotton variety Giza 70 showed that in 2014 the least mean larval population density of check plants was recorded in June (19.4 larvae) at 27.8 °C & 58 % R.H. while the highest mean number was recorded in September (43.4 larvae). The lowest and highest mean numbers of larvae in the treated plants with 13.8 & 30.5 larvae were recorded in June and August, respectively (Table 1). In this season, the highest mean number of moth which were caught by sex pheromone and light traps, occurred in July and August (76.0 and 43.5 moths respectively) at 29.5 °C and 60.1 and 60 % R.H, while the lowest mean number of moths were 35 and 4.6 recorded in June, respectively at 27.8 °C & 58% R.H).

In 2015 season, the highest mean number of moths, caught by sex pheromone and light traps, occurred in August (96 and 49.3 moths, respectively) at 30.5 & 54.5 % R.H. While the lowest mean number of moths were 43.4 and 5.8 which obtained during June, respectively at 24.1 °C & 65 % R.H.

In both studying seasons, although pheromone traps caught only male moths but the mean population density of these males were higher than the mean population density of male and female moths caught by the light traps.

Statistical analysis during 2014 season, showed high significant differences between the larval population density in check and treated plots at all sampling dates (F values =17.4 and 26.3 and LSD = 9.7 and 5.3, respectively. There were no significant differences between the populations of moths caught by sex pheromone traps. On the other hand there were significant differences between the populations of moths caught by light traps in various sampling dates (Table 1).

Statistical analysis during 2015 season indicated high significant differences between the larval population density in check and treated plots at all sampling dates (F values = 29.8 and 57.2 and LSD=6.2 and 3.2), respectively. The differences among the population of moths caught by sex pheromone traps were significant and they were highly significant among the populations of moths caught by light traps at all sampling dates (F values-5.6 and 92.2 and LSD=16.4 and 8.6, respectively).

Table 1. Mean Population density of *E. insulana* larvae collected from cotton bolls and moths catches in pheromone & light traps at Behira Governorate throughout 2014 & 2015 on Giza70 cotton variety.

Sampling date		Mean of season 2014						Mean of season 2015					
		Larvae		Trapped moths		Weather factors		Larvae		Trapped moths		Weather factors	
		Check	treated	Sex pheromon	Light	Temp.	R.H	check	treated	Sex pheromon	light	Temp.	R.H
June	T	27	21	98	18	-	-	69	42	337	29.8	-	-
	X	19.4	13.8	35	4.6	27.8	58	14.8	9.0	43.4	5.8	24.1	65.0
July	T	119	69	436	153	-	-	115	47	439	107	-	-
	X	82.1	23	76.0	25.7	29.5	60.1	22.7	9.7	93.1	20.5	27.8	61
August	T	163	92	427	248	-	-	141	58	453	231	-	-
	X	54.03	30.5	43.5	46.7	30.4	62	33.5	20.3	96	49.3	30.5	54.5
Sept.	T	99	59	271	181	-	-	79	52	325	159	-	-
	X	43.4	15.9	43.8	42	27.5	53.3	20	15.7	80.1	47	29.8	58.5
F		17.4***	26.3***	19.5	3.8	-	-	29.8***	57.2***	5.6	92.2	-	-
LSD		9.7	5.3	17.9	8.9	-	-	6.2	3.2	16.4	8.6	-	-

T (Total) – X (mean)

Table 2 showed that the least mean number of larval population density, On Giza 88 cotton variety recorded in 2014 and 2015 seasons was 10 & 8 and 12.9 & 9.0 larvae in June on check and treated plants, respectively.

In 2014, the highest mean larval population density was obtained in August on both check and treated plants (28.3 & 16.3 Larvae) respectively. The highest larval population density in 2015 on

treated plots was 14.9 recorded in September. On the contrary, on check plants 31.7 larvae were recorded as the highest population density in August (Table, 2).

The lowest densities of moths obtained during June from sex pheromone and light traps which were 33.2 & 4.6 in 2014 season at 27.8 °C & 58 % RH. and 54&5.8 in 2015 season at 24.1°C & 65 % R.H. In 2014 season 75 moths were recorded as the highest population density in July for sex pheromone traps. While it was 43.9 moths in August for light traps.

Statistical analysis during 2014 season, showed significant differences between the larval population density in check and treated plots on various sampling dates (F values= 10.2 and 34.5 and LSD = 6.5 and 4.4 respectively). Oppositely highly significant differences were recorded between the population of moths caught by sex pheromone traps and light traps at all sampling dates (F values =17.6 and 2.6 and LSD =16.5 and 9.4, respectively).

Statistical analysis during 2015 season, indicated high significant differences between the larval population density in check and treated plots at various sampling dates (F values = 21.87 and 18.7 and LSD = 6.5 and 3.40, respectively. For traps, significant differences between the population of moths caught by sex pheromone traps were reported but highly significant differences between the population of moths caught by light Traps were calculated at various sampling dates (F values =7.5 and 92.3 and LSD= 16.2 and 8.7 respectively).

Table 2. Mean population density of *E. insulana* Larvae collected from cotton bolls and moths catches in pheromone & light traps at Behira governorate throughout 2014 & 2015 on Giza 88 cotton variety.

Sampling data		Mean of season 2014						Mean of season 2015					
		Larvae		Trapped moths		Weather factors		larvae		Trapped moths		Weather factors	
		Check	treated	Sex pheromon	Light	Temp.	R.H	check	treated	Sex pheromon	light	Temp.	R.H
June	T	24	19	96	13	-	-	63	37	321	27.9	-	-
	X	10	8	33.2	4.6	27.8	58	12.9	9.0	54	5.8	24.1	65
July	T	113	62	421	147	-	-	110	45	430	99	-	-
	X	18	13.5	75	22.6	29.1	55.1	21.6	8.9	86.6	19.7	27.8	61
August	T	157	90	419	235	-	-	137	53	441	221	-	-
	X	28.3	16.3	72.8	43.9	30.4	62	31.7	13.5	92.8	51.5	30.5	54.5
Sept.	T	96	52	263	175	-	-	75	49	315	167	-	-
	X	19.9	13.7	48.7	39.6	27.5	53.3	19.8	14.9	79.8	49.5	29.8	58.5
F		10.2	34.5	17.6	2.6	-	-	21.87	18.7***	7.5	92.3***	-	-
LSD		6.5	4.4	16.5	9.4	-	-	6.5	3.4	16.2	8.7	-	-

T (Total) – X (mean)

Data in Table (3) revaled that the lowers' larval mean population density at Beni- Sueif governorate on Giza 80 cotton variety in 2014 and 2015 seasons, was recorded in June (15 &13.3 and 16.7 and 10.7 Larvae) on check and treated plants respectively at 32.0°C & 48.6 % R.H during 2014 season and 29.9°C & 49.6 % R.H .during 2015 season. The highest mean larval population density was obtained in August (36 larvae) on check plots; while on treated plots in was 22.7 Larvae in September in 2014. The highest mean of larval population density was cited in August and it was 39.3 and 23.8 Larvae on check and treated plants, respectively in 2015 season.

In 2014 moths were recorded as the highest population density in August for sex pheromone traps with mean captured moths 83.7 while it was 43.9 moths for light traps.

The obtained results during June being 46.5 & 5.2 in 2014 season and 61.7 & 15 in 2015 season for sex pheromone and light traps respectively, at 29.3°C & 49.6 R.H. For the two types of traps, the lowest and the highest population densities were recorded in June and august respectively (Table3).

In 2014 season, the differences between the larval population density in check plots were significant and in treated plots were highly significant at various sampling dates (F values = 13.2 and 23.7 and LSD = 9.0 and 4.2, respectively). No significant differences between the population of moths caught by sex pheromone traps were recorded ,while highly significant differences between the population of moths captured by light traps were reported at various sampling dates (F values = 3.0 and 28.9 and LSD =22.8 and 12.5, respectively).

In 2015 season the differences were highly significant between the larval population density in check and treated plots at various sampling dates, the differences were significant between the population of moths caught by sex pheromone traps and highly significant between the populations of moths caught by light traps on various sampling dates.

Table 3 Mean population density of *E. insulana* larvae collected from cotton bolls and moths catches in pheromone and light traps at Beni- Sueif Governorate throughout 2014 & 2015 seasons on Giza 80 cotton variety.

Sampling data		Mean of season 2014						Mean of season 2015					
		Larvae		Trapped moths		Weather factors		Larvae		Trapped moths		Weather factors	
		check	treated	Sex pheromon	Light	Temp	R.H	check	treated	Sex pheromone	light	Temp	R.H
June	T	67	43	337	25	-	-	96	63	373	85	-	-
	X	15	13.3	46.5	5.2	32.0	48.6	16.7	10.7	61.7	15	29.9	49.6
July	T	115	71	391	145	-	-	131	78	493	125	-	-
	X	23	14.5	29.5	33.5	30.4	51.0	26.7	17.4	99.3	26.3	33.2	58.6
August	T	180	85	441	237	-	-	193	115	515	198	-	-
	X	36	17	83.7	43.9	29.3	48	39.3	23.8	106.6	37	31.5	52.8
Sept.	T	141	109	320	230	-	-	127	83	351	127	-	-
	X	22.7	-	-	-	31	47.5	35.5	27.2	71.5	33.2	29.1	59.1
F		13.2	23.7	3.0ns	28.9***	-	-	53.2	49***	45.3***	71.5***	-	-
LSD		9.0	4.2	22.8	12.5	-	-	5.8	4.5	20.6	9.9	-	-

T (Total) – X (mean)

In 2015 season the differences were highly significant between the larval population density in check and treated plots at various sampling dates, the differences were significant between the population of moths caught by sex pheromone traps and highly significant between the populations of moths caught by light traps on various sampling dates.

In general, the tested cotton varieties can be ranked in relation to the sensitivity to spiny bollworm infestation as follows, Giza70, Giza80, and Giza88. Therefore, Giza 88 is the most recommended cotton variety. It was observed from Tables (1-3) that the population of the spiny bollworm in Beni-Swif was higher than Behira with regard to larval or adults. It could be due to two reasons: (i) the availability of preferred stage of the cotton plants (ii) seasonal variation particularly the hot and dry weather. The cotton season is from mid-March - November and emergence of adult moths usually occurs in June.

The larvae and adult moths of cotton bollworm, *E. insulana,* were present throughout the cotton season (Table 1-3), from June-September (2014-2015) in studied localities, but the number of different bollworm seemed variable in both localities due to some variation in weather condition and availability of host plants.

The present results are considered in harmony with those obtained by **[38]**, in Egypt, who studied the population dynamics of *E. insulana* in cotton fields during 1994 and 1995 growing seasons, the

average male moths captured per night using pheromone trap was positively correlated with the rate of larval infestation of cotton bolls.

The study revealed that light trap catches proved the occurrence of the spiny bollworm, *E. insulana* moths all over the year, where the numbers were small in June, moderate in August-October and large in September. **[39]** determined the innate capacity of increase in numbers of *E. insulana* at 30 °C, 35 and 40 °C and 40, 70 R.H. optimum temperatures for the survival and development of different stages of the insect was 30 °C and moderate to low R.H conditions. The immature stages failed to develop at 40 °C .their development was faster at 35 °C but their survival was low at this temperature.

[40] indicated that the non-biotic components such as temperature, relative humidity and rainfall positively and negatively affect the spotted bollworm population; they further stated that highest infestation was recorded in those months when no rain fall was recorded. **[41]** found that rain fall of 2006 & 2007 and the graphic presentation of population of study in two localities Hala and Saeedabad, Hyderabd, Sindh, Pakistan, the adult moths of all four species of cotton boll worms, *E. insulana, E. vittella, P. gossypiella and H. armigera* affected on the population of all species which was low in 2006 than 2007 during July –September when there was heavy raining in both localities. [**42]** reported that a-biotic factors such as temperature and relative humidity are positively co-related to population of *Helicoverpa armigera* while rainfall is negatively co-related with it. They found the young cotton plants are preferable for oviposition and as soon as larvae hatched from eggs the immature green cotton bolls were present in the field and the number of bollworms was increasing from June to August with the maturing of cotton crop and reached to their highest peak in August that was the peak season of cotton crop (when cotton crop is fully matured) in both localities, the crop was full of matured cotton bolls.

Despite the fact that only male moths were caught by pheromones, the moth catches were significantly higher by pheromones than light trap which has both male and female catches. Therefore the sex pheromone traps were more effective for monitoring the population of the spiny boll worm. They are particularly very effective for *Pectinophora gossipiella* for which light trap was almost failed **[41]**. The adult caught of all (cotton varieties) species were high in both localities but was higher in Beni- Sueif than Behira governorate specially the variety of Giza 80 may be affected by a-biotic factor temperature and relative humidity.

The cotton varieties differ significantly among themselves with regards to the infestation of sucking and chewing types of insect pests **[43] [4] [5] [6] [44] [7] [8]**. The criterion of distinguishing varieties is the comparison of infestation level and very few studies revealed difference in other biological parameters such as life history and characteristics **[45] [46]** [**47]**.

The results of this study reveal success of using sex pheromone against cotton bollworms, *E. insulana.* A sex pheromone has been employed for reduction of bollworms infestation up to 30-46 % in field. This strategy is less expensive as compared with insecticides resulting in environment protection and safety for animal and human health .The reduced use of insecticides resulted in higher net return, environmental safety and conservation of beneficial insects **[48] [49]** [**50].** For future prospective, we recommended sex pheromone use to control the boll worms within the integrated pest management (IPM) rather than the complete reliance on insecticides. The feasibility of sustainable IPM approach should be demonstrated in other cropping systems especially vegetables and its large scale application is recommended based on promising results.

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