THE EFFECT OF SOME BIOTIC AND ABIOTIC FACTORS ON SEASONAL FLUCTUATIONS OF *HELICOVERPA ARMIGERA* (HUB.)

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Abstract

Studies were conducted to ascertain the effect of biotic and abiotic environmental factors on the seasonal population fluctuation of *H. armigera* and relationships of its eggs and larvae on cotton variety (Giza 86) during four successive cotton seasons (from 2005 to 2008) that extended from the first week of April to the last week of September at Zefta district, in Gharbia Governorate, Egypt.

Results showed that the *H. armigera* moths harboured to the cotton fields, as soon as, the cotton seedlings appeared. The moths have been existed in 4-5 main peaks with few minor peaks during the experimental seasons. The fruit cotton structures, (Receptors) began to emerge at the first half of May and continued to the end of the study period. Also, one to three main peaks of *H. armigera* eggs and larvae were existed per season. Statistically, multiple regression were judged by (full model) to predict the relationship between the dependent variables (eggs or larvae of ABW) that affected by four or five independent variables, lunar days, percentages of moon light, moths caught in light trap, eggs and cotton receptors, during 2005 to 2008 cotton seasons. The Analysis of Variance showed highly significant regression values between the expected eggs, larvae & trapped moths and lunar days, percent moonlight & the cotton receptors for the four experimental seasons. The expected eggs = (4.470) + (-0.121* lunar days) + (0.151*percent moonlight) + (1.023*moths) + (1.136*receptors). The expected larvae = (2.482) + (0.003*lunar days) + (-0.060*percent moonlight) + (-0.004*moths) + (0.342*eggs) + (-0.021*receptors) as average for the four seasons. The fit regression equation was represented with the r^2 values which were 0.554 and 0.949 & the total effect 55.41 and % 94.9 and sum of the deviations square were 3339.21 and 44.57, respectively. Therefore, the previous four or five independent factors can be used to forecast population of ABW eggs or larvae before appearing of its peaks on cotton plants by enough periods to organize control measures and apply the recommended pesticides when really needed.

Key words: *Helicoverpa armigera* (Hub.), American bollworm (ABW), Seasonal fluctuation & biotic and abiotic environmental factors.

INTRODUCTION

Cotton plays a vital role in economy of Egypt. *Gossypium barbadens* (L.) resembled other field crops to be attacked by a range of insect pests during its growing season. In Egypt, *Helicoverpa armigera* (Hub.) is polyphagous and causes substantial losses to various crops. In case of cotton, they attack flowers, squares and bolls.

Helicoverpa armigera (Hb.) is one of the most important economic insect pests of cotton in many parts of the world .The eggs and /or larvae of this polyphagous pest were recorded on more than 60 plant species belonging to 47 families including maize, sorghum, tomato, Lucerne, tobacco, cotton clover and cowpea (Fitt, 1989). Egg numbers of *H. armigera* were significantly higher on sunflower, okra and tomato than cotton, but larval numbers were not significantly differed from cotton at comparable time (El-Sayed, *et al.,* 2009). Direct damage to flowering and fruiting structures by larvae and extensive periodic insecticide applications resulted in low yield and high control costs. Many investigations suggested that generation's cycles of American bollworm (ABW) are synchronized with lunar cycles, independently of host plant phenology, climatic factors and accumulated heat units (Legaspi *et al.*, 1989, Zalucki *et al.*, 1994). An inverse relationship has been established between light trap catches of ABW moths and moon light with the highest trap catch occurring during new moon and lowest during full moon (Nemec, 1971, Bowden, 1973, and Youssef & Ismail, 1999). Sadanny *et al.* (1999) reported that mean air temperature and relative humidity were positively correlated with infestation, while Ragab (2009) reported that there were conspicuous positive correlation between the numbers of ABW moths and thermal heat units expressed as day-degrees accumulation. Ibrahim *et al.* (1994), Nada *et al.* (2004), Nada & Ragab (2010) and Nada *et al.* (2012) studied the relationship between population fluctuations of *H. armigera* as an important cotton pest and the physical environmental factors in Egypt. Also, Bilal Saeed Khan *et al.* (2003), K uldeep Singh *et al.* (2011) & Khalid Zafar *et al.* (2013 determined the effect of different weather factors on egg count and larval population of *H. armigera* in sunflower and different nectary and non-nectary cotton varieties. Studies of abiotic factors against the infestation fluctuation of American bollworm revealed that maximum temperature showed significant and positive correlation *r*- value with the egg counts, whereas, relative humidity had negative and significant correlation with the eggs count with *r*- value.

More detailed knowledge of the seasonal activities of this insect is necessary in order to organize control measures and the application of recommended insecticides when really needed.

The main objective of the present study was:

1- Monitoring of cotton bollworm moths in light trap to study its seasonal activity.

2- Assay the effect of some weather factors on cotton bollworm population and study the relationship between moth catches of cotton bollworm ,the numbers of laid eggs and larvae   with these factors and the cotton receptors (fruit structures :squares, bloom and bolls) during four cotton seasons (2005 – 2008).

MATERIALS AND METHODS

The present study was carried out at a private farm located in a Village at Kafr El-Guindy, Zefta district, Gharbia Governorate, within an assemblies of cotton, about 40 - 50 feddan, during four successive cotton seasons (from 2005 to 2008). The fields were sown by the Egyptian cotton, *Gossypium barbadense* (L.) variety Giza 86 during 2005 and 2008 cotton seasons. Cotton seeds were cultivated at dates ranged between the second half of March to the first week of May. The experimental area was subjected to normal agricultural practices at critical growth stages of cotton crop. Procedures of cotton pest control in the experimental area were applied according to programs of the Ministry of Agriculture. Cotton fields were surrounded by clover, wheat and vegetables fields during the winter seasons prior to the cotton, and with maize and vegetables during the summer seasons.

One light trap, modified by Hosny (1958), was set on the roof of a village house six meters above the ground near the cotton experimental fields. The light trap catches were collected weekly and sorted to species. *H. armigera* adults were especially collected and inspected .One feddan ($4200m^2$) was selected as the experimental area (sown at the third week of March). A stratified random sampling technique was used (Gomez and Gomez, 1983). Twenty five meters (50 hills = 100 plants) of one meter row each of cotton plants (2 hills /meter) were for counting eggs and larvae, (at the upper terminal of the cotton plants, 20 cm.). All fruit structures (squares, bloom and bolls) on the same plants in one meter of row samples were examined at weekly intervals throughout the growing seasons. The total receptors were summation of the squares, bloom and bolls.The lunar days were calculated from the beginning lunar year. The daily percentages of visible moonlight cycle were

obtained from the site (WWW.Calendar-365.com). To determine the seasonal population fluctuations of *H. armigera* adults, the collected data were represented graphically. It was plotted according to Gregorian months. The impact of six variables were converted every three days and subjected to statistical analysis to determine the relationship between *H. armigera* eggs and larvae and four or five environmental factors abiotic(lunar days & moonlight) and biotic factors (collected moths, counted eggs, larvae & receptors).

RESULTS AND DISCUSSION

Field observations proved that, as soon as, the cotton seedlings appeared in the cotton fields, which are sown at the third week of March, the *H. armigera* moths harboured to the cotton fields as an important host in this time. The ABW moths' occurrence in the light trap began to be recorded at the first week of April. The actual number of *H. armigera,* represented in the different stages, moths, eggs and larvae, at the experimental area in the four seasons, are tabulated in Tables (1-6) and graphically illustrated in Figs. (1-6).

a) Seasonal fluctuations of *H. armigera* :

i) Seasonal fluctuation of moths, data in Table (1) Figs (1-4) demonstrated that 4-5 main peaks of *H. armigera* moths which occurred during the investigated seasons, with few minor peaks. In the first season (2005), four main moth peaks were recorded. Moths recorded in the trap at the 23rd of April and increased gradually till the 11th of May, the first moth peak. The three other moth peaks were recorded at the 13th of Jun, the 7th of July, and the 9th of August. The largest moth peak in trap was recorded in the fourth peak at the 9th of August and the lowest was in the first moth peak at the 11th of May, Table (1) and Fig. (1). Four main moth peaks were recorded similar to the previous season In the second season (2006),where the first record of moths were at the 17th of April and increased gradually till the 29th of May(the first peak). The three other moth peaks were at the 28th of Jun, the 3rdof Aug. and 30th of August, respectively. The lowest number of trapped moths were at the 29th of May, while the largest number were recorded at the fourth peak (30th of August) Fig. (2).The moth peaks recorded in the third season (2007), was actually similar to the two previous seasons, whereas in the fourth season (2008) moths recorded five peaks differently from the previous three seasons Figs. (4).

Moth peaks were occurred at different times throughout the investigated cotton seasons (2005-2008). The differences in days between the peaks occurrence was 18 days, 9 days and 9 days among 2005 &2006, 2006 & 2007 and 2007 & 2008,

respectively. The same trend was found in the second, third and fourth peaks of moths during the four experimental seasons Table (1). These differences in days between the peaks in the different seasons attributed to the lunar cycles as an abiotic factor. These results agreement with Nada, *et al*. (2012) that found the highest number of the trapped moths was during the darkness period, no moon, and the lowest number of moths was caught during the full moon period.

ii)Eggs occurrence, data in Table (2) and Figs (1 -4) are demonstrated to 1-3 main egg peaks of *H. armigera* that occurred during the four cotton seasons, by two egg peaks, a peak, two peaks and three peaks in 2005,2006,2007&2008, respectively. The fruit cotton structures (squares) appeared at May,20 th in the two seasons of 2005 and 2006, while at 8th May, in 2007 and11 th May in 2008 cotton seasons that followed by the other fruits (blooms and bolls) to the end of the study period. The present observations recorded that The ABW eggs occurrence at the selected cotton plant area (6 – 9 days) earlier than the receptors appearance during the investigation periods, the only exception occurred in 2007 season where the receptors emerged earlier by 3days. The largest number of eggs was recorded at the second, first, first and second peak during June,22 nd, July,7 th, Jun,25 th and July13 th, , during the four cotton seasons, respectively. The differences in the eggs occurrences might be attributed to the nature of the receptors growth. Receptors occurrences on the cotton plants are almost located at close dates, this is because the mechanism of plant growth depends heavily on the thermal requirements and the length of the day. While, egg occurrences located almost at the dates far between, because the egg-laying mechanism relies mainly on moths, which in turn depends on the environmental factors as the moon light which consequently determined by the lunar calendar.

iii) Larval occurrence, Table (3) illustrated in Figs. (1 -4) recorded that the ABW larvae had 1-2 main peaks in the investigated period. In the first season (2005), the larvae occurred in a peak and recorded on cotton plants at the 14th of May, legitimate biologically after eggs laying by 6 days, and increased gradually till the peak of larvae at the 22nd of June. Two peaks, one peak and two peaks were occurred in the second, the third and the fourth seasons. The larval occurrence during 2006 season was at the 28th of June and at the 28th of July.

Numbers of eggs and larvae that recorded in the study periods were inconsistent with numbers of moths caught at the same periods (May, Jun, July and the first half of August). The numbers of eggs are not commensurate with the moth

population in these periods, where the moth population is much higher than the number of eggs and larvae. Ragab, 2004 and Ragab *et al.*, 2009 recorded some common insect predators as Coccinelids spp., *Paederus alfierii*, *chrysoperla carnea*, *Orius* spp. and other predators that attack cotton pests at cotton fields in this period, which leads to predation the eggs and larvae. Salem *et al.*, 2004 and Ragab, 2009 reported that many hosts of this pest located in the summer planting season as maize, sunflower and vegetables etc. The moths move to the previous surrounded suitable hosts, and these hosts have produced its fruits that are favorites to insect for eggs lying. Thus, this is other cause to inconsistent between the moths, eggs and larvae on cotton fields**.**

b) Effect of some biotic and abiotic environmental factors the on population density of *H. armigera*:

i)Relationships between eggs and the four independent factors, present results indicated that fit regression equation between the dependent variable (eggs) and the independent variables, lunar days, percentages of moon light, moths caught in light trap and receptors (squares, bloom and green cotton bolls) (Table 4 and Fig.5). Variables was represented in the coefficient of determination r^2 values, total effect of five independent variables and sum of deviations   square of the expected than observed population.

In 2005 cotton season, analysis of variance showed a highly significant to the regression and independent variables lunar days. The percentage of moon light, moths and receptors were insignificant. The r^2 value was 0.350 and the total effect of independent variables on the dependent variables eggs was 358%. The expected population of larvae does not coincide with fluctuation of the observed one (Table 4 & Fig.5). Sum of the deviations   square was 5100.23. In 2006 cotton season, the analysis of variance showed highly significant regression between caught moths and the independent variables. The other independent variables (the percentage of moon light, lunar days and receptors) were insignificant. The r^2 value was 0.480 and the total effect was 48.0%. The expected population of eggs dose not coincides with fluctuation of the observed one (Fig. 5). Sum of the deviations square of the expected than observed population were 3523.4. The same trend was found in the two seasons of 2007 and 2008, where, the r^2 values were 0.708 and 0.514 and the total effect was 70.75 and 51.37%, also, sum of deviations square were 9285.2 and 2924.05 (Table 6).

In 2007 cotton season, the representing high deviation might be due to the occurrence of eggs population at more than one peak.

The multiple regression equation (full model) between the dependant and independent variables for average of 2005-2008 cotton seasons was the expected population of *H. armigera* eggs = (4.470)+ (-0.121* lunar days) 0.151*percent moonlight)+(-1.023*moths) +(1.136*receptors). The fit regression equation was represented in the r^2 value which was 0.5541, total effect 55.41$^\%$ and sum of deviations square was 3339.21.

ii)Relationship between larvae and five independent factors, multiple regression (full model) were subjected between dependent variable (larvae) and five independent variables, lunar days, percentages of moon light, Moths in trap, eggs and receptors (squares, bloom and green cotton bolls) during 2005 -2008 cotton seasons in Tables (5& 6) and Fig. (6). Also, fit regression equation between the dependant and independent variables was represented in the coefficient of determination r^2 values and total effect of five independent variables.

In 2005 cotton season, the analysis of variance of the multiple regressions showed a highly significant relation with the four independent variables, lunar days, percentage light, eggs and receptors, and an insignificant relation with moths. The r^2 value was 0.939 and the total effect of independent variables on the dependent variables larvae was 93.9%. The expected population of larvae coincides with fluctuation of the observed one (Fig. 6). Sum of deviations square of the expected than observed population were 50.8 Table (6). In 2006 cotton season, the analysis of variance of the multiple regressions showed a highly significant with the four independent variables, lunar days, moths, egg and receptors and an insignificant relation with the percentage of light. The r^2 value was 0.824 and the total effect of independent variables on the dependent variables larvae was 82.4%. The expected population of larvae coincides with the fluctuation of the observed one Fig. (6). Sum of the deviations square of the expected than observed population were 302.7. The same trend was found in the two other seasons 2007 and 2008, where, the r^2 values were 0.8401 and 0.8334 and the total effect was 84.01 and 83.34%, also, sum of deviations square was 204.9 and 88.0.

The expected population of *H. armigera* larvae in 2006 cotton season coincides with the observed peak which occurred in 2005 cotton season where the lowest deviation 50.8 occurred in 2005, in contrary the highest deviation 302.7 in 2006. The highest deviation may be due to the fluctuation of larval population at more

than peak. 2007 &2008 cotton seasons deviation values came in between the previous values (Table 6). The multiple regression equation (full model) between the dependant and independent variables was the expected population of *H. armigera* larvae = (2.482)+ (0.003* lunar days) +(-0.060*percent moonlight)+(-0.004*moths)+(0.342*eggs)+(-0.021*receptors) as an average for four seasons. The fit regression equation was represented in the r^2 value which was 0.949, total effect 94.9% and sum of deviations   square was 44.57 Table (6).

The accuracy of the multiple regression equation for larvae was more accurate than the same equation with eggs. Therefore, the five independent variables, lunar days, percentages of moon light, moths in trap, eggs and receptors (squares, bloom and green cotton bolls) can be used to forecast population of ABW larvae before appearing of its peaks with enough periods for control of this pest.

Table 1. The occurrence of *Helicoverpa armigera* moths in cotton season of (2005-2008).

Phenomenon	2005	2006	***The different between 2005-2006	2007	The different between 2006-2007	2008	The different between 2007-2008
Recorded at	*April,23	April,17	6	April,2	15	April,2	0
peaks 1	**May,11	May,29	18	May,20	9	May,11	9
2	Jun,13	Jun,28	15	Jun,19	9	Jun,7	12
3	July,7	Augu.,3	27	July,16	18	July,7	9
4	Aug.,7	Augu.,30	23	Aug.,15	15	Aug.,3	12
5	-	-	-	-	-	Sept.,2	
Largest peak	Aug.,9	Aug.,30	-21	Aug.,15	15	Aug.,3	-12
Lowest peak	May,11	May,29	0	Sept.,29	0	Sept.,29	0

*=Moths recorded at.., **= peaks occurred at..,***= Population occurred early (+) or late (-) than the previous season.
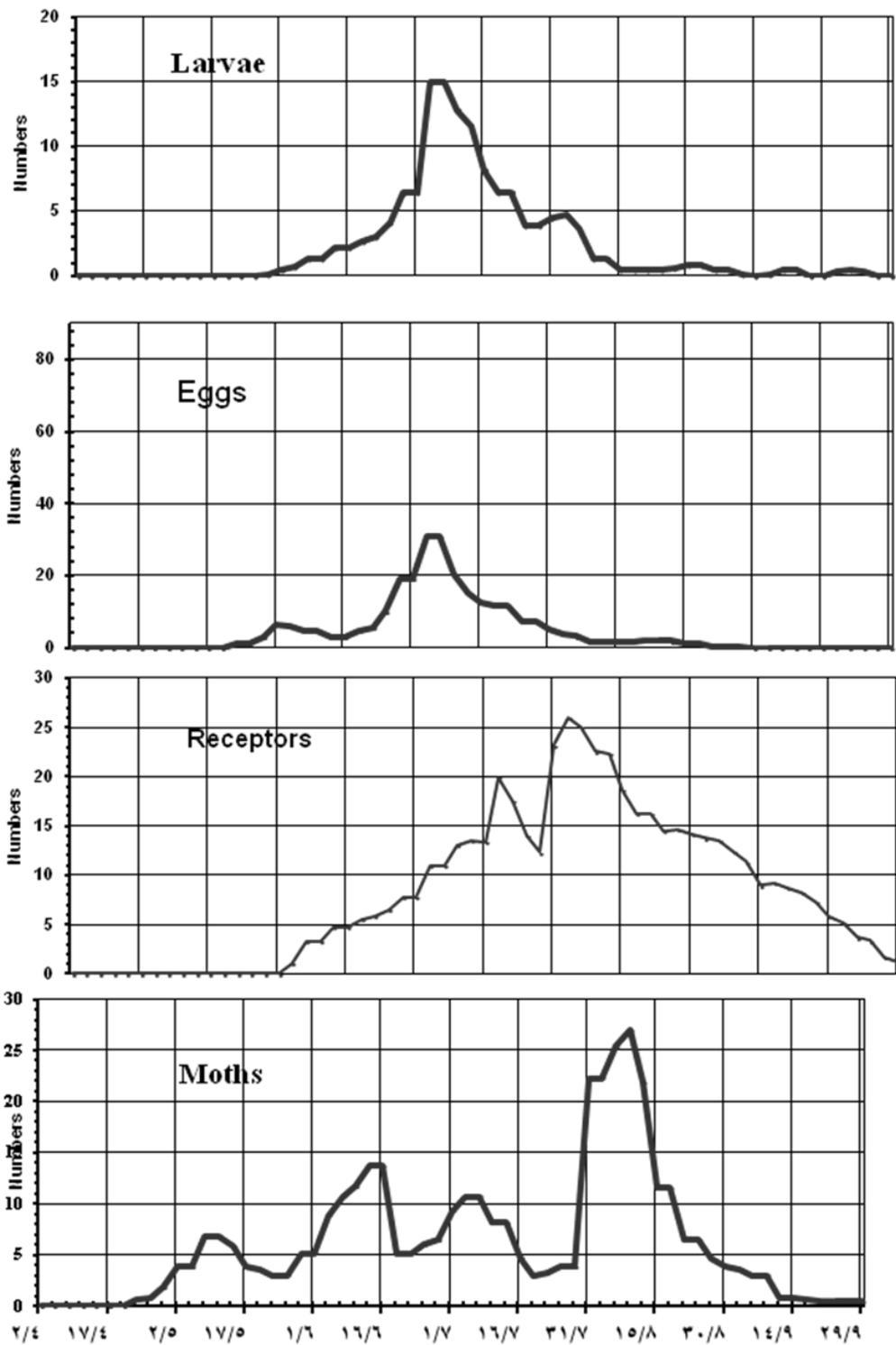
Figure(1): Peaks occurrences of different stages of *Helicoverpa armigera*
, moths, eggs, larvae, and cotton receptors during 2005 cotton season
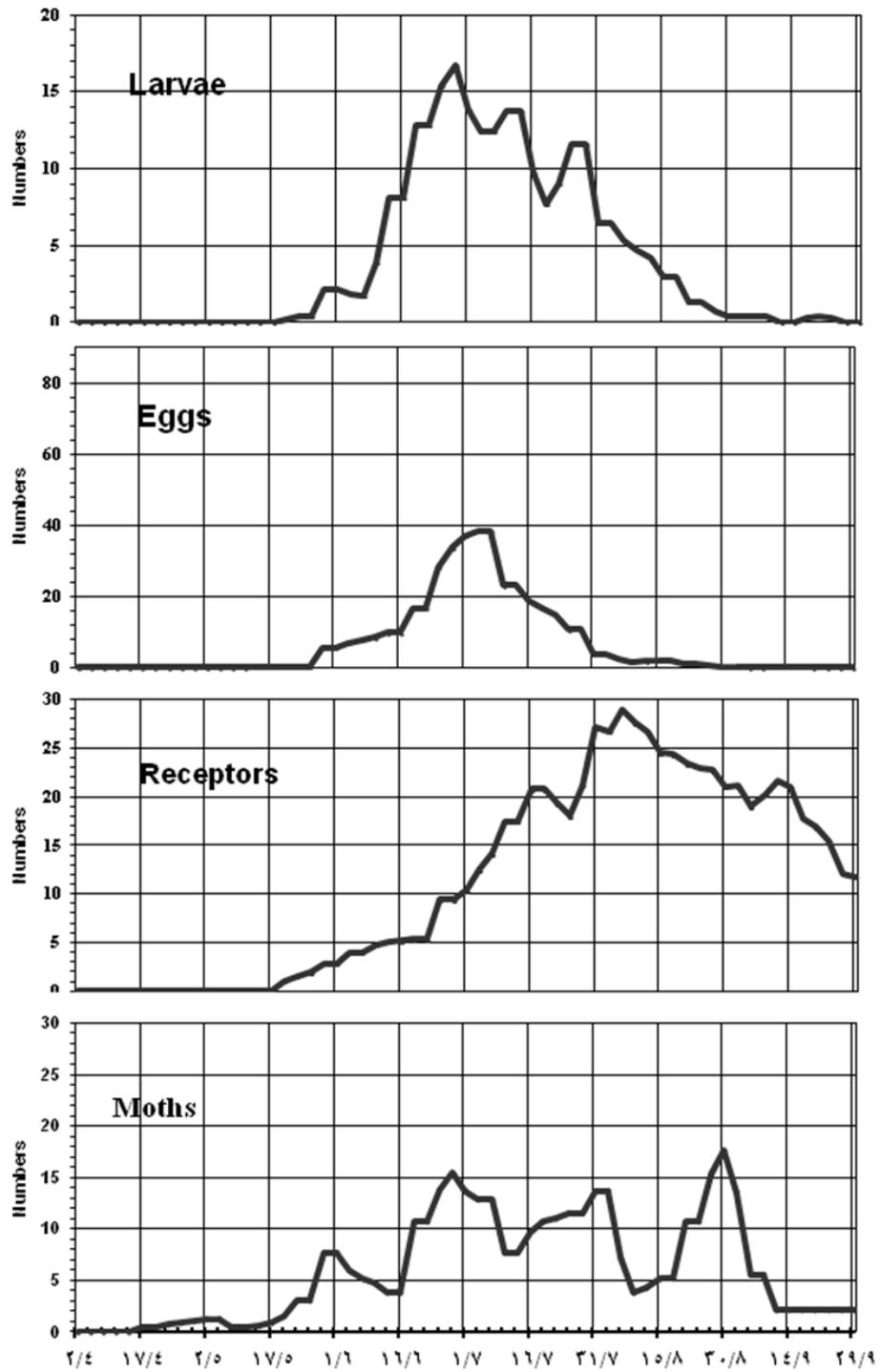
Figure(2): Peaks occurrences of different stages of *Helicoverpa armigera*
, moths, eggs, larvae, and cotton receptors during 2006 cotton season
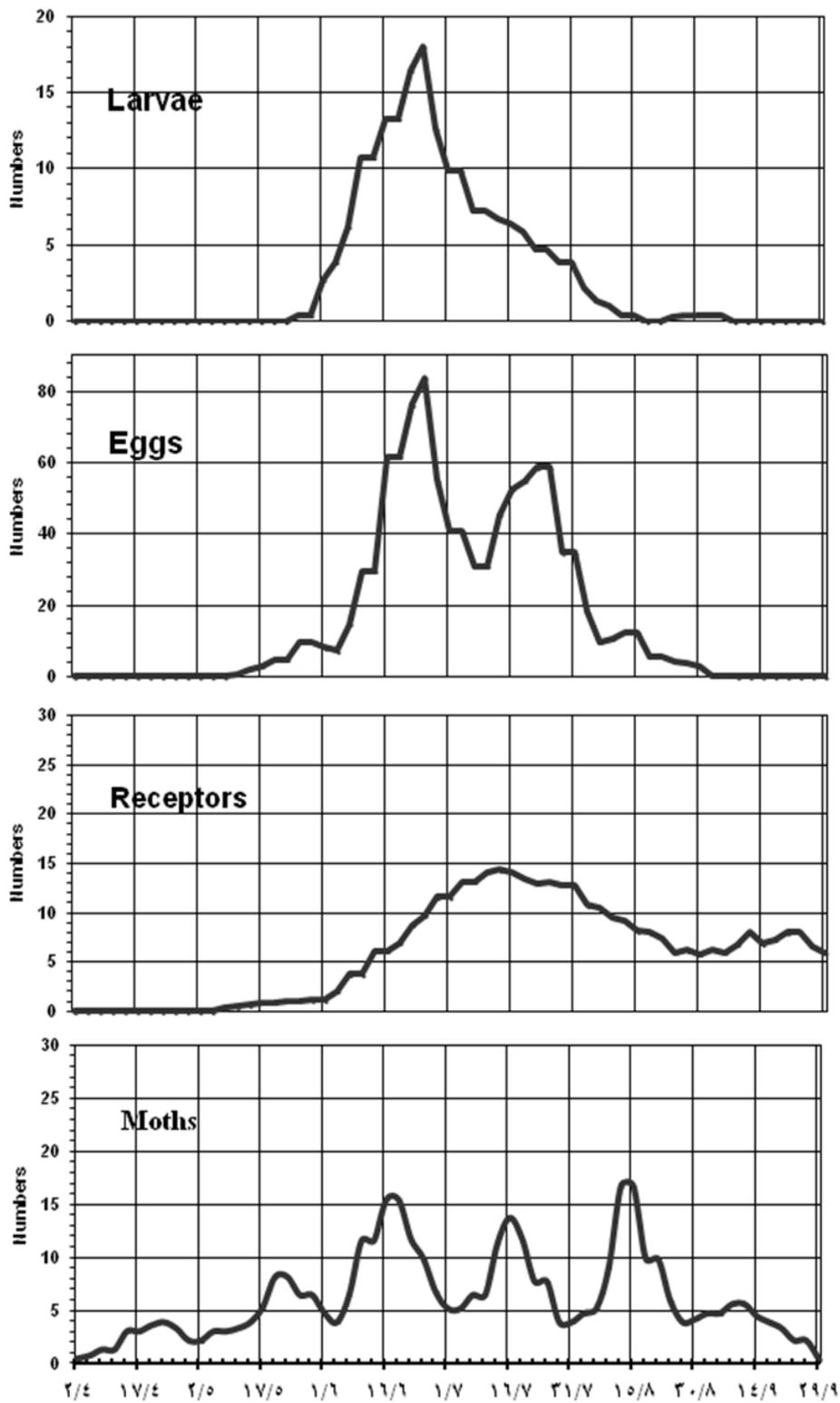
Figure(3): Peaks occurrences of different stages of *Helicoverpa armigera*
, moths, eggs, larvae, and cotton receptors during 2007 cotton season

Table 2. The occurrence of *Helicoverpa armigera* eggs in cotton season of (2005-2008).

Phenomenon	2005	2006	***The difference between 2005-2006	2007	The difference between 2006-2007	2008	The difference between 2007-2008
Receptors apeared at	May,20	May,20	0	May,8	12	May,11	-3
Egg recorded	*May,8	May,14	-6	May,11	3	May,20	-9
Egg peaks 1	**May,17	July,7	-51	Jun,25	12	Jun,16	9
2	Jun,22	-	-	July,25	-	July,13	12
3	-	-	-	-	-	Aug.,9	-
Largest peak	Jun,22	July,7	-15	Jun, 25	12	July,13	-18
Lowest peak	May,17			July,25	12	Aug.,9	18

*=Eggs recorded at.., **= peaks occurred at.., ***= Population occurred early (+) or late (-) than the previous season.

Table 3. The occurrence of *Helicoverpa armigera* larvae in cotton season of (2005-2008).

The Phenomenon	2005	2006	***The difference between 2005-2006	2007	The difference between 2006-2007	2008	The difference between 2007-2008
Receptors apeared at	May,20	May,20	0	May,8	12	May,11	-3
larvae recorded at	*May,14	May,20	-6	May,26	-6	Jun,4	-11
larvae peaks 1	**Jun,22	Jun,28	-6	Jun,25	3	July,7	-12
2	-	July,28	-	-	-	July,28	-
Largest peak	Jun,22	Jun,28	6	Jun,25	3	July,7	-3
Lowest peak	0	July,28	0	0		July,28	
*=Larvae recorded at.., **= peaks occurred at..,***= Population occurred early (+) or late (-) than the previous season.							

Tables 4. Briefly analysis Varriance of multiple reggression (full model) and Regression equation parameter of predicted dependant variable (eggs) for four independent variables during 2005 -2008 cotton season

2005							r^2	Total effect of independent variables
Analysis Varriance			Regression equation parameters of predictrd larvae					
Source	F	P	parameters	Coef.	Std Error	P		
Regression	5.4	0.0015 *	Intercept	21.781	5.416	.0002 ***	0.350	35.00%
lunar dayes	20.3	0.0001 ***	lunar dayes	-0.112	0.026	.0001 ***		
Percent LIGHT	1.0	0.3203 ns	Percent LIGHT	0.032	0.032	0.06518		
Moths	0.1	0.7062 ns	Moths	0.046	0.179	.7968 ns		
Rec	0.1	0.8101 ns	Rec	-0.406	0.222	.8101 ns		
2006								
Regression	12.9	.0000 ***	Intercept	-2.228	4.814	.0170 *	0.480	48.00%
lunar dayes	0.2	.6892 ns	lunar dayes	0.002	0.038	.9581 ns		
Percent LIGHT	0.1	.8108 ns	Percent LIGHT	0.055	0.031	.0788 ns		
Moths	48.2	.0000 ***	Moths	1.762	0.250	.0000 ***		
Rec	3.3	.0727 ns	Rec	-0.406	0.222	.0727 ns		
2007								
Regression	26.6	.0000 ***	Intercept	31.792	12.815	.0170 *	0.708	70.75%
lunar dayes	11.6	.0014 **	lunar dayes	-0.292	0.054	.0000 ***		
Percent LIGHT	3.2	.0795 ns	Percent LIGHT	0.009	0.073	.9032 ns		
Moths	37.0	.0000 ***	Moths	1.598	0.696	.0265 *		
Rec	54.6	.0000 ***	Rec	4.047	0.548	.0000 ***		
2008								
Regression	11.4	.0000 ***	Intercept	6.351	7.864	.4238 ns	0.514	51.37%
lunar dayes	4.1	.0490 *	lunar dayes	-0.094	0.034	.0079 **		
Percent LIGHT	0.4	.5278 ns	Percent LIGHT	0.061	0.037	.1029 ns		
Moths	23.4	.0000 ***	Moths	0.833	0.372	.0302 *		
Rec	17.5	.0001 ***	Rec	1.120	0.268	.0001 ***		
Average 2005-2008								
Regression	17.4	.0000 ***	Intercept	4.470	9.351	.6345 ns	0.554	55.41%
lunar dayes	0.3	.6031 ns	lunar dayes	-0.121	0.030	.0001 ***		
Percent LIGHT	2.7	.1058 ns	Percent LIGHT	0.151	0.175	.3914 ns		
Moths	54.0	.0000 ***	Moths	1.023	0.392	.0116 *		
Rec	12.6	.0008 ***	Rec	1.136	0.320	.0008 ***		

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Table 5. Briefly analysis Varriance of multiple reggression (full model) and Regression equation paramet (larvae) for four independent variables during 2005 -2008 cotton season

Analysis Varriance			Regression equation parameters of predictrd larvae				r^2	Total effect of independent variables
Source	F	P	parameters	Coef.	Std Error	P		
2005								
Regression	119.1	.0000 ***	Intercept	-0.169	1.023	.8695 ns	0.939	93.90%
lunar dayes	169.5	.0000 ***	lunar dayes	0.001	0.005	.9034 ns		
Percent LIGHT	14.8	.0004 ***	Percent LIGHT	-0.006	0.005	.2663 ns		
Moths	0.6	.4418 ns	Moths	-0.102	0.029	.0009 ***		
EGG	388.7	.0000 ***	EGG	0.492	0.025	.0000 ***		
Rec	22.0	.0000 ***	Rec	0.122	0.026	.0000 ***		
2006								
Regression	36.5	.0000 ***	Intercept	6.238	2.413	.0136 *	0.824	82.40%
lunar dayes	36.2	.0000 ***	lunar dayes	-0.039	0.015	.0131 *		
Percent LIGHT	0.4	.5567 ns	Percent LIGHT	-0.016	0.011	.1630 ns		
Moths	57.4	.0000 ***	Moths	-0.019	0.110	.8666 ns		
EGG	80.3	.0000 ***	EGG	0.397	0.042	.0000 ***		
Rec	8.3	.0064 **	Rec	0.210	0.073	.0064 **		
2007								
Regression	46.6	.0000 ***	Intercept	-2.149	2.064	.3521 ns	0.840	84.01%
lunar dayes	37.3	.0000 ***	lunar dayes	0.007	0.010	.6327 ns		
Percent LIGHT	0.0	.8737 ns	Percent LIGHT	0.030	0.011	.0108 *		
Moths	67.6	.0000 ***	Moths	0.148	0.114	.1891 ns		
EGG	122.7	.0000 ***	EGG	0.214	0.023	.0000 ***		
Rec	5.5	.0235 *	Rec	-0.302	0.122	.0235 *		
2008								
Regression	42.0	.0000 ***	Intercept	4.799	1.334	.0008 ***	0.833	83.34%
lunar dayes	3.2	.0787 ns	lunar dayes	-0.045	0.006	.0000 ***		
Percent LIGHT	3.0	.0900 ns	Percent LIGHT	0.003	0.006	.6470 ns		
Moths	51.0	.0000 ***	Moths	0.149	0.066	.0300 *		
EGG	5.0	.0311 *	EGG	-0.120	0.026	.0000 ***		
Rec	147.8	.0000 ***	Rec	0.650	0.053	.0000 ***		
Average 2005-2008								
Regression	204.0	.0000 ***	Intercept	2.482	1.093	.0268 *	0.949	94.90%
lunar dayes	4.0	.0515 ns	lunar dayes	0.003	0.004	.3896 ns		
Percent LIGHT	3.1	.0850 ns	Percent LIGHT	-0.060	0.021	.0046 **		
Moths	435.1	.0000 ***	Moths	-0.004	0.048	.9610 ns		
EGG	577.6	.0000 ***	EGG	0.342	0.016	.0000 ***		
Rec	0.3	.6052 ns	Rec	-0.021	0.041	.6052 ns		
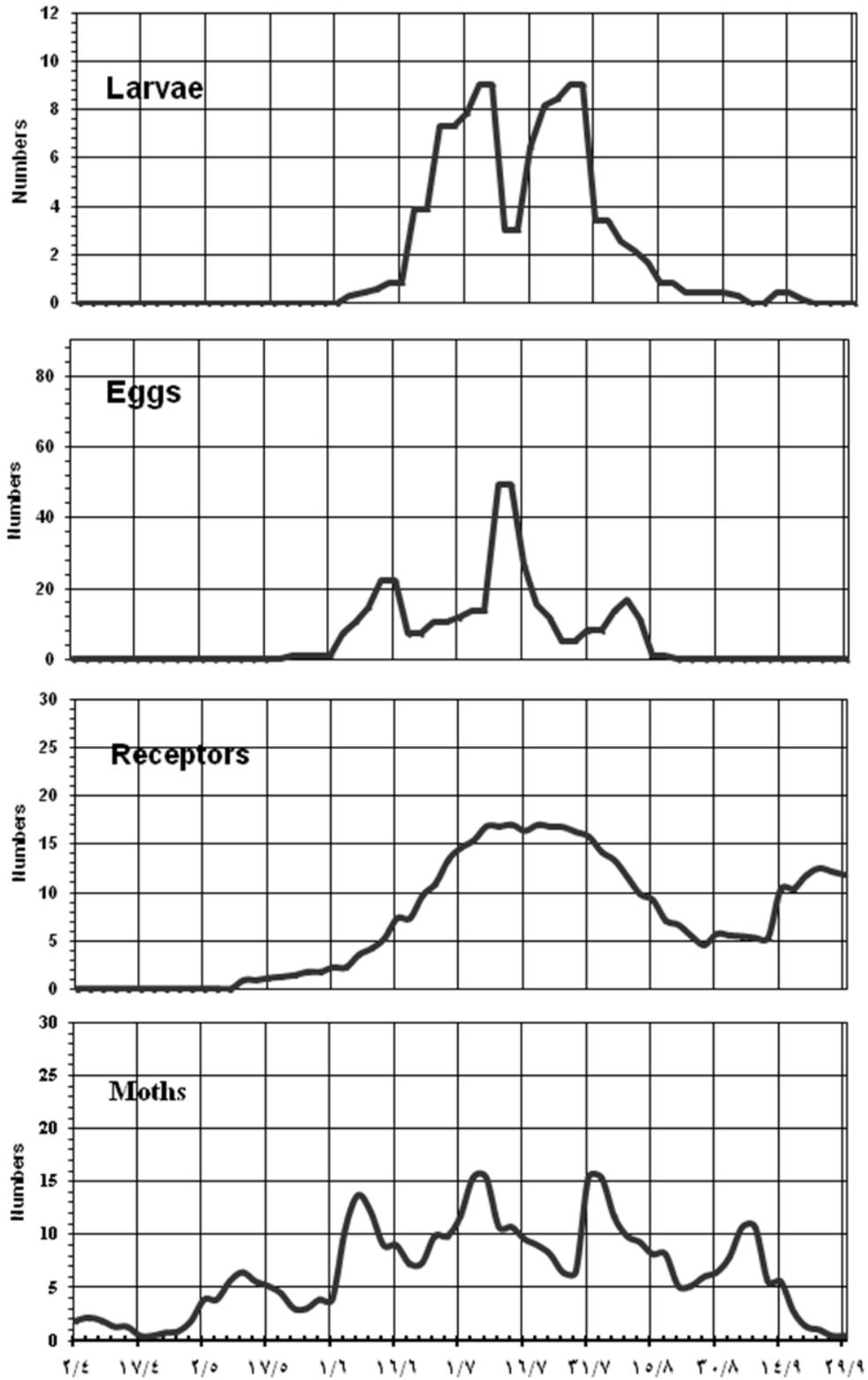
Figure(4): Peaks occurrences of different stages of *Helicoverpa armigera*
, moths, eggs, larvae, and cotton receptors during 2008cotton season

Figure (5): Observed *Helicverpa armigera* eggs and the predicted dependant variable (eggs) affected by four independent variables subjected to the multiple regression (full model) during 2005-2008 cotton seasons

Table 6. Sum of deviation   squares of the expected than observed population of *H. armigera* eggs and larvae

Season	summation	
	Eggs	Larvae
2005	5100.23	50.8
2006	3523.37	302.7
2007	9285.21	204.9
2008	2924.05	88.0
average 2005-2008	3339.21	44.57

REFERENCES

1. Bilal Saeed Khan, M. Afzal and M. Afzal Murtaza. 2003. Effect of Abiotic Factors Against the infestation of American Bollworm (*Heliothis armigera* Hub.) on Different Varieties of cotton under Unsprayed Conditions. OnLine Jurnal of Biological Science 3 (1): 82-85, 2003

2. Bowden, J., and B. M. Church. 1973. The influence of moonlight on catches of insects in light traps in Africa. 11: The effect of moon phase on light trap catches, Bull. Ent. Res., 63: 129-142.

3. El-Sayed, A.A.A., Merfat A. Kandil and A.E.A Amer. 2009. Seasonal fluctuation of *Helicoverpa armigera* (Hubner) (Lepidoptera: Noctuidae) on cotton & okra and heat units related. Egypt. J. Agric. Res., 87 (4):909-921.

4. Fitt, G. P. 1989. The ecology of *Heliothis* in relation to agro-ecosystems. Ann. Rev. Ent., 34:17-52.

5. Gomez, K.A. and A. A. Gomez. 1983. Statistical procedures for agricultural research. Hand book (Second edition).Sampling Techniques, 534 P.

6. Hosny, M. M. 1958. Ecological studies on the environment preference and sex ratios in catches of macrolepidoptra in UV- light traps. Bull. Soc. Ent. Egypte', 42:421-37.

7. Ibrahim, M.M., A.G. Metwally, N. H. Nazmy and F.E. Z. Ibrahim. 1994. Studies on the American bollworm on cotton in Egypt *Heliothis zea* (Boddie), *Heliothis armigera* (Hb.)(Lepidoptera: Noctuidae). Agric. Res. Rev., 52:1-8.

8. Khalid Zafar, Anjum Suhail, M.Arshad and M.Jalal Arif. 2013. Impact of Weather Factors on population fluctuation of *H. armigera* on *H. armigera* on Sunflower.Pakistan Journal of   Nutrition 12 (1):50-54, 2013.

9. K uldeep Singh, SVS Raju and DK Singh. 2011. Population Succession of tomato fruit borer (*Helicoverpa armigera*) on tomato (*Lycopersicon esculentum* Mill.) agro - ecosystem in eastern region of U.P.Vegetable Science (2011) 38(2):152-155.

10. Legaspi, B. A., W. L. Sterling, A. W. Hartstack and D. A. Dean. 1989. Testing the interaction of pest-predators-plant components of the Texcim model. Environ. Entomol. 4:157-163.

11. Nada, M. A., M. G. Ragab and E.S. Mansour. 2004. Seasonal abundance and prediction possibility of American bollworm, *Helicoverpa armigera* (Hüb.) in relation to pheromone trap catches and heat unit accumulations. Egypt.J.Appl.Sci., 19 (11): 394-409.

12. Nada, M. A. M. and M.G. Ragab. 2010. Prediction of American bollworm, *Helicoverpa armigera* (HÜb.), depending on accumulated heat units in cotton fields. J. Plant Protection and Pathology, 1 (4):195-208.

13. Nada, M.A., M. G. M. Ragab and A.A.A. Zaki. 2012. Relationship between lunar light and population of *Helicoverpa armigera* (HÜb.) moths at Gharbia Governorate. J. Plant Prot. and Path., Mansoura Unv., 3 (11):1241-1251.

14. Nemec, S. J. 1971. Effect of lunar phases on light trap collection and population of bollworm moths. J. Econ. Ent. 64: 860-64.

15. Ragab, M. G. 2009. Effect of accumulated heat units and cotton fruit structures on larval infestation of *Helicoverpa armigera* (Hüb.) on cotton and cowpea in different planting systems. Bull. Entomol. Soc. Egypt, 86: 249-265.

16. Ragab, M.G. 2004. Abundance of certain insect pests and associated predators in cotton fields. J. Agric. Sci., Mansoura Univ. 29(1). 6625-6642.

17. R a g a b, M. G., H. A. S. Abdel-Gawad and S. N. Kostandy. 2009. The correlation between the predatory insects and the cotton bollworms in untreated cotton fields at Gharbia Governorate. Bull. Ent. Soc. Egypt, 86: 149-160.

18. Sadanny, E.L., A. M. Hossain, R. S. M. El-Fateh and M. A. Romeilah 1999.The Simultaneous effect of physical environmental factors governing the population activity of cotton bollworm moths. Egyptian J. Agric. Res., 77: 591-609.

19. S a l e m, Hoda Abd El-Fattah, M.G. Ragab and Mahasen M.A. El-Shershaby 2004. Monitoring the triangular r e l a t i o n s h i p between maize, cotton and the infestation of the American bollwonn (ABW), *Helicoverpa armigera* (Hüb.) and the spiny bollworm (SBW), *Earias insulana* (Boisd.). AI-Azhar J. Agric. Res., 39 : 3 1-35.

20. Youssef, H. L. and H. Ismail. 1999. Phenological synchronism for *Spodoptera littorals* (Boisd.) life cycle (Lep.-Noct.). Ann. of Agric., 37:2049-2057.

21. Zalucki, M. P., D.A. H. Murray, P. C. Grgg, G. P. Fitt, P. H. Twine and C. Jones. 1994. Ecological of *Helicoverpa armigera* (Hb.) and *H. punctigera* (Vallengren) in the land of Australia : Larval sampling and host relationships during winter and spring. Aust. J. Zool., 42: 329-333.

تأثير بعض العوامل البيئية الحيوية وغير الحيوية
علي التقلبات الموسمية لدودة اللوز الأمريكية (هيليكوفيربا أرميجرا (هوبنر))

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يهدف هذا العمل إلى دراسة تقلبات تعـــداد هيليكوفيربـــا أرميجـــرا(هـــوبنر) الموسمية وعلاقة تعداد البيض واليرقات ببعض العوامل الحيوية وغير الحيوية. تـــم تنفيذه التجربة في مركز زفتي، محافظة الغربية ، مصر، خلال أربعة مواسم قطـــن متعاقبة (من ٢٠٠٥ إلى ٢٠٠٨) ، التي امتدت من الأسبوع الأول مـــن أبريـــل إلـــى الأسبوع الأخير من شهر سبتمبر ، وأظهرت النتائج أن فراشات هيليكوفيربا أرميجـــرا انجذبت لحقول القطن (صنف جزة ٨٦) ، بمجرد ظهور البادرات ، وقـــد تواجـــدت الفراشات في ٤-٥ قمم رئيسية ، مع عدد قليل من القمم الصـــغيرة خـــلال مواســـم الدراسة ، بدأت تراكيب القطن الثمرية (المستقبلات) في الظهور في النصـــف الأول من مايو واستمرت حتى نهاية فترة الدراسة. و إحصائيا وجد من واحد إلى ثلاث قمم رئيسية لبيض ويرقات هيليكوفيربا أرميجيرا أثناء فترات الدراسة، ولتوقع المتغيرين التابعين (البيض أو اليرقات) متأثرين بأربعة أو خمسة عوامل مستقلة هـــى الأيـــام القمرية ، والنسب المئوية لضوء القمر ، الفراشات التي تم إصـــطيادها ، عـــددالبيض والمستقبلات النباتية.

تم تطبيق الانحدار المتعدد (النموذج الكامل) على هذه المتغيرات خلال مواسم القطن الأربعة (من ٢٠٠٥ إلى ٢٠٠٨)، أظهر تحليل التباين معنويه عاليه جداً، فـــي تعداد البيض المتوقع مع الأيام القمريه (نسبة ضوء القمـــر) ، تعـــداد الفراشـــات و المستقبلات الثمرية ، وتعداد اليرقات المتوقع والأيام القمرية (نسبة ضـــوء القمـــر) ، تعداد الفراشات والبيض والمستقبلات كمتوسط لأربعة مواسم قطـــن متتاليـــة (مـــن ٢٠٠٥ إلى ٢٠٠٨)، ومثلت قيم r^2 (معامل التحديد) ونسبة التأثيرالكلي و مجموع مربع الانحرافات دقة معادلة الانحدار. وإتضح من نتائج الدراســـة أن العوامـــل الأربعـــة أوالخمسة المستقلة السابقة يمكن استخدامها للتنبؤفى برامج المكافحة المتكاملة بتعـــداد بيض أو يرقات هيليكوفيربا أرميجيرا قبل بلوغها مستويات الذروة على نباتات القطن بفترات كافية لمكافحتها.