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Field Trapping of the American Bollworm, *Helicoverpa armigera* (Hübner) (Lepidoptera: Noctuidae) with the Sex Pheromone

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ABSTRACT

Helicoverpa armigera Hb. is found on many different host plants in Egypt. Field trapping showed that the most preferred hosts were tomato, followed by okra and maize. Highest population density in tomato, okra and maize was recorded in August, during the successive seasons of 2005 and 2006. Multiple regression analysis showed that only the temperature degree had a considerable and significant influence on the insect populations of *H. armigera*. Meanwhile, the relative humidity and wind speed did not significantly influence the population. The sex pheromone trap containing (Z)-11-Hexadecenal, (Z)-9-Hexadecenal and (Z)-7-Hexadecenal was highly effective for monitoring the insect pest in tomato, okra and maize fields.

Key Words: *Helicoverpa armigera*, Sex pheromone, Host plants.

INTRODUCTION

The American bollworm, *Helicoverpa armigera* (Hübner) is one of the most important economic insect pests in Egypt (Ibrahim *et al.*, 1974) and in many parts of the world (Fitt, 1989). This insect is highly polyphagous; eggs and/or larvae have been recorded on more than 60 plant species belonging to 47 families (Zalucki *et al.*, 1994 and Mustapha *et al.*, 2004). *H. armigera* is recorded as a pest of virtually all field and horticultural crops, being a major pest of maize, sorghum, tomato, lucerne, tobacco, cotton, clover and cowpea. Direct damage to flowering and fruiting structures by larvae and extensive insecticide spraying result in low yields and high control costs (McGahan *et al.*, 1991). Increased resistance to insecticides in *H. armigera* (Forrester *et al.*, 1993 and Kranthi *et al.*, 2002) has led to a renewed interest in developing alternatives to insecticidal control, such as Pheromone traps, in contrast, are usually very effective even at low population densities and should, since they sample from a larger area, give a more accurate picture of the average population density than soil samples (Kumar and Shivakumara, 2003).

The sex pheromone of *H. armigera* is a multi-component system containing five chemicals, viz. (Z)-1-hexadecenal, (Z)-9-hexadecenal, (Z)-11-hexadecen-1-ol, hexadecenal and hexadecanol (Nesbitt *et al.*, 1979). However, (Z)-11-hexadecenal was identified as the major sex-pheromone component (Piccardi *et al.*, 1977) and (Z)-9-hexadecenal, the important minor component (Nesbitt *et al.*, 1980 and Kehat *et al.*, 1980). Trap catches are likely to vary depending on the parameters of the trap design, blend ratio of the components of the lure and environmental conditions. In addition, the population parameters such as density and genetic variation in the population might also contribute to the variable trap catches. Furthermore, they can supply information on the phenology of the target species. Monitoring systems based on sex pheromones, are in use for all of the lepidopterous mentioned above and under development for the sawflies (Herz *et al.*, 2000). The study was designed to evaluate the efficacy of the synthetic pheromone traps contained three pheromone blends to monitor population dynamics and control of *H. armigera* in tomato, maize and okra fields.

MATERIALS AND METHODS

The study was conducted during the two successive crop seasons of 2005 and 2006 in a private farm, El-Atta village, Giza Governorate. Delta traps with the rubber septum impregnated by sex pheromones for *H. armigera* (two grams per capsule produced by International Pheromone Company, UK) were used. Sex pheromone components were (Z)-11-Hexadecenal, (Z)-9-Hexadecenal and (Z)-7-Hexadecenal. The traps were placed in three cultivated crops, tomato, *Lycopersicon esculentum* (variety, Beto-52), okra, *Abelmoschus esculentus* (variety, Giza-1) and maize, *Zea mays* L. (variety, single hybrid -10). The traps were placed during May in case of tomato and okra and during June in maize fields in season 2005 and approximately at the same time in season 2006. The traps were hung 0.5- 1 meter above the soil, on the crop level and heights were adjusted weekly to accommodate for each crop growth.

An area of each crop was 4200 m^2 (one Feddan). The area was surrounded by citrus trees. The traps were placed on each corner and one in the center of each crop field (5 traps/ crop). Every 30 days the pheromone

septum was replaced with new one and the moths captured were collected. The mean number of moths captured/trap/crop was recorded. At each crop, the five traps were balanced five replicates. The environmental factors, namely temperature, relative humidity and wind speed were obtained by Meteorological Station, Agriculture Research Institute.

Statistical analysis:

The data were analyzed using multiple regression analysis by use computer program of SPSS version, 11.0, (2001) to analysis the relationships between the climatic factors and population of the insect during the two seasons of the study.

RESULTS AND DISCUSSION

1. Population density and seasonal variation by pheromone traps

Data in Table (1) show that the first moth appeared during May in season 2005 in the field of tomato and okra and during June in case of maize. Numbers of moths were 11.0, 8.8 and 3.2 moths /trap, respectively. The populations caught in the traps were low then increased gradually to reach maximum mean number of 38.8, 23.4 and 11.8 in tomato, okra and maize during August, respectively. Afterwards, the mean numbers of the captured moths decreased to the end of the season to record the lowest numbers (21.4, 8.2 and 3.2 moths/trap in tomato, okra and maize fields, respectively) during September 2005 season.

In 2006 season, data in Table (2) show that the mean number of moths was low during May and then gradually increased till August when, the highly number of the captured moths was recorded (25.6, 21.8 and 22.8/trap) in tomato, okra and maize fields, respectively. On the other hand, the trap catches decreased during September to reach 13.2, 13.4 and 14.8 moths per trap in tomato, okra and maize fields, respectively. Malik *et al.* (2003) recorded the maximum mean number trap catches in tomato field (11.0 moths/trap) when average temperature was 28.8° C during August. Moral (2006) stated that highly mean number of moths caught by pheromone traps was 4.59 moths on tomato field during July. Trap catches are likely to vary depending on the parameters of the trap design, blend ratio of the components of the lure and environmental conditions. In addition, the population parameters such as density and genetic variation in the population might also contribute to the variable trap catches (Kumar and Shivkumara, 2003). Jian *et al.*, (2006) found that the blend contained (Z)-11-hexadecenal and (Z)-9-hexadecenal with a ratio of 97:3 in traps were the highest effective for capturing *H. armigera* in cotton fields.

Table (1): Monthly mean population density of *Helicoverpa armigera* and climatic factors in experimental fields at El-Katta village, Giza governorate during 2005 season.

Month	Monthly mean population moths / trap ±S.E.				Climatic factors		
	Tomato	Okra	Maize	Total	Temp.*	R.H.%*	W.S.*
May	11.0± 1.6	8.8±1.2	-	19.8	24.3	48	0.86
Jun.	15.6±1.98	10.4±1.9	3.2±0.86	29.2	28.0	51	0.54
Jul.	29.4±7.3	11.6±1.86	8.4±2.5	49.4	29.7	63	0.95
Aug.	38.8±4.1	23.4±5.01	11.8±2.3	74.0	30.4	54	1.03
Sep.	21.4±3.31	8.2±1.74	3.2±0.58	32.8	28.8	53	0.94

Temp. = Temperature; R.H. % = Relative humidity; W.S = Wind speed (Km/h).

Table (2): Monthly mean population density of *Helicoverpa armigera* and climatic factors in experimental fields at El-Katta village, Giza governorate during 2006 season.

Month	Monthly mean population moths / trap ± S.E.				Climatic factors		
	Tomato	Okra	Maize	Total	Temp.*	R.H.%*	W.S.*
May	10.2±1.6	5.8±1.16	-	16.0	23.99	47	0.98
Jun.	15.2±2.1	17.4±3.07	7.4±3.18	40.0	27.80	49	1.05
Jul.	23.4±5.81	21.2±1.82	16.0±3.16	60.6	27.80	51	0.90
Aug.	25.6±1.6	21.8±7.19	22.8±1.93	70.2	29.40	51	0.96
Sep.	13.2±2.6	13.4±2.08	14.8±3.45	41.4	28.00	51	0.92

Temp. = Temperature: R.H.% = Relative humidity; W.S = Wind speed (Km/h).

In maize field during August of 2006 season, the traps caught the highest number of moths (22.8 moth/trap); while in 2005 season at the same month, the highest number of moths was 11.8 moth/trap. The results indicated that the *H. armigera* preferred tomato; maize and then okra. *H. armigera* is a highly mobile noctuid moth of tomato and numerous other crops, including cotton, corn, chickpea, pigeonpea, sorghum, sunflower, soybean and groundnut (Fitt & Boyan, 1989; Fitt, 1991 and Reddy & Manjunatha, 2000). The ability of gravid females to locate and utilize a wide range of hosts from a number of families for oviposition is one of the major factors contributing to this insect.

2. Influence of the climatic factors on the population density of *H. armigera*

To identify the main climatic factors that caused important variation in insect catches, multiple regression analyses were carried out (Table 3); three variables (mean monthly temperature, relative humidity and wind speed) were considered. With regard to the wind speed, it was not very high; ranged between (0.54 and 1.03 km/h) and (0.9 and 1.05 km/h) during 2005 and 2006 seasons, respectively. Multiple regression analyses showed that it had no significant influence of the moth catches. As well, there was no significant influence between the relative humidity on the trap catches. It ranged between (48 and 63%) in 2005 season and (47 and 51%) in 2006 season. Temperature degrees were significantly correlated with the number of trap catches. The relationship between trap catches and temperature was conditional on the emergence of new adults; when temperature increased, the rate of emergence was higher and vise versa (Figs.1 and 2).

In maize field, there was no significance between trap catches and temperature in season 2005. Temperature had direct relation with insect development and distribution (Malik, 2001and Malik *et al.*, 2003). Moral (2006) stated that the factors related to temperature and humidity did not have considerable influence on insect populations of *H. armigera*. While, correlation analyses showed that only the percentage of cloudless day and the time that northeastern winds were pre-dominant, were significantly correlated with the number of trap catches.

Table (3): Statistical analysis to the effect of the three climatic factors on the *H. armigera* trap catches.

Crop	Independent Variable	2005 Season Coefficient[a]			2006 Season Coefficient[a]		
		Partial	T. statistical	significant	Partial	T. statistical	significant
Tomato	Temperature	0.874	4.024^{*}	0.010	0.88	4.152^{**}	0.005
	R.H.	0.096	0.215^{NS}	0.839	-0.614	-1.741^{NS}	0.142
	Wind Speed	0.472	1.197^{NS}	0.285	-0.553	-1.484^{NS}	0.198
Okra	Temperature	0.834	3.383^{*}	0.020	0.880	4.151^{**}	0.009
	R.H.	-0.260	-0.601^{NS}	0.574	-0.347	-0.827^{NS}	0.446
	Wind Speed	0.260	0.592^{NS}	0.579	-0.340	-0.808^{NS}	0.456
Maize	Temperature	0.739	2.456^{NS}	0.057	0.799	2.974^{*}	0.031
	R.H.	0.376	0.907^{NS}	0.406	-0.039	-0.87^{NS}	0.934
	Wind Speed	0.332	0.788^{NS}	0.466	-0.143	-0.324^{NS}	0.759

[a]Dependent variable was insect (P=0.05).

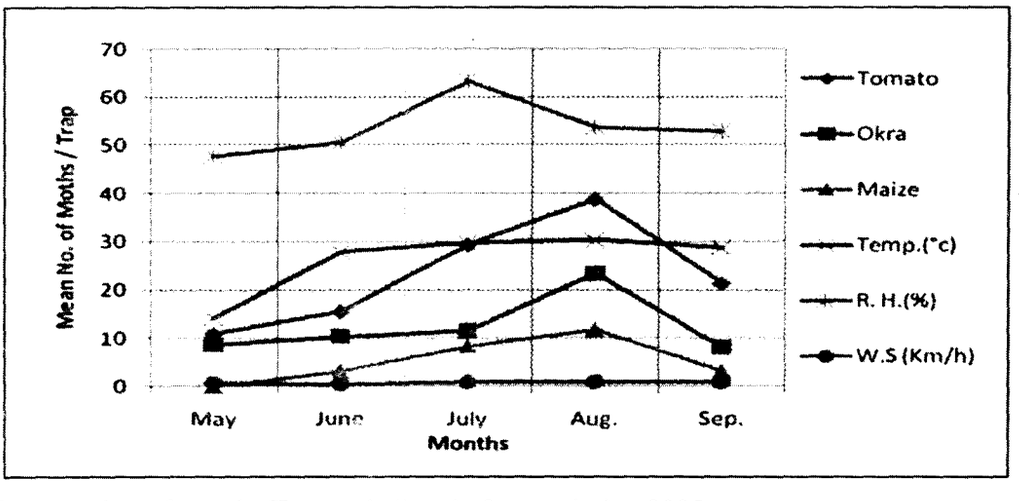

Fig. (1): Mean number of months/Trap and climatic factors during 2005 season.

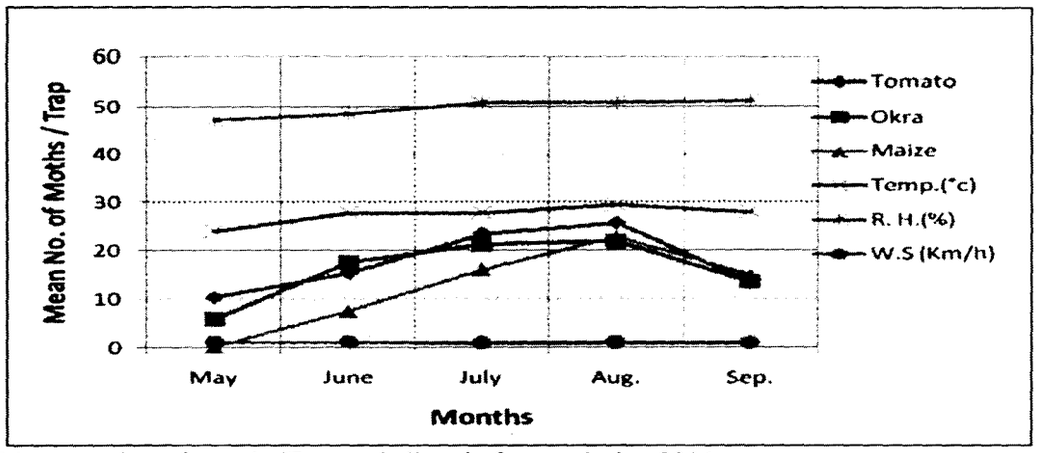

Fig. (2): Mean number of months/Trap and climatic factors during 2006 season.

Finally, correlation analyses confirmed that only temperature degrees were significantly correlated with trap catches. Others meteorological factors did not affect insect populations.

The relationships between insect catches and temperature degrees were highly significant. However, temperature degrees reached 30.4 and 29.4? C in August during 2005 and 2006 season, respectively when the highest population densities of the trap insect catches were recorded in all the crops under this study. Insect densities were always higher at the borders of the plantation (Figs 1 and 2).

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الملخص العربى

الاصطياد الحقلى لدودة اللوز الأمريكية *Helicoverpa armigera* (Hubner) باستخدام المصائد الفرمونية

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سجلت دودة اللوز الأمريكية *Helicoverpa armigera* Hb. على عدد كبير من العوائل النباتية فى مصر. اظهرت النتائج الحقلية باستخدام المصائد الجنسية ان الحشره تفضل نباتات الطماطم يليها البامية ثم الذرة حيث سجل أعلى تعداد لذكور فرشات الأفة على نباتات الطماطم يليها البامية ثم الذرة خلال شهر اغسطس فى الموسمين المتعاقبين ٢٠٠٥ – ٢٠٠٦ . وقد تبين من التحليل الاحصائى لمعامل الارتباط والانحدار ان هناك علاقة معنوية بين درجة الحرارة وتعداد ذكور فرشات دودة اللوز الأمريكية فى مصايد الجاذبات الجنسية بينما لم تكن هناك علاقة معنوية فى حالة الرطوبة النسبية وسرعة الرياح. وأثبتت المصائد الجنسية المحتوية على (Z)-11-Hexadecenal, (Z)-9-Hexadecenal and (Z)-7-Hexadecenal كفاءة عالية فى التنبؤ بتعداد الافة.