SEASONAL FLUCTUATION OF *HELICOVERPA ARMIGERA (*HUBNER) (LEPIDOPTERA: NOCTUIDAE) ON COTTON AND OKRA AND HEAT UNITS RELATED

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Abstract

The seasonal fluctuation of the American bollworm (ABW), *Helicoverpa armigera* (Hub.), (moths and larvae) was studied on cotton, *Gossypium barbadense* and okra, *Hibiscus esculentus*, in Dakahlia Governorate during 2007 and 2008 cotton seasons. Results revealed that the population of ABW male moths occurring three peaks each season. The first peak had highest average number of male moths than others during the two seasons. Populations of ABW larvae infest cotton and okra plants appeared two peaks during the same period. The average numbers of larvae on okra was higher than cotton during the two seasons and average. The probability regression values revealed highly significant between accumulated heat units and each of ABW male moths and larval infestation in cotton and okra. The calculated $R^{\wedge 2}$ values ranged between 0.8148 and 0.9619. The same trend was found between accumulated ABW male moths and larval infestation in cotton and okra. The calculated $R^{\wedge 2}$ values ranged between 0.9185 and 0.9793. Also, between larval infestation in okra and cotton plants were highly significant. The calculated $R^{\wedge 2}$ values ranged between 0.6030 and 0.9899. Consequently, accumulated heat units can be used to predict pheromone traps catch and larval infestation on okra and cotton. Pheromone traps catch can be used to predict larval infestation on okra and cotton also can be used larval infestation on okra to predict larval infestation on cotton.

INTRODUCTION

The American bollworm *Helicoverpa armigera* (Hubner) (Lepidoptera: Noctuidae) is a polyphagous pest causing extensive damage on many crops such as cotton, okra and tomato (Sharma, 2001). Intercropping cotton with okra reduced the boll damage and okra acts as a good trap and highly preferred for feeding more than cotton for *H. armigera* (DuraimuruJan and Regupathy 2005 a and b). Eggs 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 (Ravi *et al*. 2005). The host plants sequence and host suitability play an important role in population dynamic of *H. armigera* male moths (Fitt, 1989). Mean survival, development and reproductive performance of *H. armigera* varies on different food plants (Pretorius, 1976 and Jallow *et al.* 2001). The pheromone traps are convenient and powerful tools which gives reliable information for monitoring of population density and intensity and for forecasting of *H. armigera* infestation (Gawand *et al.*, 2006). Pheromone traps had been used to determine the seasonal dynamics (Slosser *et al.*, 1987). Monitoring the population of *H. armigera* is greatly important in the programs of integrated pest management in crops.

Common in Egypt, okra is planted in small area adjacent cotton fields. Thus, the aim of this work was to study seasonal fluctuation of *H. armigera*, relationships between accumulated heat units, male moths and larval infestation on cotton and okra plants.

MATERIALS AND METHODS

The present study was carried out at Aga district in Dkahlia Governorate during two cotton seasons 2007 and 2008. The cotton varity Giza 86 and okra were planted on the second week of April during the two seasons. The total area planted with cotton at Aga district was about 150 and 75 feddan in 2007 and 2008 cotton season, respectively. The experimental area was 2200 m^2 during the two seasons. The cotton crop occupied in area of 2000 m^2 and okra about 175 m^2 on the border of the cotton area. The okra was normally planted on border of cotton plants in Aga districts. The agronomic practices were carried out as usual. The experimental area was sprayed according to the recommendation ministry of agriculture program.

Three funnel pheromone traps were fixed in cotton fields throughout a period extended from fourth week of May to the 3rd week of September during the two cotton seasons 2007 and 2008. The pheromone capsule was changed every two weeks. The numbers of *H. armigera* male moths caught was recorded weekly. Daily maximum and minimum temperatures were obtained from the Meteorological Laboratory, Agricultural Research Center. The degree days were calculated according to Seaver *et al.* 1990 and the lower and upper temperature thresholds were 11.73 and 30 °C. The accumulated heat units were calculated from 1st January in both seasons.

Samples

Weekly twenty plants from each cotton and okra plants were chosen randomly and investigated carefully to estimate the larvae of *H. armigera* from the fourth week of May to the 3rd week of September.

Statistical analysis

Data were statistically analyzed using 'Costat' program a product of Cohort software Inc., Berkeley, California.

RESULTS AND DISCUSSION

1. Seasonal fluctuation of male moths

The population of ABW, *H. armigera*, male moths captured per trap fluctuated during the two seasons showing up three peaks each (Figures 1). The average number of ABW captured increased gradually from the fourth week of May to reach the first peak on 21st June and 14th June with 135 and 175 moth/trap/week during 2007 and 2008 cotton seasons, respectively. The population declined gradually and increased to reach the second peak at 26th and 19th July with 25 and 55moths/trap/week during the first and second season, respectively. The population decreased and after that, the mean numbers of male moths captured increased till the third peak on 30th August during the two seasons. The first peak had the highest number of male moths captured than the others during the two seasons. The total numbers of male moths captured was higher during the second season than the first one.

2. Seasonal fluctuation of larval infestation in cotton and okra

The population of ABW larval infestation in cotton and okra crops started earlier one week on okra than cotton during the two seasons (Figures 1). On okra, larval infestation began at the fourth week of May with 1 and 2 larva/20 plants, while on cotton plants began at the first week of June with 6 and 5 larva/20 plants during 2007 and 2008 cotton seasons, respectively. Larval populations fluctuated on cotton and okra crops occurring two peaks during each season. On okra plants, the infestation with the ABW larvae increased gradually to reach the first peak with 17 and 20 larvae/20 plants at the fourth week of June and the first week of July during the two seasons, respectively. And after that, the population decreased and fluctuated during July and August till the second peak with 11 and 13 larvae/20 plants on second and first week of September during the 2007 and 2008 seasons, respectively. On cotton plants, the infestation with the ABW larvae increased gradually to reach the first peak with 13 and 17 larvae/20 plants at fourth week of June during the two seasons, respectively. And after that, the population decreased and fluctuated during July and August till the second peak on second week of September (6 and 7 larvae/20 plants). The total numbers ABW larval infestation was higher on okra than cotton plants.

3- Heat units and male moths captured & larval infestation related

The probability regression values between accumulated heat units (AcHu) and weekly average number of ABW male moths captured in sex pheromone funnel taps revealed that the slope values were insignificant during 2007 cotton season while, it was significant during 2008 season and average for the two seasons. However, $R^{\wedge 2}$ values were 0.1984, 0.4709 and 0.3948, for the two seasons and average, respectively (Tables 1-3 and Figures 2). Also, relationships between accumulated heat unit and larval infestation in cotton and okra were insignificant for the two seasons and average, while highly significant at accumulated male moths, accumulated larval infestation in cotton and okra for the two seasons and average. The calculated $R^{\wedge 2}$ values ranged between 0.8148 and 0.9619 (Tables1-3).

Relation between male moths captured and larval infestation

The probability regression values between male moths captured and larval infestation in cotton and okra were highly significant during the two seasons and average, except in case of okra during the second season which was insignificant. The obtained $R^{\wedge 2}$ values were (0.4959 & 0.4269), (0.4084& 0.1769) and (0.5614& 0.3953) for the two seasons and average, respectively. The probability regression values between accumulated male moths and accumulated larvae infested cotton and okra were highly significant during the two seasons and average. The calculated $R^{\wedge 2}$ values ranged between 0.9185 and 0.9793 (Tables 1-3 and Figures 3).

Relation between okra and cotton larval infestation

The probability regression values between larval infestation on okra and cotton plants were highly significant during the two seasons and average. Also, the regression value between accumulated larvae infested okra and accumulated larvae infested cotton were highly significant during the two seasons and average. The obverse $R^{\wedge 2}$ values ranged between 0.6030 and 0.9899 (Tables 1-3 and Figures 4).

Gawande *et al.* (2006) reported that the male moth trap catches of *H. armigera* had significant and positive correlation with its egg population in the field and infestation in green fruiting, whereas it had non significant correlation with larval population. Egg numbers were significantly higher on okra than on cotton (Ravi *et al.*, 2005). Survival of larval stage is very much dependent on the appropriate responses by females when selecting host plants (Fitt and Bayan, 1991& Fitt, 1991).

Fig .1

Fig .2

Fig .3

Fig .4

Table 1. Regression equations between accumulated heat units, weekly average numbers of ABW moths, larvae infest cotton and Okra plants during 2007cotton season

Independent	dependant	Equation parameters			R^2
		a	bx	probability of regression	
Accumulated heat units	Mean number of moth	80.05	-0.027	.0640 ns	0.1984
Accumulated heat units	Larvae infested cotton	9.63	-0.003	.0962 ns	0.1634
Accumulated heat units	Larvae infested okra	10.26	-0.002	.4109 ns	0.0427
Accumulated heat units	Accumulated moth	-168.33	0.310	.0000 ***	0.8864
Accumulated heat units	Accumulated larvae infested cotton	-25.54	0.043	.0000 ***	0.8796
Accumulated heat units	Accumulated larvae infested okra	-46.11	0.066	.0000 ***	0.9289
Mean number of moth	larvae infested cotton	2.01	0.081	.0011 **	0.4959
Mean number of moth	larvae infested okra	4.04	0.094	.0033 **	0.4269
Accumulated moth	Accumulated larvae infested cotton	-1.57	0.139	.0000 ***	0.9793
Accumulated moth	Accumulated larvae infested okra	-6.90	0.206	.0000 ***	0.9702
Larvae infested okra	Larvae infested cotton	-0.61	0.742	.0000 ***	0.8492
Accumulated larvae infested okra	Accumulated larvae infested cotton	3.59	0.669	.0000 ***	0.9887

Table 2. Regression equations between accumulated heat units, weekly average numbers of ABW moths, larvae infest cotton and Okra plants during 2008 cotton season.

Independent	dependant	Equation parameters			R^2
		a	bx	probability of regression	
Accumulated heat units	Mean number of moth	160.41	-0.06	.0017 **	0.4709
Accumulated heat units	Larvae infested cotton	11.89	0.00	.0851 ns	0.1739
Accumulated heat units	Larvae infested okra	11.48	0.00	.3057 ns	0.0654
Accumulated heat units	Accumulated moth	-137.04	0.45	.0000 ***	0.8148
Accumulated heat units	Accumulated larvae infested cotton	-43.33	0.06	.0000 ***	0.9210
Accumulated heat units	Accumulated larvae infested okra	-60.50	0.08	.0000 ***	0.9619
Mean number of moth	Larvae infested cotton	3.25	0.06	.0043 **	0.4084
Mean number of moth	Larvae infested okra	6.10	0.04	.0822 ns	0.1769
Accumulated moth	Accumulated larvae infested cotton	-17.21	0.13	.0000 ***	0.9574
Accumulated moth	Accumulated larvae infested okra	-22.55	0.15	.0000 ***	0.9185
Larvae infested okra	Larvae infested cotton	-0.11	0.78	.0002 ***	0.6030
Accumulated larvae infested okra	Accumulated larvae infested cotton	2.91	0.79	.0000 ***	0.9885

Table 3. Regression equations between accumulated heat units, weekly average numbers of ABW moths, larvae infest cotton and okra plants (mean of two seasons), 2007- 2008 cotton seasons.

Independent	dependant	Equation parameters			R^2
		a	bx	probability of regression	
Accumulated heat units	Mean number of moth	120.73	-0.04	.0052 **	0.3948
Accumulated heat units	Larvae infested cotton	10.75	0.00	.0810 ns	0.1782
Accumulated heat units	Larvae infested okra	10.84	0.00	.3166 ns	0.0626
Accumulated heat units	Accumulated moth	-154.79	0.38	.0000 ***	0.8478
Accumulated heat units	Accumulated larvae infested cotton	-34.69	0.05	.0000 ***	0.9076
Accumulated heat units	Accumulated larvae infested okra	-53.48	0.07	.0000 ***	0.9513
Mean number of moth	Larvae infested cotton	2.18	0.08	.0003 ***	0.5614
Mean number of moth	Larvae infested okra	4.73	0.07	.0052 **	0.3953
Accumulated moth	Accumulated larvae infested cotton	-10.04	0.13	.0000 ***	0.9779
Accumulated moth	Accumulated larvae infested okra	-15.95	0.18	.0000 ***	0.9518
Larvae infested okra	Larvae infested cotton	-1.28	0.89	.0000 ***	0.8470
Accumulated larvae infested okra	Accumulated larvae infested cotton	3.02	0.74	.0000 ***	0.9899

Generally, the larval infestation of *H. armigera* on okra was more than cotton plants during the whole two seasons and started earlier on okra than cotton with one week during the two seasons. The average number of larvae was decreased during July and August on cotton and okra during the two seasons, it may be due to climate changes and pesticides used to control cotton bollworm. The pesticide application could causes changes in the distribution pattern of the *H. armigera* (Balla and Singh, 1997).

Therefore, accumulated heat units can be used to forecast pheromone traps catch and larval infestation on cotton & okra. Pheromone traps catch can be used to forecast of *H. armegrea* larval infestation on cotton & okra, also larval infestation on okra can be used to forecast larval infestation on cotton.

Khan *et al.* (2003) found positive correlation between infestation and weather factors (temperature and relative humidity). Nada *et al.* (2004) found that the population of *H. armigera* at Dakahlia had three and four peaks and the days from peak to peak ranged between 30-33 days, also, heat units between 440-486 units.

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التقلبات الموسمية لدودة اللوز الأمريكية في القطن والبامية وعلاقتها بالوحدات الحرارية

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تم دراسة التقلبات الموسمية لفراشات ويرقات دودة اللوز الأمريكية في القطن و البامية في محافظة الدقهلية خلال موسمي ٢٠٠٧ و ٢٠٠٨. أوضحت النتائج أن لفراشات دودة اللوز الأمريكية المصادة بواسطة المصائد الفرمونية ثلاثة قمم خلال كل موسم وكانت القمة الأولي أعلاها في التعداد. وكان لإعداد يرقات دودة اللوز الأمريكية علي القطن و البامية قمتين خلال الموسم وكانت القمة الأولي هي الأعلى في التعداد وكان تعداد اليرقات علي البامية اعلي من أعدادها الموجودة علي القطن خلال الموسمين. ووجد ان هناك علاقة ارتباط معنوية بين الوحدات الحرارية المتجمعة وتعداد الفراشات في المصائد وعدد اليرقات في القطن و البامية وتراوحت قيمة $R^{\wedge 2}$ بين ٠.٨١٤٨ و ٠.٩٦١٩ . ووجد أن هناك علاقة مابين التعداد المتجمع لفراشات دودة اللوز الأمريكية وتعداد اليرقات في القطن و البامية وكانت قيمة $R^{\wedge 2}$ ٠.٩١٨٥ و ٠.٩٧٩٣ وكذلك وجدت علاقة عالية المعنوية مابين تعداد اليرقات في البامية و القطن وكانت قيمة $R^{\wedge 2}$ ٠.٦٠٣٠ و ٠.٩٨٩٩ . وبصفة عامه يمكن استخدام الوحدات الحرارية المتجمعة للتنبؤ بتعداد الفراشات في المصائد الفرمونية و الإصابة في القطن و البامية. كما يمكن استخدام تعداد الفراشات في التنبؤ بالإصابة في القطن و البامية وكذلك استخدام تعداد اليرقات في البامية للتنبؤ بتعداد يرقات دودة اللوز الأمريكية في القطن.