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USING HEAT ACCUMULATION AND SEX PHEROMONE CATCHES TO PREDICATE THE AMERICAN BOLLWORM *Helicoverpa armigera* HUB. FIELD GENERATIONS

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ABSTRACT

The present study was carried out at Fayoum Governorate during 2005 and 2006 seasons under field condition. The temperature is an important environmental factor on, rate of development, survival and in any other biological and ecological aspects for the American Bollworm *Helicoverpa armigera*. Seasonal abundance of the insect population and predication of field generation throw a light on the temperature influence on development in the field. The data showed that the American Bollworm *Helicoverpa armigera* had five generations on the prevailing host plants during the period from March 1st to November 1st in addition to overwintering generation, which the moths emerged during March from the hibernation. The predicted peaks of generations could be detected when the accumulation thermal units 557.5 dd's. The males of the overwintering generation reached the real and predicted peaks at the same time (during the April for the two investigated seasons). The predicted peaks for the other five generations detected earlier or later +3 to -3 days than the observed peaks. The expected peaks and the corresponding expected generations for American bollworm could be helpful when IPM control tactics are considered.

INTRODUCTION

The American bollworm *Helicoverpa armigera* Hubner, is a polyphagous pest causing damage to cotton, cereals, pulses, vegetables etc. since it largely feeds on the reproductive parts of plants, controlling it with chemical insecticides is often difficult. In order to develop nonchemical method for its management Anita *et al.,* 1984 and Valand and Patel 1993).

Although the use of insecticides is still the most effective method to control pests, it is becoming increasingly important to design and develop an alternative program to safe man and/ or environment.

Integrated pest management program involves a total system to suppression of pest population, which depends on predicting the seasonal population cycles of insects, which has led to the formulation of many mathematical methods (Clement *et al*., 1979; Richmond *et al.* 1983), which described the developmental rates as a function of temperature (Wagner *et al*., 1984). Also, Taman (1990) stated that pheromone traps provided as useful ecological tool for monitoring cotton insect pests and early prediction of their successive generations.

In present ecological studies were carried out for forecasting and monitoring population systems on the basis of the seasonal fluctuations and annual generations of the American bollworm according to the number of males attracted and captured by the pheromone baited traps and the heat units required completing each generation. Although a number of workers have reported about sex pheromone traps and heat requirements for lepidopterous insect pests (Davidson 1944; Bierl *et al.,* 1974; Sevacherian *et al.,* 1977; Potter *et al.,* 1981; Moftah *et al.,* 1988; Abdel - Meguid and Amin 1994; Khidr *et al.,* 1995; Dahi 1997; Dahi 2003; Sing *et al.,* 2004 and Ismail *et al.,* 2005).

MATERIAL AND METHODS

To study the prediction possibility in relation to heat units accumulations, the temperature data could be transformed into heat units and serve as a tool for studying insect population dynamics and predicting appearance of American bollworm in the field during two successive seasons 2005 and 2006 at Fayoum Governorate. Each season extended from early March (after emergence from its hibernation) to early November (before next hibernation).

Daily maximum and minimum temperatures were obtained and recorded by Central Laboratory for Agricultural Climate (CLAC). Degree-days (DD) were calculated from the daily maximum and minimum temperatures (°C) with developmental threshold (t_0), which has been estimated in the laboratory under constant conditions, where the zero development (t_0) was 10.87 °C with 557.5 DD's for generation development. The following formula was used for computing the Degree-days (DD) according to Richmond *et al*., (1983**)** under fluctuation temperatures:

$$H = \sum HJ$$

Where: H = number of heat units to emergence;

HJ = (max. + min./2-C, if max.>C & min.>C.

= (max. - C)2/(max. - min.), if max.>C & min<C.

= 0 if max.<C & min.<C.

C = threshold temperature.

This study was conducted at Fayoum Governorate; the monitoring by pheromone trap was carried out using the sex pheromone traps (funnel trap) described by Rashad (1981). The traps were baited with the synthetic pheromone formulation in polyethylene vials. Every vial is containing one of the active ingredients of the specific pheromone for American bollworm.

The traps were fixed in the fields on a steel stands and placed above the different prevailing host plants canopy with a distance of about 20 cm high and were kept in the same level till the end of the season (Flint and Merkle, 1983 and Dhawan and Sidhu, 1988.

As a frequent routine, the funnel traps was changed monthly and replaced by new ones, the pheromone vials were replaced by new ones every two weeks and the daily catch of American bollworm males were collected, counted identified and recorded. Daily mean number of male moth of American bollworm per trap was accumulated for three days for the two seasons (2005 and 2006) was represented graphically to determine the population peaks (the real peaks were considered in case of a significant correlation between the accumulated degree days and moth activity) in the successive generations in relation to the accumulated degree-days.

RESULTS AND DISCUSSION

As shown in Table (1) and Figs. (1, 2), the observed and expected peaks of **overwintering generation** occurred at April 9th and 3rd where the maximum average number of captured moths were 8.6 and 5.2 males for 2005 and 2006 respectively.

The first generation: the observed peak occurred on May 18th and May 21st when the average male moths reached to 13.2 and 8.4 males for 2005 and 2006 seasons, respectively. On the other hand, the expected peaks for the same generation where May 21st at 556.5 and 554.0DD's for 2005 and 2006, respectively with deviation intervals -3 days later than the real peak for 2005 season, but the real peak and the expected one occurred at the same date for 2006 season.

The second generation: the real peak occurred at Jun 26th for the two seasons when the average male moths reach 9 and 10.2 male/trap/ 3 nights for 2005 and 2006, respectively. The expected dates of this generation were Jun 24th and 26th with an average 563.9 and 557.5 DD's for 2005 and 2006 respectively. The deviations between observed and expected peaks were +2 and +3 days earlier for two seasons respectively.

The third generation : the observed and expected peaks of this generation occurred at (July 25th and July 24th) & (July 22nd and July 23rd) for 2005 & 2006, respectively, when the accumulated heat requirements completed 561.7 and 557.4 DD's during two seasons, respectively. The deviation between observed and expected peaks were +1 day earlier and -1 day later for 2005 and 2006, respectively.

The fourth generation: the male moths emergence of the 4th generation, i.e. the actual observed peak which represented the highest average number of captured male moths, appeared on Aug. 21st and Aug. 18th, where the average reached 19 and 9.2 males for 2005 and 2006, respectively. The expected dates of this generation occurred at Aug. 21st for both seasons with deviation intervals zero and -3 days when the accumulated degree days completed 559.7 and 551.1 DD's for 2005 and 2006, respectively.

Fifth generation: the peak of the 5th generation occurred on Sep. 18th and Sep. 23rd for 2005 and 2006 with an average 10 and 7 male. On the other hand, the expected date was Sep. 21st and appeared with -3 days later when accumulation heat units of 552.3 and 560.0 DD's for the two successive seasons, respectively.

Generally, it will be better for good prediction to have a positive periods between predicted and actual observed and to be as short as possible to obtain good accuracy of prediction according to dd's population patterns of *H. armigera* particularly in hot spots of infestation where early preparation of pest control materials are of great importance. This leads to good and perfect control and minimized the costs of control. Also, when both accumulated and calculated (dd's) above threshold of development for generation were confirmed, however, this technique could be considered as one of the most important factor of pest management program.

These results agree with those obtained by Abdel-Badie (1977) and Mohamed (1977) on *S. littoralis*: Clement *et al.,* 1979 on *A. ipsilon*; Potter *et al.,* 1981 on *Helicoverpa virescens* and Moftah *et al.,* 1988 on *Pectinophora gossypiella*. Taman (1990) mentioned that the maximum and minimum daily temperature were responsible for 23% and 30% of the *S .littoralis* population density.

The expected peaks and the corresponding expected generations for American bollworm could be helpful when IPM control tactics are considered. Finally, it could be concluded that the prediction of the American bollworm field activities is based on lower threshold of development (t_0), thermal units (DD's) for complete generation, T_{max}, T_{min}. and catch moths.

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Table (1): Comparison of observed and expected *H. armigera* generations by monitoring sex pheromone traps and accumulated degree days (dd's) at Fayoum Governorate during 2005 and 2006 seasons.

Seasons	Generation	Generation dates		Deviation (days)	Accumulated degree-days (dd's)
		Observed	Expected		
2005	Overwintering	9/4	9/4	0	-
	1st	18/5	21/5	-3	556.5
	2nd	26/6	24/6	+2	563.9
	3rd	25/7	24/7	+1	561.7
	4th	21/8	21/8	0	559.7
	5th	18/9	21/9	-3	552.3
	Average			-0.5	558.8
2006	Overwintering	3/4	3/4	0	-
	1st	21/5	21/5	0	554.0
	2nd	26/6	26/6	+3	557.5
	3rd	22/7	23/7	-1	557.4
	4th	18/8	21/8	-3	551.1
	5th	23/9	21/9	+2	560.0
	Average			+0.2	556.0

F1

F2

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استخدام التراكم الحراري والفرمونات الجاذبة الجنسية للتنبؤ بالأجيال الحقلية لدودة اللوز الأمريكية

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أقيمت الدراسة الحالية بمحافظة الفيوم خلال موسمي ٢٠٠٥ و ٢٠٠٦ لدراسة التواجد الموسمي لدودة اللوز الأمريكية حقليا ، حيث تعتبر الحرارة أهم العوامل البيئية تأثيرا علي معدل النمو والسلوك والنواحي البيولوجية والبيئية الاخري، ودراسة التغيرات الموسمية في مجموع الحشرة وكذلك التنبؤ بالأجيال الحقلية يلقي الضوء علي تأثير درجة الحرارة علي معدل النمو في الحقل. أوضحت النتائج أن لدودة اللوز الأمريكية خمسة أجيال علي ماهو متاح لها من عوائل في الفترة من أول مارس إلي أول نوفمبر بالإضافة إلي جيل الشتاء والتي خرجت فراشاته خلال شهر مارس من البيات الشتوي والتي قضته الحشرة في صورة عذارى. بالنسبة لهذه الحشرة القمم المتوقعة يمكن اكتشافها عندما يكتمل التجمع الحراري للجيل الكامل ٥٥٧,٥ وحدة- يوم. قمم الأجيال المشاهدة (الحقيقية) والمتوقعة للجيل الخارج من البيات الشتوي جاءت متطابقة تماما في شهر ابريل خلال موسمي الدراسة، بينما القمم المتوقعة لباقي الأجيال الخمسة تراوح انحرافها من + ٣ إلي – ٣ يوم قبل أو بعد ظهور القمة المشاهد (الحقيقية).أوضحت الدراسة أن طريقة التراكم الحراري وهي من أهم الطرق المستخدمة عالميا وبكفاءة عالية جدا في التنبؤ بالأجيال لتحديد توقيت الرش لابد من أخذها في الاعتبار أو كعتبة أساس للاستفادة من علوم التنبؤ في النواحي التطبيقية لعمليات المكافحة لدودة اللوز الأمريكية ضمن برامج المكافحة المتكاملة للآفات IPM .