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Predication The Cotton Leafworm, *Spodoptera littoralis* (Boisd.) Field Geuerations As Influenced by Heat Unit Accumulation

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ABSTRACT

The present study was conducted at the experimental farm, Sakha Research station, Kafr El –Sheikh region under field conditions during the seasons of 2016 and 2017. Results indicated that the population of the cotton leafworm moths. *Spodoptera littoralis* (Boisd.) had seven peaks starting from the 3rd week of May until the 1st week of September during the two studied seasons. The highest number of moths was recorded during the end of June which being 8023.2 and 2063.2 moth /trap/ 30 days and 60 days after cotton planting in both seasons, respectively. The predicted peaks of generations could be detected when the accumulated thermal units recorded 525.42 DD's. The predicted peaks for the detected four generations varied from +1 to +8 days from the observed peaks. For better prediction of the cotton leafworm the period between the observed and expected peaks should be positive and as short as possible when early preparation of control materials are of great important, consequently, it could be helpful when IPM tactics are considered.

Keywords: Cotton leaf worm, *Spodoptera littoralis*, peaks, predicting, generations, thermal units accumulations.

INTRODUCTION

The cotton leaf worm, *Spodoptera littoralis* (Boisd.) known as a major polyphagous key pest in Egypt and active all year around without hibernation period, attacking plants include 73 species recorded at Egypt (Ahmad, 1988, Amin and Salam, 2003). Sex Pheromone traps were found to be more effective than the high-Pressure mercury lamp (Rizk, *et al*, 1990).

In Egypt, it is necessary to design an alternative program for controlling this pest which the use of insecticide is considered the most effective method to control such this pest, so, it is becoming very important to find out and develop a program associated to the use of insecticides for human health safety and / or better agroecosystem.

Integrated pest management program involves a system to suppress the pest population which depends on predicting the seasonal population cycles insects, this led to the formulation of many mathematical methods (Richmond, *et al*., 1983), which described the developmental rates as function of temperature (Wagner *et al*., 1984).

Predicting and monitoring population systems for lepidopterous insect pests by using light or pheromone traps based on heat- requirements were reported by Potter *et al*., 1981, Sing *et al*., 2004, Dahi, 2007, Amer *et al*., 2009, El-Sayed *et al*., 2009 and El-Mezayyen and Ragab, 2014.

Therefore The objectives of the current study were to:

a. Study the seasonal fluctuations of *S. littoralis* moths by using sex pheromone trap.
b. Predicting of *S. littoralis* generations in cotton fields in relation to accumulated heat units.

MATERIALS AND METHODS

The study conducted during two cotton growing seasons, 2016 and 2017 at the experimental farm of Sakha Research station, Kafr El-Sheikh region. The sex pheromone traps were fixed in the cotton fields on wooden stands and placed above the cotton canopy with a distance of about 20 cm high and were kept in the level till the end of the season.

The synthetic sex pheromone capsules were obtained by cotton leafworm Research Department, Plant Protection Research Institute, Dokki, Giza, Egypt. Four traps were baited with a vial loading 1 gm. A.I. of specific pheromone for each. The chemical structure of cotton leafworm pheromone according to Nesbitt *et al*., 1973 as follows:

Zg, E11 – 14 AC.
Zg, E11 – Tetradecadienyl Acetate.
Zg, E12 – 14AC.
Zg, E12 n- tetradecadienyl Acetate.

The sex pheromone vial was hooked in the cap of trap above the surface of soaped water (catching solution). Cotton, *Gossypium barbadeuse* L. namely Giza 86 was sown on April 27th and 30th in 2016 and 2017 seasons, respectively. The cotton occupied an area of 20 and 25 feddans in the first and second season, respectively.

The daily catch of the cotton leafworm males were collected, counted, identified and recorded. Daily number of the captured moths was accumulated for three days during both seasons and was presented graphically to determine the population peaks in the successive generations in relation to the accumulated thermal units in degree days.

To study the prediction possibility in relation to heat units accumulations, the temperature was could be transformed into heat units and serves as a tool for measuring insect population dynamics and predicting the appearance of the cotton leafworm in the field during the aforementioned two successive seasons. Each season extended from early May to the second week of October.

Daily Maximum and minimum temperatures were obtained and recorded by Rice Research and Training Center, Sakha Agricultural Research Station, Kafr El-Sheikh. Degree –days (DD's) were calculated from the daily maximum and minimum temperature (°c) with developmental threshold (t_0) which has been estimated in the laboratory under constant conditions, where the zero development (t_0) was 10.14 °C with 523.27 DD's for generation development (Dahi, 1997). The following formula was used for computing the degree- days (DD's) according to Richmond *et al*.(1983) and fluctuation temperatures:

$$Hj = \sum HJ$$

Where:

Hj = Number of heat units to emergence.

$$Hj = \frac{(Max. + Min.)}{2} - C, \text{ if } max. > C \ \alpha \ min. > C$$

$$(Max. + Min.)^2$$

$$Hj = \frac{\text{Max. + Min.}}{2} - C, \text{ if max.} > C \text{ α min.} < C$$

= 0,if Max. < C α Min. < C
C = threshold temperature.

RESULTS AND DISCUSSION

Seasonal fluctuation of *Spodoptera littoralis* moths and its relation to cotton planting:

Figures (1 and 2) indicate that *S. littoralis* moths during the two studied seasons showed seven peaks for each. These peaks occurred from the 3rd week of May until the 1st week of September. The first peak was occurred on 19th and 22nd May. The corresponding moths were 775 and 229 moth /trap/ three day during 2016 and 2017 cotton season, respectively, then population fluctuated and increased to reach the second peak on 28th June where the captured moths were recorded 655.3 and 255.3 moth /trap/ three days during the first and second season, respectively. The third peak was occurred on 18th and 21st June, where the trapped moths equal 1161.8 and 336.3 moth /trap/ three days in the two tested seasons, respectively. The fourth peak occurred on 3rd July where the trapped moths recorded 46.8 and 41.8 moth / trap/ three days during the two tested seasons. The fifth peak was recorded on 21st and 18th July, where the trapped moths equal 243 and 63 moth /trap/ three days in the two tested seasons, respectively. The sixth peak was occurred on 14th August, where the trapped moths were 221.5 and 355.5 moth /trap/ three days in both seasons, respectively. The seventh peak recorded on 1st September, where the captured moths reached to 181.3 and 345.5 moth /trap/ three days during the two seasons of 2016 and 2017, respectively.

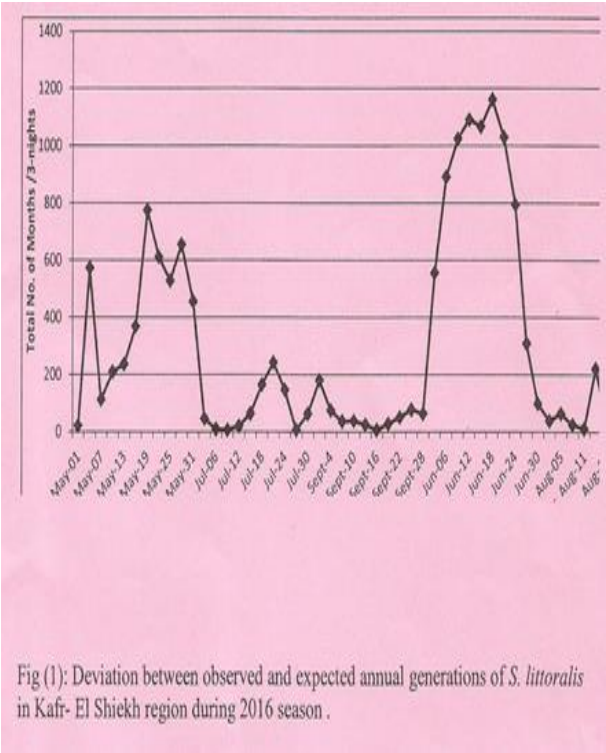

Fig (1): Deviation between observed and expected annual generations of *S. littoralis* in Kafr- El Shiekh region during 2016 season .

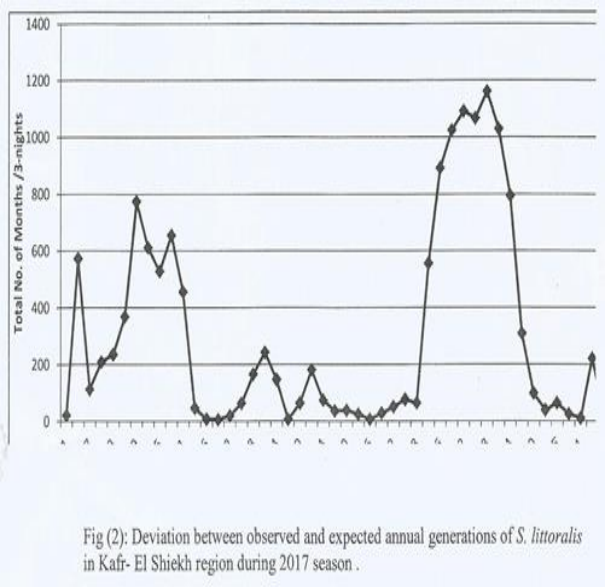

Fig (2): Deviation between observed and expected annual generations of *S. littoralis* in Kafr- El Shiekh region during 2017 season .

It could be noticed that the third peak during the two seasons of 2016 and 2017 had highest number of moths (1161.8 and 366.3 moth /trap) than the other six peaks in the first and second seasons, respectively, During the season of 2016 and 2017, the highest number of moths was recorded during the end of June (8023.2 and 2063.2 moth/trap/ 30days) after 60 days cotton planting while the number of moths are higher in the first season (14355.6 moth /trap) than the second one (5194.3 moth /trap).

These results are in agreement with those obtained by Abdel – Fattah *et al*. (1987) who indicated that four moth broods of *S. littoralis* of variable sizes could be detected with their peaks that occurred late in May and June, in mid – August and late in September. In Kafr El-Sheikh, El-Mezayyen *et al*. (1997) recorded three adult population peaks of *S. littoralis* in May, August and November in the first season and it occurred in April , July and November in the second one. In addition, Dahi (1997) recorded seven main peaks of *S. littoralis* from May until September with only four minor peaks in Menufia Region At the same trend, Robert, *et al*. (2019) indicated that pheromone trap is an important tool for monitoring *Spodopter frugiperda* in the USA.

Prediction of *S. littoralis* generation and in relation to accumulated heat unit.

Date in Table (1) and figures (1 and 2) showed that the observed peak of overwintring generation was occurred on 19th and 28th May in 2016 and 2017 seasons, respectively. On the other hand, the expected peak for the same generation was observed on 18th and 22nd May at 519.02 and 517.45 DD's during the two seasons of 2016 and 2017, respectively with deviation interval +1 and +6 than the real peak for both 2016 and 2017 seasons. The real peak of the first generation was occurred on the 18th and 21st June in the first and second season while the expected dates of this generation were observed on the 17th and 18th June with an average of 535.34 and 519.27 DD's during 2016 and 2017, seasons respectively. The deviations between the observed and expected peaks were +1 and +3 days earlier for the two seasons, respectively.

Table(1): Comparison of the observed and predicted *S. littoralis* generations monitored with sex pheromone related to accumulated degree days (DD ´s) in Kafr El-sheikh region during 2016 and 2017 seasons.

season	Generations	Generations dates		Deviation	Accamulated degree – days (DD,s)
		observed	Predlcted		
2016	Overwintring	19/5	18/5	+1	519.02
	1st generation	18/6	17/6	+1	535.34
	2nd generation	21/7	13/7	+8	520.36
	3rd generation	14/8	9/8	+5	534.07
	Average			+3.75	527.19
2017	Overwintring	28/5	22/5	+6	517.45
	1st generation	21/6	18/6	+3	519.27
	2nd generation	18/7	13/7	+5	530.90
	3rd generation	14/8	7/8	+7	526.95
	Average			5.25	523.64
	Average of two Seasons			4.5	525.42

The observed and expected peaks of the second generation were occurred on 21st and 18th July and 13th July during the two seasons of 2016 and 2017, respectively when the accumulated heat requirements completed 520.36 and 530.90 DD's during both seasons, respectively. The deviation between the observed and expected peaks were +8 and +5 days earlier for 2016 and 2017, respectively. The actual observed peak of the third generation appeared on 14th August for both seasons. The expected dates of this generation occurred on the 9th and 7th August in the first and second seasons with a deviation intervals of +5 and +7 days when the accumulated degree days were 534.07 and 526.95 DD's in 2016 and 2017, respectively. It could be concluded that the highest number of moths was appeared on 18th June (1116.8 moth/trap) during the season of 2016 while during the season of 2017, the highest peak was occurred on 21st June (366.3 moth/trap) during the first generation. In addition, it could be noticed that the strength of the *S. littoralis* population appeared during the two studied seasons depended mainly on the number of male moths occurred during May and early June where the males occurred during that period emerged from the brood reared on clovers and other host plants during winter. If the occurrence of he male moths was high during May, the insect population should be high during the main successive occurrence and vice versa.

These results are in agreement with thoe obtained by Taman (1990) mentioned that the maximum and minimum daily temperatures were responsible for 23% and 30% of the *S. lihoralis* population density. Dahi (1997) recorded overwintring generation during May on clovers and there main overlapping generations during June, July and August during the three tested seasons in cotton fields. He found that the average of thermal units of these generations was 523.27. DD's. At the same trend, temperature is an influencing factor affecting the insect life and activity. This factor May be utilized to gain some insight into the size and behavior of field population and consequently into the history and ultimately prediction of future generation (Ragab, 2009, Amer *et al*.,2009, Dahi, 2007 and El-Mezayyen and Ragab, 2014). Similarly, Duraimrugan and Alivelu (2018) used pheromon trap for determining action threshold of *S. litura* based on number of moths catches. They concluded that pheromone trap based on action threshold identified can be used to forecast the seasonal status of *S. litura.*

It could be concluded that accumulated heat units can be used to predict the cotton leafworm population before the appearance of it peaks with appositive or negative periods between predicted and actual peaks. For better prediction of the cotton leafworm, the period between the observed and expected peaks should be positive and as short as possible where early preparation of pest control materials are of great importance. Consequently, it could be helpful when IPM tactics are considered.

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التنبؤ بالأجيال الحقلية لدودة ورق القطن، باستخدام الوحدات الحرارية التراكمية

جمال على المزين [1] ، عبد البديع عبد الحميد غانم [2] و عبد الخالق السيد عبد الرازق حاتم[1]

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اجريت هذه الدراسة بمزرعة محطة البحوث الزراعية بسخا – كفرالشيخ خلال موسمي ٢٠١٦ و ٢٠١٧م. اوضحت الدراسة أن تعداد دودة ورق القطن سجل سبعة ذروات خلال الفترة من الأسبوع الثالث من مايو حتي الأسبوع الأول من سبتمبر في موسمى الدراسة. سجل اعلي تعداد لفراشات هذه الحشرة في نهاية شهر يونيو (٨٠٢٣,٢ و ٢٠٦٣,٢ فراشة للمصيدة الجاذبة الجنسية / ٣٠ يوم) بعد ٦٠ يوم من زراعة القطن خلال موسمي الزراعة علي الترتيب.يمكن اكتشاف الذروات المتوقعة لهذه الحشرة عندما يكتمل التجمع الحراري للجيل الكامل ٤٢و٥٢٥ وحدة – يوم. تراوح انحراف الذروات المتوقعة للأجيال الأربعة عن الذروات المشاهدة (الحقيقية) من +١ إلي +٨ يوم قبل ظهور الذروات المشاهدة. أظهرت الدراسة ايضاً انه من الأفضل في التنبؤ بأجيال دودة ورق القطن ان يكون الانحراف بين الذروات المتوقعة والمشاهدة موجباً وبفترة قصيرة بقدر الامكان حتي يمكن الاستعداد والتجهيز لمكافحة هذه الحشرة ومن ثم يمكن الاستفادة منها ضمن برامج الادارة المتكاملة IPM لدودة ورق القطن حيث تعتبر هذه الطريقة مفيدة عملياً للتنبؤ بالأجيال لتحديد التوقيت المناسب للرش.