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FACTORS STIMULATING THE OUTBREAKS OF THE COTTON LEAFWORM IN ASSUIT GOVERNORATE

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Abstract

An abnormal increasing in air temperature above the general average during the critical period (January – May) of certain years (2000-2001), increase the emergence of moths and the immature stages mainly as 'pupae". Mass emergence of moths would then be stimulated by the prevalence of warmer weather, normally taking place during April, but happened in March. The sudden emergence of a somewhat large number of adults, particularly at that time when it is still too early in the season, offers vast possibilities for mating and oviposition unlikely to have occurred if normal or warmer "critical periods" had prevailed. In the latter case, individuals emerge gradually or sparsely over a fairly long period. Thus, their mating chances become unlimited, and hence, their subsequent generations would attain abnormal and perhaps higher rates

Introduction

Among all cotton pests in Egypt, the cotton leaf worm (CLW), *Spodoptera littoralis* is the most important. It is extremely polyphagous, and always apt to inflict excessive damage when it occurs in masses during certain years, commonly referred-to as "cotton worm monsoons." The fluctuations in the acuteness of its attack and in its population density depend on ecological and physiological factors, which, up to the present, are not precisely determined. In contrast to the biology of this insect, which has been adequately studied, the ecological knowledge, notwithstanding the attempts rendered by several workers, is still incomplete. This lack of ecological information is mainly due to several factors; the first and most momentous is that the insect becomes more reproductive under alternating physical conditions rather than under constant or artificial ones. Ecological studies are made more difficult by the fact that *Spodoptera littoralis* is a poly-phagous insect known to infest approximately 112 host plants belonging to 44 different plant families. Thereupon, its diet preferences and its microclimatic relationships on the host plants are far from precise or complete. The following is a brief review of some published ecological works on this insect pest and on certain other related subjects. Edison *et al* (2002) studied the effects of meteorological variation on mortality in populations of the spittlebug *Deois flavopicta* (homoptera: cercopidae). They found that variation in temperature and humidity significantly affected mortality rates and population dynamics of the spittlebug. Miche`le *et al* in Canada (2002) studied the relationship between temperature and developmental rate of *stethorus punctillum* (coleoptera: coccinellidae) and its prey *tetranychus mcdanieli* (acarina: tetranychidae). They stated that temperature affects insect and mite development, allowing species-specific traits including optimal temperature and low and high temperature thresholds to be observed. Development rate models and biological parameters estimated from them can help determining if synchrony exists between pests and natural enemies. Umble and Fisher (2002) in Oregon, USA, determined the influence of temperature and photoperiod on pre oviposition duration and oviposition of the strawberry root weevil *otiorhynchus ovatus* (coleoptera: curculionidae) in strawberry. They stated that the high temperature the longest oviposition duration. Broufas and Koveos (2000) studied the threshold temperature for post diapause development and degree-days to hatching of winter eggs of the European red mite *Panonychus ulmi* (Koch), in northern Greece. The threshold temperature for post diapause after the accumulation of a mean sum of 129.4 64.5 DD is above the threshold of 7.4 ^{o}C. Yonggyun and Wonrae in Korea (2000) studied the effect of thermo-period and photoperiod on cold tolerance of beet armyworm, *Spodoptera exigua* (Hubner). In this study, they analyzed the effect of daily temperature and photoperiod cycles on the cold-hardening process. Their results indicate that fluctuating temperature and photoperiod significantly affected cold tolerance of *S. exigua*.. Hamed and Foda (1999) at Fayoum, Egypt, reported the thermal requirements and the threshold development degree for the spiny bollworm, *Erias insulana.* Gergis *et al* (1994) at Minia, Egypt, investigated the relationship between temperature and developmental rate of *S. littoralis life* sequenced on cotton under field conditions. They found high accurate relationship between temperature and rate of development.

The main object of this study is to determine the preceding environmental conditions which would be responsible for the outbreaks of the cotton leaf-worm in Assuit governorate during 2000 and 2001 hence, the possibility of anticipating or predicting the approximate rate of the insect's infestation during the summer.

Materials and Methods

The present work was carried out during four successive cotton-growing seasons i.e. (1999-2002) in the Assuit Governorate, (375 Km south Cairo on Nile Delta where Latitude: 27.30 N, Longitude: 30.970 E and Altitude: 29.90 m). Two districts were chosen for the study: Dirrout and El-qusea, which cultivated with cotton Giza 83. The chosen area represents the whole governorate and also had a large area cultivated by sugar beet. Regular and routine agriculture practices were done. The hand picking of cotton leaf worm's egg masses was done and the collected egg masses were counted every three days from mid May to the third week of July.

Statistical Procedures

Daily maximum and minimum temperatures for Dirrout and El-qusea for 1998 through 2002 were obtained from the General Metrological Authority Stations located in each district (2002). Cotton growing degree-days, calculated using the rectangle technique with minimum and maximum temperatures of 15 and 30 °C, respectively (Higley et al. 1986), were accumulated from 1 April, the approximate earliest day that cotton planting begins in Assuit. Cumulative growing degree-days were determined for each Julian day that the percentage of cotton acres was reported. Daily Degree days (DD's) were calculated from the daily maximum and minimum temperatures (°C), with developed threshold value estimated at constant temperatures carried out before, and zero of development equals 10.14°C (523 DD's) (Dahi 1997). The following formula was used for computing the heat units according to Richmond *et al*. (1983).

Where

H = Number of heat units to emergence

$$
\begin{aligned}
Hj &= (\text{max.} + \text{min.})/2 - C && \text{if max.} > C \ \& \ \text{min.} > C.\\
&= (\text{max.} - C)^2/2(\text{max.} - \text{min.}), && \text{if max.} > C \ \& \ \text{min.} < C.\\
&= 0 && \text{if max.} < C \ \& \ \text{min.} < C.
\end{aligned}
$$

C = Threshold temperature

ANOVA were considered between the general average of each maximum and minimum temperatures in the five tested years.

Results and Discussion

The goal of this work was to explain the outbreak in cotton leaf worm's egg masses happened in Assuit during 2000 and 2001 cotton growing seasons.

1-The Maximum Temperature

Careful examination of data represented in table (1) and Fig (1) showed that (2000) was the highly maximum temperature followed by (2001), (1998), (2002) and (1999). The difference between the highest year (2001) and the lowest one was 4.15 C and the deviation from the general average of the maximum temperature ranged from +1.7 and –2.45. Statistical analysis using ANOVA one-way complete randomized blocks, showed significant differences between (2000 & 2001) and (1999), slightly differences between (2000 & 2001) and each of (2002) and (1998).

2-The Minimum Temperature

The minimum temperature did not show significant variation, it ranged from 10.78 to 10.00 °C during the period extended from January first to May 31st. Statistical analysis using ANOVA one-way complete randomized blocks, did not show any significant differences between any tested years.

3-Calculated Generations

Using Richmond *et al*. (1983) to calculate the generation during the marked period for every year alone without extension with the both of fore and follow years, four generations occurred in each of (2000 & 2001) growing seasons and three in each of the rest (2002, 1999 and 1998). The dates of the mentioned generations are listed in Table (2). Assumed theoretical cotton leaf worm's generations revealed that one more generation happened in the tested period in the years of outbreaks (2000 & 2001).

4-Number Egg Masses

The numbers of hand picked CLW's egg masses in both of Dirout and El-Qusea districts in Assuit Governorate during four successive cotton growing seasons could be summarized in Table (3). As it could be seen from Table (3) and Fig. (2) the highest numbers of egg masses were laid during (2000 & 2001) seasons. The percentage of egg masses may arrange as follows: (2000): 43.1 %, (2001): 36.2%, (2002): 17.6 %, and (1999): 3.1%. Statistical analysis using ANOVA one-way complete randomized blocks, showed that no significant differences between each of (2000 and 2001) but the significant differences were detected between thee two seasons and each of (1999) and (2002).

5-Relationship Between Temperature and Egg Masses

Simple correlation between egg masses and both of maximum and minimum temperatures was calculated. Statistical analysis showed highly significant differences between egg masses and maximum temperature (r = 0.7859), while no significant differences were detected between minimum temperature and egg masses. Multiple regression using the temperatures elements as independent factors (X1 and X2) and egg masses as the dependent factor (Y), revealed highly significant differences refereeing to maximum temperature. The explained variance was 64 % and that means there are about 36 % for unknown factors responsible for outbreak may be that new introduction of favorable host like sugar beet in Dirout and El-Qusea districts.

From the foregoing results it could be concluded that an abnormal increasing in air temperature above the general average during the critical period (January – May) of certain years (2000-2001), increase the emergence of moths. Mass emergence of moths would then be stimulated by the prevalence of warmer weather, normally taking place during April, but happened in March. The sudden emergence of a somewhat large number of adults, particularly at that time when it is still too early in the season, offers vast possibilities for mating and oviposition unlikely to have occurred if normal or warmer "critical periods" had prevailed. In the latter case, individuals emerge gradually or sparsely over a fairly long period. Thus, their mating chances become unlimited, and hence, their subsequent generations would attain abnormal and perhaps higher rates. In other words, high temperature-averages during the critical period produce relatively high population levels of the insect as well as fairly synchronized sub-sequent generations and vice versa.

The obtained results are in full agreement with those of: De Gryse (1929), who emphasized the importance of meteorological phenomena in the study of insects by testing that the variation of 4 or 5 ^{0}F would definitely affect the rate of development and behavior of insects. Janisch (1930), who studied the causes of out-breaks of the cotton leaf-worm *Prodenia litura* F. in Lower Egypt and came to the conclusion that the beginning and end of an out-break are determined, by temperature since humidity varied little throughout the season, owing to irrigation.

In the recent decades Gergis *et al* (1994) at Minia, Egypt, investigated the relationship between temperature and developmental rate of *S. littoralis life* sequenced on cotton under field conditions. They found high accurate relationship between temperature and rate of development. Yonggyun and Wonrae in Korea (2000) studied the effect of thermo-period and photoperiod on cold tolerance of beet armyworm, *Spodoptera exigua* (Hubner). In this study, they analyzed the effect of daily temperature and photoperiod cycles on the cold-hardening process. Their results indicate that fluctuating temperature and photoperiod significantly affected cold tolerance of *S. exigua.*

The obtained data are opposed with the findings of Hosny and Iss-hak (1967), who studied the preceding environmental conditions which would be responsible for the out-breaks of the cotton leaf-worm in the U.A.R., hence, the possibility of anticipating or predicting the approximate rate of the insect's infestation during the summer. They found that, low temperature-averages during the critical period produce relatively high population levels of the insect as well as fairly synchronized subsequent generations and vice versa.

References

Amin A. A. Hamed and M. E. Foda (1999): Field-based, degree-day model for spiny bollworm Earias insulana development, Beltwide Cotton Conferences, Orlando, FL. 923-925.

Broufas; G. D. And D. S. Koveos (2000): Threshold Temperature for Post-Diapause Development and Degree-Days to Hatching of Winter Eggs of the European Red Mite (Acari: Tetranychidae) in Northern Greece. Environ. Entomol. 29(4): 710-713.

Dahi H. F.(1997):New approaches for management the population of cotton leaf worm, *Spodoptera littoralis* and pink bollworm, *Pectinophera gossypiella*. In Egypt. M. Sc. Thesis, Faculty of Agriculture, Cairo University, Egypt.

De Gryse, J. J. (1929): The relation of Entomology to Meteorology. Pap. Conf. Emp. Meteorol, London, pp. 148-167.

Edison R. Sujii, Maria Alice Garcia, Eliana M. G. Fontes, Carmen S. S. Pires, and Robert J. O'neil (2002): Effects of Meteorological Variation on Mortality in Populations of the Spittlebug *Deois flavopicta* (Homoptera: Cercopidae) Environ. Entomol.31(2):299-305.

Gergis, M. F.; M. A. Rizk; M. A. Makadey and A. Hussein (1994): Relationship between temperature and rate of development of cotton leaf worm, *Spodoptera littoralis.* Minia j. Agric. Res. & Dev., 14 (2):235-243.

Hosny M. M. And R. R. Iss-Hak (1967): Factors Stimulating The Outbreaks Of The Cotton Leaf-Worm In U.A.R. And The Principles Of Its Prediction. U.A.R. Ministry of Agric, Tech. Bull. No. 1, pp. 1-36.

Janisch E. (1930): Experimental investigations on the effect of the environmental factors on insect. 1- the outbreak of *P. litura* F. in Egypt. Morph. Oekol. Tiere, Berlin, XVII, No. 1-2: pp. 339-416.

Miche ` Le Roy, Jacques Brodeur, and Conrad Cloutier : Relationship Between Temperature and Developmental Rate of *Stethorus punctillum* (Coleoptera: Coccinellidae) and Its Prey *Tetranychus mcdanieli* (Acarina: Tetranychidae). Environ.Entomol. 31(1): 177 - 187.

Richmond, J. A.; H. A. Thomas and H. B. Hattachargya (1983). Predicting spring flight of nuantucket pine tip moth (Lepidoptera: Olethreutidae) by heat unit accumulation. J. Econ. Ent., 76: 269-271.

Umble; J. R. And J. R. Fisher (2002): Influence of Temperature and Photoperiod on Preoviposition Duration and Oviposition of *Otiorhynchus ovatus* (Coleoptera: Curculionidae). Ann.Entomol.Soc.Am.95(2):231-235.

Yonggyun Kim and Wonrae Song (2002): Effect of Thermo period and Photoperiod on Cold Tolerance of *Spodoptera exigua* (Lepidoptera: Noctuidae). Environ. Entomol. 29(5): 868-873.

Table 1. Maximum and minimum temperatures averages during five successive years (1998-2002) in Assuit Governorate.

	Tested Season	**Maximum Temp**	**Deviation from the Average**	**Significances**	**Minimum Temp**	**Significances**
1	2000	28.65	1.7	a	10.78	a
2	2001	28.5	1.55	a	10.51	a
3	1998	26.7	-0.25	ab	10.23	a
4	2002	26.4	-0.55	ab	10.11	a
5	1999	24.5	-2.45	b	10.00	a

Table 2. Assumed theoretical cotton leaf worm's generations in Assuit Governorate during five successive years (1998-2002).

Tested Season	**I**	**II**	**III**	**IV**	**Duration in Days for Whole & All Generations**
2000	28/3	7/5	10/6	11/7	162
2001	17/3	3/5	6/7	9/7	158
1998	12/4	18/5	19/6		171
2002	5/4	16/5	19/6		173
1999	6/4	17/5	21/6		171

Table 3. Total CLW's egg masses in both of Dirout and El-Qusea districts in Assuit Governorate during four successive cotton-growing seasons (1999-2002).

Years	**Total No. of Egg Masses**		**% of Collected Egg Masses**
1999	248	a	3.1
2000	34308	b	43.1
2001	2883	b	36.2
2002	1400	c	17.6

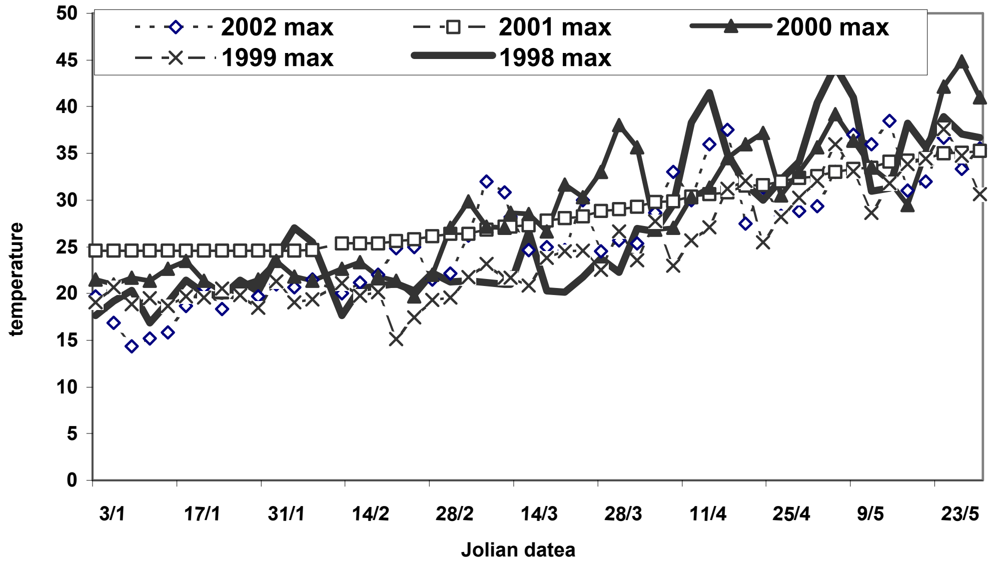

Figure 1. Maximum temperature in five successive years (1998-2002) Assuit Governorate.

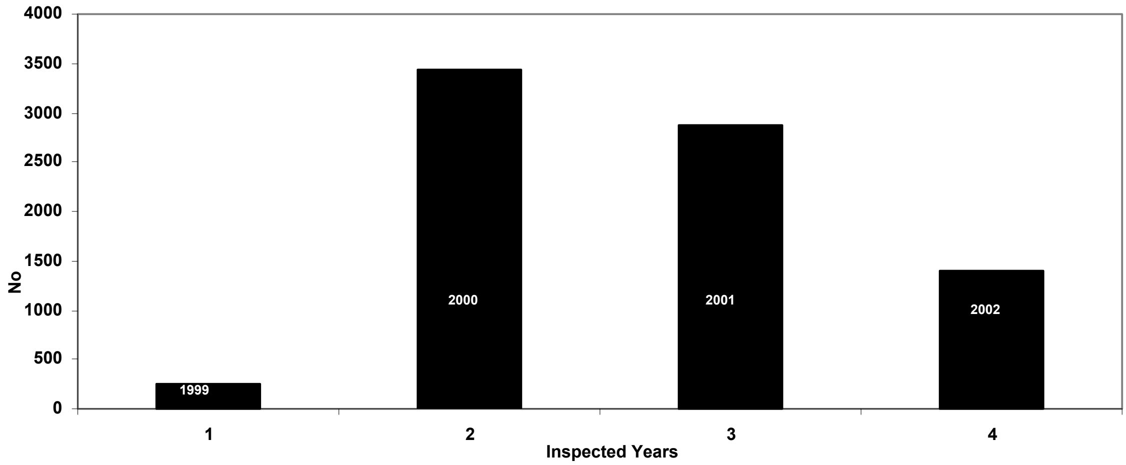

Figure 2. Total no. of cotton leafworm's egg masses in two districts in Assuit Governorates in four successive cotton growing seasons (1999-2002).