FIELD-BASED, DEGREE-DAY MODEL FOR SPINY BOLLWORM *EARIS INSULANA* DEVELOPMENT

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Abstract

Field studies were conducted throughout 1996 and 1997 in Fayoum Governorate to analyze the population size of spiny bollworm, *Earis insulana* using delta pheromone traps. Field generation numbers were calculated. Life table parameters for field data were constructed. Thermal requirements and heat unit's accumulation were used. *Earis insulana* was found to have 7-8 field generation a year. Generations occurred at an average of 436.8 DD's above threshold of 11.6 °C.

Introduction

Cotton in Egypt, that considered as the main cash crop, in addition to its international importance is subjected to yield and quality losses by arthropod insect pests. The cotton ballworms cause the greatest part of yield losses resulted from one million feddans cultivated annually. Spiny bollworm, (SBW), *Earis insulana*, has a number of difficult problems regarding sampling techniques, i. e. (A)- larvae feed inside the green bolls, (b)- It is a phytophagous insect presenting a variable numbers of annual generations, and (c)- Special difficult in estimation the population density in the development stages of the insect pest. Riper and George (1965) in Suddan stated that the life –cycle of SBW varies according to temperature. They stated 13 generations for year. In Egypt Taher (1977), stated that SBW had three overlapping generations from mid August to mid November. Nasr et al. (1982), in Egypt concluded that the size of SBW moth populations were apparently, not related to prevailing temperature, for they were relatively high in Autumn, moderate in Summer and low in Winter and Spring seasons. Gill and Sidhu (1989) stated that the optimum temperature for the survival and development of SBW was 30 °C. In Egypt Hamid et al. (1994), reported that highly significant correlation between catch of SBW and daily mean temperature. In (1997), in Egypt Romeila, stated that, the amount of changes in the maximum day temperature, night minimum temperature and daily mean relative humidity required to alert the catch of SBW.

The present work was conducted to analyze the population size of SBW using pheromone traps throughout two successive years, (1996-1997) in Fayoum Governorate. Field generation numbers were calculated. Life table parameters for field data were constructed. Thermal requirements and heat unit's accumulation were used.

Material and Methods

The present work was carried out in the Fayoum Governorate. Delta pheromone traps were used baited with the specific spiny pheromone capsules. Traps were installed and operated for two successive years, December 1995 to December 1997. Weekly examination of traps was done and the captured adults were recorded. New pheromone capsules were replaced every two weeks in hot weather and 3-4 weeks in cold weather.

Life Table Parameters

Captured adult was used to determine the growth rate (r_m) according to Pearl method (1930). Captured adults used also to fit the logistic equation:

$Log_e (K-N)/N = a-r_m^t$ where:

N = population size, t= time,

r_m = innate capacity for increase and K= upper asymptote or maximal value of N. The slope of this line is approximate estimate of innate capacity for increase (r_m), and the y intercept is an estimate of "a". Net reproductive rate (R_o) was calculated according to Birch (1948) formula: $r_m = Log_e R_o / T$.

Field Generations

The numbers and duration of annual generations of SBW was worked out by two methods:

a) According to Audemard & Milaire (1975) and Iacob (1977) formula on Gauss's scale.
b) Richmond formula (1983) using daily minimum and maximum air temperature was adopted to compute the heat units summation as a first step in forecasting the occurrence peaks and generation duration.

Results and Discussion

Seasonal Fluctuations

Fig (1) presenting the weekly numbers of SBW during two successive yeas 1996 and 1997 as indicated by Delta pheromone traps in Fayoum Governorate. Moths Started to appear in pheromone traps throughout the first week of January in both two years. First generation took its peak in the third week of April in 1996 and the third week from February in 1997. The second generation started earlier in 1997 (the first week of May, while in 1996 appeared on the first week of June. The third one took its place in the first week of July and June in 1996 and 1997 respectively. The fourth generation occurred in fourth week of July in 1996, while it occurred in the second week of July. The fifth one happened on the third week of August in 1996 and on the first week of August 1997. The sixth generation occurred in the third week of September in 1996 and in the fourth week of August in 1997. In 1996 the seventh generation took its

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place on the third week of September while it was happened in the fourth week of September in 1997. The eighth generation happened only in 1997 on the second week of November.

Estimation of Field Generations

The numbers and duration of annual generations of SBW was worked out by two methods:

a) According to Audemard & Milaire (1975) and Iacob (1977) formula on Gauss's scale.
b) Richmond formula (1983) using daily minimum and maximum air temperature was adopted to compute the heat unit's summation as a first step in forecasting the occurrence peaks and generation duration.

According to the biological data obtained after Taher (1986) the threshold of development for SBW was worked out and found to be 11.6 ºC. Richmond formula (1983) using daily minimum and maximum air temperature was adopted to compute the heat unit's summation to complete one field generation. Calculations showed that SBW needs 436.8 DD's for the completion of one generation. Data in table (1) demonstrated the beginning and ending of 8 field generations of SBW in Fayoum Governorate during 1996 and 1997.

Data in table (1) and Figs (2 &3) on semi-Gaussian paper (scale gauss) represent the number of generations by regression lines. Results show the presence of 7and 8 overlapping field generations for SBW in both 1996 and 1997.

Life Table Parameters

The parameter known as the intrinsic rate of natural increase, (r_m), which was developed for demographic analysis by Lotka, is introduced as a useful concept for the study of insect populations.

A: 1996

Data in Table (2) show the life tables parameters of SBW in different generations in the tested years. As it appears from the table, first generation that started on January 7 and ends on March 25/4 in low temperature conditions had relatively low (r_m) value (0.9729) and highly (R_o) (4.7). In the second generation the (r_m) value almost the same (0.9557) while (R_o) decreased (3.361). Fluctuation in (r_m) value around (0.9) extended to the fifth generation and on the other hand the (R_o) fluctuated around the value of (3.2 - 3.3). The innate capacity of increase (r_m) for the sixth and seventh generations increased to be (1.105 and 1.002) respectively. In the opposite side (R_o) values also followed the same trend to be 3.37 and 3.689 respectively.

B: 1997

The same trend of 1996 generations for SBW was obtained. Generations of temperate months had relatively low rm values and those of hot months showed high r_m values. From the above results it could be concluded that SBW needs a high conditions for growing and build its generations. It seems to be that the population had a stable age distribution initially. The logistic model assumes that the population beginning growth [when ((K-N)/K) is very nearly 1.0] increases at a rate approximately equal to r_m N. The careful examination of the above monitored data reveal that the attack of SBW to cotton fields start at the end of April and increasing to reach to its maximum on the end of October, where bolls come to its maturation and migrate to find another host passing winter months with low activity and to start its activity again in spring. The above monitored results are in agreement with the findings of many authors in different countries i.e. Hammad (1967), Hiadari (1967), Taher et al (1977), Couilloud (1983), and Romeila (1997), who concluded that SBW have 6-8 generation a year.

References

Audemard, H. and H. G. Milaire. 1975. Lepiégage du carpocapse (*Laspeytesia pomenell* L.), avec une phéromone sexuelle de synthése. Zoo. Ecol. Anim., 7 (1), 61-80.

Couilloud, R. 1983. *Earias spp.* On cotton in Ivory Coast: *Earias insulana* (Boisd); *Earias biplaga* (Wlk.) (Lepidoptera: Noctuidae). Variation in relative importance of each species. Cotton-et-Fibers-Tropicals. 38:2, 187-200.

Gill, J. S. and A. S. Sidhu. 1989. Comparatives survival and development of *Earias spp.* in relation to some constant ecological factors. Indian J. Ecol. Vol. 16, No. 2, pp142-146.

Hamid, A. M.; A. M. Al-Beltagy and M. A. El-Hamaky. 1994. Influence of certain weather conditions on the bollworm at El-Mansoura District. J. Agric. Sci. Mansoura Univ. 19 (2): 815-812.

Hammad, S. M.; Amer and A. A. El-Deeb. 1967. Studies on the spiny bollworm *Earias insulana* (Boisd) in Alexandria district. Alexandria Journal of Agricultural Research XIV (2).

Hiadari, M. 1967. Biology on the spiny bollworm, *Earias insulana* (Boisd). Entomological Phytopath. Apple. 26: 54-71.

Icob, N. 1977. Un model matematic pebtru stabilirea limitelor economic de toleranta ata cului moliilor fructelor in Iupta integrata. A nalela I. C. P. P., Vol. 15:179-189. Romania.

Nasr, E-Sayed, A.; N. A, Badr; M. A. Hamid and M. A. Ahmed. 1982. Population density and flight activity of adult stage of spiny bollworm *Earias insulana* (Boisd). Agric. Res. Rev. 58(1): 167-197.

Riper, W. E. and Lioyd George. 1965. Cotton pests of Sudan and their habitats and control. Oxford. 345.

Romeila, M. A. 1997. Investigation on implementation of certain agricultural practices and specific chemical agents in the cotton IPM programs. Ph. Thesis, Thesis, Faculty of Agric., Ain Shams Univ., Cairo.

Taher, S. H. 1977. Biological and ecological studies on the spiny bollworm *Earias insulana* (Boisd) in Egypt. M. Sc. Thesis, Faculty of Agric., Ain Shams Univ., Cairo.

Table (1): Observed and predicted field generations of Spiny bollworm as indicated by heat units' summation. Fayoum 1996-1997.

Generation	1996		1997	
	Predicted	Observed	Predicted	Observed
First	22/4	25/4	17/2	20/2
Second	3/6	4/6	12/5	7/5
Third	1/7	3/7	2/6	11/6
Fourth	29/7	28/7	14/7	9/7
Fifth	19/8	23/8	4/8	8/3
Sixth	16/9	21/9	25/8	29/8
Seventh	28/10	27/10	15/9	28/9
Eighth			3/11	10/11

Table (2) Life table parameters of Spiny bollworm field generations in Fayoum Governorate, 1996-1997.

Generation	1996			1997		
	r_m	R_o	t	r_m	R_o	t
First	0.9729	4.7	115	1.002	4.75	116
Second	0.9557	3.6	40	0.9729	4.3	76
Third	0.9757	3.37	30	0.9835	3.53	35
Fourth	0.9464	3.16	25	0.9835	3.31	28
Fifth	0.9805	3.23	26	0.9761	3.19	25
Sixth	1.0126	3.37	29	1.0137	3.27	26
Seventh	1.1057	3.68	36	1.1162	3.51	30
Eighth				1.009	3.77	43

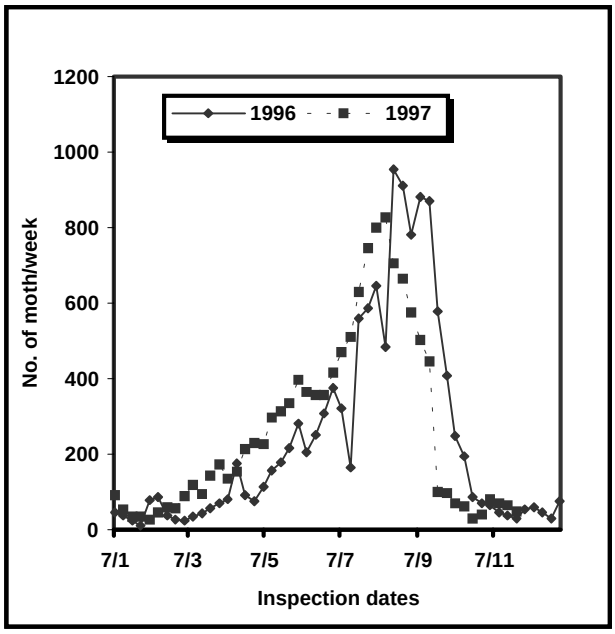

Figure 1. The annual fluctuations of spiny bollworm in Fayoum Governorate. (1996-1997).

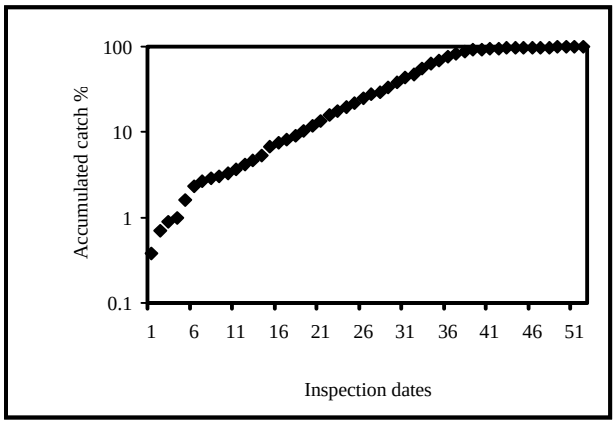

Figure 2. The approximated number of field generation of SBW, Fayoum Governorate (1996).

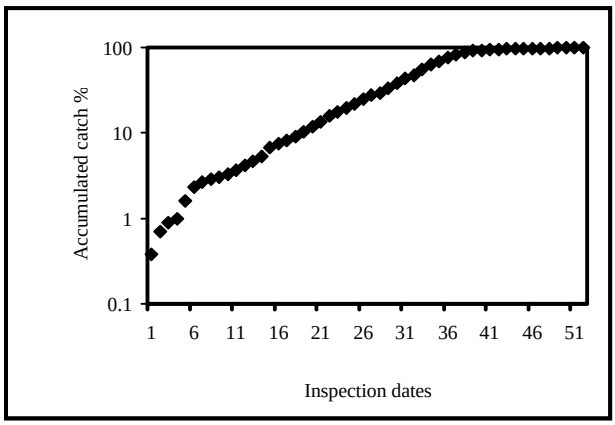

Figure 3. The approximated number of field generation of SBW, Fayoum Governorate (1997).