THERMAL CONSTANT AND DEGREE-DAY REQUIREMENTS FOR THE DEVELOPMENT OF THE EGGPLANT STEM BORER, *EUZOPHERA OSSEATELLA* TRIET. (LEPIDOPTERA: PYRALIDAE).

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Abstract

Developments of the egg-plant stem borer *Euzophera osseatella* Triet (Lepidpterra :Pyralidae) was studied at constant temperatures 15,20, 25 and 30C^0 ±1 C^0 . Development of immature stages was accelerated as the tested temperatures increased. Total developmental time averaged 201, 93.43, 57.2 and 48.17 days at15, 20, 25 and 30C^0 respectively. Generation period ranged between 205.6 and 49.17 days depending on rearing temperature. Adult female survived slightly longer than male. Fecundity was higher at (15C^0) than 30C^0. Female deposited 134.4 eggs at 15 C^0, while this number drastically decreased to 62.0 eggs at 30 C^0. However, egg hatchability (%66.25) showed a reversed trend.

Thermal constant or threshold of development (t_0) and thermal requirements (K) degree- day (DDs) were estimated to be 7.3 C^0,11.43 C^0 and 5.9 C^0 for eggs, larvae and pupae, respectively. Based on estimated preferred temperature30 C^0, heat units (U.T.) 82.85, 413.6 and 538.55 are required to compled the development of egg, larval and pupal stages. Development of one generation may acquire 931.22. degree-days.

INTRODUCTON

The egg-plant stem borer *Euzophera osseatella* Triet (Lepidpterra :Pyralidae) is an injurious pest of some vegetable plants of the family Solanaceae. The earliest record on the occurrence of this pest in Egypt was given by Casoria (1917) on potato and Willcocks (1922) on egg-plant.

Egg-plant, pepper and potato suffer from insect attacks, among, which the egg – plant stem borer *Euzophera osseatella* Triet. Larval stage feeds upon stems and tuunnel causing several damage to these plants. This pest became widely distributed and fairly abundant on egg- plant in lands devoted to vegetables. It was found all round the year, but it decreases very much in winter. Larvae hibernate at low temperature inside plants (HaraKly, 1965; Ferial Loutfi, 1969).

Heat units a method of quantifying the biological organis ons affected by thermal environment. Researches conducted over the past several decades proved that proper use of heat units can provide a reliable mean of predicting the growth and development of many pests (Strong &Apple, 1958; Stinnet *et. al.* 1974; Ali &Ewies, 1982; Richmond *et. al*, 1983, Prness, 1993 and Abd-El-Wahab *et. al.*, 2009).

Following up the literature shows that information about ecology and biology of this pest still insufficient. There fore, it was advisable that detailed studies on thermal constant and thermal requirements of this pest had to be under taken. It is hopped that the present contribution will add to our knowledge of the vegetable insect pests of Egypt.

MATERIALS AND METHODS

To determine the rate of development and the thermal units, the experimental work was carried out under controlled conditions (temperature and relative humidity). .Eggs of the egg –plant stem borer *E. osseatella* reared in the laboratory on potato tubers (Diamont variety), in glass jars were taken for each temperature Four incubators were used to provide constant temperatures of 20, 25, 30 and 35 °c .All stages from egg to adult were kept under the constant temperatures and 70±5% R.H., to determine the developmental rate and other biological parameters of each stages.

The effects of different temperatures, the rate of development and thermal unites were tested on the immature and adult stages of *E. osseatella* . The theoretical development thresholds were determined according to (Miyashita, 1971 and Nasr *et. al.*, 1974), (b) the points obtained when the reciprocal for time (1/y) in days are plotted against temperature T in degrees centigrade, each of the reciprocals is multiplied by 100, so that the values on the ordinate (100/y) represent the average percentage of development made by the stage per day at the given temperature. Therefore, the distribution of the points indicates the course of temperature- velocity curve (Davidson, 1944), (c) theoretically, the point which the velocity line crosses the temperature axis is the threshold of development in degrees centigrade. Thermal units required for complete development of each stage were determined according to the equation of thermal summation (Blunk.1923): $K=y\ (T- t_0)$.

Where y= developmental duration of a given stage; T= temperature in degrees centigrade; t_0 = temperature threshold of development in degrees centigrade; K= Thermal units (degree-days).

To study the prediction possibility in relation to heat unit accumulations, the temperature data is transformed into heat units and served as a tool for studying insect population dynamics and predicting appearance of the egg –plant stem borer in the field during two successive seasons 2005/2006 and 2006/2007 at Qalubia Governorate .

The following formula was used for computing the heat units (DD) according to Richmond *et. al*. (1983):

$$H = \lesssim HJ$$

H=Number of accumulated heat units to emergence.

HJ=(Max.+Min.)/3-C,if max.>C&min.>C.

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

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

C=Threshold temperature.

RESULTS AND DISCUSSION

Data obtained in Table (1), showed that the duration period of *E. osseatella* eggs at 30C° was 3.72±0. 14 days; being shorter than those at 15 and 20 C° (11.0±0.98and 6.45±0.85) while 25C° (4.6±0.32) respectively (<*P*0.05).

Showed that (Table 2), adult female survived slightly longer than male. Fecundity was higher at lower temperature (15C^0) than higher one (30C^0). Female deposited 134.4 eggs at 15 C^0, while this number drastically lowered to 62.0 eggs at 30 C^0, however, egg hatchability (%66.25) showed a reversed trend and sexes rate was higher at 25 C^0 with female 64.11 while male 35.9 % .

The duration of larval stage was also affected by the degree of temperature. Data in Table (1) showed that, the duration of the larval stage was 125.72±1.23, 43.63±3.12: 28.2± 6. 24 and 24.18±1.41 at 15, 20, 25, 30C° respectively, being insignificantly different from each other (*P*<0.05) (Table 1). From the aforementioned results, it can be concluded that *E. osseatella* took longer developmental period at 15C° than the other two tested temperatures. In four-tested temperature, however, the duration of the developmental stages of *E. osseatella* was temperature dependent; i.e., the duration of each developmental stage decreased with increasing temperature.

- Egg stage

As mentioned before, the incubation period of *E. osseatella* was markedly affected by temperature variations. The rate of embryo development was positively dependent on temperature; i.e. increased with increasing of tested temperatures. In this case, the percentage of egg hatchability was 77.1, 61.6, 66.58 and 57.8% at the four tested temperatures (Table 2). The estimated threshold of egg development (t_0) was (7.34C°) (Table 1). On the other hand, the average of thermal units or thermal summation was (84.2, 81.65, 81.23 and 84.29 DD's), respectively, at 15, 20, 25 and 30C°, (Table 1).

The larval stage

Larvae of *E. osseatella* passed through larval instars. The larval duration was shortened with the increase in temperature (Table 1). Hence, the developmental rate of larvae increased as the temperature became higher from 15 to 30°C.

The threshold of larval development (t_0) was estimated as (11.43°C) and the thermal units were (448.82, 373.9, 382.67 and 449.02 DD's, respectively, at15, 20, 25 and 30°C (Table 1) .

The pupal stage

As other developmental stages, the duration of the pupal stage decreased with temperature increase; while the rate of development was retarded at lower temperature.

For *E. osseatella*, the estimated threshold of pupal development (t_0) was 5.9C° . The thermal units were (584.77, 615.18, 466.04and 488.51 DD's) at15, 20, 25 and 30C°; (Table 1).

Longevity:

As in case of each developmental stage of *E. osseatella*, the duration of Longevity decreased with increasing temperatures from 15 to 30C°. The development rates on the other hand increased with increasing of tested temperatures (Table 1). The thermal units for the Longevity as a whole also varied at the four tested temperatures, being 129.98, 76.3, 51.2 and 71.6 at 15, 20, 25 and 30C°, (Table 1).

The duration of life cycle and generation decreased with increasing temperatures from 15 to 30C°. The thermal units for the life cycle and generation as a whole also varied at the four tested temperatures, being 948.63, 615.18, 466.04 & 488.51 and 966.74, 929.55, 859.95 & 968.65.1at 15, 20, 25 and 30C°, (Table1).

In the present study, an explanation for variation in the number of annual generations was given here for the first time on the basis of available data and calculated degree-days required for insect development. Similarly, the expected number of annual generation could be predicted by determining the date at which 931.22 DDs have been accumulated at the beginning of spring. Sevacherian (1977), and Johnson *et. al.*(1979) developed similar degree-day systems for predicting the need for and timing of insecticide application for different insect species.

Table 1. Influnce of constant temperatures on the biological aspects of *Euzophera osseatella.* Treitscke reared on potato at 70±5% R.H. and thermal units.

Stage	Temperature C°	Development periods (days)	Development Rates 1/Y X100	t_0 $\frac{T_1 - p_2(t_1-t_2)}{P_1 - p_2}$	D.Ds $Y(t_1-t_0)$
Egg	15	11±0.98	9.09	7.34C°	84.2
	20	6.45±0.85	15.50		81.65
	25	4.6±0.32	21.74		81.23
	30	3.72±0.14	26.88		84.29
Average					82.85
Larva	15	125.72±1.23	0.79	11.43 C°	448.82
	20	43.63±3.12	2.29		373.9
	25	28.2±6.24	3.55		382.67
	30	24.18±1.41	4.15		449.02
Average					413.6
Pupa	15	64.26±2.25	1.56	5.9 C°	584.77
	20	43.35±3.25	2.31		615.18
	25	24.4±5..3	4.90		466.04
	30	20.27±1.4	4.12		488.51
Average					538.55
Total of immature.	15	200.98±3.11	0.50	10.28 C°	948.63
	20	93.43±5.56	1.07		908.14.
	25	57.2±2.15	1.74		842.10
	30	48.17±0.97	2.07		950.0
Average					912.21
Generation	15	205.69	0.48	10.3 C°	966.74
	20	95.83	1.04		929.55
	25	58.5	1.7		859.95
	30	49.17	2.03		968.65
Average					931.22
Longevity	15	13.4±2.8	7.5	5.3 C°	129.98
	20	5.19±0.43	19.3		76.3
	25	2.6±0.1	38.5		51.2
	30	2.9±0.17	34.5		71.6
Average					77.2

t_0= developmental threshold

D.Ds =Thermal units

Table 2. Effect of different temperatures on the longevity, number of eggs laid per female and Hatching% of *Euzophera osseatella* Treitscke reared on potato tuber at 70±5% R.H.

Temp.	Female longevity (days)	Male longevity (days)	No. of eggs laid/female	Hatching%	Sexes ratio	
					Female	Male
15∘C	13.4±2.8*	12.2±1.7*	134.4±17.2*	57.6	52.2	47.8
20∘C	5.19±0.43	4.42±0.33	72.0±18.36*	66.58	52.0	48.0
25∘C	2.6±0.1*	2.3±0.12*	97.3±15.13	61.6	64.11	35.9
30∘C	2.9±0.17*	2.7±0.22*	62.0±9.66*	77.1	58	42
LSD $_{0.05}$	8.9	8.06	57.7	-	-	
LSD $_{0.01}$	16.2	15.08	108	-	-	

REFERENCES

1. Abd El-Wahab, H. A., S. A. Ebrahim and R. M. El-Dabi. 2009. Influence of constant Temperatures on the biological aspects of *Phithorimaea opercuella* (Zeller0 and thermal units (degree days) J. Agric. Sci. Mansoura Univ.,34: 2191-2197.
2. Ahmed, S. , S. B. Huq and F. A. Talukder. 1991. Susceptibility of potato to potato moth in field and storage. Bangladesh Journal of Agricultural Sciences, 18: 2, 289-290.
3. Ali, M. A. M. and M. A. Ewies. 1982. Response of the Egyptian alfialfa weevil *Hypera brunneiprnnis* Boh. to temperature and photoperiod. Proc. Egypts Natiopnal conf. Ent.Vol. 1 : 239 -250.
4. Blunk,M. 1923. Die Entwicklung Von Dytiscus marginalis L.von. Eibis zur Imago,Teil Die Metamorphase Zracht.Wiss.Sool.121-171.
5. Casoria, M. 1917. Notes sur un insecte ravageur de pommes de terre. Bull. Union Agriculteurs d, Egypt, XV, No. 120: 77-81.
6. Davidson, J. 1944. On the relation between temperature and rate of development of insects at constant temperatures J.Anim. Ecol. 13 ;26-38.
7. Ferial, M. Loutfi. 1969. Studies on the morphology and biology of the egg-plant stem borer *Euzophora osseatella* Treit. (Lepidoptera, Pyralidae). Msc. Thesis, Fac. Agric. Alexandria Univ. :169.

8. Harakly, F. A. 1965. External morphology and life –history of egg-plant stem borer, *Euzophora osseatella* Treit. (Lepidoptera, Pyralidae). Bull. Soc. Ent. Egypt,XLIX :259-276.
9. Johanson, E. F. , R. Trottier and I. E. Laing. 1979. Degree-day relationships to the development of (Lepidoptera :Gracillariidae) and its parasite Apanteles ornigis (Hymenoptera :Braconidae). Can. Entomol.,111:1177-1184.
10. Miyashita, K. 1971. Effective of constant and alternateranating temperatures on the development of *Spodoptera litura* F. (Lepidoptera:Noctuidae). Appl.ent.Zool. 6 (3): 105-111.
11. Nasr,E.A. , M. R.Tucker and D. G. Compion. 1974. Distribution of moths of the Egyptian cotton leaf worm . *Spodoptera littoralis* (Boisd.) (Lepidoptera:Noctuidae). In the Nile delta interpreted from catches in a pheromone to temperature and humidity. Bull. Soc. Ent. Egypt, 28:123-131.
12. Pruess, K. P. 1993. Day degree methods for pest management. Enviro. Entomol. 12: 613-619.
13. Richmond, J. A. , H. A. Thomas and H. B. Hattachargya. 1983. Predicting spring fligt of Nantucket pint tip moth (Lipidoptera: Olethreutidae) by heat unit accumulation .J. Econ. Entomol., (76): 260-271.
14. Sevacherian, V. 1977. Heat accumulation for timing Lygus control measure in a dependent growth rate simulation. Can. Ent. 106:519-524.
15. Stinner, R. E. , A.P. Gutierrez and G. P. Bulter. 1974. An algorithm for temperature dependent growth rate simulation. Can. Ent. 106: 519- 524.
16. Strong, F. E. and J. W. Apple. 1958. Studies on the thermal constants and seasonal occurrence of the seed maggot in Wisconsin. J. Econ. Entomol., 51:704-707.
17. Willcocks, F. C. 1922. A survey of the more important economic insects and mites of Egypt.

الوحدات الحرارية ودرجات الحرارة الثابتة المتطلبة لنمو أطوارحفار ساق الباذنجان

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٢. *معهد بحوث وقاية النبات الدقى – جيزة- جمهورية مصر العربية*

تمت دراسة تطور فترات النمو لحفار ساق الباذنجان *Euzophera osseatella* Triet (Lepidpterra :Pyralidae)للحرارة الثابتة ١٥و٢٠و٢٥و٣٠ م±١ م .معدل النمو للاطوار الغير كاملة كانت أطول فى دراجات الحرارة المنخفضة .. معدل النمو لمجموع الاطوار كان ٢٠١، ٩٣,٤٣، ٥٧,٢ و٤٨,١٧ يوم مع معدلات الحرارة ١٥و٢٠ و٢٥ و٣٠ م على التوالى.معدل فترة نمو الجيل بين ٢٠٥,٦ و٤٩,١٧ يوم تعتمد على دراجات الحرارة. مدة بقاء الحشرة الكاملة فى الانثى أطول من الذكر.بينما وضع البيض ١٣٤,٤ على درجة حرارة ١٥ وأقل وضع بيض على درجة حرارة ٣٠م.٦٢,٠ بيضة.الحد الحرج للنمو (صفر النمو) والوحدات الحرارية المجمعة عند درجات حرارة ثابتة وحددت صفر النمو البيولوجى لطور البيض واليرقة والعذراء ، ٧,٣، ١١,٤٣ و ٥,٩ م على التوالى. بينما بلغ متوسط الوحدات الحرارية عند درجة الحرارة المفضلة ٣٠م ٨٢,٨٥ و٤١٣,٦ و٥٣٨,٥٥ وحدة حرارية اللازمة لتطور البيض واليرقة والعذراء على التوالى . متوسط الوحدات الحرارية اللازمة للجيل ٩٣١,٢٢ وحدة حرارية.