RELATIONSHIP BETWEEN DEVELOPMENTAL STAGES OF *PECTINOPHORA GOSSYPIELLA* (SAUND.) IN FOUR GOVERNORATES OF THE NILE DELTA AND THE REQUIRED THERMAL UNITS

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Abstract

The present work was conducted to study the relationship between developmental stages of *Pectinophora gossypiella* (Saund.) and required thermal units at two constant temperatures, 25 and 30°C ± 1°C in Sharkia, Dakahlia, Monofia and Gharbia Governorates, in Delta, Egypt. Results showed that there was variation in growth periods that is necessary to complete the various developmental stages of pink bollworm from eggs to adult, whether, on 25 or 30°C, at the four Governorates. Increasing the temperature was accelerated the developmental rate and shortened the periods of the different stages. Also, the lower thermal threshold for the development of pink bollworm stages differed from governorate to another. In the four Governorates, Sharkia, Dakahlia, Monofia and Gharbia, at the generation, t_0's were 12.92, 11.67, 11.99 and 11.23°C (the coefficient of variability was 7.089) and the DDU were 541.67, 586.67, 536.18 and 564.69 units (the coefficient of variability was 0.86), respectively. The biological measurements and the required DDU under different environmental factors are necessary for prediction occurrence of the pest harmful stages of the pest and can help decision makers to decide the appropriated procedures to control *P. gossypiella* in the IPM program.

INTRODUCTION

Pectinophora gossypiella (Saunders) is a major insect pest of cotton. Population dynamics of pink bollworm are strongly influenced by environmental conditions, particularly temperature. Estimates of the temperature at which pink bollworm can develop and reproduce vary from 6.9ºC (Venette and Hutchison, 1999) to 15.6ºC (Sevacherian *et al.*, 1977) in USA. In Egypt, few authors studied the zero developmental temperature under laboratory conditions and it was ranged between 12.01- 12.68 (Gergis *et al.*, 1990), El-Sayed, (2005) and Yones *et al.* (2011). Knowledge of developmental times of the stages life history of the pink bollworm is an important pre requisite to understand of the population dynamics of this pest in the field. The thermal requirements (degree-days) of development was often used for estimating developmental times because temperature has a major effect in

determining the rate which insects develop (Howe, 1967 and Zaslavski, 1988), the rates of development under natural conditions was largely determined by temperature.

Several studies had shown that the temperature is dependent development of aphid *Brevicornye brassicae* (L.) and *Plutella xylostella* (L.) it may be strongly influenced by the geographical origin (Campbell *et al.*, 1974, Foottit and Mackauer, 1990, Harcourt, 1986 and Cammell and Kinght, 1992). The developmental rates help to better understanding insect evolution and predict insect population growth rates. It will change our perception of the relationship between temperature and insect development and how it is adapted to geographic and seasonal factors and predict the potential geographical range of species (Vojtech *et al.*, 2002 and Melody, 2006).

The aim of this work was to study the adaptation of pink bollworm and its relationship with the required thermal units to development in four localities in Delta Egypt.

MATERIALS AND METHODS

Pink bollworm collection, *P. gossypiella*, were obtained from green cotton bolls collected of cotton fields in four Governorates, Sharkia, Dakahlia, Monofia and Gharbia, when the population increased at September. The collected bolls were transferred to laboratory and fifty bolls each were kept in clothes bags. After one week, pupae and full grown larvae which exited out of green bolls were collected from cloth bags. The pupae and larvae were placed singly in glass tubes (2.7 X7 cm) and plugged with cotton wool until moth's emergence. The emerged moths were sexed and each five pairs were confined in a glass jar (1/2 kg) covered with muslin cloth as a suitable site for eggs deposition and kept under the constant condition 26±1 ºC and 70-75 R.H. Moths were fed on 10% honey solution absorbed on cotton piece that daily renewed and hanged in the chimney cages. The muslin clothes with the deposited eggs were transferred to a convenient glass jars. The deposited eggs were obtained daily and incubated under constant conditions at 25 and 30 ±1 ºC and 70-75 R.H. About 200 freshly deposited eggs of pink bollworm obtained from each Governorate were incubated at each temperature until hatching. Treatments were replicated five times. The newly hatched larvae were reared on modified artificial diet according to (Abd El-Hafez *et al.*, 1982 and Rashad and Amar, 1985). Fifty newly hatched larvae were used for each replicate and each treatment (Governorate) was replicates six times. The incubation period, larval duration, prepupal and pupal periods, adult longevity, preoviposition, oviposition and postoviposition periods, and

generation period were recorded. Coefficient of variability (C.V.) was used to compare between the biological measurements in the four Governorates.

The biological parameters were performed from two methods:

1- Mangat method, lower developmental threshold temperature (t_0) and the total effective temperature (degree-day) for different stages and generation were calculated from two rearing constant temperatures at 25 and 30ºC ±1, according to two methods, the first described by Mangat (1977) and the second from general developmental curve as follows:

The first: data in Table (1) indicate that 5.45 days at a temperature of 25°C were necessary for the development of pink bollworm egg stage from newly laid egg to 90% hatched one, while at a constant temperature of 30°C, 4.15 days were required. As mentioned in Table (2) using the data from the constant temperature cabinet study to show the number of degree-days which must accrure at various temperature thresholds for compatible development. Incubated the pink bollworm egg, at 25°C, for example, shows 103.6 degree-days would have accumulated if 6°C were the temperature threshold development, while a total of 99.6 DDU would have accumulated in the 30°C cabinet culture if the same temperature threshold was used. These data (the degree-days corresponding to various base lines) are plotted graphically in Figure (1). The point of intersection represents the best estimate of the thermal threshold and temperature accumulation necessary from laid egg to 90% hatched one (Mangat, 1977).

Table 1. Incubated period of pink bollworm egg from newly laid egg to 90% hatched one at tow constant temperature.

Temperature °C	Average days to 90 percent of hatched egg
25	5.45
30	4.15

Table 2. The number of Degree-day- (DD) necessary for pink bollworm egg from newly laid egg to 90% hatched one at tow constant temperatures using hypothetical temperature thresholds below rearing temperatures of 25 and 30°C.

*Temperature thresholds	25°C (5.45 days) **DD=d(T-$t_\circ$)	30°C(4.15days) DD=d(T-$t_\circ$)
6	103.6	99.6
7	98.1	95.5
8	92.7	91.3
9	87.2	87.2
10	81.8	83.0
11	76.3	78.9
12	70.9	74.7
13	65.4	70.6
14	60.0	66.4
15	54.5	62.3
16	49.1	58.1
17	43.6	54.0
18	38.2	49.8
19	32.7	45.7
20	27.3	41.5
21	21.8	37.4
22	16.4	33.2
$t_\circ$ = 9.15°C and DD = 86.54		
*= hypothetical temperature thresholds, ** DD= effective cumulative temperature, d= the duration of development (days), T= temperature (C°), t_o= temperature thresholds, according to Clement,1992		

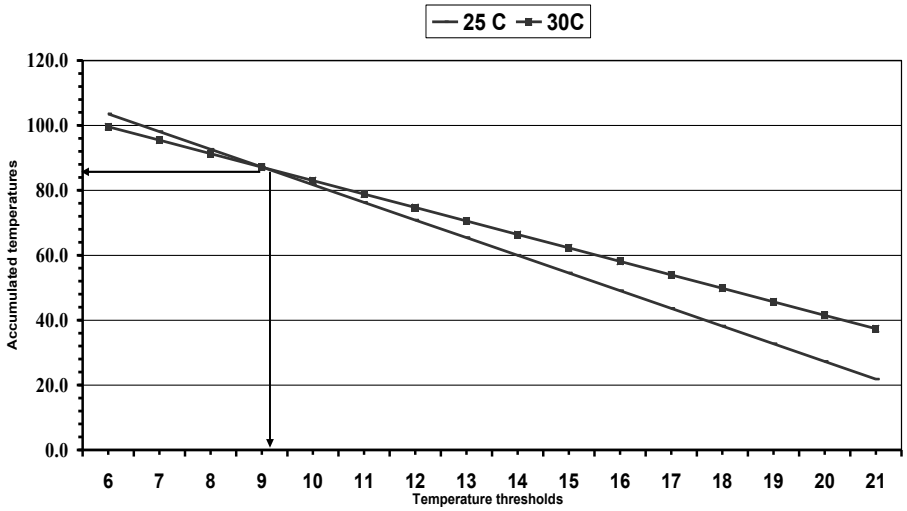


Figure (1) Day-degrees according in 25 and 30°C incubator cultures of cotton bollworm of various temperatures thresholds for development

The straight line for development in the 25°C incubator is expressed by the equation

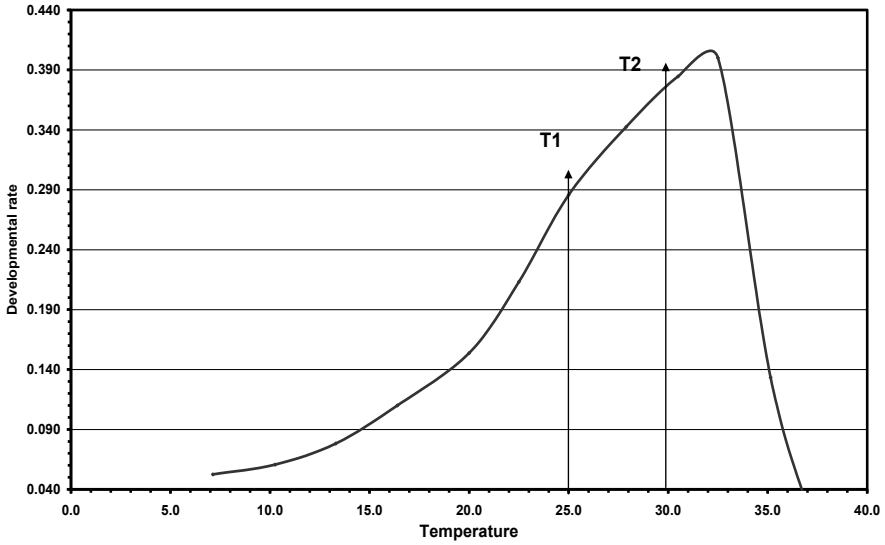
Y= 136.25 -5.45X equation..... (1), where y is the effective cumulative temperature, x is the threshold temperature, 137.0912 is the y intercept and -5.52647 is the slope of the line.

The equation of the straight line for the culture at 30°C is

Y= 124.5- 4.15X .....(2)

t_o =X=(a_2-$a_{1)/(}$$b_1$-b2).....(3)

The simultaneous solution of (1) and (2) equations gives x (the threshold temperature for development) equal to 9.04°C and Y (the day-degrees necessary for development) equal to 86.98 units. It recognized that the true threshold temperature is undoubtedly below 9.15°C.



Figure(2) Genaral developmental curve

The second: from the general developmental curve Figure (2) and the law of total effective temperature, applied to the temperature-dependant of arthropods or parasites, is expressed by the equation

$K= D(T-t_o)$.....(4)

Where the product of the duration of development, D(days), temperature T (degree), developmental zero temperature t_o, effective cumulative temperature K which constant for each strain of organism (Clement,1992).

From Table (1) and equation (4), the cumulative temperature K at the constant temperature 25°C and duration 5.45 days equal

$K= 5.45(25-t_o)$.....(5) .

And at the constant temperature 30°C and duration 4.15 days equal

$K= 4.15(30-t_o)$..... (6).

$T_o = (D_2T_2- D_1T_1)/(D_2- D_1)$.....(7).

The simultaneous solution of (5) and (6) equations gives t_o equation (7) the threshold temperature for development) equal t_o 9.04°C and K (the degree-days necessary for development from equation (3)) equal to 86.98 unit.

Daily maximum and minimum temperatures during ten years from 1997-2006 were obtained from Agricultural Research Center (ARC), meteorological central laboratory Table (3).

Table 3. Maximum, minimum and mean temperature of the four governorates, Menofia, Dakahlia, Sharkia and Gharbia for ten years.

Governorate	Sharkia	Dakahlia	Menofia	Gharbia
Minimum temperature	18.4 ± 6.1	15.5±5.7	14.9 ±5.8	16.2±5.5
Maximum temperature	29.61 ± 6.4	28.2±8.0	27.8 ± 6.5	27.3±6.2
Mean temperature	23.6 ± 6.0	21.9±6.4	21.3± 6.0	21.8±5.7

The four Governorates, Sharkia, Dakahlia, Monofia and Gharbia, under study differ in the most important elements of environmental components of, a temperature. Since, the minimum temperature ranged between 14.9 and 18.4 ^{0}C.

RESULTS AND DISCUSSION

Duration

Data in Tables (4 and 5) show that the required periods to complete the development of pink bollworm different stages collected from cotton fields at the four Governorates, Sharkia, Dakahlia, Monofia and Gharbia, and reared on artificial diet at two constant temperatures 25 and 30°C.

At constant temperatures 25°C, data in Table (4) revealed that the egg stage incubation period was varied from Governorate to another. At Sharkia Governorate, it was the longest period (5.45 days), whereas it was the lowest one was at Dakahlia Governorate (4.88 days). The other two Governorates were recorded between them i.e. Monofia and Gharbia. The average of incubation periods for the four Governorates and coefficient of variability (C.V.) were 5.16 days and 9.41%, respectively. Larval stage duration, at Sharkia, proved the longest period but the shortest one was reported at Monofia with 22.48 and 17.8 days, respectively. The periods at Dakahlia and Gharbia came between the two Governorates with 20 and 18.35 days, respectively. The average of durations and C.V were 19.66 days and 7.38%, respectively, at the four Governorates.

Table 4. Duration of different stages of the pink bollworm collected from four Governorates maintained at constant temperature 25°C

Developmental stage	Governorate				Mean	C.V. %
	Sharkia	Dakahlia	Monofaia	Garbaia		
Eggs	5.45	4.88	5.20	5.12	5.16	9.41
Larvae	22.48	20.00	17.80	18.35	19.66	7.38
Pre pupa	4.05	4.13	2.92	2.80	3.48	24.30
Pupa	10.00	11.00	10.70	10.65	10.59	6.13
Pre-ovipostion	2.88	4.00	4.60	4.09	3.89	21.91
Generation	44.86	44.01	41.22	41.01	42.77	3.26
Ovipostion	8.43	9.90	8.90	7.00	8.56	12.83
Post-ovipostion	5.00	4.60	4.66	5.30	4.89	11.66
Adult	16.30	18.50	18.16	16.39	17.34	6.20

Table 5. Duration of different stages of the pink bollworm collected from four Governorates maintained at constant temperature 30°C

Developmental stage	Governorate				Mean	C.V. %
	Sharkia	Dakahlia	Monofaia	Garbaia		
Eggs	4.15	3.72	3.90	3.90	3.92	10.72
Larvae	14.86	14.75	13.25	13.59	14.11	6.40
Pre pupa	2.74	3.05	2.20	2.10	2.52	26.64
Pupa	7.72	7.50	7.19	7.60	7.50	6.34
Pre-ovipostion	2.25	2.99	3.24	2.90	2.84	22.79
Generation	31.72	32.01	29.78	30.09	30.90	3.44
Ovipostion	6.50	7.41	5.98	5.00	6.22	16.12
Post-ovipostion	3.29	3.48	3.33	3.88	3.49	14.89
Adult	12.04	13.87	12.55	11.78	12.56	7.69

Considering prepupal stage duration, the longest period was at Dakahlia and the shortest one was at Gharbia with 4.13 and 2.8 days, respectively. The average of durations and C.V were 3.48 days and 24.30%, respectively. Pupal stage duration was the longest was at Dakahlia and shortest one was at Sharkia with 11.0 and 10.0 days, respectively. The average of duration and C.V were 10.59 days and 6.13%, respectively. Preoviposition period proved the longest at Monofia and shortest at Sharkia with 4.6 and 2.88 days, respectively. The average of periods and C.V were 3.89 days and 21.91%, respectively. Regarding generation period, egg to egg, data indicated that Sharkia, duration was the longest period but the shortest one was recorded at Gharbia with 44.86 and 41.01 days, respectively. The average of periods for the tested Governorates and C.V were 42.77 days and 3.26%, respectively. The other parameters oviposition, postoviposition and adult periods also differed in the four Governorates and the C.V. ranged between 6.20 and 16.83. At constant temperature 30°C, data in Table (4) revealed that the increasing of temperature accelerated the developmental rate and shorted the developmental periods of different *P. gossypiella* stages. Also, the same trends of differences were found in the developmental periods required to different stages and C.V at the four Governorates.

Rearing of field pink bollworm, *P. gossypiella*, which was collected from different Governorates, on constant temperature showed variances in duration that required completing the different developmental stages from egg to adult, whether, on 25 or 30°C. The coefficient of variability for the different stages periods ranged between 3.26 at generation and 24.30 at prepupal stage on rearing at constant temperature 25°C (Table, 4).Whereas, it was ranged between 3.44 at generation and 26.69 at prepupal stage when rearing at constant temperature 30°C (Table, 5).

These results are agree with the finding of El-Sayed (2005) , and Yones *et al*. (2011) reported that, increasing rearing temperature accelerated the developmental rate and shorted the periods which required completing different stages.

Lower developmental threshold

Data in Table (6) showed the values of lower developmental threshold temperature of *P. gossypiella* different stages for the previous four Governorates, Sharkia, Dakahlia, Monofia and Gharbia. At egg stage, the lower thresholds of developmental temperature were 9.04, 8.98, 10.00 and 9.02°C, respectively. The average and C.V were 9.27°C and 7.518%, respectively, for the tested Governorates. Larval stage, at Sharkia, gave 15.25°C that represented the highest value of the lower developmental threshold and the lowest value was at Monofia with 10.44°C. Dakahlia and Gharbia were between the two Governorates with 10.95 and 10.74°C,

respectively. The average and C.V were 11.85°C and 12.739%, respectively. Prepupal stage, at Sharkia, proved the highest value but the lowest one was recorded at Monofia with 14.47 and 9.72°C, respectively. Dakahlia and Gharbia came in between the two Governorates. The average and C.V were 11.26°C and 13.15, respectively. Considering pupal stage, the lower thresholds, at Monofia was the highest value and the lowest one was at Sharkia with 14.76 and 8.10°C, respectively. Dakahlia and Gharbia were between the two Governorates. The average and C.V were 12.42°C and 14.025%, respectively. Preoviposition, the lower developmental threshold, at Monofia, was the highest value also and the lowest one was at Sharkia revealed 13.15 and 7.00°C, respectively. Dakahlia and Gharbia were between the two Governorates. The average and C.V were 10.81°C and 15.596%, respectively. Regarding generation, the lower developmental threshold, at Sharkia, was the highest value also and the lowest one was at Gharbia with 12.92 and 11.23°C, respectively. Dakahlia and Monofia were between the two Governorates. The average and C.V were 11.95°C and 7.089%, respectively. At the other parameters oviposition, postoviposition and adult also differed in the four Governorates and the C.V. ranged between 10.979 and 14.865%.

The average of lower developmental threshold and C.V. for the previous different pink bollworm stages ranged between 9.27°C at egg & 12.42°C at pupal stage and 7.089 at generation & 15.596 at pre-oviposition period, respectively (Table, 6).

The changing of durations and lower developmental thresholds attributed to the differences of the environmental factors in the four Governorates, and consequently available food of the pest. These results are differed a little bit with the finding by El-Sayed, 2005 and Yones *et al.*, 2011 because the pink bollworm collected from four Governorates which represents the differences in environmental components hence affecting the rate of growth of different stages and biological measurements.

Thermal units requirement

Data in Table (7) indicated values of the thermal units of pink bollworm at the previous four Governorates, Sharkia, Dakahlia, Monofia and Gharbia. At egg stage, the thermal units required for egg development till hatching were 86.98, 78.13, 78.00 and 81.84 unit, respectively. The average for the tested Governorates and C.V were 81.16 unit and 2.49%, respectively. Regarding larval stage, the thermal units required for larvae development till prepupal stage, at Dakahlia, was the highest value and the lowest one was at Sharkia with 280.95 and 219.30 unit, respectively. Monofia and Gharbia were ranked between the two Governorates with 259.18 and 261.61 units, respectively.

Table 6. Zero developmental of different stages of pink bollworm collected from four Governorates maintained at two constant temperatures 25 and 30°C

Developmental stage	Sharkia	Dakahlia	Monofaia	Garbaia	Mean	C.V. %
Eggs	9.04	8.98	10.00	9.02	9.27	7.518
Larvae	15.25	10.95	10.44	10.74	11.85	12.739
Pre pupa	14.47	10.86	9.72	10.00	11.26	13.150
Pupa	8.10	14.29	14.76	12.54	12.42	14.025
Pre-ovipostion	7.00	10.29	13.15	12.82	10.81	15.596
Generation	12.92	11.67	11.99	11.23	11.95	7.089
Ovipostion	8.15	10.15	14.76	12.50	11.39	14.865
Post-ovipostion	15.42	9.46	12.48	11.34	12.18	12.969
Adult	10.90	10.01	13.83	12.23	11.74	10.979

Table 7. Thermal heat unit (degree-day) of different stages of pink bollworm collected from four Governorates maintained at two constant temperatures 25 and 30°C

Developmental stage	Sharkia	Dakahlia	Monofaia	Garbaia	Mean	C.V. %
Eggs	86.98	78.13	78.00	81.84	81.16	2.49
Larvae	219.30	280.95	259.18	261.61	255.26	1.99
Pre pupa	42.61	58.45	44.61	42.00	46.92	5.94
Pupa	169.01	117.86	109.59	132.69	132.29	3.88
Pre-ovipostion	51.75	58.82	54.51	49.84	53.73	3.68
Generation	541.67	586.67	536.18	564.69	557.30	0.86
Ovipostion	142.04	147.06	91.13	87.47	116.92	4.84
Post-ovipostion	47.92	71.46	58.34	72.41	62.53	5.46
Adult	229.89	277.25	202.87	209.38	229.85	2.52

The average for the tested Governorates and C.V were 255.26 units and 1.99%, respectively. In case of prepupal stage the thermal units required, at Dakahlia, were the highest value and the lowest one at Gharbia showed 58.45 and 42.00 unit, respectively. Monofia and Sharkia were between the two Governorates. However, the average for the tested Governorates and C.V were 46.92 unit and 5.94, respectively. Considering, pupal stage, the thermal units required at Sharkia was the highest value and the lowest one was at Monofia with 169.01 and 109.59 units, respectively. Gharbia and Dakahlia were between the two Governorates. The average for the tested Governorates and C.V were 132.29 unit and 3.88%, respectively. With respect to preoviposition, the thermal units required, at Dakahlia, were the highest value and the lowest one at Gharbia with 58.82 and 49.84unit, respectively. Monofia and Sharkia were between the two Governorates. The average for the tested Governorates and C.V were 53.73 unit and 3.68%, respectively. In case of the thermal units required for generation at Dakahlia, were the highest value and the lowest one at Sharkia with 586.67 and 541.67 unit, respectively. Monofia and Gharbia were between the two Governorates. The average for the tested Governorates and C.V were 557.30 unit and 0.86%, respectively. The other parameters oviposition, postoviposition and adult periods also differed in the four Governorates and the C.V. which ranged between 62.53 and 229.85unit and 2.52- 5.46%.

The average of the thermal units required and C.V. for the previous different pink bollworm stages ranged between 46.92 at prepupal stage & 557.3 at generation and 0.86% at generation and 5.46 at post-oviposition period, respectively (Table, 7). The coefficient of variability for generation was 0.86% this means that values of the thermal constant to pink bollworm at generation is almost an equal among the four localities (Governorates). However, there were differences of durations, lower developmental thresholds, the environmental components, temperatures and available food for the pest in the four Governorates. Daily maximum and minimum temperatures during ten years varied at the four Governorates (Table, 3). These results are agree with the finding by Clement (1992) which reported that the required thermal units is constant for each strain of organism.

In this respect, Vojtech *et al.* (2002) and Melody (2006) reported that the developmental rate help to better understand insect evolution and predict insect population growth rates. It will change our perception of the relationship between temperature and insect development and how it is adapted to geographic and seasonal factors and predicting the potential geographical range of species.

Knowledge of developmental times of the life history stage of the pink bollworm is an important pre requisite to an understanding of the population

dynamics of this pest in the field. The thermal requirements (degree-days) of development were often used for estimating developmental times because temperature has a major effect in determining the rate which insects develop (Howe, 1967 and Zaslavski, 1988). Honek and Kocourek (1990) showed that insect development data appeared too correlated with average annual temperatures that occurred in the region of origin for each species. Significant geographic variations in thermal characteristics of insect development were found by Honek (1996).

The lower developmental threshold (t_o) and the thermal units required (Degree-daily) to complete different pink bollworm stages under different environmental components (at the four governorates), it is necessary to forecast by occurring the harmful stages of the pest and help the decision makers to decide the appropriate procedures to control in the *P. gossypiella* IPM program.

REFERENCES

1. Abd El-Hafez, A., A.G. Metwally and M.R. Saleh. 1982. Rearing pink bollworm, *Pectinophora gossypiella* (Saunders) on kidney bean diet in Egypt (Lepidoptera: Gelechiidae) Bull. Fac. of Agric., Zagazig Univ., 5, 10pp.
2. Cammell, M. and T.C. Kinght. 1992. Effects of climatic change for insect pests in the UK, with emphasis on non-indigenous species. Glob. Chang. Biol., 4:785-796.
3. Campbell, A., B.d. Frazer, N.G. Gilber, A.P. Gutieterz and M. Mackaure. 1974. Temperature requirements of some aphids and their parasites. J. App. Ecol., 11:431-438.
4. Clement, A. N. 1992. The biology of mosquitoes. Chapman & Hall, London.
5. EL-Sayed A.A. 2005. Ecological studies on the pink bollworm *Pectinophora gossypiella* (Saunders) and its natural enemies. Ph.D. Thesis, Fac. of Agric., Moshtohor, Benha Univ.
6. Foottit, R. G. and Mackauer, M. 1990. Morphometric variation within and between populations of the pine aphid, *Cinara nigra* (Wilson) (Homoptera: Aphidoidea: Lachnidae) in western North America. Canadian J. of Zool**,** 68 (7): 1410-1419.
7. Gergis, M.F., E.A. Moftah, M.A. Soliman and A.A. Khidr. 1990. Temperature-dependant development and functional responses of pink bollworm *Pectinophora gossypiella* (Saund.). Assiut J. of Agric. Sci., 21(3):119-128.
8. Harcourt, D.G. 1986. Population dynamics of the diamondback moth in southern Ontario, in Diamondback moth management. Proc., 1st international workshop. Asian Veg. Res. and Development Center. Taiwan pp. 3-15.

9. Honek, A. 1996. Geographical variation in thermal requirements for insect development. Eur. J. Entomol., 93:303-312.
10. Honek, A. and F. Kocourek. 1990. Temperature and development time in insects: a general relationship between thermal constant. Zool. Jb. Eyst., 117:401-439.
11. Howe, R.W. 1967. Temperature effects on embryonic development in insect. Ann. Rev. Entomol., 10:15-42.
12. Mangat, B. S. 1977. Thermal threshold and temperature accumulation for the cotton bollworm. J. The Tennesset Acad of Sci., 52(1):15-16.
13. Melody, A.K. 2006. Effects of temperature on *Anoplophora glabripennis* (Coleoptera: Cerambycidae) adult survival, reproduction and egg hatch. Environ, Entomol., 35(4):912-921.
14. Rashad, A. and E.D. Ammar. 1985. Mass rearing of the spiny bollworm *Earias insulana* (Boisd.) on semi artificial diet. Bull. Ent. Soc. Egypt. 65:239-244.
15. Sevacherian, V., N.C. Toscano, R.A. Van Steenwyk, R.K. Sharma and R.R. Sander. 1977. Forecasting pink bollworm emergence by thermal summation. Environ. Entomol., 6:545-546.
16. Venette, R.C. and W.D. Hutchison. 1999. Assessing the risk of establishment by pink bollworm (Lepidoptera: Gelechiidae) in the Southeastern United States. Environ. Entomol., 28: 445-455.
17. Vojtech J., A. Honek and Anthony F.G. Dixon. 2002. Developmental rate isomorphy in insects and mites. The American Naturalist, 160(4):497-510.
18. Yones, M.S., H.A. Abd ElRahman, A.F. Abou Hadid, S.M. Arafat and H.F. Dahi. 2011. Heat unit requirements for development of the pink bollworm *Pectinophora gossypiella* (Saund.). Egyp. Acad. J. Biolog. Sci., 4(1):115-122.
19. Zaslavski, V.A. 1988. Insect development: photoperiodic and temperature control. Springer- Verlag, Berlin, N.Y. 187 pp.

العلاقة بين تطور الأطوار المختلفة لدودة اللوز القرنفلية في اربعة محافظات بدلتا النيل و الوحدات الحرارية المتجمعة

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معهد بحوث وقاية النباتات مركز البحوث الزراعية الدقي الجيزة مصر

تم دراسة العلاقة بين مراحل تطوردودة اللوز القرنفلية بكتينوفورا جوسيبيلا والوحدات الحرارية المتجمعه المطلوبة على درجتي حرارة ثابتة وهما ٢٥ و ٣٠ ± ١ درجة مئوية في أربع محافظات هى الشرقية والدقهلية والمنوفية والغربية في دلتا مصر أظهرت النتائج أن هناك تفاوتا في فترات النمو الضرورية لاستكمال مختلف مراحل النمو من البيض حتى الحشرات الكاملة سواء على ٢٥ أو ٣٠ درجة مئوية ، في المحافظات الأربع، أدت زيادة درجة الحرارة إلى زيادة معدل النمو وتقصير فترات الاطوار المختلفة أيضا ، إختلفت درجة حرارة صفر النمو لمراحل تطور دودة اللوز القرنفلية المختلفة من محافظة إلى أخرى وذلك في المحافظات الأربع ، الشرقية، الدقهلية ، المنوفية والغربية، أما بالنسبة للجيل فكانت درجة حرارة صفر النمو ١٢,٩٢، ١١,٦٧، ١١,٩٩ و ١١,٢٣ درجة مئوية (وكان معامل التباين ٧,٠٨٩ %) و الوحدات الحرارية اللازمة لمدة الجيل ٥٤١,٦٧، ٥٨٦,٦٧، ٥٣٦,١٨ و ٥٦٤,٦٩ وحدة (وكان معامل التباين ٠,٨٦ %) على التوالي. القياسات البيولوجية والوحدات الحرارية تحت الظروف البيئية المختلفة ضرورية لتوقع حدوث المراحل الضارة لهذه الآفة والتى يمكن أن تساعد صانعي القرار للبت في الإجراءات القياسية للسيطرة على البكتينوفورا جوسيبيلا في برنامج المكافحة المتكاملة لآفات القطن.