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THERMAL REQUIREMENTS FOR DEVELOPMENT OF *Aphis nerii* BOYER DE FONSCOLOMBE AND ITS PREDATOR *Cydonia vicina isis* MULS.

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ABSTRACT

Laboratory experiments were conducted in Economic Entomology Department, Faculty of Agriculture, Mansoura University to estimate the heat requirements for *Aphis nerii* Boyer de Fonscolombe. attacking oleander shrubs at Mansoura district and its *predator Cydonia vicina isis* Muls.

The results assured that, the lower development threshold for the nymphal stage was 13.11 ºC , and the thermal units expressed as degree-days (dd's) required for nymphal stage were 98.53, 95.12 and 102.74 (dd's) at 20ºC, 25ºC and 28ºC, respectively and the adult stages needed about 129.92, 140.66 and 153.27 day-degrees to complete their development on the three tested degree temperatures, respectively.

The results indicated that the lower development threshold of the adults s were 12^0C, 14^0C for male and female, respectively and the degree day's at 20^0C, 25^0C and 28^0C, were 538.4, 721.6 and 609.6 for male and 467.4, 610.5, and 565.6 for female.

INTRODUCTION

Oleander aphid is universal, being found in tropical to warm temperate regions throughout the world. This species probably originated in the Mediterranean region, the origin of its host of Apocynaceae, the mean host of milkweed aphid is *Nerium oleander* as common ornamental shrub in Egypt. The coccinellidea predator *C. vicina isis* is an important prdator prey on *A. nerii* (Abdel-Salam, 2004) Temperature is considering an important environmental factors that affect the survival rate through each immature stage of the history and hence the rate of survival from egg to adult emergence(Meats,1984).

Studying of this parameter is essential for *A. nerii* and *C. vicina isis isis* to obtain a useful and good forecasting and prediction of the insects population.

Each development stage of an organism has its own total heat requirement. Development can be estimated by accumulating degree-days between the maximum and minimum temperatures throughout the season. E*ach* species requires a defined number of degree-days that known as the biofix date varies with the species biofix points were usually based on some specific events such as first trap catch or first occurrence of the pest. Once the biofix point is established, the degree-days can be accumulated. Degree-days will allow for predicting pest occurrence and used as a tool for scheduling sprays and beneficial insect release at the optimum time to obtain best results, to monitor pest activity and to determent the best sampling times(Herms,2007). Therefore this investigation was conducted to study the thermal requirements for development of *A. nerii* and its prdator *C. vicina isis*.

MATERIALS AND METHODS

The experiments were conducted in a neglected area grown with *Lantana camara* L. (without chemical treatment) located at the experimental farm, Faculty of Agriculture, Mansoura University.

Rearing the oleander aphid

Ten apterous, of *A. nerii* was confined in glass Petri dishes (9 cm in diameter) on oleander leaves to produce nymphs. Each Petri dish was provided with a layer of moistened filter paper to provide humidity. All nymphs produced within 24 hours were assumed uniform age. There were 20 replicates for each test with three degrees of temperatures (20, 25 and 28). The experiment conducted under relative humidity (60.0±5.0%). The leaves were replaced every two days. Each first nymph instar was placed on new leaves of oleander plant in a separate Petri dish and observed to determine the developmental time of nymphal instars and total days taken to reach the adult stage. The presence of exuviae was used to determine molting. The pre-reproductive, reproductive, and post-reproductive periods were determined.

Developmental times for each life stage, as well as the total nymphal stage, were used to calculate developmental rates (1/development time) which were regressed against temperatures. Regression parameters and slopes were used to estimate the minimum temperature threshold for development (t_o) and the thermal constant (dd's), as described by Campbell *et al.* (1974).

Rearing the coccinellid predator *C. vicina isis*

1- Immature stages:

Adults of *C. vicina isis* was collected from the fields and reared on *A. nerii*. The eggs were collected daily, and monitored until hatching. Hatched larvae were reared individually to avoid cannibalism in Petri- dishes (9 cm in diameter) in the incubator at 20±1, 25±1 and 28±1^{o}C. The relative humidity was 60.0±5% with each temperature. Twenty larvae from the predator were reared on *A. nerii* and each one was considered a replicate. Developmental times for eggs, total larval stage, pupal stage as were used to calculate development rates, which were regressed against temperature. The regression parameters and slopes were used to estimate the lower temperature threshold for development (t_o) and the thermal constant (dds), as described by Campbell *et al.* (1974).

2. Adult stage:

After emergence from the pupae, the predatory adults were sexed and then introduced singly into a Petri dish then fed on the oleander aphid species until development was completed.

The regression parameters and slopes were used to estimate the lower temperature threshold for development (t_o) and the thermal constant (dds), as described by Campbell *et al.* (1974).

Statistical analysis:

Data were analyzed by the analysis of variance (ANOVA) and Duncan multiple range test.

Degree- days "DDS" were calculated using linear regression method as follows.

1. The thermal units (DDS) required for development of each stage were calculated from this equation:

K= y(X-t)

Whereas K represents degree days

(Y) represents stage duration (in days)

(X) represents temperature (C^0) during development

and t represents the lowers development threshold.

2. The lower development threshold (T_o) were determined according to linear regression method

the straight line equation: **Y= a+ bx**

Whereas(Y) represented y- coordinate (rate of development)

(a) represents y-intercept.

(b) represents slope of the line and (x) represents log of x – coordinate (temperatures).

RESULTS AND DISCUTION

A: Biology of *Aphis nerii*

1. Developmental times of nymphal instars:

Developmental time of the four nymphal instars of *A. nerii* when fed on *Nerium oleander* at the three tested temperatures are presented in Table (1) the total days of nymphal development were 14.3±0.54, 8.0± 0.59 and 6.90±0.69 days at 20, 25 and 28^{o}C, respectively.

Hwa and Yun(1999) in Taiwan, mentioned that the longest duration development for nymphal stage of *A. nerii* reared on *Asclepias curassavica* L. was observed at 5 ℃ and the shortest at 30 ℃.

Abdel-Salam (2004), found that there were differences statistically variation in the developmental time of nymphs of *A. nerii* between the two tested temperatures20 ^{o}C and 25 ^{o}C .

Nihal Özder and Özgür Sağlam (2013) in Turkey, studied the development time of the *A. nerii* on the *Nerium oleander* at four constant temperature degreesof found that the total nymphal development time ranged from 15.85 days at 25^{o}C to 12.57 days at 20 ^{o}C of *A. nerii*

Table (1). Developmental times (mean ± SE) in days of *A. nerii* nymphal instars when reared on *Nerium oleander* at three constant temperatures.

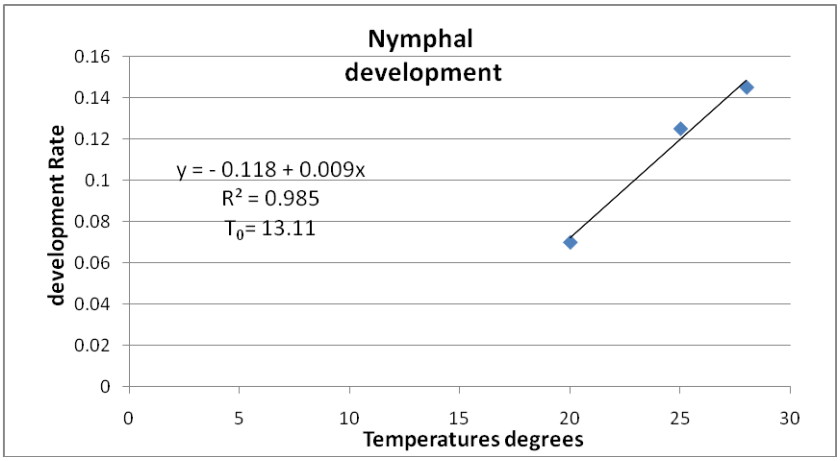
Temp. (^{o}C)	Nymphal instars				Total
	1st	2nd	3rd	4th	
20	3.25 ±0.89	3.14 ± 0.62	3.3 ±0.97	3.8 ±0.86	14.30 ±0.54
25	2.05 ±0.55	2.13 ± 0.4	2.06 ± 0.72	2.00 ±0.44	8.0 ± 0.59
28	1.70 ±0.59	1.77 ±0.51	1.73 ±0.71	1.70 ±0.56	6.90 ±0.69

2. Degree-Day Requirements of *A. nerii*:

a- Nymphal stage:

Relationship between temperature degrees and developmental rates estimates of DD's and lower developmental thresholds (T_o) for nymphal instars are summarized in Figure (1) and Table (2). Degree-day requirements and lower developmental thresholds were estimated for *A. nerii* on *N. oleander* from the linear regression equations developed to describe the relationship between developmental rates and temperatures. Lower developmental thresholds for nymphal stage was 98.53,95.12 and 102.74 DD's at 20^0C , 25^0C and 28^0C, respectively.

Ghanim *et al*. (2015) in Egypt, studied the lower developmental threshold for the nymphal stage of *A. craccivora* was 7.69, and the thermal units expressed as degree-days (dd's) required for nymphal stage were 118.30 ; 121.26; 112.69; 118.09 and 122.22 (dd's) at 15ºC; 20ºC; 25ºC; 30ºC and 35ºC respectively.



Figure(1). Linear regression analysis of temperatures versus developmental rates, degree-days requirements, and lower developmental thresholds of *A. nerii* when reared on *N. oleander*.

Tabel (2). Duration numphal period in days and thermal units (DD's) of *Aphis nerii* numphal stage when reared on oleander shurbs at different constant temperatures.

Temp.C^0	Duration (days) Mean	Developmental rates	DD's
20	14.30	0.070	98.53
25	8.0	0.125	95.12
28	6.90	0.145	102.74

b- Adult stage:

Developmental time of the longevity of *A. nerii* when fed on *N. oleander* at the three tested temperatures are presented in Table (3) and Figure(2) the

total days of longevity development were 23.2, 13.27 and 11.27 days at 20, 25 and 28°C, respectively.

Hwa and Yun(1999) in Taiwan reported that the longest longevity of *A. nerii* adults was 42.67 days at 10 ℃, and the shortest was 6.69 days at 30 ℃.

As temperature increased, the developmental time and longevity of the *A. nerri* decreased, this results agree with Aleosfoor and Fekrat (2014) in Iran who mentioned that the shortest developmental time of nymphal stage of *A. nerii* was(17.72 ± 0.244 days) and the longevity was(10.3 ± 0.234 days) were obtained at 30 ºC.

Similar results were recorded by Abdel-Salam (2004) who found that the female longevity of *A. nerii* was decreased at 30°C more than at 25°C.

Table (3). Longevity (mean±SE) in days of *A. nerii* when reared on *N. oleander* at three constant temperatures.

Temp. (°C)	Longevity			
	Pre-reproductive period	Reproductive period	Post-reproductive period	Total in days
20	1.9 ±0.54	19.5 ±0.94	1.8 ±0.65	23.2 ±0.5
25	0.90 ±0.64	11.46 ±1.03	0.91 ±0.6	13.27± 0.65
28	0.67 ±0.75	9.8 ±0.92	0.80 ±0.53	11.27 ±0.54

Relationship between temperature and developmental rate and estimates of DD's and lower developmental thresholds (T_o) for each longivety are summarized in Figure (2) and Table(4). Degree-day requirements and lower developmental thresholds were estimated for *A. nerii* on *N. oleander* from the linear regression equations developed to describe the relationship between developmental rates and temperatures. Lower developmental thresholds for longevity was14.4°C and the stages needed about 129.92, 140.66 and 153.27 day-degrees to complete their development on the three tested temperatures, respectively.

Table (4). Longevity period in days and thermal units (DD's) of adult stage of *Aphis nerii* when reared on *N. oleander* at different constant temperatures.

Temp.C°	Duration (days) Mean	Developmental rates	DD's
20	23.2	0.043	129.92
25	13.27	0.075	140.66
28	11.27	0.089	153.27

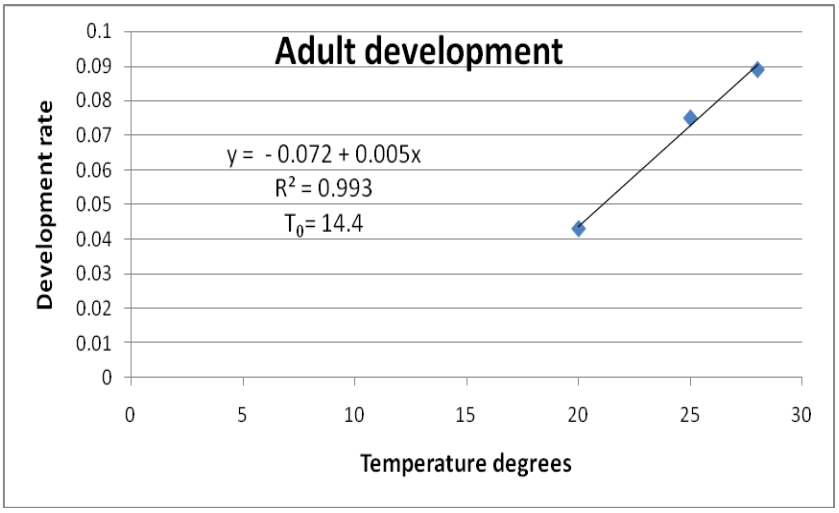


Figure (2). Linear regression analysis of temperatures versus developmental rates, degree-days requirements, and lower developmental thresholds of *Aphis nerii* when reared on oleander shurbs.

B: biology of *Cydonia vicina isis:*

1. Developmental times of immature stage:

Incubation period

The incubation period of *C. vicina isis* was dependent on temperature degrees, it was decreased with increased of temperatures 6.01± 0.73, 4.7±0.74 and 2.55±0.56 days at 20, 25 and 28^{o}C, respectively. (Table 5)

Larval stage

Developmental time of the larval stage of *C. vicina isis* when fed on *A. nerii* at the three tested temperatures are presented in Table (5), it can be noted that the duration period lasted 18.76±0.87, 11.3±0.75 and 6.3±0.83 days at 20, 25 and 28^{o}C, respectively.

Pupal stage

Data represented in Table (5) showed that the required time for developing pupal stage of *C. vicina isis* when reared on *A. nerii*. The mean periods of pupal stage were 13.67±0.75; 7.7±0.82 and 3. 55±0.68 at 20, 25 and 28 ^{0}C, respectively.

El-serafi *et al*. (2000) in Egypt, mentioned that the total development from egg to adult eclosion of *Chrysoperla carnea* (Steph.) was 32.07 when reared on *A. nerii*.

Oueed *et al.* (2013) in Iraqe, found that the pupal stage duration of *Coccinella undecimpunctata* when fed on *A. nerii* was six days.

Table (5). Developmental times (mean ± SE) in days of *C. vicina isis* immature stages when reared on *A. nerii* at three constant temperatures.

Temp. (°C)	Incubation period	Larval instars				Total larval period	Pupal period	Total
		1st	2nd	3rd	4th			
20	6.01 ±0.73	4.30 ±0.72	4.52 ±0.72	3.95 ±0.81	5.99 ±0.81	18.76 ±0.87	13.67 ±0.75	38.44 ±0.79
25	4.7 ±0.74	2.5 ±0.65	2.6 ±0.65	2.6 ±0.74	3.6 ±0.73	11.3 ±0.75	7.7 ±0.82	23.7 ±0.84
28	2.55 ± 0.56	1.4 ±0.74	1.3 ±0.85	1.3 ±0.71	2.3 ±0.74	6.3 ±0.83	3.55 ±0.68	12.4 ±0.7

2.Degree-Day Requirements of *Cydonia vicina isis*:

Incubation period

The obtaind results represented in Fig.(3) and Table(6) illustrated the relationship between developmental rates and temperatures. The lower developmental thresholds for incubation period were 0.166, 0.213 and 0.392 and degree days at 20^0C, 25^0C and 28^0C, were 33.84, 49.96 and 34.76 respectively.

Tabel (6). Duration of incubation period in days and thermal units (DD's) of adult stage of *C. vicina isis* when reared on *A. nerii* at different constant temperatures.

Temp.C^0	Duration (days) Mean	Developmental rates	DD's
20	6.01	0.166	33.84
25	4.7	0.213	49.96
28	2.55	0.392	34.76

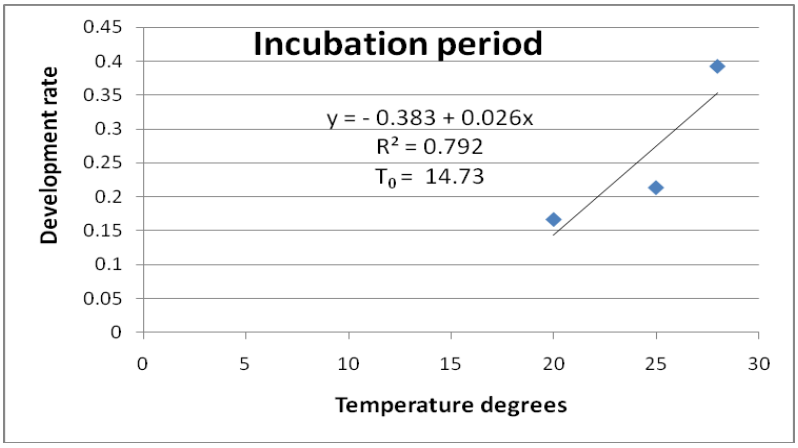


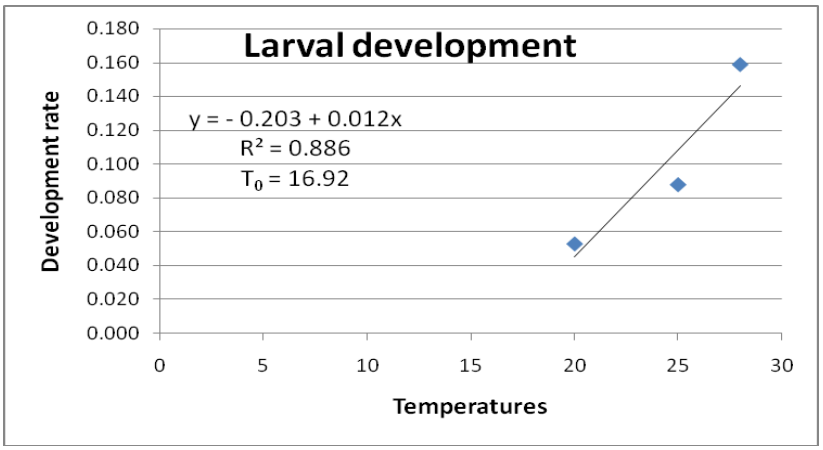
Figure (3).Linear regression analysis of temperatures versus incubation period, degree-days requirements, and lower developmental thresholds of *C. vicina isis* when reared on *A. nerii*

Larval stage

Relationship between temperatures and developmental rates estimates of (dd's) and lower developmental thresholds (T_o) for larval stage are summarized in Figure (4) and Table (7). Degree-day requirements and lower developmental thresholds were estimated for *C. vicina isis* on *A. nerii* from the linear regression equations developed to describe the relationship between developmental rates and temperatures. Minimum developmental thresholds for nymphal stage were 0.053, 0.088 and 0. 159 and degree day's at 20^0C, 25^0C and 28^0C, were 57.78, 91.30 and 69.80 respectively.

Tabel (7). Duration of larval period of female in days and thermal units (DD's) of adult stage of *C. vicina isis* when reared on *A. nerii* at different constant temperatures.

Temp.C^0	Duration (days) Mean	Developmental rates	DD's
20	18.76	0.053	57.78
25	11.3	0.088	91.30
28	6.3	0.159	69.80



Figure(4). Linear regression analysis of temperatures versus larval stage, degree-days requirements, and lower developmental thresholds of *C. vicina isis* when reared on *A. nerii*.

Pupal Stage

The regression line of the relation between the developmental rate and temperature degrees are a remarkably good fit to calculate the temperature velocity line for detecting statistically the lower development threshold, in (Fig.5 and Tabel 8) showed that the (T_o) of pupal stage was 18.21 the thermal units required for pupal stage was 33.58 at temperature of 20 ^{0}C, 52.28 at 25 ^{0}C and 34.75 at 28^0C.

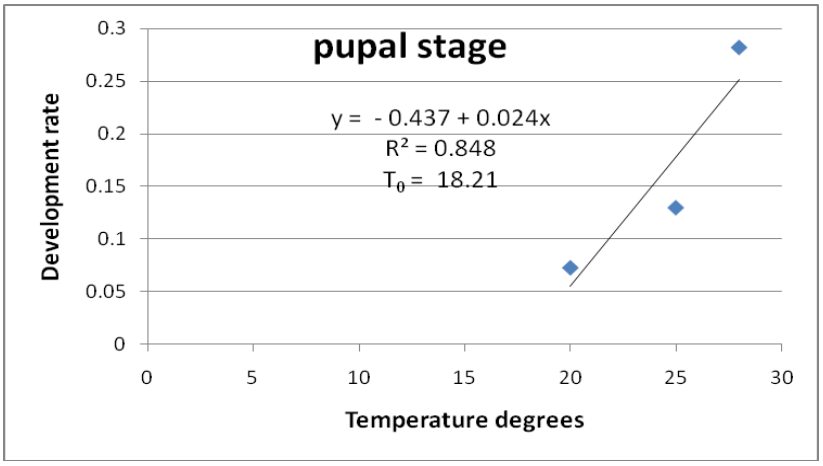
Abdel-Rahman (2005) found that temperatures of 25°C and 30°C were the most favorable temperatures for the development of *Coccinella undecimpunctata* L. predator reared on *A. nerii*. Threshold temperatures (T_0) of 10.62, 12.25, and 8.61°C were calculated for the egg, larval and pupal stages, respectively. Based on these thresholds, the stages respectively

needed about 40.69, 114.09 and 107.21 day-degrees to complete their development.

El-Serafi (2006) reared the larvae of *Exochomus nigromaculatus* on *A. nerii*, under laboratory conditions and the durations were 17.1 days

Tabel (8). Duration of pupal period in days and thermal units (DD's) of adult stage of *C. vicina isis* when reared on *A. nerii* at different constant temperature.

Temp.C^0	Duration (days) Mean	Developmental rates	DD's
20	18.76	0.053	33.58
25	7.7	0.131	52.28
28	3.55	0.282	34.75



Figure(5). Linear regression analysis of temperatures versus larval stage, degree-days requirements, and lower developmental thresholds of *C. vicina isis* when reared on *A. nerii*.

3. Longevity of adult stage:

The longevity of male and female of *C. vicina isis* when reared on *A. nerii* at the three tested temperatures (20, 25, and 28^{0}C) are given in Table (9). The total longevity periods lasted (67.3± 0.86, 49.6± 0.84 and 43.1±0.79at 20,25and28 ^{0}C) for male (77.9±0.83, 55.5±0.75 and 40.4±0.77 at20, 25 and 28 ^{0}C) for female.

El-serafi *et al.* (2000) in Egypt, stated that the total longevity duration of the femal and male of *C. carnea* reared on *A. nerii* were 17.36 and 42.6, respectively.

Oueed *et al.* (2013) in Iraqe, studied the developmental duration of the larval stage of *Coccinella undecimpunctata* when fed on *A. nerii* was 16.17 days. The pupal stage duration was six days and the pre – oviposition period was eight days.

Table (9). Duration of longevity (mean±SE) in days of *C. vicina isis adults* when reared on *Aphis nerii* at three constant temperatures.

Temp. (°C)	Sex	Longevity (in days)			
		Pre-oviposition period	Oviposition period	Post -oviposition period	Total longevity
20	♂	-	-	-	67.3 ± 0.86
	♀	8.9±0.72	59.60±0.70	9.4±0.72	77.9±0.83
25	♂	-	-	-	49.6± 0.84
	♀	4.7±0.87	45.6± 0.77	5.2±	55.5±0.75
28	♂	-	-	-	43.1± 0.79
	♀	3.2±0.79	34.5±0.78	3.7±0.75	40.4±0.77

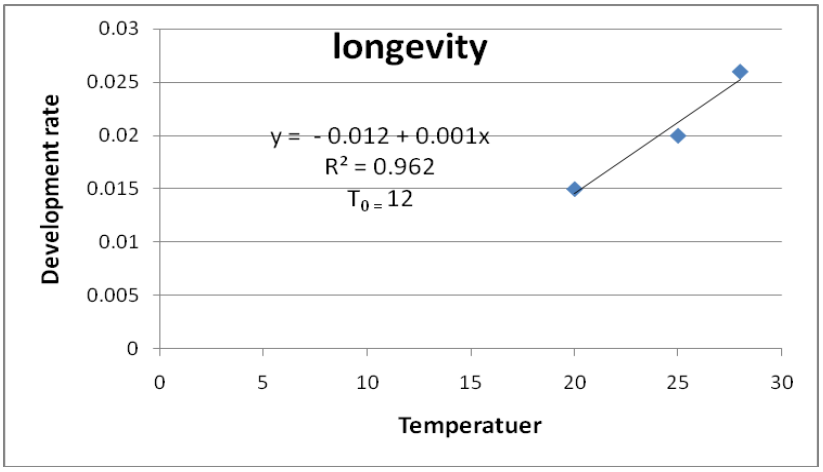
4.Degree-Day Requirements of *Cydonia vicina isis*:

Lower developmental thresholds (T_o) for adults stage were summarized in Figure (6,7) and Table (10). Degree-day requirements and lower developmental thresholds were varied between male and female for *C. vicina isis* on *A. nerii* from the lowere temperatures were 12^0C, 14^0C for male and female, respectively. The degree day's at 20^0C, 25^0C and 28^0C, were 538.4, 721.6 and 609.6 for male and 467.4, 610.5, and 565.6 for female.

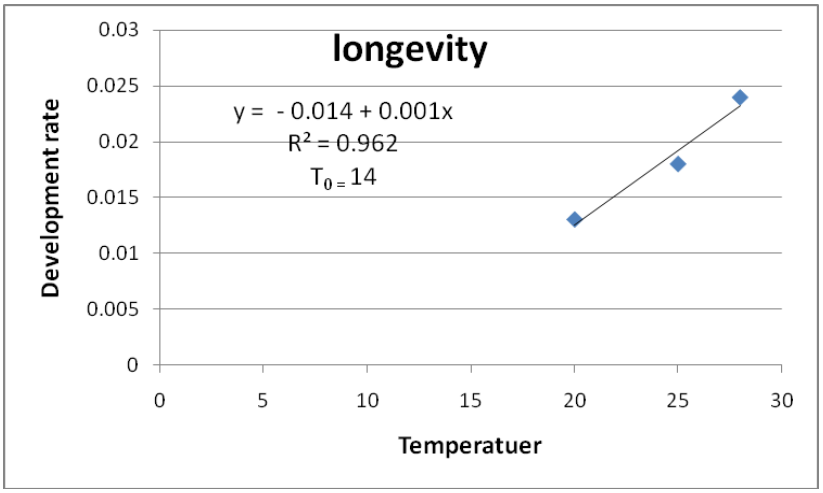
El-Serafi (2006) found that rearing *Exochomus nigromaculatus* on *A. nerii*, under laboratory conditions, the Longevity of the female averaged 49.00days

Tabel (10). Duration of longevity of female and male in days and thermal units (DD's) of adult stage of *C. vicina isis* when reared on *A. nerii* at different constant temperatures.

Temp.C^0	sex	Duration (days) Mean	Developmental rates	DD's
20	♂	67.3	0.015	538.4
	♀	77.9	0.013	467.4
25	♂	49.6	0.020	721.5
	♀	55.5	0.018	610.5
28	♂	38.1	0.026	609.6
	♀	40.4	0.024	565.6



Figure(6). Linear regression analysis of temperatures versus longevity stage, degree-days requirements, and lower developmental thresholds of *C. vicina isis* male when reared on *A. nerii*



Figure(7). Linear regression analysis of temperatures versus longevity stage, degree-days requirements, and lower developmental thresholds of *C. vicina isis* female when reared on *A. nerii*.

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الاحتياجات الحرارية اللازمة لنمو وتطور من التفلة والمفترس ابو العيد الاسود

ليلى عبدالستار البطران ، عبد البديع عبد الحميد غانم ، لبيب محمود شنب و مروة محمود السيد رمضان
قسم الحشرات الاقتصادية - كلية الزراعة – جامعة المنصورة.

أجريت تجارب معملية في معامل قسم الحشرات الاقتصادية، كلية الزراعة، جامعة المنصورة لتقدير الاحتياجات الحرارة كوسيلة للتنبؤ للجيل السنوي لكل من *Aphis nerii* و التي تصيب شجيرات التفلة في منطقة المنصورة ومفترس ابو العيد الاسود.

وأوضحت النتائج أن الوقت اللازم لنمو أعمار الحورية *Aphis nerii* انخفضت كلما ارتفعت درجة الحرارة عند تربية هذه الحشرة على شجيرات التفله

ان عتبة النمو لأعمار الحوريه كانت على درجة حرارة ١٣.١١ وان الاحتياجات الحرارية المطلوبة للمرحلة الحورية كانت ٩٨.٥٣ ، ٩٥.١٢ و١٠٢.٧٤ بينما الاحتياجات الحرارية اللازمة للتنمية المبايض كانت ١٢٩.٩٢ ، ١٤٠.٦٦ و ١٥٣.٢٧ على درجات الحرارة ٢٥,٢٠° و٢٨ ° على التوالي.

وأظهرت النتائج أن اقل معدل نمو للحشرات الكاملة لمفترس ابو العيد الاسود كانت ١٢ درجة مئوية للذكور و ١٤ درجة مئوية للاناث.

وان الوحدات الحرارية سجلت ٥٣٨.٤، ٧٢١.٦ و٦٠٩.٦ (يوم) للذكور وان الوحدات الحرارية لنمو مبياض الاناث سجلت ٤٦٧.٤، ٦١٠.٥ و٥٦٥.٦ (يوم) في ٢٥،٢٠° و ٢٨°على التوالي.