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TEMPERATURE AND PREYS AS FACTORS AFFECTING THE BIOLOGY OF *COCCINELLA SEPTEMPUNCTATA* GROWTH AND ITS PREDATION CAPACITY UNDER LABORATORY CONDITIONS

AZZA K. EMAM[1], S. A. GAFFAR[2], M. E. H. HANAFY[1] AND

NADA Z. S. SALAMA[2]

1- Faculty of Agriculture, Ain- Shams University, Cairo, Egypt.

2- Central Laboratory of Organic Agriculture, ARC, 12619, Giza, Egypt.

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Abstract

The effect of three constant temperatures (20, 25 and 30 °C) and two host preys (*A. gossypii* and *M. persicae*) on *Coccinella septempunctata* egg incubation periods, instars larvae and adults was studied. Obtained results indicated that using *M. persicae* as a prey at 25 °C was The effect of three constant temperatures (20, 25 and 30 °C) and two host preys (*A. gossypii* and *M. persicae*) on *Coccinella septempunctata* egg incubation periods, instars larvae and adults was studied. Obtained results indicated that using *M. persicae* as a prey at 25 °C was the most favorable conditions for rearing *C. septempunctata* adults. The less generation time (Gt) and the net reproduction rate (Ro) didn't vary when *C. septempunctata* was reared on the two prey species. Temperatures of 20 and 25°C produced high values of Ro, while at 30 °C it had the highest Rm and (λ), the shortest doubling time (Dt) and Gt when larvae of the predator fed on one of the two prey species.The study proved that the temperature zone 20- 25°C seemed to be the most favorable conditions for *C. septempunctata* reproduction depending on the net reproductive rate values (Ro). Predation capacity of this predator was higher in adults than larvae. Female consumed much number of aphids than male.

Key words: *Coccinella septempunctata,* laboratory studies, temperatures, preys, development.

INTRODUCTION

Aphids' nymphs and adults physically attack flowering plants, piercing the plant tissues and fed on sap vigorously. Heavy aphid infestation decreases the market value, and reduces plants' flowering efficiency, lastly 20-40% losses. Population of aphids may resurgent quite quickly under natural conditions by reproducing parthenogenetically. However, **Aheer *et al.* (2008)** stated that in the presence of coccinellid, aphids do not grow as rapidly as they are consumed.

Many biological studies were done on *Coccinella septempunctata* to estimate the effect of rearing temperatures and prey species on the predator life cycle and life table parameters. **Katsarou *et al.* (2005)** studied the immature stages development, mortality, aphid consumption, and weight and size upon reaching the mature stage of the *Hippodamia convergens* Gue´ rin-Me´ neville and *C.septempunctata* L. under four temperatures (14, 17,

20 and 23 °C) and L16:D8. Moreover, **Sattar *et al*. (2008)** studied the biology of *C. septempunctata* fed on *A. gossypii* Glover under laboratory conditions (26±2 degrees °C and 65±5% R.H.). They found that a single female laid 177.0 eggs during the entire life period. The egg hatching percentage was 98.3%, while the total larval survival percentage was 82.2%. Sex ratio recorded 1:1.5 (Male: female). The consumption of aphids per *C. septempunctata* adult recorded 77.8, whereas, larval stages consumed about 21.9, 55.9, 107.4 and 227.3 aphids/larva during 1st, 2nd, 3rd and 4th instars, respectively. Another study on life table parameters of *C. septempunctata* at 26±2 °C, 65±5% R.H. and 16L: 8D photoperiod when fed on *A. gossypii* was carried out by **Mollashahi *et al*. (2009)** who studied *C. septempunctata* and stated that the value of intrinsic rate of increase (rm) was 0.159 while the value net reproductive rate (Ro) was 373.916. In addition, they found that the ladybird mean generation time (T) was 37.25 days and the population doubled (DT) was 4.35 days. In addition, **Savita *et al*. (2013)** stated that a single female of *C. septumpunctata* laid 135-321 eggs, the eggs hatched within 4.3days. Furthermore, the larval stage total duration recorded 14.7days, while pupal period lasted for 8.3days. Male longevity was 28.8 days while for female was 34.5 days. The oviposition period was the longest one flowed by the post- oviposition then the pre-oviposition (26.6, 4.0, 2.4and days, respectively). They added that when larvae fed on *A. gossypii,* under laboratory conditions, male and female beetles consumed about 1490 and 1880 aphids during their life span, respectively.

This study aimed to determine the effect of different temperatures and aphid species as preys on *C. septumpunctata* life cycle, life table parameters and the feeding capacity**.**

MATERIALS AND METHODS

1. Rearing of *M. persicae* and *A. gossypii*

The broad bean, *Vicia faba* seeds were planted in foam trays (60 x 30 cm) contained peat moss or in plastic pots of size 20x20 cm^2 (height x width). Seeds were planted at 1-2 cm deep water and fertilizer were applied as required. Plants were sown at different intervals to ensure proper supply time for the predator. Bean leaves were infested separately with *M. persicae* and *A. gossypii* where they were distributed over the new foliage of cultivated trays. The infested trays were opserved until *M. persicae* and *A. gossypii* population increased and became a suitable prey for *C. septempunctata* predator which took a period of about 5 days. The aphid colonies were cultured under laboratory conditions, on leaves of bean plants which were previously infested by different stages of *M. persicae* and *A. gossypii.* They were kept under wooden cages (90 x 90 x 90 cm) with upper opening and sides covered with white muslin. Aphid colonies were renewed with new seedlings to ensure a continuous supply for the predator throughout the experimental duration **(François *et al*., 2009)**.

2. Effect of temperatures and preys on life cycle and life table parameters of *C.septempunctata*

2.1. Rearing of *C. septempunctata* :

Predator adults were reared in rectangular boxes (35 cm long, 15 cm height and 20 cm width) with five rectangular holes, covered with lids of white muslin to ensure proper ventilation in the boxes. *C. septempunctata* was supplied with new bean plants infested with *M. persicae* or *A. gossypii* every day and pieces of black paper as oviposition substrate.

2.2. Developmental durations of immature stages and survival rate of *C. septempunctata* on *M. persicae* and *A. gossypii*:

Biological parameters of immature stages of *C. septempunctata,* at three constant temperatures*, i.e.* 20, 25 and 30 °C, were studied. Two hours old fresh eggs of predator were collected from a stock culture with a soft brush. Three hundred eggs were counted, under a binocular microscope, and kept in petri dishes, (150 eggs of *C. septempunctata* / pray species /at the three tested temperature degrees). After hatching, larvae were transferred individually in petri dishes of 5cm, provided with moisted tissue paper at the bottom to avoid desiccation covered with muslin cloth at the top and fixed with rubber bands. Aphid nymphs were previous introduced to previous petri dishes on faba bean leaves for feeding. The petri dishes were kept in incubators at each of the three constant temperatures. Data concerning the effect of the three constant temperatures on the developmental durations, life span of each individual of predator (total duration from egg to adult emergence) and cumulative survival rates (egg to adult emergence) were recorded. In addition, total numbers of aphids consumed per day were counted in each treatment and the following measurements were recorded:

1- Duration of each instar larvae.

2- Daily feeding capacity of larvae.

3- Duration of pre-pupa and pupal stage.

4- Mortality % of each instar larva.

5- Rate of emergence (= No. of adults/ No. of pupae x 100).

6- Sex ratio = (No. of adults males or females/ total No. of adults x 100).

7- Total larval period (TLP)

8- Total duration period (TDP)

Moreover, each of *A. gossypii* and *M. persicae* were tested, as rearing preys, at the three constant temperatures and their treatments were as follows: T1, T2 and T3 = *A. gossypii* at 20, 25 and 30°C, whereas, T4, T5 and T6 = *M. persicae* at the same temperatures, respectively.

2. 3. Longevity and fecundity of *C. septempunctata* females

The biological parameters of *C. septempunctata* adults were studies at the three constant temperatures (20, 25 and 30 °C). Freshly emerged one day old adults were collected from stock culture that was reared on *M. persicae* and *A. gossypii*. Males and females were paired and kept in rectangular boxes (35 cm long, 15 cm height and 20 cm width). Each temperature was triplicated. Females were provided daily with new bean plants infested with *M. persicae* or *A. gossypii*, in addition pieces of black paper, as an oviposition substrate were used. The adults were observed daily for pre-

oviposition, oviposition and post-oviposition periods in each replicate. During the oviposition period, the eggs of *C. septempunctata* were daily collected from the black paper then counted and kept in Petri dishes for hatching in the incubators at the required temperatures. After hatching, the number of progeny/ female/ day was recorded for calculation of life table parameters. Pre-oviposition, oviposition and post-oviposition periods, fecundity, and male and female longevity were also observed.

2.4. Statistical analysis

Data was submitted to ANOVA test and the means were compared using the LSD at 0.05 level, using SAS statistical package **(SAS Institute, 1988)**.

2.3. Assessing zero of development, rate of development and the thermal units required for immature and mature stages of *C. septempunctata*:

Zero of development, rate of development and the thermal units necessary for the immature and mature stages of *C. septempunctata* were assessed according to the results obtained from the previously mentioned experiment concerning the effect of temperatures on duration of predator stages when reared on both preys; *A. gossypii* and *M. persicae*.

Rate of development equation was used to calculate the each stage.

The theoretical zero development was determined according to linear regression method as follows:

1. According to the points acquired when time in days (t) is lined against temperature in degree centigrade degree (T).

2. The points found when cross time in days (1/ t) are lined versus temperature in degree centigrade (t, each of the reciprocals is multiplied by 100), allocation of these points marks the course of temperature velocity curve. The values of average percentages of development in one day, which are presented within normal zone of development, are fitted to starting line by method of least square (Regression line).

3. In theory, the point of which the promptness line crosses the temperature center could be were considered as the zero of development in degree centigrade (±°C).

$y= a+bx$

Where: y = rate of development

a = equation constant

b= slope of the regression line

x = temperature °C

T_o obtain to the value of y was set to zero .

$T_o = -a/b$

Thermal units required for complete development of each stage was determined according to the equation of thermal summation as follows:

$K= y (T - to)$

Where :y = developmental duration (days) of a given developmental stage

T = rearing temperature °C .

t_o = temperature zero stage development, °C

K = thermal units (degree-days)

Thermal units also can be calculated as the reciprocal of regression coefficient multiplied by 100 as follow :

K =1/bx 100

Where b = regression coefficient **(Campbell and Mackauer, 1975)**.

2. 4. Life table parameters of *C. septempunctata* :

The adults which survived were kept individually and observed to collect data for constructing the life tables. Female age (x), live individual at age x (Lx) and progeny of female x (mx) were also observed. As well the intrinsic rate of increase (rm), the other parameters of life table such as generation time, net reproductive rate, finite rate of increase, doubling time, apparent mortality percentage (A.M %) and real mortality (R.M %) were calculated.

RESULTS AND DISCUSSION

1. Effect of rearing temperatures and preys on *C. septempunctata* life cycle development:

In these experiments, the effect of the three constant temperatures (20, 25 and 30 °C) and the two host preys (*A. gossypii* and *M. persicae*) on egg incubation periods, instar larvae and adults of *C. septempunctata,* were studied.

1.1. Duration of predators' immature stages:

1.1.1. Egg stage

Statistical analysis showed that the shortest mean of incubation periods of *C. septempunctata* were obtained when the predator fed on *A. gossypii* or *M. persicae* at 30°C (3.3 and 3.28 days, respectively), while, the longest duration (5.3, 5.22 days, respectively) was occurred at 20°C (Table 2).

The highest percentage of egg hatch was at 20°C when fed on *A. gossypii*, *i.e.* 100 %. Meanwhile, the lowest % of egg hatch was 94% when the predator was reared on *M. persicae* at 25 and 30°C (Table 2). These results were in assent with that of **Katsarou *et al*. (2005)** who declared that *Harmonia convergens* and *C. septempunctata* recorded the lowest egg mortality at 23°C when both were reared on *M. persicae*.

The zero development values of *C. septempunctata* egg stage recorded 4.35 and 3.55°C when the predator was reared on *A. gossypii* and *M. persicae*, respectively (Table 2).

Results also showed that, as the temperature was increased from 20 to 30°C, rate of development was increased too, where it was 18.9, 21.7 and 30.3 % when *C. septempunctata* was reared on *A. gossypii* at 20, 25 and 30°C, respectively. Moreover, rearing on *M. persicae*, at the same temperatures, caused developmental rates of 19.2, 23.3 and 30.5%, respectively (Table 2).

The thermal units' mean (DD's) for *C. septempunctata* fed on *A. gossypii* or *M. persicae* was

87.65 and 88.3°C.

Table 2. Effect of temperature on *C. septempunctata* incubation period, egg hatching %, rates of egg development, determination of t_0 and DD:

Prey	Temperature	Incubation period (days)	Percentage of egg hatching	Rate of development	t_0	DD mean
A. gossypii	20 °C	5.3[a]	100	18.9	4.35°C	87.65
	25 °C	4.62[b]	98	21.7		
	30 °C	3.3[c]	96	30.3		
M. persicae	20 °C	5.22[a]	96	19.2	3.55°C	88.3
	25 °C	4.3[b]	94	23.3		
	30 °C	3.28[c]	94	30.5		

1.1.2. Larval stage:

Results showed that both preys had the same effect on the duration of different of instar larvae and the total larval period while the different degree of temperature affected the durations. The duration of total larvae the predator was 19.17, 19.62, 15.54, 15.06 and 11.50, 11,58 day when larvae were fed on *A. gossypii* or *M. persicae* at 20, 25 and 30 °C respectively (Table 3).

The highest larval mortality percentage (8.7) was recorded when the predator was reared on *M. persicae* at 25°C, whereas, rearing on *A. gossypii* at 25 °C caused the lowest mortality rate (2.0%) (Table 3).

The zero development values were 5.19 and 5.81°C when *C. septempunctata* larvae were reared on *A. gossypii* and *M. persicae*, respectively, at three constant temperatures (Table 3).

Rates of development increased gradually when temperature rose up from 20 to 30°C. Table 3 showed that using different preys gave almost the same results. Rearing of *C. septempunctata* on *A. gossypii*, caused developmental rates of 5.82, 6.69 and 9.42 % at 20, 25 and 30°C, respectively, while rearing the larvae on *M. persicae* recorded developmental rates of 5.46, 6.64 and 9.43 at the same temperatures, respectively.

The thermal unit of *C. septempunctata* reared on *A. gossypii* and *M. persicae* were 271.3 and 268.54, respectively (Table3).

Table 3. Effect of temperature on *C. septempunctata* larval duration, mortality %, rate of development, developmental threshold and thermal units

Prey	Temp.	Durations (days)					Mortality (%)					Rate of development	t_0	DD mean
		1st larval instar	2nd larval instar	3rd larval instar	4th larval instar	Total larval period (TLP)	1st larval instar	2nd larval instar	3rd larval instar	4th Larval instar	Larval stage			
A. gossypii	20 °C	4.36 a	3.4 a	4.8 a	6.61 a	19.17a	6.0	2.0	0.0	0.0	8	5.82	5.19 °C	271.3
	25 °C	2.58 b	3.7 b	3.51 b	5.75 b	15.54b	2.0	0.0	0.0	0.0	2	6.69		
	30 °C	1.5 c	2.7 c	2.66 c	4.64 c	11.5c	6.3	2.2	0.0	0.0	8.5	9.42		
M. persicae	20 °C	4.52 a	3.72 a	4.73 a	6.65 a	19.62a	4.2	0.0	0.0	0.0	4.2	5.46	5.81 °C	268.45
	25 °C	2.58 b	3.7 b	3.5 b	5.28 b	15.06b	4.3	0.0	0.0	4.4	8.7	6.64		
	30 °C	1.5c	2.74 c	2.72 c	4.62 c	11.58c	4.3	0.0	0.0	0.0	4.3	9.43		

*** Different letters indicate significant differences between the different treatments.**

1.1.3. Pupal stage

The shortest mean pupal duration of the predator was 4.32 days at 30°C when it was reared on *A. gossypii*, whereas, rearing on *M. persicae* caused the longest pupal durations *i.e.* 7.72 days at 20°C (Table 4).

The highest pre-pupal mortality occurred when the predator was reared on *A. gossypii* at 20 and 30°C, *i.e.*4.5%, while rearing on *M. persicae* at 20°C caused the lowest mortality, *i.e.* 2.2%. On the other hand, pupal mortality percentage, recorded the highest rate when the predator was reared on *M. persicae* at 30°C, (9.3%), yet, no mortalities was recorded in pupal stage when reared on both *A. gossypii* or *M. persicae* at the temperature of 25°C. These results were in the same line with **Farooq *et al*. (2017),** who reported that the highest percentage of adult emergence was 100% when *C. septempunctata* was reared on

M. persicae at 27 ±1 °C.

The zero development temperatures were 7.82 and 6.93°C for *C. septempunctata* when larvae were reared on *A. gossypii* and *M. persicae*, respectively. **George *et al*. (2011)** stated that the rate of developmental of *H. axyridis* increased with rising temperature in alongitudinal trend on either aphid prey (*Dysaphis crataegi* or *Aphis fabae*) within the temperatures ranged from15-30°C for each

developmental stage.

1.1.4. Adult stage:

1.1.4.1. Adult emergence:

The highest emergence percentage (100 %) was recorded at 25 °C, when reared on either *A. gossypii* or *M. persicae*, whereas, raising the temperature up to30°C and rearing on *M. persicae* resulted in the lowest adult emergence rate, *i.e.* 90.69 % (Table 4).

Data in Tables 5 detected that oviposition period was the most protracted one then pre-oviposition period, while post-oviposition period was the less one.

1.1.4.1 Sex ratio:

Sex ratio, in relation to tested temperatures and prey species, ranged between 1: 1 and 1.22: 1 male to female as shown in Table 4. The highest sex ratio of *C. septempunctata* (1:1) was recorded when larvae were fed on *A. gossypii* at 20 and 25 °C, respectively, whereas, the lowest sex ratio *i.e.* 1.22:1, was obtained when larvae were reared on *A. gossypii* at 30°C. **Katsarou *et al.* (2005)** confirmed these findings as they stated that *Harmonia convergens* and *C. septempunctata* had the highest sex ratio at 20 °C.

Pre-oviposition duration decreased as temperature increased from 20 to 30°C (Table 5). Rearing on *M. persicae* gave the shortest mean period when incubated at 30°C *i.e.* 4.96 days; whereas, the longest pre-oviposition period of *C. septempunctata* was obtained when temperature decreased to 20°C, *i.e.*12 days.

Table 4. Effect of temperature on *C. septempunctata* pre-pupal and pupal duration, mortality %, adult emergence %, rates of pupal development, t_D and DD

Prey	Temperature	Duration(days)		Mortality %		Adult Emergence (%)	Sex ratio		Rate of development	t_0	DD mean
		Pre-pupa	Pupal stage	Pre-pupa	Pupal stage		M	F			
A. gossypii	20 °C	0.88[a]	7.52[a]	4.5	4.8	95.23	1	1	13.30	7.82 °C	102.55
	25 °C	0.92[a]	7.00[a]	4.3	0.0	100	1	1	14.29		
	30 °C	0.6[b]	4.32[b]	4.5	4.8	95.23	1.22	1	23.15		
M. persicae	20 °C	1.00[a]	7.72[a]	2.2	6.8	93.18	1.05	1	12.95	6.93 °C	112.43
	25 °C	0.84[a]	7.26[a]	2.3	0.0	100	1.1	1	13.77		
	30 °C	0.4[b]	4.56[b]	4.4	9.3	90.69	1.05	1	21.93		

*** Different letters indicate significant differences between the different treatments.**

The shortest oviposition period recorded 11.4 days when the predator was reared on *A.*

gossypii and *M. persicae* at 30°C. On contrast, the longest period recorded 21.68 days when larvae were reared on *A. gossypii* at 25°C (Tables 5).

When larvae of the predator were reared on *A. gossypii* at 25 °C they recorded the longest post-oviposition period of 5.44 days, whereas, raising temperature up to 30°C decreased post-oviposition period to reach 3.36 days (Table 5). This data was similar to that of **George *et al*. 2011** on other coccinellid species.

Also results showed that prey species had insignificant effect on *C. septempunctata* female longevity (Table 5).

Results obtained in Tables 5 showed that the zero development were 9.79 and 9.68 °C for *C. septempunctata* female when larvae were reared on *A. gossypii* and *M. persicae*, respectively.

Data revealed that zero development values for *C. septempunctata* male recorded 7.48 and 7.05 °C when its larvae were reared on *A. gossypii* and *M. persicae*, respectively (Table 6). This finding in agreement with data on other aphidophagous coccinellid species by **Srivastava and Omkar (2003)** and **George *et al*. (2011**).

The rate of development of *C. septempunctata* female reared as larvae on *M. persicae* were 1.87, 2.06 and 3.31%; 1.88, 2.26 and 4.73 at temperatures of 20, 25 and 30°C, respectively.

In addition the thermal units of *C. septempunctata* female fed as larvae on *A. gossypii* and *M. persicae* were 427.05°C and 452.71°C, respectively (Table 5).

The highest mean fecundity was 402.16 eggs /female when it was reared on *A. gossypii*, at a temperature of 25°C, while the lowest one was 211.54 eggs/ female when reared on the same prey at 30°C (Tables 5).

Concerning rates of development and thermal units of *C. septempunctata* males reared on the two tested preys. Rearing predator on *A. gossypii and M. persicae,* recorded 3.65, 3.73 and 6.25%; 3.21, 4.14 and 5.62% for the three tested temperatures, respectively. Feeding on *A. gossypii* and *M. persicae* gave thermal units of 390.79 °C and 415.23 °C, respectively, as shown in Table 6.

From the aforementioned results, it could be concluded that feeding on *M. persicae* at 25 °C appeared to be the most appropriate conditions for rearing *C. septempunctata* adults under laboratory conditions.

The all previous results revealed that the interactions between the two tested factors, temperatures and preys were insignificant on all stages of *C. septempunctata*.

2. Life table studies on *C. septempunctata*

Results in Table 7 showed the parameters of life table of *C. septempunctata* larvae at the different temperatures when reared on the two prey species.

2.1. Net reproduction rate (Ro):

Results in Table 7 showed that *C. septempunctata* female gives the highest averages birth at 25°C, (167.44 and 219.89) when reared on *A. gossypii* and *M. persicae*, respectively. Decreasing temperature to 20°C or increasing it to 30°C resulted in decreasing the numbers of produced progeny.

2.2. Generation time (Gt):

Table 7 indicated that the generation time of *C. septempunctata* varied according to prey species and temperatures. The generation times were 54.88 and 57.58 days at 20°C, and 42.57 and 43.07 days at 25°C then 33.75 and 31.75 at 30°C when larvae were reared on *A. gossypii* and *M. persicae*, respectively.

Table 5. Effect of temperature on pre-oviposition, oviposition and post-oviposition periods, fecundity, egg hatch %, rates of development, t_0 and DD of *C. septempunctata* females.

Prey	Temp.	Duration (days)				Fecundity No. of Eggs/ Female	Egg hatch %	Rate of development	t_0	DD mean
		Pre-oviposition period	oviposition period	Post-oviposition period	Female					
A.	20 °C	8.16 [b]	36.4 [a]	8.76[a]	53.32 [a]	374.35 [a]	96	1.87		
	25 °C	10.72 [a]	30.96 [b]	3.72[c]	45.4 [b]	362.23 [a]	98	2.06	14.43 °C	427.05
Gossypii	30 °C	4.28 [c]	14.96 [c]	2.48[c]	21.72 [c]	172.41 [b]	100	3.31		
M.	20 °C	9.6 [b]	35.96 [a]	7.76[a]	53.32 [a]	369.58 [a]	100	1.88		
	25 °C	10.72 [a]	30.96 [b]	3.7 [c]	45.38 [b]	382.29 [a]	94	2.26	13.6 °C	452.71
Persicae	30 °C	4.96 [c]	23.96 [c]	6[b]	34.92 [c]	201.47 [b]	98	4.73		

*** Different letters indicate significant differences between the different treatments.**

Table 6. Effect of temperature on male longevity, rates of development, determination of threshold of development and DD of *C. septempunctata* males.

Prey	Temperature	Male longevity	Rate of development	t_0	DD
A. gossypii	20 °C	27.36[a]	3.65	7.48 °C	390.79
	25 °C	26.8[b]	3.73		
	30 °C	16[c]	6.25		
M. persicae	20 °C	31.16[a]	3.21	7.05°C	415.23
	25 °C	24.16[b]	4.14		
	30 °C	17.8[c]	5.62		

*** Different letters indicate significant differences between the different treatments.**

2.3. Intrinsic rate .of increase (rm.):

The highest (r.m) recorded when larvae were reared on *A. gossypii* and *M. persicae* at 30°C (0.13 and 0.14 individual/day, respectively) followed by 0.12 and 0.125 individual/day, respectively at 25°C, then 0.091 and 0.092 individual/day, respectively at 20°C (Table 7).

2. 4. Finite r,ate of increase (λ,):

The highest λ, for *C. septempunctata* was obtained at 30°C being 1.14 and 1.15 individual/day, respectively (Table 7). When larvae were reared on *A. gossypii* and *M. persicae*, their values of finite rate of increase were almost the same at all the tested temperatures at both 20 and 25°C (1.09 & 1.09 individual/day and 1.12 & 1.13 individual/day, respectively).

Table 7. Life table parameters of *C. septempunctata* reared on the two different preys at three tested constant temperatures.

Temp./°C	Prey	The net reproductive rate (Ro)	Generation time(days) (Gt.)	Intrinsic rate of natural increase (Rm)	Finite rate of increase (λ)	Population doubling time (Dt)
20	*A. gossypii*	155.81	54.88	0.091	1.09	7.61
	M. persicae	210.23	57.58	0.092	1.09	7.5
25	*A. gossypii*	167.44	42.57	0.12	1.12	5.77
	M. persicae	219.89	43.07	0.125	1.13	5.52
30	*A. gossypii*	85.03	33.75	0.13	1.14	5.33
	M. persicae	90.55	31.75	0.14	1.15	4.89

Table 8. Predation capacity of *C. septempunctata* reared on the two different preys at three tested constant temperatures.

Prey	Temp./ °C	Consumption efficiency						
		Larval instars				Total larval stage consumption	Male	Female
		1st	2nd	3rd	4th			
A. gossypii	20 °C	44.18^{a}	58.62^{b}	101.78^{b}	204.96^{a}	409.54^{b}	1552^{c}	2129.04^{a}
	25 °C	28.38^{b}	63.86^{b}	76.96^{c}	194.34^{b}	365.54^{c}	1570.12^{b}	2060.32^{b}
	30 °C	26.5^{b}	53.68^{c}	72.7^{c}	133.58^{c}	286.46^{f}	894.28^{e}	1143.72^{d}
M. persicae	20 °C	43.86^{a}	72.12^{a}	136.7^{a}	215.34^{a}	468.02^{a}	1816.64^{a}	2144.28^{a}
	25 °C	25.9^{b}	76.12^{a}	105.24^{b}	196.78^{b}	404.04^{b}	1392.28^{d}	1842.2^{c}
	30 °C	16.86^{c}	53.2^{c}	83.88^{c}	149.36^{c}	303.3^{d}	754.44^{f}	1148.16^{d}
F value		14.31	6.49	3.98	0.31	7.55	4.19	1.11
P value		0.0000	0.0019	0.02	0.73	0.01	0.01	0.03
L. S. D.		2.54	5.98	12.10	*NS	20	50	57

*NS=not significant difference.

*** Different letters indicate significant differences between the different treatments.**

2.5. Population double time (Dt):

Result in Table 7 showed that the population of *C. septempunctata* reared at 30°C had the shortest double generation values (5.33 and 4.89 days), followed by those reared at 25°C (5.77 and 5.52 days), while the longest durations were recorded at 20°C (7.61 and 7.5 days) when larvae were reared on *A. gossypii* and *M. persicae*, respectively.

Prey species and preferred temperatures for rearing *C. septempunctata* should achieve the highest net reproduction rate (Ro) and the shortest generation time (Gt), yet, values of previous parameters didn't differ between the two prey species. In addition temperatures of 20 and 25°C produced high values of Ro, while at 30°C it had the highest Rm and (λ), the shortest Dt and Gt compared to 20 and 25°C when larval predators fed on one of the two prey species. Thus, the temperature zone 20- 25°C seemed to be the most favorable conditions for *C. septempunctata* reproduction depending on the Ro. Similar observations were reported by **Ali and Rizvi (2010)** who stated that *C. septempunctata* need about 68, days to finish the whole ngeneration at 20±2°C, 61 days at 24±2 and 53 days at 28±2°C**.**

3. Feeding capacity of *C. septempunctata* at different rearing temperatures and preys

The average number of consumed preys increased with the successive predator developmental instar larvae (Table 8). Interaction between the two factors revealed insignificant effect on the fourth instar larvae (F=0.31) while significant effects occurred on the 1st, 2nd and 3rd instar larvae, total larval stage, and male and female (F= 14.31, 6.49, 3.98, 7.55, 4.19 and 1.11 respectively).

Feeding on *A. gossypii* at 20, 25 and 30°C, caused a total larval stage consumption of 409.54, 365.54 and 286.46 aphids/larva, respectively, while, it increased up to 468.02, 404.04 and 303.3 aphids/larva, when *M. persicae* was their prey (Table 8).

The mean food consumption of C. septempunctata male were 1552, 1570.12 and 894.28 aphids when fed on A. gossypii, at 20, 25 and 30°C, respectively and 1816.64, 1392.28 and 754.44 aphids when fed on M. persicae at the same temperatures, respectively. The mean food consumption of C. septempunctata female was higher than male having 2129.04, 2060.32 and 1143.72 aphids when fed on A. gossypii, at 20, 25 and 30°C, respectively and 2144.28, 1842.2 and 1148.16 aphids when fed on M. persicae at the same temperatures, respectively (Table 8). Xia et al. (1999) concluded the same finding when they detected that the relationship between predation and growth starting at 10ºC, where they noticed that the rate C. septempunctata predation rose with increasing temperatures up to a certain level (24±1ºC) beyond which the rate of predation decreased rapidly, predicted to reach zero at 40ºC.

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درجة الحرارة والفرائس كعوامل مؤثرة على النواحى البيولوجية وسعة الافتراس لمفترس *Coccinella septempunctata*

عزة كمال إمام[1] , سعد عبد الخالق جعفر[2] و حمدي السعيد محمد حنفى[1] و ندا زينهم سيد سلامة[2].

1- *كلية الزراعة- جامعة عين شمس- القاهرة- مصر.*

2 – المعمل المركزى للزراعة العضوية- مركز البحوث الزراعية- الجيزة- مصر

عند دراسة تأثير ثلاث درجات حرارة ثابتة (20 ، 25 و 30 درجة مئوية) ونوعين من الفرائس من القطن والخوخ (*A. gossypii* و *M. persicae*) على فترات حضانة البيض ,الأعمار اليرقية والحشرات الكاملة لأبو العيد 7 نقط *C. septempunctata* تحت ظروف المعمل. أظهرت النتائج عند تغذية حشرات أبو العيد على من الخوخ عند درجة 25 °م كانت هذه الظروف هى الأكثر ملائمة لتربية الحشرات الكاملة. كما وجد أن لم يختلف معدل الأنجاب (Ro) ومدة الجيل(Gt) عند تغذية المفترس *C. septempunctata* على نوعي حشرات المن. سجلت أعلى قيم لمعدل الانجاب عند درجات الحرارة 20 و 25°م ، بينما سجلت أعلى قيمة لمعدل الزيادة اليومى للتعداد (Rm) و معدل الزيادة فى وحدة الزمن (λ) و أقصرمدة لتضاعف الجيل (Dt) ومدة الجيل (Gt) عند درجة حرارة 30°م مقارنة بـ 20 و 25 °م عند تغذية يرقات المفترس على نوعي حشرات المن. أثبتت الدراسة أن درجات الحرارة 20–25 درجة مئوية هى الأكثر ملاءمة اعتمادا على صافي قيم معدل الإنجاب (Ro). كانت السعة الأفتراسية للحشرات الكاملة لأبو العيد 7 نقط أعلى من اليرقات كما أثبتت التجارب أن الآناث تستهلك عدد أكبر من حشرات المن عن الذكور.