INFLUENCE OF TEMPERATURE ON SOME BIOLOGICAL ASPECTS AND PRODUCTION OF FOUR TRICHOGRAMMATIDS

SHALABY, F. F. [1], ALIA ABD EL-HAFEZ[2], E. F. EL-KAYAT [1] AND MANAL A. A. EL-SHARKAWY[2]

1 Plant Protection Department, Faculty of Agriculture, Moshtohor, Benha
2 Plant Protection Research Institute, ARC, Dokki, Giza

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Abstract

Laboratory studies were conducted to determine the Influence of temperature on some biological aspects and production of *Trichogramma evanescens, Trichogramma embryophagum Trichogramma brassicae* and *Trichogrammatoidea bactrae* when reared on eggs of *pectinophora gossypiella*. It was found that the longest developmental period obtained at 15°C, while the shortest was at 30°C. The lower thresholds of development (LTRS) of the four species were estimated by 11.11, 10.75, 9.92 and 9.80 °C, respectively. In addition, the relation between developmental period and temperature provided upper temperature thresholds (UTRS) of 32.12, 31.91, 32.2 and 32.65°C for the four parasitoid species, respectively. While the degree-days Celsius (DDC) were estimated by 137.78, 135.32, 155.71 and 157.36 degree-days, respectively. The effect of temperature on survivorship, females' longevity and fecundity were also studied.

INTRODUCTION

During the last few years, *Trichogramma* spp. are mass reared (in the Biological Control Research Department, Plant Protection Research Institute, ARC, Cairo) and released in large numbers into sugarcane fields in Upper Egypt for controlling the lesser sugarcane borer, *Chilo agamemnon*. Also other trials are carried out in the bollworms Department at the same Institute for mass production and release of *Trichogramma* spp. into cotton cultivations for controlling the pink and spiny bollworms (Abd El- Hafez, Alia and Nada 2000). Field releases of *Trichogramma* often require the ability to produce a predictable period of discrete adult emergence, which could be determined after estimating the thermal requirements of *Trichogramma*. As known *Trichogramma* are piokkilothermic insects, in contrast to homeothermic animals, their biology thus depends upon ambient thermal fluctuations. In order to cope with these fluctuations, each species and sometimes each population, presents its own capacity of adaptation (Babi 1995). The optimum zone of temperature for rearing *Trichogramma* spp. was determined between 22-30°C, and the developmental period was inversely related to increased temperature (Parra *et al.*, 1990 and Abd El-Hafez, Alia, 1995). The effects of four different temperatures (15, 20, 25 and 30°C)

on biological characters of *T. evanescens, T. bactrae, T. brassicae* and *T. embryophagum* reared on pink bollworm eggs were studied. The aim of this study was to determine the optimal thermal conditions for production of each of these parasitoids.

MATERIALS AND METHODS

Laboratory experiments were conducted on *Trichogramma evanescens,* (native strain), *Trichogramma embryophagum, Trichogramma brassicae* (imported from Iran in 1998) and *Trichogrammatoidea bactrae* (imported from USA in 1992) to determine temperature dependent development of each parasitoid species from oviposition to adult emergence. *Trichogramma evanescens* Westwood (native strain), *T. embryophagum* Hartig and *T. brassicae* Bezdenko imported from Iran in 1998 and *Trichogrammatoidea bactrae* Nagaraja imported from USA in 1992. Parasitoid species were reared on eggs of pink bollworm, *Pectinophora gossypiella* (Saund.) for more than 10 successive generations before starting this study. Developmental period of each species was determined by allowing mated females to oviposit in pink bollworm eggs (<24hrs after oviposition). Pink bollworm egg sheets were exposed to adults of each parasitoid species for 3-hrs. All parasitoids produced during the 3-hrs were assumed to be of uniform age (Hutchison *et al*, 1990 & Abd El-Hafez, Alia 1995). Parasitized egg sheets were transferred individually in glass vials (4 x 8.5 cm), and placed in each of the following constant temperature regimes: 15±1°C, 20±1°C, 25±1°C, and 30±1°C, each combined with 80 ± 5% R.H.

Pink bollworm parasitized eggs were examined daily and maintained until they turned black (prepupal stage). Then, the parasitized eggs (black in colour) were checked twice daily until more than 50% of adults had emerged, the total developmental period (from sting to adult emergence) was determined. The rate of development from parasitization to adult emergence (1/days of development time) was determined for each temperature. By means of linear regression analysis, these data were converted to fit the equation of Higley *et al.* (1986) as follows: $Y\hat{} = a + bx$

Where: Y= reciprocal of development, x = °C and a & b are constants

The estimation of the threshold temperature (TRS) for development was determined by x when y= 0, where the estimate of degree-days-Celsius (DDC) required for *Trichogramma* development was determined by 1/b

Mortality of immature stages was determined by estimating the percentage of emerged adults, which reflected cumulative survival from egg to adult. In this study, four replicates were done to determine *Trichogramma* fecundity, longevity, and emergence rate at the above mentioned temperatures. For each replicate, 6 mated

females of each parasitoid species were placed individually in glass vials (4x8.5cm) containing sheet of <24 hr-old pink bollworm eggs (about 100 eggs/sheet), this sheet was replaced daily until females' mortality. Fecundity was determined as the total number of observed progeny in the parasitized eggs. After emergence, females were counted in the progeny was calculated as percentage of females in the emerged progeny. The sexes of newly emerged adults were distinguished on the basis of males having longer and more setose antennae than the females (Pinto *et al.* 1978). Adult emergence rate was estimated by the ratio of the number of emerged adults to the number of observed progeny in parasitized eggs. To asses longevity, the female parasites were fed on filter paper moistened with 10% sucrose solution, the number of surviving adults was also recorded daily.

Analysis of variance was done on all data (ANOVA) and Duncan's multiple range test was used to separate the means (Snedecor & Cochran 1980).

RESULTS AND DISCUSSION

1. Developmental period:

The mean total developmental periods of *Trichogramma evanescens, Trichogrammatoidea bactrae, Trichogramma embryophagum* and *Trichogramma brassicae* from sting to 50% of adults' emergence were negatively correlated to temperature (Table, 1). The correlation values were -0.9169, -0.9064, -0.8844 and -0.8991 for the four species respectively. The duration period differed significantly according to the rearing temperature and the parasitoid species. The longest developmental period was obtained at 15°C, while the shortest was at 30°C ($P<0.05$). At 15°C, the duration periods for *T. evanescens* (34.33 days), *T. bactrae* (34.0 days) and *T. brassicae* (33.68 days) varied insignificantly, while significant differences were obtained between these values and that of *T. embryophagum* (35.83 days). Thus, developmental rate of the four species was very slow at 15°C, while it increased gradually to reach its maximum at 30°C. The developmental rate for the four species at 15°C was calculated as 2.91, 2.94, 2.79 and 2.97%/ day, respectively. As the rearing temperature increased to 20°C, development rates became faster (6.35, 6.67, 7.02 and 6.82%/ day, for the four species, respectively as a result decrease in developmental periods, which reached 15.75, 15.00, 14.25 and 14.67 days, respectively. More increasing in the developmental rate was achieved at 25°C, as it averaged 11.53%/ day for *T. bactrae* and 10%/day for each of the other three parasitoid species. Statistically, the duration time of *T. bactrae* (8.67days) was significantly the shortest comparing with the other three parasitoid species (10 days). The increase of rearing temperature to 30°C resulted in shorter duration time, as it

decreased significantly to 8 days for *T. embryophagum* & *T. brassicae* and to 7.25 and 7.33 days for *T. evanescens* and *T. bactrae,* respectively. Thus, the fastest development was obtained by rearing at 30°C as the developmental rate was 12.5%/ day for the former two species and 13.79& 13.64%/ days for the latter two species, respectively. In accordance with the present results, the obtained developmental periods of *T. evanescens* and *T. bactrae* are very close to those reported by Naranjo (1993) and Abd El- Hafez (1995) when these parasitoids were reared on *P. gossypiella* eggs at constant temperatures. Navarro and Marcano (1997[a]) found an inverse relationship between rearing temperature and developmental rate of *T. pretiosum* and *T. caiaposi* reared on *Helicoverpa zea* eggs. Also Pratissoli and Parra (2000) found an inverse correlation between the duration of the cycle and the increase of temperature when *Trichogramma pretiosum* reared on eggs of *Phthorimaea operculella* (Zeller) and *Tuta absoluta* (Meyrick).

2- Lower threshold, upper threshold and thermal requirements:

The linear regression equation, Y = a + b*x was adopted for the relationship between each of the rate of development (100/ duration) or development period and the corresponding temperature. The high values of the coefficient of determinations (R^2) revealed the presence of a strong relationship between each of the two variables considered in analysis. From the relation between the rate of development (dependent variable) and temperature (independent variable), the lower thresholds of development (LTRS) of *T. evanescens, T. bactrae, T. embryophagum* and *T. brassicae* were estimated as 11.11, 10.75, 9.92 and 9.80 °C, respectively. The values of (LTRS) and Degree-Days-Celsius (DDC) of the two former species (*T. evanescens* & *T. bactrae*) or the two later species (*T. embryophagum* and *T. brassicae*) varied insignificantly, while, significant differences were found between the two pairs of the aforementioned species (Table, 1). The DDC were estimated by 137.78, 135.32, 155.71 and 157.36 degree-days, respectively. On the other hand, the relation between development period (dependent variable) and temperature (independent variable), provided an upper temperature threshold (UTRS) of 32.12, 31.91, 32.2 and 32.65°C for the aforementioned parasitoid species, respectively. Statistically, no significant difference was found between the three former species but they differed significantly than the last one.

Table 1. Developmental periods (to 50% emergence) and thermal requirements of four trichogrammatid species reared on *pectinophora gossypiella* eggs.

Temp. (°C)	*T. evanescens*		*T. bactrae*		*T. embryophagum*		*T. brassicae*		Mean	L.S.D.
	Duration	Developmental rate (%)	Duration	Developmental rate (%)	Duration	Developmental rate (%)	Duration	Developmental rate (%)		
15	34.33^{b} ± 0.472 (34-35)	2.91	34.0^{b}± 0.817 (33-35)	2.94	35.83^{a} ± 1.12 (34-37)	2.79	33.68^{b} ± 0.472 (33-34)	2.97	34.4^{a} ±1.09 (33-7)	1.185
20	15.75^{a} ± 0.957 (15-17)	6.35	15.0^{ab}± 0	6.67	14.25^{b} ± 0.500 (14-15)	7.02	14.67^{b} ± 0.471 (14-15)	6.82	14.92^{b} ± 0.774 (14-17)	0.908
25	10.0^{a} ± 0	10.00	8.67^{b}± 0.471 (8-9)	11.53	10.0^{a} ± 0	10.00	10.0^{a} ± 0	10.0	9.67^{c} ± 0.632 (8-10)	0.363
30	7.25^{b} ± 0.500 (7-8)	13.79	7.33^{b}± 0.471 (7-8)	13.64	8.0^{a} ± 0	12.5	8.0^{a} ± 0	12.5	7.65^{d} ±0.48 (7-8)	0.529
Mean	16.83^{AB} ± 10.91 (7-35)		16.25^{C} ±11.01(7-35)		17.02^{A} ± 11.47 (8-37)		16.59^{BC} ± 10.50 (8-34)		16.67 ±10.7 (7-37)	0.375
L.S.D.	0.9079		0.81199		0.9453		0.5137		0.375	
Correlation	-0.9169		-0.9064		-0.8844		-0.8991			
LTRS (°C)	11.11^{a}		10.75^{a}		9.92^{b}		9.80^{b}			0.6369
UTRS (°C)	32.12^{b}		31.91^{b}		32.20^{b}		32.65^{a}			0.3117
DDC	137.78^{b}		135.32^{b}		155.71^{a}		157.36^{a}			11.602

Navarro & Marcano (1997[b]) estimated LTRS of 9.27°C for *T. pretiosum* on *Helicoverpa zea* eggs. In addition, Pratissoli & Parra (2000) found higher thermal requirement (131.3 degree days) for the same parasitoid when reared on *Tuta absoluta* (Meyrick) in relation to *Phthorimaea operculella* (Zeller) (120.9 degree days), and the LTRS was lower (12.98°C and 13.53°C, respectively). The present estimations of LTRS, UTRS and DDC in case of *T. evanescens* and *T. bactrae* are nearly close to those reported by Abd El Hafez (1995) when the same two species were reared on the same host eggs. Also, these values were nearly close to those reported by Laing & Eden, (1990) for *T. minutum* reared on the Angoumois grain moth (10.4°C). On the other hand, the present estimations of DDC were more than those estimated by Pratissoli & Parra (2000[a]) for *T. pretiosum* (120.9 degree days) when reared on *Phthorimaea operculella.*

3- Survivorship:

Regardless of the rearing temperature and species, high percentages (86.1-97.3%) of immature stages completed their development and emerged as adults from the parasitized eggs (Table 2). No adverse effect on parasitoid survivorship occurred on all the tested species when reared at 20 or 25°C. Adults' emergence ranged between 93.07-96.36% at 20°C and 94.8-96.21% at 25°C. However, survivorship tended to be lower when insects reared at 15 or 30°C (except for *T. embryophagum* which showed 97.2% emergence when reared at 30°C). Moreover, the susceptibility of the aforementioned species to the lower (15°C) and the higher (30°C) temperature was different. For example, percentage of emerged adults averaged 86.1, 87.83, 88.00 and 91.96% when *T. evanescens, T. bactrae, T. embryophagum* and *T. brassicae* were reared at 15°C, while these percentages were 88.06, 90.34, 97.30 and 91.2%, respectively by rearing at 30°C, respectively. It could be noted that *T. embryophagum* is more tolerant to high temperature than the other three species. Cynthia and Chiang (1982) reported similar results when they studied the development of *Trichogramma ostrinia* on *Ostrinia nubilalis* eggs at 4 temperatures (15, 20, 25, and 30°C). They stated that the survival and development were more successful at higher temperatures and suggested that for the purpose of propagation, 30°C would be more efficient. On the contrary, Hutchinson, *et al.* (1990) recorded high mortality percentage during immatures development (34.6%) when they reared *T. bactrae* on the pink bollworm eggs at 30°C although they recorded similar results at 15°C (89.4% survival). On the other hand, Naranjo (1993) studied life history characteristics of *T. bactrae* at constant temperatures in Arizona and southern California and found that this parasitoid appears well adapted to high temperatures, this environmental factor should not significantly hinder the efficacy of this biocontrol

agent in the field. This finding well agrees with the present results as the survivorship of this parasitoid (*T. bactrae*) reached 90.34% at 30°C. In addition, Babi (1995), Navarro & Marcano (1997 [a & b]) and Abd El-Hafez (2001) studied the biology of different species of *Trichogramma* at different temperatures using eggs of the natural and factitious hosts and found that high rates of adults' emergence ranged between 88.9- 95.25%.

2. Survivorship (%) of four trichogrammatids reared on *pectinophora gossypiella* eggs at different constant temperatures.

Temperature (°C)	Survivorship (%)					
	T. evanescens	T. bactrae	T. embryophagu	*T. brassicae*	Mean	L.S.D.
15	86.10^{c}± 7 (66.7-100)	87.83^{b} ± 10 (66.7-100)	88.00^{b}± 9.65 (60-100)	91.96^{bc}± 5.86 (82.1-99)	88.47± 7.53 (60-100)	7.3805
20	93.07^{ab}± 4.65 (82.8-99.4)	96.36^{a}± 2.93 (89.3-100)	95.09^{ab}± 3.83 (86.1-100)	95.75^{a}± 4.08 (86.3-100)	95.07 ± 4.06 (82.8-100)	2.2004
25	96.21^{a}± 3.798 (84.2-100)	95.93^{a}± 4.01 (85.7-100)	94.82^{ab}± 5.29 (79.2-100)	95.05^{ab}± 4.599 (83.3-100)	95.50± 4.37 (79.2-100)	2.7526
30	88.06^{bc}± 10.25 (56.6-100)	90.34^{b}± 8.50 (66.7-100)	97.30^{a}± 2.73 (79.2-100)	91.21^{c}± 91.21 (72.2-100)	91.73± 8.49 (56.6-100)	4.5854
Mean	90.87± 7.6 (56.6-100)	92.62± 7.9 (66.7-100)	93.80± 6.0 (60-100)	93.49± 5.9 (72-100)	92.70± 7.0 (56.6-100)	
.L.S.D	5.938	4.053	6.829	6.267		

4- Female s ' longevity:

Results in Table (3) show that, longevity of trichogramma females differed significantly according to the rearing species and temperature. Regardless of the rearing temperature, females' longevity of the four aforementioned parasitoids differed significantly and could be arranged descendingly according to their mean longevities as: *T. evanescens* (8.01 days)> *T. brassicae* (6.62 days) > *T. bactrae* (5.65 days) > *T. embryophagum* (3.98 days). Longevity of *T. evanescens*, *T. bactrae* and *T. brassicae* female is negatively correlated with temperature, correlation values were –0.997, -0.9518 and –0.9342, respectively. As for *T. embryophagum*, adults were more

sensitive to low as well as to high temperature, since most of females died after one day of emergence when reared at 15°C (1.05days) or 30°C (1.08 days). These results are very close to those reported by Resende and Ciocoilla (1996) who found lower longevities of *Trichogramma atopovirilia* on *Helicovepa* zea eggs at 15°C and 30°C.

Table 3. Female longevity (days) of four trichogrammatids reared on *pectinophora gossypiella* eggs at different constant temperatures

Temperature (°C)	Female longevity (days)					L.S.D.
	T. evanescens	*T. bactrae*	T. embryophagum	T. brassicae	Mean	
15	13.9^{Aa}± 1.11 (12-17)	10.54^{Ba}± 0.80 (10-13.1)	1.05^{Db}± 0.20 (1-2)	8.41^{Ca}± 0.66 (6-8.42)	8.48^{a}± 4.80 (1-17)	0.409
20	10.15^{Ab}± 0.72 (8-11)	7.33^{Bb}± 0.79 (6-9)	6.83^{Ca}± 0.91 (6-9)	7.22^{Bab}± 0.46 (6.92-1)	7.88^{b} ± 1.51 (6-11)	0.424
25	6.11^{Cc}± 0.96 (4-8)	2.42^{Dc}± 0.24 (2-3)	7.04^{Aa}± 7.04 (6.69-8)	6.55^{Bb}± 0.46 (6.39-8)	5.53^{c}± 1.92 (2-8)	0.340
30	1.88^{Ad}± 0.13 (1.75-2)	2.32^{Ac}± 0.33 (2-3)	1.08^{Bb}± 0.009 (1-1.04)	2.86^{Ac}± 0.17 (2.67-3)	2.02^{d}± 0.71 (1-3)	1.747
Whole mean	8.01^{A}± 4.58 (1.75-17)	5.65^{C}± 3.54 (2.13.1)	3.98^{D}± 3.02 (1-9)	6.62^{B}± 6.26 (2.67-8.42)	5.98± 3.71 (1.75-17)	0.528
Correlation	-0.9997	-0.95177	0.00227	-0.9342		
L.S.D.	0.469	0.394	0.299	2.031	0.528	

Statistically, *T. evanescens* female lived, significantly, the longest period (10.15 days) compared to *T. bactrae* (7.33 days), *T. embryophagum* (6.83 days) and *T. brassicae* (7.22 days) when those were reared at 20°C. While at 25°C, *T. embryophagum* lived significantly the longest period (7.04 days) followed by *T. brassicae* (6.55 days), *T. evanescens* (6.11 days) and *T. bactrae* (2.42 days). There was insignificant difference between longevity of *T. brassicae* females whatever reared at 15°C or 20°C and *T. bactrae* female when reared at 25°C or 30°C. Also, longevity of *T. evanescens, T. bactrae* and *T. brassicae* varied insignificantly when reared at 30°C.

Parra *et al.* (1990) explained the longer longevity of *Trichogramma* by the decrease of metabolic activity at low temperature. The present results are in agreement with those reported by many investigators for different species of trichogramma reared at different temperatures using different hosts (Hutchison, *et al.* 1990, Babi 1995, Garcia & Tavares 1995) as they mentioned that, longevity is negatively correlated with temperature. The difference of female's longevity between the aforementioned species is consistent with previous studies by Navarro and Marcano (1997 [a & b]) for *Trichogramma pretiosum* and *T. caiaposi* at different temperatures (18, 23, 28, and 33ºC) in *Helicoverpa zea* eggs. They found that longevity was negatively correlated with temperature, averaging approximately 12.0 to 4.0 days for *T. pretiosum* and approximately 2.9 to 1.4 days for *T. caiaposi.*

5- Effect on fecundity:

The average number of progeny per female differed significantly according to the rearing temperature. Moreover, there were significant differences between fecundity of the 4 parasitoid species when reared at the same temperature (Table, 4). Regarding the rearing temperature, all parasitoids produced significantly the lowest progeny/ female (mean= 43.00± 8.54 individuals/ female) when they were reared at 15°C, as the averages were 46.08, 43.33, 37.00 and 45.58 individuals for *T. evanescens, T. bactrae, T. embryophagum* and *T. brassicae* female, respectively. On the contrary, all parasitoids produced significantly the greatest progeny (72.07 ± 14.74 individuals/♀) when reared at 25°C, the recorded progenies were 77.83, 60.75, 88.38 and 61.33 individuals / female, respectively. While, moderate numbers of progeny/ female (mean of four species = 59.43 individuals/ ♀ was produced when rearing took place at 20 °C & the obtained averages for the four parasitoids were 56.71, 54.54, 69.13 and 57.33 individuals/ ♀, respectively). On the other hand, lower averages of progenies were also produced when wasps were reared at 30°C, general mean = 46.78 & the averages = 40.04, 54.04, 53.33 and 39.71 individuals/ ♀, respectively (Table, 4).

Table 4. Fecundity of four trichogrammatids reared on *pectinophora gossypiella* eggs at 4 different temperatures.

Temperature (°C)	*T. evanescens*	T. bactrae	T. embryophagum	T. brassicae	*Mean*	*L.S.D.*
15	46.08^{Ac} ± 9.18 (38-68)	43.33^{Ac} ± 5.58 (32-53)	37.00^{Bd} ± 10.43 (31-82)	45.58^{Ac} ± 4.75 (33-55)	43.00^{d} ± 8.54 (31-82)	4.505
20	56.71^{Bb} ± 7.50 (41-68)	54.54^{Bb} ± 6.99 (36-66)	69.13^{Ab} ± 12.14 (50-99)	57.33^{Bb} ± 8.20 (44-73)	59.43^{b} ± 10.50 (36-99)	5.126
25	77.83^{Ba} ± 11.18 (53-93)	60.75^{Ca} ± 8.34 (45-75)	88.38^{Aa} ±10.20 (73-105)	61.33^{Ca} ± 7.78 (46-76)	72.07^{a} ± 14.74 (45-105)	5.216
30	40.04^{Bd} ± 3.39 (32-48)	54.04^{Ab} ± 5.28 (41-69)	53.33^{Ac} ± 6.27 (44-66)	39.71^{Bd} ± 3.83 (31-47)	46.78^{c} ± 8.42 (31-69)	2.769
Mean	55.17^{B} ± 16.02 (32-93)	53.17^{BC} ± 9.09 (32-75)	61.96^{A} ± 21.50 (31-105)	50.99^{C} ± 10.80 (31-76)	55.32 ± 15.74 (31-105)	
L.S.D.	4.524	3.819	5.730	3.683		2.234

Regardless of temperature, the present estimations of female's fecundity are much higher than those obtained by many researchers for different *Trichogramma* and *Trichogrammatoidea* species (Hutchison *et al.* (1990), Abd El Hafez, Alia 1995). In contrary, the present values of fecundity were lower than those found by Grille & Baso (1995) for *T. pretiosum* at 22-25°C. Also, the present values (except fecundity of *T. evanescens* values) are less than those obtained by Tian *et al.* (1998) and Abd El-Hafez, Alia (2001) for *T. embryophagum.* In addition, the present estimations were in agreement with those obtained by Naranjo (1993) for *T. bactrae* at 25°C, Grille and Baso (1995) for *T. galloi,* at 22-25°C, Abd El-Hafez, Alia (2001) for *T. brassicae* at 25°C.

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تأثير درجات الحرارة علي بعض المظاهر البيولوجية والكفاءة الانتاجية لطفيل الترايكوجراما

فوزى فائق شلبى[1]، علية محمد عبد الحافظ[2]، عزت فرج الخياط[1]،
منال عبد المحسن عبد الغني الشرقاوي[2]

١. *قسم وقاية النبات- كلية الزراعة - مشتهر- بنها*
٢. *معهد بحوث وقاية النبات - مركز البحوث الزراعية - دقي - جيزة*

أجريت دراسات معملية لدراسة تأثير درجات الحرارة على بعض المظاهر البيولوجية لأربعة أنواع من الترايكوجراما وهى ترايكوجراما افانسنس و ترايكوجراماتويد باكترى ترايكوجراما امبريوفاجم وترايكوجراما براسيكا المر باه على بيض دودة اللوز القرنفلية وعلى أربع درجات حرارة ثابتة وهى ١٥، ٢٠، ٢٥و٣٠ ْم وكان الهدف من الدراسة هو تحديد الاحتياجات الحرارية المناسبة لإنتاج كل نوع من هذه المتطفلات، و تحديد الفترة اللازمة للتطور Developmental period وهى الفترة منذ وضع البيض داخل العائل إلى خروج ٥٠% من الحشرات الكاملة. ولقد وجد أنه يوجد ارتباط سالب بين هذه الفترة للأربعة أنواع محل الدراسة وبين درجة حرارة التربية. وقد اختلفت هذه الفترة باختلاف درجة الحرارة ونوع الطفيل فكانت أطول فترة عندما ربيت المتطفلات على درجة ١٥ ْم وكانت أقصر فترة عندما تمت تربية هذه المتطفلات على ٣٠ ْم. حدد الحد الحرارى الأدنى للنمو وقدر بـ ١١,١١، ١٠,٧٥، ٩,٩٢و ٩,٨٠ ْم لترايكوجراما افانسنس و ترايكوجراماتويديا باكترى ترايكوجراما امبريوفاجم وترايكوجراما براسيكا ،على التوالي. أما الحد الأعلى للنمو فكان ٣٢,١٢، ٣١,٩١، ٣٢,٢ و ٣٢,٦٥ْم للأنواع الأربعة ،على التوالي. أما الاحتياجات الحرارية فقدرت بـ ١٣٧,٧٨، ١٣٥,٣٢ ، ١٥٥,٧١ و ١٥٧,٣٦وحدة حرارية يوميا وأيضا تم دراسة تأثير درجات الحرارة المختلفة على نسبة البقاء، طول فترة حياة الأنثى وخصوبة الاناث. لم يحدث أي تأثير ضار أو معاكس على نسبة البقاء لجميع أنواع المتطفلات المدروسة على درجات الحرارة ٢٠و ٢٥ ْم ، ولكن نسبة البقاء انخفضت على درجات الحرارة ١٥و ٣٠ ْم ما عدا في حالة الطفيل ترايكوجراما امبريوفاجم حيث كانت نسبة بقاءه ٩٧,٢ % عندما ربى على ٣٠ ْم. اختلفت فترة حياة الأنثى معنويا باختلاف نوع الطفيل و درجة الحرارة وقد وجد أن فترة حياة الأنثى لترايكوجراما افانسنس و ترايكوجراماتويد باكترى و ترايكوجراما براسيكا ترتبط سلبيا مع درجات الحرارة وكانت قيمة معامل الارتباط-٠,٩٩٧ و -٠,٩٥٨١ و -٠,٩٣٤٢ على التوالي. بينما إناث ترايكوجراما امبريوفاجم كانت أكثر حساسية لدرجات الحرارة المنخفضة و كذلك لدرجات الحرارة المرتفعة لأن معظم الإناث ماتت تقريبا بعد يوم واحد. اختلف متوسط النسل الناتج لكل أنثى معنويا باختلاف درجة حرارة التربية وأكثر من ذلك وجد فرق معنوي بين الخصوبة للأربع أنواع تحت الدراسة عندما ربيت على نفس درجة الحرارة. ووجد أن كل المتطفلات تنتج أقل نسل (المتوسط=٤٣ فردا/أنثى) على درجة حرارة ١٥ْم . وعلى العكس من ذلك أنتجت جميع الأنواع أكبر نسل عندما كانت درجة حرارة التربية ٢٥ْم. وعلى الجانب الأخر انخفض عدد النسل الناتج عند التربية على ٣٠ ْم.