Journal of Biological Control, 29(3): 125-130, 2015

Research Article

Influence of temperature on some biological characteristics of *Trichogramma evanescens* (Westwood) (Hymenoptera: Trichogrammatidae) on the egg of lesser date moth *Batrachedra amydraula* Meyrick

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ABSTRACT: The egg parasitoids *Trichogramma* spp. were used in a large scale application in different agriculture systems and the species *Trichogramma evanescens* (Westwood) showed a very promising results when used against lesser date moth *Batrachedra amydraula* Meyrick (Lepidoptera: Cosmopterygidae). The efficiency of the parasitoids is affected by many environmental factors including temperature. The effect of different temperature regimes on some biological characteristics of *T. evanescens* was investigated when reared on the egg *B. amydraula* under laboratory conditions. The longest life span was 35 days recorded at 15°C while the shortest one was 7 days at 33°C. The optimum temperature for the development of this parasitoid ranged between 22 and 27°C. The upper development threshold temperature was 38.4°C and the lower was 11.14°C. Results also showed that the highest parasitism rate was 94.4% recorded at 25±2°C. Adult emergence and female longevity were also influenced by temperature. The feasibility of the results in mass production and the use of the parasitoid for the control of lesser date moth also discussed.

KEY WORDS: Date palm, egg parasitoids, Iraq, lesser date moth, temperature *Trichogramma evanescens, Batrachedra amydraula*

(Article chronicle: Received: 18-05-2015; Revised: 21-08-2015; Accepted: 28-08-2015)

INTRODUCTION

The Lesser Date Moth, *Batrachedra amydraula* (LDM) is considered as a key fruit pest on date palm. Infestation begins during the early fruit setting and continues with intensive increases during the hababuk and chemri stages of fruits development. Infested fruits become dry and turned red in color from which the insect referred to its local name (Alhumara). Most of infested fruits dropped down under the trees resulting in huge yield losses. This pest is attacking all date palm varieties in Iraq and other countries, however infestation severity varied according to region and variety (Abd– Alhussain, 1985; El-Haidari and Hafeedh, 1986; Ali, 2007; Kakar *et al.,* 2010). Chemical insecticides had been and still remain the main control measure against this pest everywhere in the world without real consideration to the adverse effects of these chemicals on environment and human health (Al-Jboory, *et al.,* 1999; Al-Samarraei *et al.,* 1988; Baangood, 2008; El- Bashir and El-Makaleh, 1983; El-Juhany, 2010). The biological control means were used as a principle practice against many agriculture pests including the egg parasitoids *Trichogramma* spp. which were used in a large scale application in different agriculture systems (Al-Rubeai *et al.,* 2008; El-Mandarawy *et al.,* 2004; Mohammad *et al.,* 2011; Ulrichs and Mewis, 2004). These parasitoids were also used against lesser date palm moth and showed very promising results as an effective biological agents for controlling this pest (Ali *et al.,* 2004; Dhoubi and Essaadi, 2007; Gerling, 2006). The successful use of these agents depend on several correlated subsequent steps which start with the development of mass production of the parasitoids under controlled conditions, storage and field release. The influence of temperature on the biological performance in the laboratory and in the surrounding environment when released in the field should be taken into consideration. Therefore, the present experiment was conducted to investigate the influence of different temperature regimes on some biological aspects and on effectiveness of the egg parasitoid *Trichogramma evanescens* when reared on the egg of lesser date moth.

MATERIALS AND METHODS

Rearing of lesser date moth

Strands of infested fruits were collected from date palm trees in Saqlawyia region in Al-Anbar Province/Iraq during the seasons of 2011. Examination was made in the laboratory and infested fruits were collected and placed in small tubes (4.5x7.5 cm) covered with Aorquenzae fabric and transferred inside the incubator at 30$\pm$1^0 C and 65$\pm$5%Rh. Fruits at chemri stage of Khestawi variety were used as food for larvae, replaced every three days to avoid degradation and mold growth. Larvae were also reared on ground dry fruit of the same variety. These fruits were collected previously at chemri stage, dried in the laboratory at 30^{0}C for two weeks. Then ground in ceramic mortar, placed in plastic bags and stored in the refrigerator at – 18^{0}C (Hama *et al.,* 1989). This medium was used for mass rearing of *B. amydraula*. Twenty newly laid egg were transferred into glass tubes (2.5x 7cm) containing the larvae and fed with a mixture of 1 gm grinded fruits and 1ml water. Tubes were covered by Aorquenzae fabric and placed in the incubator at 30$\pm$1° C and 65$\pm$5% Rh. Daily observations were made for egg hatch and larval development till the pupation. Pupae were then transferred into new tubes of the same size and placed in the incubator at the same conditions mentioned above. Newly emerged adults were picked and placed in to a bottle Lantern at rate of 10:10 (males: females) covered with Aorquenzae fabric at the upper side and with fine Tulle fabric at the lower side. The lower side was also fixed at Petri-dish (9x1cm) for egg collection. Adults were fed with 5% sugar solution in a cotton pad placed inside of the bottle. Newly laid egg was collected and divided into two batches. One batch was used for colony maintenance and the second batch was used for the subsequent laboratory experiments. Eggs were irradiated with ultra violate rays for 30 min for growth inhibition (Babi and Nabhan, 1998). Arabic gum was used at concentration of 30% to adhere the egg on Yellow cards (17.5x2cm). Then these cards were subdivided into small cards each was containing approximately 50 egg of the lesser date moth.

Rearing of the egg parasitoid *Trichogramma evanescens*

The parasitoid was reared in the IPM laboratories at the National Center for Organic Farming, Abu-Ghraib. The local parasitoid was collected from cotton field in Abu-Ghraib region and identified by the British Museum of Natural History as *Trichogramma evanescens* which was considered as first record for this species in Iraq (Hussain *et al.,* 2009). A laboratory colony of *T. evanescens* was maintained to be used for subsequent experiments (Babi and Al-Nabhan,1998). The LDM egg which was glued on yellow cards as mentioned earlier was also used for rearing the parasitoid. Cards were placed in glass tubes (25x2.5cm) and adults of the egg parasitoid were transferred from the lab colony at rate of 50 female:50 males to each tube and provided with drop of honey placed at one side of the tube for adults feeding. The tubes were kept inside the rearing rooms at 23 ± 2°C and 75+ 5% Rh. and 16h-8h (L:D) photoperiod. Continuous maintenance of this colony was performed in order to obtain the required number of the parasitoids (Babi and Al-Nabhan,1998).

Influence of different temperature regimes on the biological performance of *Trichogramma evanescens*

This experiment was conducted at seven constant temperature regimes (15, 18, 20, 25, 28, 33, 35^{0}C). Two pairs of newly emerged *T. evanescens* were introduced inside a glass tubes (7.5x2.5cm) containing *B. amydraula* egg glued on small yellow cards at rate of about 50 eggs/card, as described earlier. Tubes were then placed in the incubator at each of the mentioned temperatures with 65$\pm$5%Rh. and 14:10h (L:D) photoperiods. The whole experiment was replicated five times for each temperature regime. Observations were made for the following characters:

-Development time for the parasitoid (from egg laying to adult emergence) at each temperature

-Percentage of parasitism

-Percentage of adult emergence for the egg parasitoid

-The correlation between temperature and each of development time, percentage of parasitism and percent of adults emergence

-Calculation of threshold temperature (To) and constant thermal heat units (k) according to the regression linear equation and the relation between daily development time (1/D) and temperature (T) (Madubuny and Koehler, 1974).

Statistical Analysis

Experiments were conducted in CRD design. Data were statistically analyzed using GenStat software which include an ANOVAs and mean comparison using LSD test at 0.05. Correlation equation and correlation coefficient were also used for intended parameters and factors.

RESULTS AND DISCUSSION

Results have indicated that *T. evanescens* was able to complete its development successfully when reared on *B. amydraula* egg with a significant variation correlated to the rearing temperature. The longest development duration of egg to adults emergence was 35 days recorded for individuals reared at 15° C. Development time was reduced to 20, 17, 10, 8, 7 days when reared at 18, 20, 25, 28 and 33° C respectively (Table 1). No development was observed for *T. evanescens* at 35° C. These results indicated that the relation between temperature and development time was not linear and the correlation equation was $D= 0.126T^2 - 7.478T + 116.4$ and the correlation coefficient (r=0.983). However, rate of development was increasing with increase of temperature. A linear correlation was found between daily 1/D development time and temperature, the equation was presented as: $1/D= 0.006\,T-0.067$ (r= 0.997).

Table 1. Influence of different constant temperature on the biological performance of the parasitoid *Trichogramma evanescens* when reared on lesser date moth egg

Temperature ± 2° C	Mean development period (days)
15	35
18	20
20	17
25	10
28	08
33	07
35	00
LSD (P≤ 0.05)	1.485

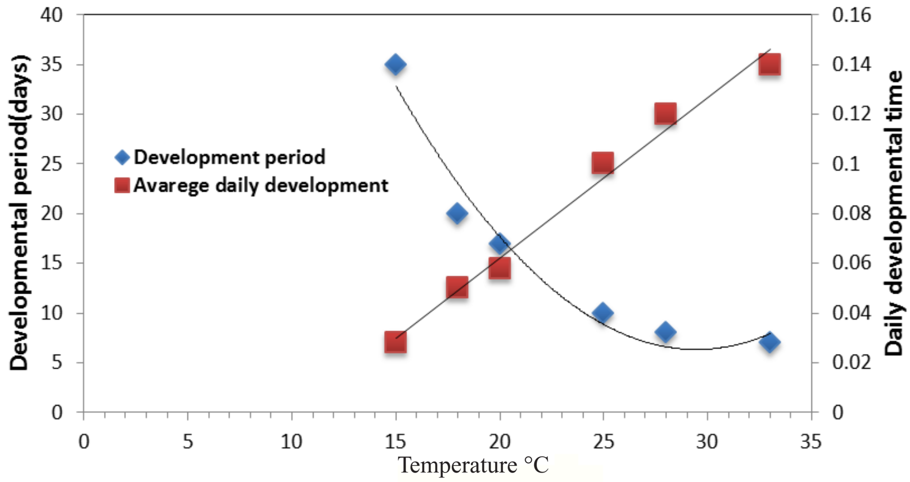

Fig. 1. Effect of temperature on the development of the parasitoid *Trichogramma evanescens.*

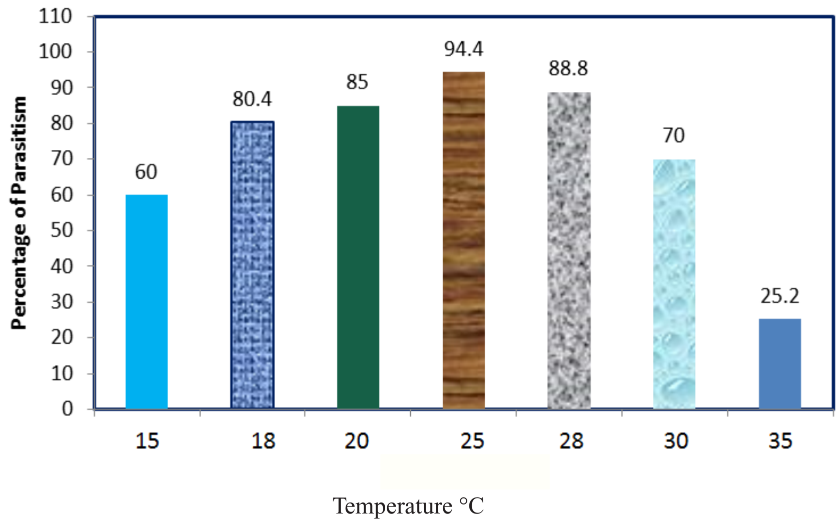

Fig. 2. Effect of temperature on percent of parasitism of *Trichogramma evanescens.*

Threshold development temperature and thermal constant of *Trichogramma evanescens*

The threshold temperature for the development of the *T. evanescens* was calculated as 11.14° C (Fig. 1) which was higher than that of the LDM which was 10.5C^O^ (Aziz, 2005). The thermal constant from egg to adult emergence of the parasitoid was 145 DD. These results indicated that the emergence of the egg parasitoid occurs shortly after the emergence of the lesser date moth (Fig.1). This short period may be enough for lesser date moth to lay egg which can be ready for to be utilized by the females of the parasitoids..

Mean percentage of parasitism of *Trichogramma evanescens* on the egg of *Batrachedra amydraula*

Results have indicated that temperature did have a significant influence on parasitoid activity. The highest percentage of parasitism was 94.4% recorded at 25^0 C . However, the parasitism rate had decreased with increasing or decreasing around this of temperature (Fig. 2). The correlation equation between temperature (T) and percentage of parasitism (P) was calculated as $P=-0.3533T^2 +21.10T-162.7$ and the correlation coefficient (r=0.994). These results indicated that the optimum temperature for egg laying of the parasitoid was ranged between 22 to 25 ^{0} C .

Percentages of adult emergence

Same trend was observed in term of the influence of temperature on the adult emergence of the parasitoids *T. evanescens* when reared on the egg of the lesser date moth (Fig. 3). The lowest percentage of adult emergence was recorded 67.7% at 15^0 C while the higher percentage was 95.4% at 25^OC with a correlation equation between temperature and percentage of emergence presented as: $E=0.222x^2 +11.42x-50.56(E)$ (r=0.952).

Female longevity

Results presented in Fig.4 showed that female longevity of egg parasitoid was decreased significantly with the increasing level of temperature. Females longevities were 16, 15, 11, 9, 7, 3, 2 days at 15, 18, 20, 25, 28, 33, 35^0 C

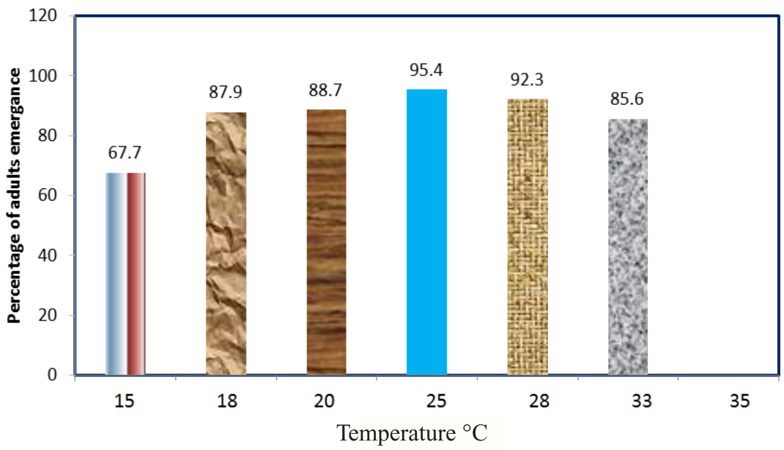

Fig. 3. Effect of temperature on the emergence of the parasitoid *Trichogramma evanescens*

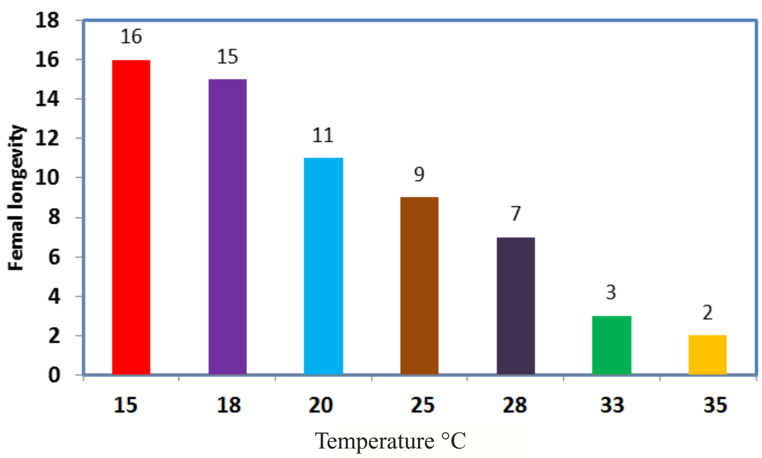

Fig. 4. Effect of temperature on female longevity of parasitoid *Trichogramma evanescens.*

respectively. The correlation equation between temperature and longevity was linear and negative (L= - 0.768x +28.55) (r=0.998). These results were similar to those found by previous studies which indicated that female longevity of the parasitoids *T. evanescens* was 20.8 days at 14^0 C and 2 days at 35^0 C when reared on the egg of *Ephestia calidella* while longevity of *T. oleae* was ranged between 10.5 and 0.5 days when reared on the same host at the same temperatures respectively. Other studies indicated that the female longevity of the egg parasitoid *T. principium* was ranged between 23.6 and 5.2 days at 18 – 33^0 C respectively (Babi and AL-Nabhan, 1998) while it was 13 and 9 days for the parasitoid *T. evanescens* when reared at 20 and 26^0 C respectively. Farther more data of present study have indicated that the biological performance of *T. evanescens*, host selection and host utilization were significantly influenced by temperature. The optimum temperature for parasitism as well as for production and mass rearing was ranged between 22-27^0 C. The increase or decrease of rearing temperature would influence the longevity of adults and parasitism behavior. The high temperature will reduce longevity while the low temperature leads to slow the biological activity and prolongation of adults life span. Parasitism rate would also be reduced with decreasing level of rearing temperature. Our data have indicated that this parasitoid requires 145 heat units for completing development compared with 172 heat units recorded for the same parasitoid by Al-rubeai *et al.,* (2005). The reason for this difference could be attributed to the difference of the host which was used for rearing the parasitoid in each experiment. It is evidence that the increasing level of temperature will help in obtaining the required accumulated heat units in shorter time and which means that reduction of period needed to complete certain developmental stage. The accumulated heat units would also help in the determination of the optimum time for releasing the parasitoid. The emergence of the parasitoid adults can be affected by high temperature which causes increasing rates of evaporation from host egg leading to desiccation and killing the parasitoid progeny inside. Previous studies have indicated that temperature below 18°C would also influence parasitoid emergence because of prolongation of development time which leads to more exposure to desiccation of the parasitoid progeny and its death inside the host. Therefore, the increasing or decreasing rates of temperature would negatively influence the physiological and biological activities of the developmental stages and the performance of the parasitoid adults in addition to increasing rates of mortalities (Babi and Al-Nabhan, 1998). Other studies also have indicated that the response of egg parasitoids to rearing temperature varied according to parasitoid species, host and rearing conditions. The parasitoid *T. evanescens* was able to complete its development in temperature ranged between 14 to $33C^0$ in a periods of 37 to 7 days respectively (Al-Rubeai *et al.,* 2005; Schoeller and Hassan, 2001). Results of the present experiment showed that the parasitoid *T. evanescens* is well adopted to the egg of the lesser date moth because of the highly successful rates of development and parasitism. Therefore, this parasitoid can be considered as an effective natural enemy against the lesser date moth in the country. However, mass rearing and timing of field release should take to considerations the importance of avoiding any decrease or increase of temperature beyond the optimum levels in order to achieve better searching ability of the parasitoid females to find and utilize the egg of the lesser date moth and that would lead to better coverage of the intended area and an efficient biological control of the pest.

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