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EFFECT OF DIFFERENT TEMPERATURES ON LIFE HISTORY OF *TRICHOGRAMMA CHILONIS* (ISHII) IN THE LABORATORY CONDITIONS

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ABSTRACT

Optimum temperature is an important physical factor for the efficient performance of *Trichogramma chilonis* (Ishii) to control notorious pests in field. To evaluate this appropriate temperature, all life fitness parameters of *T. chilonis* such as survival, parasitism, and emergence rates of parasitoid were studied under laboratory conditions by exposing the parasitoid on various temperature ranges i.e. 25±2°C, 30±2°C, 35±2°C, and 40±2°C in incubator. Highest survival rate of both male and female parasitoids were recorded at 25°C i.e. 22% up to 72 hours and 31.67% up to 120 hours respectively. The highest survival duration of female was recorded at 30°C up to 240 hours. Female possessed the ability to withstand the extreme temperature conditions and survived better than male. At 30°C it was found that ovipositing period of *T. chilonis* continued up to 264 hours and maximum parasitism recorded was 90.7%. Gradual increase in temperature resulted in increase in development rate, earlier maturation and rapid emergence of parasitoids. At Temperature 40°C emergence rate of male and female was maximum, 55% in 96 hours and 66.7% up to 120 hours respectively. The emergence duration was found maximum i.e. 216 hours for male and 240 hours for female at its favorable temperature which was 30°C. So, for successful rearing of *T.chiolonis* under laboratory conditions 25-30°C is a suitable temperature range.

Keywords: Life cycle, *Sitotroga cerellela,* temperature, *Trichogramma chilonis*

INTRODUCTION

Predators and parasitoids are considered as important biocontrol agents in integrated management of economic insect pests to reduce insecticides applications. The natural enemies of terrestrial arthropods include entomophagous (predators and parasitoids) and entomopathogens play an essential role in the regulation of the populations of arthropods (van Driesche *et al*., 2007). Trichogrammatids, egg parasitoids are worldwide distributed and employed to manage insect pest as borers, bollworms, codling moths, budworms belonging to lepidoptera. These insects are the smallest ranging in size from 0.2 to 1.5 mm (Olkowiski and Zhang, 1990). *Trichogramma* has been proved effective in managing borers of sugarcane in Pakistan (Ashraf and Fatima, 1993). *Sitotroga cerellela* (Olive) is the fictitious host for rearing *Trichogramma* species in laboratory conditions (Flanders, 1930). Easy rearing techniques are the most important in increasing popularity of natural enemies among the farmers in the pesticide competitive markets. Temperature is one of the most prominent factor affecting biological parameters such as reproduction, parasitism (fecundity), duration of development, rate of emergence and longevity of insects (Bowen and Stern, 1966; Harrison *et al*., 1985; Noldus, 1989). Determination of optimum temperature for rearing in the laboratory is an important aspect which can help in easy culture. Previous research on this aspect has been focused in the different parts of the world on different species like *T. pretiosum* and *T. acacioi* (Pratissoli *et al*., 2005). But no literature reports effect of temperature on various biological traits and rate of parasitism from Pakistan. Therefore, present study was planned to determine the effect of temperature ranges on the life history of *T. chilonis* being reared in Entomological Section of Central Cotton Research Institute (CCRI) at Multan (Pakistan). As a result, the appropriate temperatures range of 25-30°C proved effective for the life fitness parameters of both the male and female parasitoids.

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MATERIALS AND METHODS

Experiment was conducted in bio-control laboratory of the Entomological Section at Central Cotton Research Institute (CCRI), Multan. *Sitotroga cerelella* (Olivier) is a factitious host of *T. chilonis* was reared in laboratory conditions. Wheat grains were used for rearing of *S. cerelella*. For this purpose, roasted wheat grains (about 1.0 kg) were put in the jars (3 liter volume). Eggs of *S. cerelella* nearly to be hatched were introduced into roasted wheat to obtain moths. Jars were covered with muslin clothes. Moths were collected through suction apparatus powered electrically and shifted to jars of one liter size. Bottom of these jars was furnished with metallic sieve. Each jar was put on the plastic dish having fine wheat flour for egg laying. The sieve allows the eggs to reach the flour in the dish. Eggs of the *S. cerelella* were separated with fine sieve from the flour. Eggs were collected daily up to three days. Freshly sieved eggs of *S. cerelella* were pasted on paper cards (9×4 cm) with gum. Each card contained approximately 200 eggs. Freshly emerged adults of *T. chilonis* were taken from the ongoing rearing in biocontrol laboratory. A non-choice experiment was conducted in which the 20 pairs of adults *T. chilonis* were released in each replicate to parasitize *S. cerelella* eggs in (7cm × 0.9 cm) glass vials. The vials were placed in incubator at 25±2°C, 30±2°C, 35±2°C, and 40±2°C with photoperiod of 12 L: 12 D and R.H of 60% in a completely randomized design (CRD), having three replicates with control in each treatment. Every replicate consisted of 20 pairs of adult *T. chilonis* (<24 hrs age) and a paper card strip (9 × 4 cm) on which two hundred eggs of *S. cerelella* were glued with gum were exposed for parasitization for 24 hours. For the nourishment of parasitoid adults additional paper strip dipped in diluted honey was hanged into the glass vial.

After every 24 hours old card strip was replaced new card strip and kept singly in tightly closed Petri dishes in a completely randomized design in incubator on specified temperature ranges until the emergence of parasitoid took place. Control mortality of the eggs was adjusted by subtracting the dead eggs in control from the treated eggs following the unitary method. Data were recorded after every 24 hours for every treatment of life history parameters. Male was apparently smaller, blackish in color and abdomen projected in downward position than female. Survivals of male and female were recorded also after every 24 hours until all adult parasitoids wiped out. The alive adults were converted to percentages. For the parasitism was recorded by examining the eggs after every 24 hours until parasitized eggs became blackish and un-parasitised became orange. Percent parasitism was obtained. Likewise percent survival, percent emergence of male and female were determined separately for every 24 hours and converted to percentages. Data on various parameters were analyzed by analysis of variance (ANOVA) and means were further separated by LSD, if needed.

RESULTS

PERCENT SURVIVAL

a) Male

By exposing of male *T. chilonis* on various temperatures ranges i.e. 25±2°C to 40±2°C respectively. Results depicted that male is unable to survive longer on harsh environmental conditions as compared to female. Male survived above 48 hours on 25 °C in a better way i.e. 21.67 % and 4 % on 24 and 48 hours respectively than it declined (Fig. 1). It is proved that male is unable to survive on extreme hot environment which is usually common environment in our country field conditions.

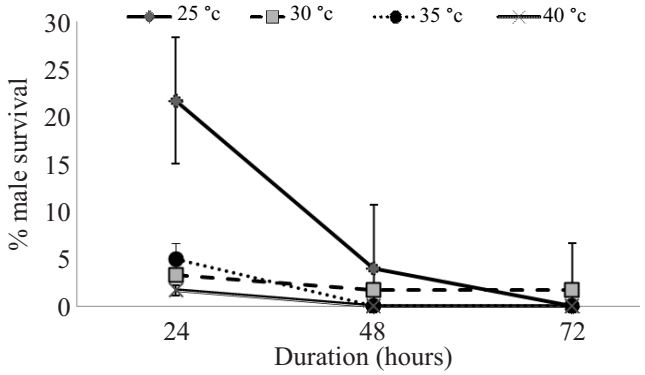

Fig. 1
Percent survival of male parasitoids on different temperature ranges. Error bars represents ± S.E.

b) Female

By exposing of female *T. chilonis* on various temperatures ranges i.e. 25±2°C, to 40±2°C. It was recorded that female survived longer than male at different temperatures. At 25°C their survival rates was up to 120 hours and gradual increase in temperature of 30°C its survival duration was increased up to 240 hours. Further increase in temperature i.e. 35°C, 40°C declined the survival of *T. chilonis* started. So it is proved that a temperature range of 25-30°C is optimum for its best performance of parasitism (Fig. 2).

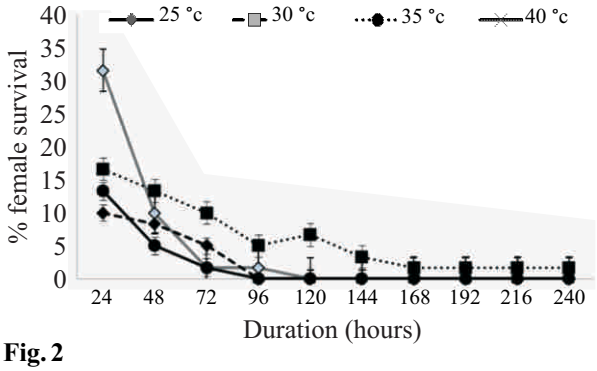

Fig. 2
Percent survival of female parasitoids on different temperature ranges. Error bars represents ± S.E.

C) Survival rate of male and female

It was also noted that both male and female parasitoids survived better on 25°C where maximum average survival rate of male 8.33 % and female 4.5 %. Whereas with gradual increase in temperature on 30°C resulted in maximum average survival rate of female 6.17 % and of male 2.22 %. Further increase in temperature on 35 °C and 40 °C resulted in declining of both male and female parasitoids but male is more sensitive to survive on higher temperature as compared to female(Fig. 3).

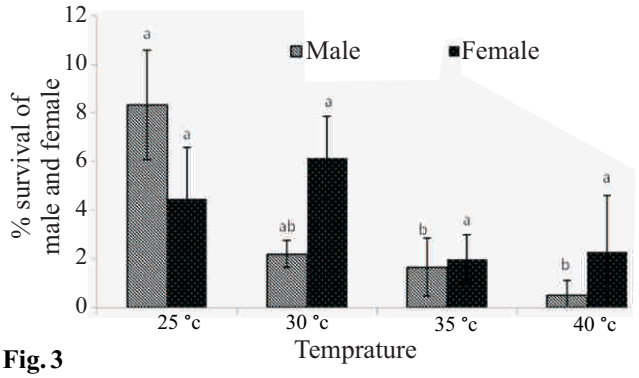

Fig. 3
Percent survival rate of male and female parasitoids on different temperature ranges. Different letters topped on the error bars represents the significant difference at the 5 % level of significance ($p < 0.05$).

Parasitism

The optimum temperature on which maximum ovipositing (parasitizing) period of *T. chilonis* recorded was founded 30°C. At 30°C, it was founded that ovipositing (parasitizing) period of *T. chilonis* continued up to 240 hours and maximum parasitism was 90.7% on 24 hours followed by 45.61%, 32.89%, 30.29%, 23.23%, 11.48%, 11.45%, 5.9%, 5.53%, 0.48% and 0.18% (Figure 4). At lower temperature on 25°C there was increase in development duration which continued for 9.5 days while gradual increase in temperature at 30°C, oviposition period was increased up to 8.5 days, but further increase in temperature at 35°C resulted in reduction in oviposition as well as in development period. Similarly, case was observed on further increase in temperature at 40°C oviposition time was reduced and development period was reduced to 7 days and increase in development rate, rapid in maturation and earlier emergence of parasitoids took place (Table 1).

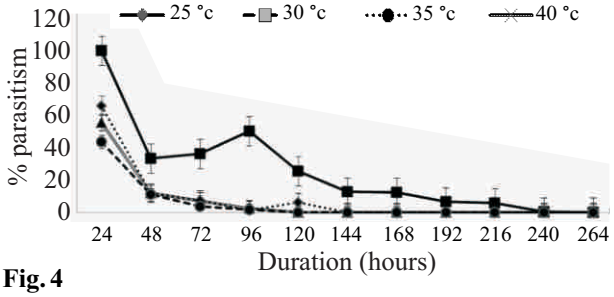

Fig. 4
Percent parasitism of female *T. chilonis* on *S. cerelella* (host) on different temperature ranges.

Table 1
Mean development duration of *T. chilonis* on various temperature ranges.

Temperature (°C)	Mean Development duration (Days)*
25	9.50 ± 3.88 a**
30	8.50 ± 1.10 ab
35	8.00 ± 0.93 b
40	7.00 ± 0.93 c

*Mean Days ± S.E

** Means followed by different letters are statistically different at the 5 % level of significance ($p<0.05$).

Emergence

a) Male
The present study revealed that increase in temperature resulted in rapidly emergence of parasitoids (Fig. 5). At highest temperature i.e. 40°C emergence rate of parasitoid was maximum (55.3%) after first 24 hours, that continued up to 96 hours, followed by 43.8%,42.9% and 22.2% emergence of male parasitoids after each successive 24 hours. But emergence duration of parasitoid was maximum (48.33%) at 30°C which continued from 24-240 hours followed by 47.31%, 44.43%, 42.95%, 30.32%, 31.03%, 25.25%, 11.11% and 10.07% emergence of male took place after each successive 24 hours (Figure 5).

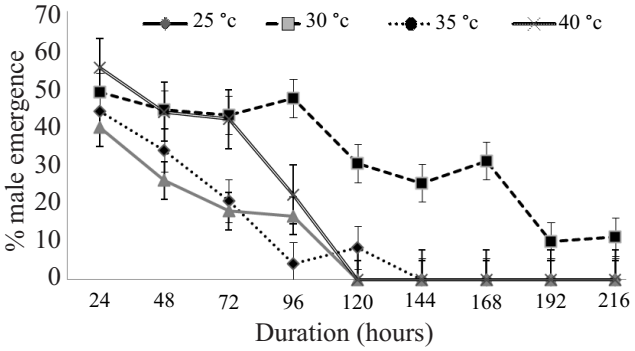

Fig. 5
Percent emergence of male parasitoids on different temperature ranges. Error bars represents ± S.E.

b) Female
Emergence rate of female parasitoid was also recorded maximum (66.67%) on highest temperature i.e. 40°C, due to increase in development rate and decrease in development duration that was continued from 24-96 hours followed by 62.1%, 60.7%, 63% and 66.7% emergence of female parasitoids. It was evident that emergence duration was increased from 24-240 hours on its favorable temperature on 30°C. It was also proved that emergence of female took place more than male (Fig. 6).

c) Average emergence rate of male and female
Average emergence rate of male and female were recorded to determine the best emergence either of male or female parasitoids. It is revealed from the (Fig. 7) that average female emergence was more as compared to male on its favorable temperature 30°C.

Average life history of *T. Chilonis*

Average life history of *T. chilonis* was concerned by summarizing the all life history parameters of it to evaluate the appropriate temperature range on which it performs its activity in an effective manner which was founded 25-30 °C (Fig. 8).

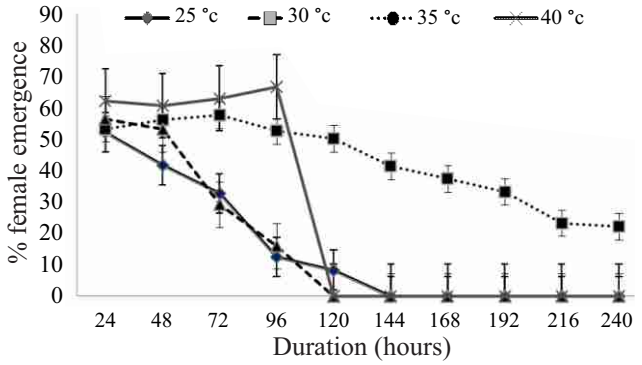

Fig. 6
Percent emergence of female parasitoids on different temperature ranges. Error bars represents ± S.E.

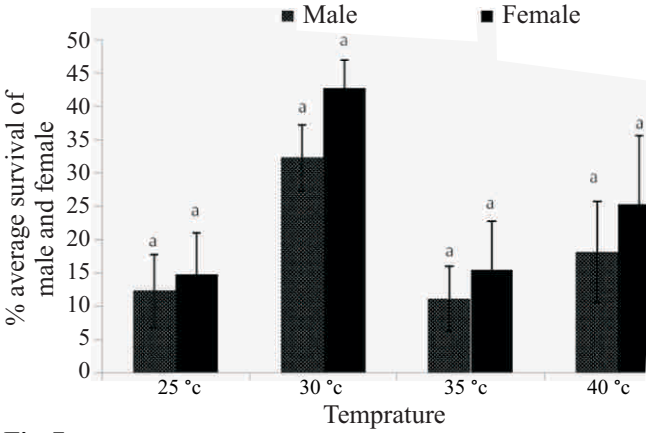

Fig. 7
Percent emergence rate of male and female parasitoids on different temperature ranges. Same letters topped on the error bars represents the non-significant difference at the 5 % level of significance ($p < 0.05$).

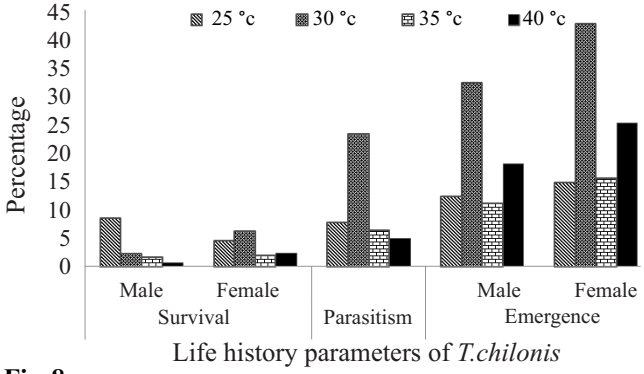

Fig. 8
Average life history parameters of *T. chilonis* on different temperature ranges.

DISCUSSION

Among the biocontrol agents predators and parasitoids play an important part in integrated management of economic insect pests to reduce insecticides applications and avoid environmental contamination. For the sake of their augmentation and appreciable control in the field it was necessary to study their all life history parameters with regard to their environmental conditions of the country. In Pakistan, the temperature is one of the most problematic and prominent factor affecting biological parameters such as reproduction, parasitism (fecundity), duration of development, rate of emergence and longevity of insects. Therefore, present study was focused on the effect of different temperature ranges on the life history parameters of *T. chilonis*, so that to evaluate the appropriate temperature on which it performs its activity of in suitable manner.

The survival results of present study maintain the compatibility with the findings of (Gross, 1988) who concluded that *T. pretiosum* best survived at 27-32 °C with 60-80% RH. These results are also correlated with the findings of Pratisoli (1995) who reported that viability of *T. chilonis* was affected by extreme temperatures with emergence rate for parasitoid species at 20 °C, 25 °C and 30 °C. Bleicher and Parra (1989) stated for similar viability of *Trichogramma* species on higher temperatures 18-32 °C.

The present parasitism studied results contain strong correspondence with the findings of different scientists (Buttler and Lopez, 1980; Harrison *et al.,* 1985; Miura and Kobayashi, 1993), that duration of development of *Trichogramma* species are inversely proportional to the temperature increase but such affects depend upon the species or line ages of *Trichogramma* (Bleicher and Parra, 1989).

The emergence results are strongly resembled to the other findings of (Gross, 1988; Cabello and Vargas, 1989) and their results showed that higher temperature can increase mortality and it can affect the sex ratio of *Trichogramma* species (Bowen and Stern, 1996). The present emergence achievements of parasitoids are antagonist to the reports of Pratissoli *et al. (*2005) as they reported that period from egg to adult of *T. pretiosum and T. acacioi* was inversely proportional to temperature increase with low emergence rate of both *Trichogramma* species at 15 and 35°C.

CONCLUSION

It is concluded from the present study that 25-30°C is most suitable temperature range on which maximum activity of life history parameters (survival, parasitism and emergence) of *T. chilonis* were recorded. It was also inferred that male is sensitive to extreme temperature ranges than female. So, for effective rearing methodology in laboratory conditions a temperature range of 25-30 °C is suitable. It was also concluded from present study that if the augmentation of *T. chilonis* is done during the season possessing the temperature range of 25-30 °C could give fruitful results for the control of the noxious borers into the field conditions than fruitful results to control the noxious borers could be achieved.

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