BIOLOGICAL PARAMETERS OF *TRICHOGRAMMA CHILONIS* ISHII (TRICHOGRAMMATIDAE: HYMENOPTERA) FEEDING ON *SITOTROGA CEREALELLA* EGGS AT THREE CONSTANT TEMPERATURES

Rizwana Sultan*, Javed Khan, Ehsan ul Haq, Tariq Mehmood**, Roshan Zada Khattak***, and Naheed Akhtar**

ABSTRACT:-The study was conducted on the biological parameters of *Trichogramma chilonis* Ishii (Trichogrammatidae: Hymenoptera) feeding on grain moth, *Sitotroga cereallela* eggs at three constant temperatures and five different ages of host eggs at Insect Pest Management Programme, National Agricultural Research Centre, (NARC) Islamabad. The results revealed that maximum rate of parasitism was 95.70 ± 1.94 at 28 ± 1 ˚C while minimum was 61.30 ± 1.70 at 32 ± 1 ˚C. Maximum adult emergence and female ratio from parasitized eggs were 96.30% with 59.2± 5.83 female ratio at 28 ±1 ˚C while minimum was 51.10% with female ratio of 58.1 at 32±1 ˚C. The maximum developmental duration (9.6 ± 0.32 days) and adult longevity (4.3 ± 0.38 days) was at 24 ±1 ˚C while minimum was 7.4 ±0.36 and 2.0 ±0.56 days at 32 ± 1 ˚C. The results indicate that temperature has a significant effect on the biological parameters of *Trichogramma* and with increasing temperature developmental duration decreased. Similarly effect of host eggs age indicates that maximum parasitism and adult emergence were 97.40 ± 0.84% and 98.20 ± 0.94% on 2h old eggs while minimum parasitism was 24.6 ± 4.92% and adult emergence was 21.5 ± 1.33% from 72h old eggs. Adult longevity and female ratio was not significantly different at different ages of host eggs. Thus out of three tested temperatures, 28 ±1 ˚C was more suitable for mass rearing of *Trichogramma* and feeding 2-12h old eggs for maximum parasitism and adult emergence from parasitized eggs under laboratory condition of 28 ±1 ˚C.

Key Words: Trichogramma chilonis; Sitotroga cereallela; Feeding; Temperature; Host Egg Age; Biological Parameters; Pakistan.

INTRODUCTION

Trichogramma parasitizes eggs of Lepidoptera by laying one or more eggs inside the eggs of the host insects. The eggs hatch into small larvae, which feed on the embryo of the moth eggs, there by killing it. After 8-10 days of feeding and growth, an adult wasp chews out through the shell of the moth egg. It then copulates with the opposite sex and starts searching for fresh Lepidoptera eggs for further egg-laying (Smith, 1996).

Trichogramma can easily be reared on moth eggs under laboratory condition. Rearing of *Trichogramma* requires first rearing of an insect typically specie of moth to produce eggs in which the wasp will develop. The most common lepidopterous

** Department of Zoology, Hazara University Garden Campus Mansehra, Pakistan.*
*** Insect Pest Management Program, National Agricultural Research Centre, Islamabad, Pakistan*
**** National Insect Pest Management Program, National Agricultural Research Centre, Islamabad, Pakistan.*
Corresponding author: javednarc2010@gmail.com

insect hosts used for mass rearing of *Trichogramma* are the Angoumois grain moth (*Sitotroga cereallela* Olivier), Rice meal moth (*Corcyra cephalonica* Stain) and Mediterranean flour moth (*Ephestia kuehniella* Zetler). All these three moths are easily and inexpensively reared on wheat or other grains and are commonly used to rear *Trichogramma* but *Sitotroga* is more practical for large scale production (Hassan et al., 1988).

Several factors affect the mass rearing of *Trichogramma* i.e., temperature, relative humidity, photoperiod and host eggs quality. The size of the host eggs could alter the size of the emerged wasp, which could have effects on wasp attributes such as target host acceptance and fecundity (Greenberg et al., 1998).

Rearing conditions such as food, temperature, light etc. may effect the performance of *Trichogramma* (Hoffmann et al., 2001). Fluctuating temperatures from upper and lower extreme limits are prevailing in natural environment of insects for which they have to develop adaptation at certain limits against these temperatures. (Hassan, 1994). Similarly the age of host eggs involve in *Trichogramma* production in at least two ways. Firstly the oviposition preference of the parasitoid females and secondly as an indicators of the resource quality available for the developing parasitoid larvae (Farid et al., 2001).

The present study on the biological parameters of *Trichogramma chilonis* Ishii at varying temperature and host ages was conducted, which could be usefully employed for mass and quality production of the parasitoid under local environmental conditions and to explore its potential as a bio control agent against lepidopterous insect pests of agricultural importance.

MATERIALS AND METHOD

The present study was conducted on the biological parameters of *Trichogramma chilonis* feeding on *Sitotroga cerealella* eggs at Institute of Plant and Environmental Protection, NARC, Islamabad, during 2010.

Effects of Constant Temperatures on the Biological Parameters of *Trichogramma chilonis* Feeding on *Sitotroga cerealella* eggs

The biological observations of *T. chilonis* were studied at three constant temperatures (24, 28 and 32 ± 1°C), 50-60% R.H. and 16hL:8hD period in a growth chamber. Two hours fresh eggs of *S. cereallela* were obtained from culture stock. A total of 100 eggs of *S. cerealella* were stuck to white hard card (1.5x3.0cm) with glue and placed in transparent glass jars (3.5 cm in diameter x 12 cm in length) for 24h. Each jar contained 20 mated one-day old female parasitoids. The experiment was replicated 10 times. After 5 days, the parasitized eggs which turn black were counted under a microscope. Adult emergence from parasitized eggs was recorded after 8-12 days. Total developmental period from parasitism to adult emergence and female ratio were also recorded in each treatment. After adult emergence 100 males and females were kept separately in a gelatin capsules provided with honey solution. The adults were critically observed daily till their death in capsules and the duration in days were calculated for all male and female wasps separately.

Effect of Host Egg Age on the Biological Parameters of *Trichogramma chilonis*

The experiments were conducted on the effect of *S. cerealella* eggs of different ages (2h, 12h, 24h, 48h and 72h) Eggs were glued separately on paper card at 100 eggs per each card. Each card (with age of one age only) was placed singly in 12cm x 4 cm glass jars containing 20 pairs of male and female parasitoid under laboratory conditions of 28 ±1 ˚C with 50-60% R.H. The cards were removed after 24h. The following parameters were recorded daily: percent parasitism, adult emergence from parasitized eggs, total developmental period from parasitism to adult emergence, female ratio from emerged adults.

The data were statistically analyzed by using analysis of variance (ANOVA). Then LSD test at P<0.05 probability was used for the comparison of means of significant results.

RESULTS AND DISCUSSION

Effects of Constant Temperatures on the Biological Parameters of *Trichogramma chilonis* Feeding on *Sitotroga cerealella* Eggs

The study revealed that maximum rate of parasitism (95.7%) was observed at 28 ±1˚C followed by 24 ±1˚C (92.3%) and minimum rate of parasitism were 61.3% on 32 ±1˚C. The rate of parasitism by *T. chilonis* were not significantly different to each other at 24˚C and 28˚C, while it was significantly different at 32 ±1˚C. The result further indicates that at high temperature, rate of parasitism by *Trichogramma* decreased significantly (Table 1).

Some earlier studies by different authors also indicate significant effect of temperature on the biological parameters of *T. chilonis.* Singh et al. (2002) reported that some strains of *T. chilonis* could tolerate up to 37±1˚C. Calvin et al. (1984) reported 30˚C was the most suitable temperature for *T. chilonis.* Miura and Kobayashi (1993) demonstrated that 28˚C was the optimum temperature for *T. chilonis* developing on eggs of Diamond back moth which are in agreement with our present study that 28˚C was the optimum temperature for *T. chilonis* feeding on eggs of *S. cereallela.*

The results further indicate that maximum adult *Trichogramma* emergence from parasitized eggs were 96.3% at 28˚C followed by 89.4% at 24˚C and 51.1% at 32 ±1˚C which indicates that adult emergence from parasitized eggs were significantly

Table 1. Effect of temperatures on biological parameters of *Trichogramma chilonis* feeding on *Sitotroga cerealella* eggs

Treatment	Percent parasitism ±SD	Percent adult emergence ±SD	Developmental duration ±SD	Female ratio ±SD	Adult longevity ±SD
24 ±1˚C	92.30±4.92a	89.40±5.33b	9.6±0.32a	51.0±2.39b	4.3±0.38a
28 ±1˚C	95.70±1.94a	96.30±3.45a	8.2±1.08b	59.2±5.83a	3.6±0.41b
32 ±1˚C	61.30±1.70b	51.10±1.41c	7.4±0.36c	58.1±4.13c	2.0±0.56c

Means followed by the same letters do not differ significantly at P< 0.05 (LSD test)

different at different temperature levels.

Nadeem et al. (2009) reported highest emergence (98.0%) of *T. chilonis* adults from host eggs at 28˚C, while lowest emergence (33.7%) was at 35˚C. The result of the present study also indicates that 28 ±1 ˚C was the suitable temperature due to maximum adult emergence from the parasitized eggs which are in close conformation with some previous studies.

Developmental period was significantly different at different temperature levels. Maximum developmental period was 9.6 days at 24 ± 1˚C while minimum duration was 7.4 days at 32 ± 1˚C, which indicates that developmental period were significantly different at different temperature levels. The results further indicate that with increasing temperature developmental period decreased. Harrison et al. (1985) have compared developmental time, parasitism and emergence of two strains of parasitoid by using eggs of *Heliothis virescens* Fab. at five constant temperatures i.e., 15˚, 20˚, 25˚, 30˚ and 35˚C. Developmental period of both parasitoid species was decreased with an increase in temperature.

Female ratio was highest (59%) at 28 ±1˚C and lowest (51%) at 24 ±1˚C. The results indicate, that the female ratios were non-significant to each other. Female longevity was maximum (4.8 days) followed by 3.6 and 2.7 days at three constant temperatures, respectively. The result indicates that *T. chilonis* longevity were significantly different at different temperatures.

Effect of Host Egg Age on the Biological Parameters of *Trichogramma chilonis*

The results indicate that rate of parasitism was 97.4, 96.3, 79.4, 59.4 and 24.6% respectively (Table 2). Host egg age have significant effect on the rate of parasitism by *Trichogramma chilonis* and further with increasing host egg age rate of parasitism by *T. chilonis* significantly decreased. The present results were in conformity with Schmidt et al. (1999) who found that *T. chilonis* significantly decreased its parasitization when the eggs were older than 48h at the time of encounter. The host egg ages at the time of parasitism appears to have implication on the fitness of progeny and parasitoids which preferentially attack younger host eggs (Renzik et al., 1997).

Table 2. Effect of host egg age on biological parameters of *Trichogramma chilonis* reared on *S. cerealella* eggs under laboratory condition of 28 ±1 ˚C

Host egg age	Percent parasitism ±SD	Percent adult emergence ±SD	Female ratio ±SD	Adult longevity ±SD
2 h	97.40±0.84a	98.20±0.94a	61.2±1.64a	3.6±0.27a
12 h	96.30±0.67a	91.30±4.52b	60.5±3.32a	3.5±0.59a
24 h	79.40±4.47b	76.50±1.13c	62.1±3.36a	3.4±0.32a
48 h	59.4±5.18c	52.3±1.28d	61.2±2.51a	3.5±0.32a
72 h	24.6±4.92d	21.5±1.33e	59.4±1.19a	3.4±0.25a

Means followed by the same letters do not differ significantly at P< 0.05 (LSD test)

Maximum adult *Trichogramma* emergence were 98.2% in 2h old eggs of *S. cereallela* While minimum emergence was 21.5% in 72h old eggs. The results for different host egg ages were significantly different except 2 and 12h old eggs.

The female ratio was 61.2, 60.5, 62.1, 61.2 and 59.4 at different ages of host eggs, respectively. Results indicate that host age have no significant effect on the female ratio of *Trichogramma chilonis*.

The adult *Trichogramma* longevity was 3.6, 3.5, 3.4, 3.5 and 3.4 days at different ages of host eggs. Results indicate that host age have no significant effect on the adult longevity of *Trichogramma.*

LITERATURE CITED

Calvin, D. D., M. C. Knapp, S. M. Welch, F. L. Poston. and R. J. Elzinga. 1984. Impact of environmental factors on *Trichogramma pretoisum* reared on southwestern corn borer eggs. Environ. Entomol. 13(3): 774-780.

Farid, A., S. Tilal, A.U. Khan, A.S.U. Khattak, and Karimullah. 2001. Host age effect on oviposition preference and development of *Trichogramma chilonis* (Ishii). Pakistan J. Biol. Sci. 4(2): 121-122.

Greenberg, S. M., R.K. Morrison, D.A. Nordlund, and E.G. King. 1998. A review of the scientific literature and methods for production of factitious hosts for use in mass rearing of *Trichogramma* spp. (Hymenoptera: Trichogrammatidae) in the former Soviet Union, the United States, Western Europe and China. J. Entomol. Sci. 33 (1):15-32.

Harrison, W.W., E.G. King, and J.D. Ouzts. 1985. Development of *Trichogramma exiguum* and *T. pretiosum* at five temperature regimes. Environ. Entomol. 14 (2): 118-121.

Hassan, S.A. 1988. Selection of suitable *Trichogramma* strains to control the codling moth *Cydia pomonella* and the two summer fruit tortrix moths *Ado-xophyes orana, Pandemis heparana* (Lep.: Tortricidae). Entomophaga, 33(4): 19-27.

Hassan, S. A. 1994. Strategies to select *Trichogramma* species for the use in biological control. CAB International, UK, 4(1): 55-73.

Hoffmann, M.P., P.R. Ode, D.L. Walker, J. Gardner, S. van Nouhuys, and A.M. Shelton. 2001. Performance of *Trichogramma ostriniae* (Hymenoptera: Trichogram-matidae) reared on factitious hosts, including the target host, *Ostrinia nubilalis* (Lepidoptera: Crambidae). Biological Control, 21(1) 1-10.

Miura, K., and M. Kobayashi. 1993. Effect of temperature on the development of *Trichogramma chilonis* Ishii (Hymenoptera: Trichogrammatidae), an egg parasitoid of the Diamondback moth. Appl. Entomol. and Zool. 28 (3): 393-396

Nadeem, S., M. Ashfaq, M. Hamed, S. Ahmed, and M. Kashif. 2009. Comparative rearing of *Trichogramma chilonis* (Ishii) (Hymenoptera: Trichogrammatidae) at different temperature conditions, Pakistan Entomol. 31 (1): 33-36.

Renzik, S., T. Ya, Y. Umarova, and N.D. Voinovich. 1997. The influence of previous host age on current host acceptance in

Trichogramma. Entomologia Experimentalis et Applicata 82(2):153-157.

Schmidt, M., G. Mandel, and R. Schmuck, 1999. Impact of *Vairimorpha* sp. (Microsporida: Burnellidae) on *T. chilonis* (Ishii) Hymenoptera, parasitoid of the cabbage moth, *Plutella xylostella.* J. Inverteb. Pathol. 74: 120-126.

Singh, S. P., J. Singh, and K. S. Brar. 2002. Effect of temperature on different strains of *Trichogramma chilonis* Ishii. Insect Environ. 7(4): 181-182.

Smith S. M. 1996. Biological control with Trichogramma: advances, successes, and potential of their use. Ann. Rev. Entomol. 41 (1): 375-406.