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Research Article

Influence of short term exposure to different temperatures on key biological parameters of *Trichogramma chilonis* Ishii under laboratory conditions

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ABSTRACT: Laboratory studies on the influence of short term exposure to different temperatures on the biological parameters of *Trichogramma chilonis* Ishii revealed that 25 ± 1°C was most suitable for almost all the biological parameters, *viz.,* developmental period, adult emergence, number of parasitized eggs per female, female longevity and sex ratio. However, adult emergence, no. of parasitized eggs per female and female longevity were affected adversely when the egg and larval stages of *T. chilonis* were exposed to higher temperatures beyond 30 ± 1°C, 40 ± 1°C being the most detrimental temperature, whereas the pupal stage was found relatively tolerant.

KEY WORDS: *Trichogramma chilonis*, temperature, biological parameters

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INTRODUCTION

The most crucial aspect influencing the survival of natural enemies in the field is temperature. Each natural enemy is known to have a specific temperature tolerance range. High temperature during summer and low temperature during winter prevailing in different parts of Indian subcontinent have varying influence on the performance of *Trichogramma*. The developmental rate, fecundity, longevity and sex ratio of *Trichogramma* spp. are affected by temperature (Consoli and Parra, 1995; Ramesh and Baskaran, 1996; Singh and Ram, 2006). The thermal requirements of biocontrol agents and the effects of temperature on their performance are among many attributes that influence the outcome of biological control projects (Butler and Lopez, 1980, Chihrane *et al*., 1993).

In Vidarbha region of Maharashtra State in India, *Trichogramma chilonis* is being used in a large area, particularly in cotton ecosystem against bollworms. *Trichogramma* has a wide scope for inundative releases in areas under non-Bt cotton. Vidarbha is highly heat prone and the temperature in the field normally rises up to 35-40°C in September-October, popularly called 'October heat', which is also the peak *Trichogramma* release period on cotton. Although previous Indian workers such as Jalali and Singh (1992) and Baitha *et al*. (2003) have carried out studies on the effect of different temperatures on *Trichogramma* spp., still information on the performance of *Trichogramma* at different temperature regimes is scanty. Therefore, a laboratory study was carried out to study the effect of short term exposure to different temperatures on the key biological parameters of *T. chilonis*.

MATERIALS AND METHODS

Trichogramma chilonis *culture*

Fresh culture of local strain of *Trichogramma chilonis* was procured from the Biocontrol Laboratory, Department of Entomology, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola and further maintained in the laboratory on the eggs of *Corcyra cephalonica* (Stainton) at ambient temperature for further studies.

About 200 fresh UV treated eggs of *C. cephalonica* were pasted on a 25 x 6 mm card strip. The host eggs were exposed to a large number of *T. chilonis* adults (about 500 females) in glass test tubes (25 x 150 mm) provided with honey streaks for three hours in order to achieve uniform and one time parasitism of eggs. Immediately after parasitism, parasitized eggs were kept in a BOD incubator and exposed to different temperatures (20, 25, 30, 35 and 40°C), *i.e.*, on the 1st day of parasitism for six hours. After six hours the parasitized eggs were reared at ambient temperature (22 to 28°C) till adult

emergence. Similarly, the larval stage (on 3rd day of parasitism) and pupal stage (on 5th day of parasitism) of *T. chilonis* were exposed to different temperatures as described by Dahlan and Gordh (1996). All the treatments were replicated five times in Completely Randomized Design. Observations on adult emergence were recorded based on emergence holes on parasitized egg as observed under a stereoscopic microscope.

Immediately after adult emergence, 20 mated females from the different replications were isolated treatment wise in small glass vials (12 x 75 mm). Each female was provided with about 80-100 freshly UV-irradiated eggs of *Corcyra* pasted on card strips for parasitism until death and were kept at ambient temperature. A fine streak of honey was provided on the back of the card strips as food. Observations on the female longevity were recorded daily in the morning. The egg strips were replaced daily with fresh strips containing fresh eggs of *C. cephalonica* and the old strips containing parasitized host eggs were marked with date of parasitism and kept separately. After five to six days of parasitism, the blackened eggs on all the strips were counted and the total number of host eggs parasitized by each female, *i.e.,* fecundity, was calculated. Daily observations on the survival of females were recorded to work out the female longevity. Per cent females in the progeny were recorded by mixing together all the adults that emerged from the parasitised eggs of each replication and observed under the microscope for sexing based on antennal differences.

Statistical Analysis

The data on different biological parameters like developmental period, fecundity, longevity and per cent females in the progeny of *T. chilonis* as influenced by different temperatures were analyzed by using complete randomized design (CRD) after appropriate transformation for interpretation of results.

RESULTS AND DISCUSSION

Developmental period

Trichogramma chilonis completed its development satisfactorily when different developmental stages exposed to different temperatures for six hours (Table 1). Developmental period of the parasitoid was slightly faster when exposed to 30 ± 1°C for six hours during different stages of development. It was found that when the parasitoid was exposed to different temperatures ranging from 20 ± 1°C to 40 ± 1°C during different stages of development, the developmental period was prolonged, being maximum at 20 ± 1°C. Maximum developmental period (9.54 days) was recorded when parasitized host eggs were exposed to 20 ± 1°C on the 1st day of parasitism (egg stage) and minimum (7.58 days), when the larval stage and pupal stages of the parasitoid were exposed for six hours at 30 ± 1°C. Significantly longer developmental time was observed when parasitized host eggs were exposed to 20 ± 1°C during different stages of development.

The slower development of the parasitoid with decrease in temperature may be due to the stress caused by low temperature exposure to the host and parasitoid. The increase in developmental period with increasing temperature levels beyond 30 ± 1°C is in conformity with the studies of Naranjo (1993). Similar results were reported earlier for *T. pretiosum* under fluctuating high temperature regimes (Butler and Lopez, 1980; Calvin *et al*., 1984). It was also interesting to note that *T. chilonis* completed its development even after exposure to 40 ± 1°C, though, it took slightly longer time to develop as compared to 30 ± 1°C. Ramesh and Baskaran (1996) revealed that high temperature shocks of 40°C proved highly deleterious to all the species of *Trichogramma* except *T. chilonis* which withstood high temperature to some extent.

Adult emergence

A single six-hour exposure of different developmental stages of *T. chilonis* to high temperatures ranging from 30 ± 1°C to 40 ± 1°C resulted in a reduction in the adult emergence. Exposure to higher temperature (30 ± 1°C to 40 ± 1°C) levels resulted in a reduction in adult emergence from 88.89 to 62.93 per cent, 94.39 to 77.60 per cent and 98.60 to 96.51 per cent, when parasitized host eggs were exposed on the 1st day (egg stage), 3rd day (larval stage) and 5th day (pupal stage) of parasitism, respectively. Significant decrease in adult emergence was observed when the egg and larval stages of the parasitoid were exposed to 30 ± 1°C, 35 ± 1°C and 40 ± 1°C. When the pupal stage of the parasitoid was exposed, more significant reduction in adult emergence was observed at 40 ± 1°C than the rest of the treatments. Maximum reduction in adult emergence of the parasitoid was observed when it was exposed to heat shocks in the egg stage as compared to larval and pupal stages. Considering the effect of a single high temperature shock on adult emergence, pupal stage of the parasitoid was found to be more tolerant as compared to egg and larval stages as there was a minimal reduction in adult emergence even when exposed to 40 ± 1°C.

The lower adult emergence when egg and larval stages of the parasitoid within the host egg were exposed to different temperatures as compared to pupal stage could have been due to shrinkage or desiccation caused by high temperature shocks, thus affecting the development

Table 1. Biological parameters of *T. chilonis* as influenced by short term exposure of different life stages to different temperatures

Temperature (°C)	Developmental period (days)			Adult emergence (per cent)			Number of eggs parasitized per female			Female longevity (days)			Sex ratio (Females in the progeny)		
	Egg stage	Larval stage	Pupal stage	Egg stage	Larval stage	Pupal stage	Egg stage	Larval stage	Pupal stage	Egg stage	Larval stage	Pupal stage	Egg stage	Larval stage	Pupal stage
20±1	9.54	9.42	9.14	96.04 (78.57)	97.01 (80.09)	99.40 (86.05)	124.21	134.0	141.8	11.35	11.90	12.25	78.95 (62.70)	79.46 (63.10)	81.67 (64.69)
25±1	8.55	8.36	8.20	97.53 (81.13)	98.00 (82.25)	99.11 (84.65)	114.8	117.4	126.0	10.15	11.30	11.95	77.32 (61.58)	78.44 (62.35)	80.04 (63.48)
30±1	7.68	7.58	7.58	88.89 (70.62)	94.39 (76.32)	98.60 (83.35)	89.6	104.8	112.8	9.55	10.60	11.45	78.72 (62.57)	79.76 (63.31)	81.22 (64.35)
35±1	8.20	8.18	7.96	76.12 (60.91)	91.24 (82.21)	98.12 (82.21)	75.6	90.4	97.00	8.65	9.70	10.55	72.56 (58.63)	77.85 (61.93)	82.01 (64.93)
40±1	8.22	7.98	8.10	62.93 (52.62)	77.60 (61.97)	96.51 (79.28)	56.6	69.4	82.4	7.85	8.40	9.20	71.31 (57.64)	79.42 (63.03)	81.25 (64.35)
SEM±	0.22	0.21	0.18	1.21	1.31	0.70	3.18	3.20	3.21	0.27	0.27	0.30	0.80	0.77	0.70
CD (P = 0.05)	0.64	0.63	0.54	3.57	3.86	2.07	9.38	9.44	9.47	0.79	0.80	0.87	2.36	–	–

Figures in parentheses are arcsine transformed values

of the parasitoid. Our results are in accordance with the findings of Chihrane *et al.* (1993) and Gross (1988). Lopez and Morrison (1980) stated that exposure of 5 to 7 day-old parasitized eggs of *T. pretiosum* for four hours to temperatures higher than 37°C reduced the rate of emergence by more than 80 per cent.

Number of eggs parasitized per female

Progeny of *T. chilonis* which emerged from parasitized host egg exposed to different high temperature shocks (30 ± 1°C to 40 ± 1°C) during different developmental stages were able to parasitize the host eggs. With an increase in the temperature shock levels, there was a reduction in the number of eggs parasitized per female from 124.2, 134 and 141.8 at a temperature of 20 ± 1°C to 56.6, 69.4 and 82.4 to 40 ± 1°C on 1st, 3rd and 5th days of parasitism, respectively. Considerable reduction in the number of host eggs parasitized was observed when parasitized host eggs were exposed on the 1st day of parasitism (egg stage) to higher temperatures in comparison to low temperatures. The same trend was also observed when larval and pupal stages of *Trichogramma* were exposed to various temperatures. The females emerging from the parasitized host eggs exposed to different high temperatures on the 5th day of parasitism could parasitize maximum number of host eggs as compared to females emerging from the parasitized host eggs exposed on 1st and 3rd days of parasitism which indicated that the pupal stage of *Trichogramma* is relatively more tolerant to high temperatures. This corroborates the findings of Calvin *et al* (1984).

Female longevity

Female parasitoids emerging from parasitized host eggs exposed to high temperature during different stages of development survived for more than seven days. Female longevity was maximum (12.25 days) when parasitized host eggs were exposed to 20 ± 1°C on the 5th day of parasitism and minimum (7.85 days) when parasitized host eggs were exposed to 40 ± 1°C on 1st day of parasitism. Significant reduction in female longevity (8.40 days and 9.20 days, respectively) was recorded when larval and pupal stages of the parasitoid were exposed to 40 ± 1°C. Females emerging from the parasitized host eggs exposed to different high temperatures during pupal stage lived longer as compared to those emerging from parasitized host eggs exposed to different high temperatures during egg and larval stages of the parasitoid. The reduction in longevity of females emerging from parasitized host eggs exposed to high temperatures during egg and larval stages may be due to the emergence of weak females due to poor quality or desiccation of host eggs. Ram and Sharma (1977) and Babi and Nabham (1998) have also reported decreased longevity of females of different *Trichogramma* spp. with increasing temperatures.

Sex ratio

Females always outnumbered males in the progeny of *T. chilonis* emerged from the parasitized host eggs exposed to different high temperature shocks during different stages of development. There was non-significant difference in the percentage of females in the progeny when larval and pupal stages of *T. chilonis* were exposed to different high temperatures. Singh and Ram (2006) have reported that there was no significant effect of high temperature exposure on the sex ratio in the progeny of the parasitoid, which supports the present findings.

The findings of the present study indicate that the temperature levels from 20 to 30 ± 1°C did not have any adverse effect on *T. chilonis.* As the temperature increased beyond 30 ± 1°C, the biological parameters of *T. chilonis* were significantly affected. The highest temperature (40 ± 1°C) was found to be significantly most detrimental among the temperature levels tested, particularly, when the egg and larval stages were exposed. However, the pupal stage was found to be tolerant even at 40 ± 1°C temperature.

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