Effect of Different Temperatures on Growth and Development of Trichogramma

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ABSTRACT

The studies in the laboratory at four temperatures of 25, 28, 30 and 32°C of T. japonicum and T. chilonis revealed that with higher temperature the percent parasitisation, emergence of adult, development time and longevity decreased. Adult emergence for parasitisation was best at 25 to 28°C. At 25°C the highest percent parasitisation, emergence ratio, adult longevity and development time was observed at different generations followed by 28, 30 and 32°C.

Keywords: Trichogramma, Parasitism, Temperature

Introduction

Egg parasitoids (Trichogramma sp.,) offer an effective population regulation for lepidopteran pests especially for control of rice YSB and leaf folder (Hou et al., 2006; Yuan et al., 2012) Trichogramma egg parasitoids are important biological control agents and have been successfully used against a wide range of agricultural and forest pests for more than 70 years (Li, 1994).

World-wide, approximately 15 million ha of agricultural crops and forests are treated annually with large numbers of Trichogramma (van Lenteren, 2000). The study and uses of parasites, predators and pathogens for the regulation of host (pest) densities (DeBach, 1964) is need of the hour. In view of rich natural enemy complex of YSB and leaf folder incidence, it is necessary to select best bio-agents which is effective for both pests.

Materials and Methods

One hundred parasitised eggs of Corcyra cepholonica by T. chilonis, T. japonicum were taken in closed polythene bags of 35 X 30cm having 300 guage thickness bags were kept in an incubator at four different temperature (25°C, 28°C, 30°C and 32°C) for taking following observations at relative humidity (RH) of 75%. The host eggs after turning black were counted for calculating %
parasitisation and % emergence. The trial was replicated five times for conformity.

% Parasitisation
No. of parasitised eggs in trichocards X 100
Total no. of eggs in tricho cards

Adult longevity = Number of days until the death of adults

Development time = Number of days required for development from egg to adult emergence from egg

Emergence %
No. of adults emerged from trichocards x100
Total no. of parasitised eggs in tricho cards

The data obtained from recording of various activity of Trichogramma observed at different temperature from the laboratory studies were statistically analysed as per CRD design having five replications.

Results and Discussion

At 25°C the highest percent parasitisation, emergence ratio, adult longevity and development time was observed at different generations followed by 28, 30 and 32°C.

T. chilonis

The percent parasitisation by T.chilonis as shown in table 1 it was observed that out of four temperatures, the maximum was found at 25°C as 83.61%. With the passing generations (F1 to F10) a decrement was observed in percent parasitisation from 83.61 to 78.71%. At 28°C the parasitisation percentage was observed from 80.40 (F1) to 76.54% (F10) with each passing generations, at 30°C the parasitisation % was observed as (F1) 79.61 to 71.25% (F10) and at 32°C the parasitisation was observed as (F1) 70.75 to 62.25% (F10). With the increase in temperature, the decrease in % parasitisation was observed. Moreover, this decrement in percent parasitisation was also been observed with subsequent generations (F1 to F10). Yuan et al., (2012) also observed that the temperature and the humidity significantly affected the ability of all of the Trichogramma species to parasitise the eggs of their host. Garcia and Tavares (1994) found that T. chilonis parasitised more eggs at 26°C than at the other temperatures. A major effect of temperature on the population growth parameters is observed, a faster oviposition at higher temperatures will allow this pro-ovogenic parasitoid to lay most of its available eggs during a short lifetime period. Garcia and Tavares (1994) found significant differences between all temperatures for Trichogramma longevity, which increased with the decrease of temperature, results that are similar to ours. According to Jervis and Copland (1996) there is an optimal range of temperature for insect development, beyond which they would be unable to continue oogenesis and laying eggs or unable to function appropriately for a long period of time. This could be due to the increase in respiration rate, i.e., the insects would be unable to produce fertile eggs due to the high consumption of energy (Mills and Kuhlmann, 2000).

Development time from egg to adult at 25°C was observed between (F1) 2.67 to 2.42 days (F10), at 28°C the time taken was 2.32 to 2.46 days (F1 to F10), at 30°C the development time was marked as 2.14 to 1.85 days (F1 to F10) and at 32°C the duration was observed between 1.55 to 1.47 days (F1 to F10). Development time needed by the Trichogramma strains was shorter as temperature increased. This finding is in agreement with Consoli and Parra (1995) who
assumed that this might be due to a more appropriate metabolic process of the immature stages. The optimal temperature for development and survival was 25°C (McDougall and Mills 1997). However, the total mortality was greater at the higher temperature; these results are similar to the findings of Hawkins and Smith (1986). Pintureau and Bolland (2001) also found that as temperature increases, the duration of development decreases. Baitha et al., (2003) reported 25-33% parasitisation of T. japonicum at 25°C and up to 60% has been observed at 30°C. There was an inverse relation between temperature and development of T. japonicum. The parasitism levels were higher when the average maximum temperature ranged from 27.9 to 29.4 °C and average minimum temperature ranged between 13.8 and 16.4 °C (Rao and Ali, 1977).

Emergence rate of adults from egg at 25°C was observed between 80.41 to 70.25% (F1 to F10) emergence, at 28°C the emergence % was observed between (F1) 73.57 to 67.64% (F10) at 30°C the emergence was seen between (F1) 67.75 to 59.24% (F10) and at 32°C the emergence was observed between 63.75 to 52.51% (F1 to F10).

The adult longevity at 25°C was observed between (F1) 3.45 to 3.14 (F10) days at ten generations, at 28°C the longevity was observed as 3.17 to 2.55 days (F1 to F10), at 30°C the longevity observed was between 2.57 to 1.97 days (F1 to F10) and at 32°C the longevity observed was between (F1) 1.55 to 1.38 (F10) days. According to Nagarkatti and Nagaraja (1978), female fertility of Trichogramma wasps reared for a long time under laboratory conditions was significantly lower than that of wild females. However, female longevity is affected by many factors, such as temperature (Pak and Oatman, 1982), humidity (Stinner et al., 1974), host size (Stinner et al., 1974) and food. McDougall and Mills (1997) found that the high temperature could have caused sterilization of Trichogramma because they stopped laying eggs but lived for a few more days without laying new eggs. Also a reduction in female longevity was recorded from 5.3 days at 10°C and 3 days at 35°C.

T. japonicum

Data on table 2 represents the percent parasitisation at 25°C was observed highest between (F1) 82.12% to 69.25% (F10), at 28°C the percent parasitisation was observed between 75.03 to 60.75% (F1 to F10), at 30°C the parasitisation was observed between 63.51 to 51.50% (F1 to F10) and at 32°C the parasitisation was observed between 42.75% to 53.21 (F1 to F10).

Development time from egg to adult i.e. emergence from egg at 25°C was observed between (F1) 4.22 to 4.01 days (F10), at 28°C the development time recorded was (F1) 3.75 to 4.17 days (F10) and at 30°C the development time was observed between (F1) 3.71 to 3.17 days (F10) and 32°C the development days was observed between (F1) 2.47 to 1.77 days (F10).

Emergence % at 25°C was observed between 83.75 to 74.52% (F1 to F10), at 28°C the emergence was seen between 75.61 to 68.41% (F1 to F10), at 30°C the emergence was seen as 71.75 to 62.57% (F1 to F10) and at 32°C the emergence was seen as 71.55 to 57.12% (F1 to F10).
**Table 1** Percent parasitisation, development time (egg to adult), emergence rate and adult longevity of *T. Chilonis* at different temperatures for ten generations

| Temp (in °C) | F₁ | F₂ | F₃ | F₄ | F₅ |
|--------------|----|----|----|----|----|
| 25           | 83.61 | 2.67 | 80.41 | 3.45 | 83.21 | 3.01 | 76.21 | 3.51 | 83.64 | 2.64 | 75.21 | 3.24 | 83.25 | 2.58 | 74.21 | 3.18 | 80.61 | 2.62 | 73.24 | 3.28 |
| 28           | 80.41 | 2.32 | 73.57 | 3.17 | 79.40 | 2.42 | 71.82 | 2.92 | 80.41 | 2.32 | 74.44 | 2.58 | 80.21 | 2.54 | 73.42 | 2.62 | 76.42 | 2.48 | 73.43 | 2.62 |
| 30           | 79.61 | 2.14 | 67.75 | 2.57 | 76.61 | 2.11 | 68.84 | 2.31 | 76.01 | 1.64 | 65.62 | 2.24 | 74.21 | 1.68 | 68.44 | 2.12 | 75.80 | 1.52 | 68.64 | 2.12 |
| 32           | 70.75 | 1.55 | 63.75 | 1.55 | 69.40 | 1.42 | 63.41 | 1.63 | 68.42 | 1.28 | 63.44 | 1.76 | 69.34 | 1.38 | 62.63 | 1.56 | 68.23 | 1.34 | 61.27 | 1.58 |
| Mean         | 78.55 | 1.73 | 71.37 | 2.67 | 77.15 | 2.23 | 70.05 | 2.59 | 77.11 | 1.97 | 69.65 | 1.95 | 76.55 | 2.03 | 69.65 | 1.89 | 75.24 | 1.99 | 69.05 | 2.39 |
| SEm(±)       | 0.43 | 0.10 | 1.36 | 0.12 | 0.77 | 0.08 | 0.74 | 0.04 | 1.12 | 0.10 | 1.13 | 0.07 | 1.00 | 0.12 | 1.07 | 0.05 | 1.17 | 0.10 | 0.58 | 0.10 |
| SE(d)        | 0.60 | 0.14 | 1.92 | 0.17 | 1.29 | 0.12 | 1.04 | 0.06 | 1.58 | 0.14 | 1.60 | 0.10 | 1.41 | 0.16 | 1.52 | 0.08 | 1.66 | 0.15 | 0.82 | 0.14 |
| CD₀.₀₅      | 1.27 | 0.31 | 4.04 | 0.36 | 2.31 | 0.24 | 2.19 | 0.13 | 3.35 | 0.29 | 3.36 | 0.21 | 2.98 | 0.34 | 3.19 | 0.16 | 3.50 | 0.30 | 1.73 | 0.31 |

| Temp (in °C) | F₆ | F₇ | F₈ | F₉ | F₁₀ |
|--------------|----|----|----|----|-----|
| 25           | 81.24 | 2.81 | 72.37 | 3.24 | 80.61 | 3.12 | 69.81 | 3.12 | 79.62 | 2.44 | 70.64 | 3.34 | 79.21 | 2.52 | 69.24 | 3.36 | 78.71 | 2.42 | 70.25 | 3.14 |
| 28           | 76.82 | 2.38 | 72.01 | 2.34 | 75.62 | 2.42 | 69.23 | 2.48 | 78.64 | 2.58 | 66.45 | 2.32 | 75.81 | 2.28 | 66.23 | 2.32 | 76.54 | 2.46 | 67.64 | 2.55 |
| 30           | 74.63 | 1.62 | 63.42 | 2.16 | 74.83 | 1.58 | 62.45 | 1.68 | 74.89 | 1.64 | 60.83 | 1.46 | 72.26 | 1.68 | 61.24 | 1.68 | 71.25 | 1.85 | 59.24 | 1.97 |
| 32           | 65.40 | 1.28 | 54.24 | 1.52 | 65.24 | 1.38 | 56.45 | 1.38 | 66.41 | 1.41 | 52.61 | 1.36 | 63.84 | 1.44 | 54.42 | 1.44 | 62.25 | 1.47 | 52.51 | 1.38 |
| Mean         | 74.54 | 2.04 | 65.43 | 2.30 | 74.05 | 2.12 | 64.35 | 2.16 | 74.61 | 2.01 | 62.62 | 2.12 | 72.62 | 1.98 | 62.72 | 2.19 | 71.71 | 2.01 | 62.45 | 2.21 |
| SEm(±)       | 1.46 | 0.11 | 0.72 | 0.11 | 1.08 | 0.08 | 1.31 | 0.08 | 0.87 | 0.12 | 0.79 | 0.09 | 1.28 | 0.09 | 1.29 | 0.07 | 1.31 | 0.09 | 0.81 | 0.72 |
| SE(d)        | 2.06 | 0.15 | 1.02 | 0.14 | 1.53 | 0.12 | 1.84 | 0.12 | 1.23 | 0.17 | 1.11 | 0.13 | 1.80 | 0.13 | 1.83 | 0.09 | 1.85 | 0.13 | 1.14 | 0.09 |
| CD₀.₀₅      | 4.34 | 0.32 | 2.15 | 0.31 | 3.22 | 0.24 | 3.89 | 0.25 | 2.61 | 0.36 | 2.36 | 0.27 | 3.81 | 0.28 | 3.86 | 0.19 | 3.91 | 0.27 | 2.41 | 0.20 |

Temp. = Temperature,  I = percent parasitisation (%),  II = Development time (Days),  III = Emergence rate (%),  IV = Adult longevity (Days)
Table 2 Percent parasitisation, development time (egg to adult), emergence rate and adult longevity of *T. japonicum* at different temperatures for ten generations

| Temp (in C) | F1 | F2 | F3 | F4 | F5 |
|-------------|----|----|----|----|----|
| 25          | 82.12 | 4.22 | 83.75 | 2.40 | 81.02 | 4.06 | 82.54 | 16.24 | 80.64 | 4.28 | 82.21 | 16.12 | 80.84 | 4.02 | 81.64 | 3.08 | 78.81 | 4.04 | 81.45 | 3.56 |
| 28          | 75.03 | 3.75 | 75.61 | 2.67 | 74.84 | 3.71 | 75.43 | 14.96 | 75.64 | 3.72 | 74.65 | 15.12 | 70.66 | 3.92 | 75.86 | 2.51 | 71.22 | 3.84 | 76.24 | 2.74 |
| 30          | 63.51 | 3.71 | 71.75 | 2.15 | 62.21 | 3.76 | 66.75 | 12.44 | 61.66 | 3.58 | 69.45 | 12.32 | 60.84 | 3.58 | 67.41 | 1.69 | 58.65 | 3.74 | 67.81 | 1.66 |
| 32          | 53.21 | 2.47 | 71.55 | 1.62 | 54.23 | 2.23 | 64.63 | 10.84 | 56.44 | 2.42 | 64.86 | 11.28 | 52.26 | 2.32 | 64.45 | 1.34 | 48.66 | 2.14 | 63.42 | 1.33 |
| Mean        | 68.81 | 3.53 | 75.5 | 2.21 | 68.75 | 3.43 | 72.45 | 2.53 | 68.58 | 3.56 | 72.77 | 2.05 | 66.0 | 3.46 | 72.34 | 2.15 | 64.34 | 3.42 | 72.52 | 2.32 |
| SEm(±)      | 1.13 | 0.05 | 1.05 | 0.27 | 1.05 | 0.06 | 1.29 | 0.33 | 1.02 | 0.09 | 0.71 | 0.23 | 0.69 | 0.07 | 0.92 | 0.28 | 0.96 | 0.03 | 0.68 | 0.34 |
| SE(d)       | 1.59 | 0.08 | 1.48 | 0.38 | 1.49 | 0.09 | 1.82 | 0.47 | 1.43 | 0.12 | 0.99 | 0.32 | 0.98 | 0.11 | 1.30 | 0.41 | 1.35 | 0.05 | 0.96 | 0.48 |
| CD0.05      | 3.36 | 0.17 | 3.14 | 0.80 | 3.15 | 0.21 | 3.85 | 1.01 | 3.02 | 0.27 | 2.10 | 0.69 | 2.07 | 0.22 | 2.75 | 0.84 | 2.86 | 0.12 | 2.03 | 1.02 |

| Temp (in C) | F6 | F7 | F8 | F9 | F10 |
|-------------|----|----|----|----|-----|
| 25          | 78.23 | 4.08 | 81.4 | 2.78 | 74.44 | 3.98 | 77.44 | 3.67 | 69.41 | 4.06 | 76.21 | 3.37 | 69.24 | 3.74 | 74.44 | 3.44 | 69.25 | 4.01 | 74.52 | 2.63 |
| 28          | 70.64 | 3.92 | 74.23 | 2.79 | 66.42 | 3.88 | 72.85 | 2.84 | 65.65 | 3.56 | 70.26 | 2.54 | 62.23 | 3.98 | 69.67 | 2.44 | 60.75 | 4.17 | 68.41 | 2.48 |
| 30          | 57.46 | 3.46 | 68.81 | 1.70 | 55.61 | 3.16 | 65.24 | 1.83 | 53.26 | 2.96 | 65.80 | 1.81 | 52.84 | 3.32 | 63.41 | 1.70 | 51.50 | 3.17 | 62.57 | 1.65 |
| 32          | 46.41 | 2.08 | 63.26 | 1.29 | 46.45 | 1.84 | 62.41 | 1.28 | 45.24 | 1.68 | 62.86 | 1.24 | 43.84 | 1.84 | 56.45 | 1.21 | 42.75 | 1.77 | 57.12 | 1.19 |
| Mean        | 63.10 | 3.38 | 71.81 | 2.14 | 60.74 | 3.20 | 69.45 | 2.39 | 58.39 | 3.06 | 68.54 | 2.23 | 56.90 | 3.21 | 65.95 | 2.20 | 56.15 | 3.35 | 65.7 | 2.18 |
| SEm(±)      | 0.77 | 0.06 | 0.57 | 0.33 | 1.33 | 0.11 | 0.85 | 0.41 | 1.35 | 0.12 | 0.77 | 0.33 | 1.20 | 0.09 | 0.73 | 0.32 | 0.79 | 0.11 | 0.75 | 0.30 |
| SE(d)       | 1.08 | 0.09 | 0.80 | 0.47 | 1.88 | 0.14 | 1.18 | 0.57 | 1.90 | 0.17 | 1.0 | 0.47 | 1.70 | 0.12 | 1.03 | 0.45 | 1.12 | 0.16 | 1.05 | 0.43 |
| CD0.05      | 2.29 | 0.20 | 1.69 | 1.0 | 3.97 | 0.31 | 2.48 | 1.22 | 4.02 | 0.36 | 2.31 | 0.99 | 3.58 | 0.27 | 2.17 | 0.96 | 2.37 | 0.34 | 2.23 | 0.91 |

Temp. = Temperature,  I = percent parasitisation (%),  II = Development time (Days),  III = Emergence rate (%),  IV = Adult longevity (Days)
Adult longevity at 25°C was observed between 2.40 to 2.63 days (F₁ to F₁₀), at 28°C the longevity was seen between (F₁) 2.67 to 2.48 days (F₁₀) and 30°C the longevity was marked between (F₁) 2.15 to 1.65 days (F₁₀) and at 32°C the longevity was observed between (F₁) 1.62 to 1.19 days (F₁₀).

In both the species with the increase in temperature the decrease in percent parasitisation, emergence percent and the duration of life cycle was observed. The changes in the life cycle were observed as decrement in time of development from egg to adult and decrease in adult longevity. With the passing generations in the laboratory, affect on the efficacy of the parasitoid was marked.

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