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Effect of Different Temperatures on Growth and Development of *Trichogramma*

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A B S T R A C T

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.

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.

$$\% \text{ Parasitisation} = \frac{\text{No. of parasitised eggs in trichocards}}{\text{Total no. of eggs in tricho cards}} \times 100$$

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

$$\text{Emergence } \% = \frac{\text{No. of adults emerged from trichocards}}{\text{Total no. of parasitised eggs in tricho cards}} \times 100$$

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 (F_1 to F_{10}) a decrement was observed in percent parasitisation from 83.61 to 78.71%. At 28°C the parasitisation percentage was observed from 80.40 (F_1) to 76.54% (F_{10}) with each passing generations, at 30°C the parasitisation % was observed as (F_1) 79.61 to 71.25% (F_{10}) and at 32°C the parasitisation was observed as (F_1) 70.75 to 62.25% (F_{10}). With the increase in temperature, the decrease in % parasitisation was observed. Moreover, this decrement in percent parasitisation was also been observed with subsequent generations (F_1 to F_{10}). 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 (F_1) 2.67 to 2.42 days (F_{10}), at 28°C the time taken was 2.32 to 2.46 days (F_1 to F_{10}), at 30°C the development time was marked as 2.14 to 1.85 days (F_1 to F_{10}) and at 32°C the duration was observed between 1.55 to 1.47 days (F_1 to F_{10}). 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% (F_1 to F_{10}) emergence, at 28°C the emergence % was observed between (F_1) 73.57 to 67.64% (F_{10}) at 30°C the emergence was seen between (F_1) 67.75 to 59.24% (F_{10}) and at 32°C the emergence was observed between 63.75 to 52.51% (F_1 to F_{10}).

The adult longevity at 25°C was observed between (F_1) 3.45 to 3.14 (F_{10}) days at ten generations, at 28°C the longevity was observed as 3.17 to 2.55 days (F_1 to F_{10}), at 30°C the longevity observed was between 2.57 to 1.97 days (F_1 to F_{10}) and at 32°C the longevity observed was between (F_1) 1.55 to 1.38 (F_{10}) 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 (F_1) 82.12% to 69.25% (F_{10}), at 28°C the percent parasitisation was observed between 75.03 to 60.75% (F_1 to F_{10}), at 30°C the parasitisation was observed between 63.51 to 51.50% (F_1 to F_{10}) and at 32°C the parasitisation was observed between 42.75% to 53.21 (F_1 to F_{10}).

Development time from egg to adult i.e. emergence from egg at 25°C was observed between (F_1) 4.22 to 4.01 days (F_{10}), at 28°C the development time recorded was (F_1) 3.75 to 4.17 days (F_{10}) and at 30°C the development time was observed between (F_1) 3.71 to 3.17 days (F_{10}) and 32°C the development days was observed between (F_1) 2.47 to 1.77 days (F_{10}).

Emergence % at 25°C was observed between 83.75 to 74.52% (F_1 to F_{10}), at 28°C the emergence was seen between 75.61 to 68.41% (F_1 to F_{10}), at 30°C the emergence was seen as 71.75 to 62.57% (F_1 to F_{10}) and at 32°C the emergence was seen as 71.55 to 57.12% (F_1 to F_{10}).

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)	Generation of *T. chilonis* from F_1 to F_5																			
	F_1				F_2				F_3				F_4				F_5			
	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
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
$CD_{0.05}$	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)	Generation of *T. chilonis* from F_6 to F_{10}																			
	F_6				F_7				F_8				F_9				F_{10}			
	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
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	2.024	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	71.7	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
$CD_{0.05}$	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)	**Generation of *T. japonicum* from F_1 to F_5**																			
	F_1				F_2				F_3				F_4				F_5			
	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
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
$CD_{0.05}$	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)	Generation of *T. japonicum* from F_6 to F_{10}																			
	F_6				F_7				F_8				F_9				F_{10}			
	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
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
$CD_{0.05}$	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 (F_1 to F_{10}), at 28°C the longevity was seen between (F_1) 2.67 to 2.48 days (F_{10}) and 30°C the longevity was marked between (F_1) 2.15 to 1.65 days (F_{10}) and at 32°C the longevity was observed between (F_1) 1.62 to 1.19 days (F_{10}).

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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