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RESEARCH ARTICLE

EFFECT OF DIFFERENT TEMPERATURES ON THE NUMBER OF HOST EGGS PARASITIZED BY TRICHOGRAMMA CHILONIS ISCHII AT DIFFERENT DENSITIES OF ITS HOST *Helicoverpa armigera* (HÜBNER)

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ABSTRACT

The egg parasitoids of the genus *Trichogramma* have been used successfully as inundative biological control agents against a range of agricultural pests mainly lepidopterans and are the most widely used natural enemies in biological control worldwide. Parasitoids depend on a series of adaptations to the ecology and physiology of their hosts and host plants for survival and are thus likely highly susceptible to changes in environmental conditions. Temperature is one of the most important environmental factors influencing physiology and behavior of insects including parasitoids. The aim of this study was to describe functional responses of *Trichogramma chilonis* Ishii on *Helicoverpa armigera* (Hübner) infesting pigeonpea at four temperatures *viz.* 12, 17, 22 and 27°C that represent a common range of daytime temperatures in northeastern Uttar Pradesh during October (When plant starts flowering) to December (when pods starts maturing) and when *Helicoverpa armigera* (Hübner) populations can exceed the Economic Injury Level (EIL) and natural enemies can be important for their control.

INTRODUCTION

The functional response is an essential element of dynamics of host-parasitoid interactions and is an important determinant of the stability of the system (Oaten and Murdoch, 1975). Holling (1959a, b; 1966), who developed mathematical models to describe natural enemy responses to changing prey or host density, initially described three types of functional responses. *Type I* response is exemplified by a parasitoid with a constant attack rate over all host densities and a random search pattern. The number of hosts parasitised per female in a *type I* response is directly proportional to host density and represented by a linear response until satiation is reached Hassell (1978). Type II response incorporate handling time, which refers to the act of subduing the host, host acceptance, oviposition, and then perhaps cleaning and resting before moving on to search for more hosts. The type III functional response model is depicted by a sigmoidal curve with an accelerating attack rate (caused by a change in search activity) as the host density increases (Hassell, 2000; Hirashima *et al.*, 1990b; Karimiyan, 1998; Faria *et al.*, 2000; Lashgari *et al.*, 2004; Mills and Lacan, 2004). Functional response tests, shows the potential of parasitoid ability to suppress the different density of host (Moezipour *et al.*, 2008). *Trichogramma chilonis* Ishii easily parasitised *Helicoverpa armigera* (Hübner) and was used to control its population in fields of pigeonpea, chickpea, cotton etc. (Tandon and Bakthavatsalam, 2003).

Temperature is one of the most important environmental factors influencing physiology and behavior of insects including parasitoids (Ratte, 1985; Reznik and Vaghina, 2006; Moezipour *et al.*, 2008; Reznik *et al.*, 2009). A common pattern for the relationship between temperature and parasitoid fertility is that lower fertility is observed at extreme temperatures with higher fertility at moderate temperatures (Force and Messenger, 1964; Harrison *et al.*, 1985; Hirashima *et al.*, 1990a; Foerster and Foerster, 2009; Reznik *et al.*, 2009). Thus, the general presumption is that parasitoid cannot mature their eggs or are unable to oviposit outside a range of tolerable temperatures (Lopez and Morrison, 1980; Honek and Kocourek, 1990; Singh *et al.*, 2002; Wang *et al.*, 2004; Kalyebi *et al.*, 2006).

MATERIALS AND METHODS

Functional response experiments

The eight egg densities of host (*Helicoverpa armigera* (Hübner)) eggs (4, 8, 10, 20, 40, 60, 80 and 120 eggs per adult parasitoid (*Trichogramma chilonis* Ishii), were used. Glass shell vials (12×100 mm) served as experimental units. For each host density, eggs of natural host (less than 1 day old) were placed on a small thick paper and inserted into glass vial. One-day-old mated female parasitoids (fed on drop of 20% honey solution) were exposed to different density levels of *Helicoverpa armigera* (Hübner) eggs. This experiment was done at 12, 17, 22 and 27°C, 60±5% RH, and 16: 8 (L:D)

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Table 1a. Number of host eggs parasitised (mean±SD) by *Trichogramma chilonis* Ishii at different densities of its host *Helicoverpa armigera* (Hübner). Regression equation, Y= a + b. logX

Host density	Temperatures			
	12°C	17°C	22°C	27°C
4	3.50±0.97	4.30±0.67	4.60±0.97	5.90±1.85
8	6.50±1.08	8.90±0.88	9.90±1.60	11.1±0±2.56
10	8.10±1.29	12.30±2.26	21.90±2.28	24.90±6.31
20	15.60±1.78	22.70±3.89	37.00±3.27	40.60±3.98
40	22.50±2.01	33.20±3.88	47.50±2.51	53.50±4.67
60	28.30±2.63	43.40±3.75	54.40±3.66	60.60±3.66
80	30.60±2.63	46.70±3.83	57.10±3.87	63.30±5.64
120	32.10±2.38	49.90±2.88	58.60±3.86	64.405.42
A	-11.799	-19.793	-20.014	-21.257
B	21.632	34.001	40.391	44.263
R	0.991	0.992	0.983	0.981
P	0.001	0.001	0.001	0.001

Table 1b. Summary of computation of analysis of variance of the above data

Components	d.f.	S.S.	Variance	F-value	P
Between temperatures	3	2315.31	771.77	23.0407	0.001
Between host densities	7	9780.79	1397.26	41.7141	0.001
Error	21	703.42	33.50		
Total	31	12799.52			

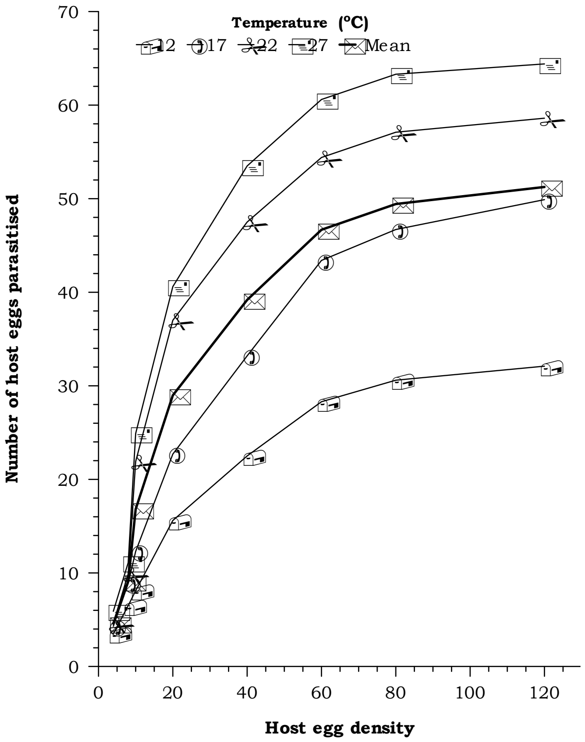

Fig. 1. Number of host eggs parasitised (mean±SD) by *Trichogramma chilonis* Ishii at different densities of its host *Helicoverpa armigera* (Hübner) and at different temperatures

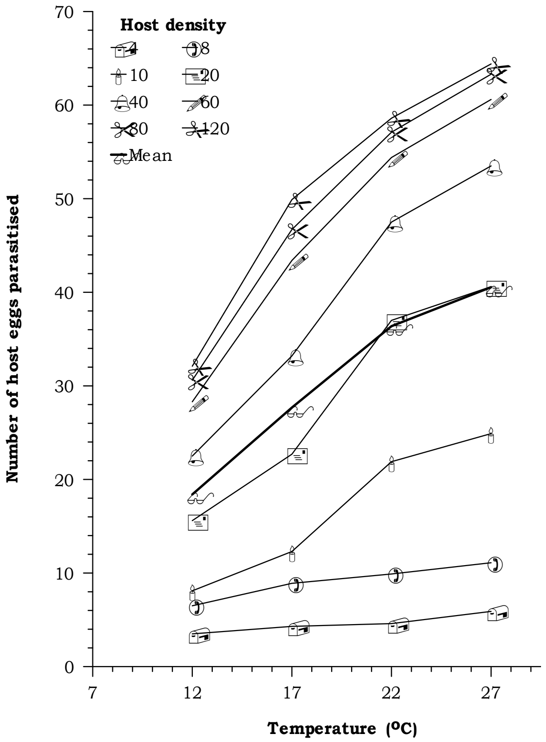

Fig. 2. Number of host eggs parasitised (mean±SD) by *Trichogramma chilonis* Ishii at different temperatures and at different densities of its host *Helicoverpa armigera* (Hübner).

photoperiod condition. After 24 hours the female parasitoids were removed and again exposed to the host eggs of different densities as mentioned above for three more days. The host egg, that were exposed to the parasitoid, were maintained under 25±1°C and 70±5% RH condition. Ten replications of each density were set up, simultaneously. To determine the number of parasitised egg, the number of black eggs was counted. After emergence, the adult parasitoids were sexed. At each temperature, the wasps were reared at that condition at least for two generations and the third generation was used for experiments.

Statistical analysis

Data analysis for functional response includes two steps: 1. regression analyses, and 2. performing analyses of variances. In the first step, the shape (type) of functional response was determined, typically by determining if the data fit a *type I, II* or *III* functional response of Holling (1959a, b; 1966). Logistic regression of the proportion of parasitised hosts vs. the initial number of hosts is the most effective way in determining this Juliano (1982). However, the main purpose of determining such type of relations, regression of two variables (host density, number of hosts parasitised) are done to fit the curve. In this first step, a regression between logarithmic value of host numbers exposed for parasitism and numerical value of number of hosts parasitised was done as: $Y = a + b \log X$. It gives least variance at all temperature regimes. Where a (intercept), and b (slope) are the constants to be estimated. These constants can be estimated by using the EXCEL regression function.

The shape of the curve denotes that the functional response of *Trichogramma chilonis* Ishii follow the *type II* of Holling. Some authors (Rogers and Hassell, 1974) emphasize on the limitation of Holling's disk equation, and suggest Rogers' parasite equation as an alternative, which is more appropriate when host re-encounter occurs during the experiment. Holling's disk equation can be used only when Rogers' model does not enable the researcher to estimate valid parameters (Allahyari *et al*., 2004). Effect of temperature on the functional response was measured by regression of number of hosts parasitised at different temperature at each host density.

In the second step, two way analysis of variance, was performed to observe the effect of host density and temperature on the number of host parasitised.

RESULTS

Number of The Host Eggs Parasitised

Number of the host eggs parasitised by parasitoid *Trichogramma chilonis* Ishii in different temperature conditions are illustrated in Figure 1. At different temperatures *Trichogramma chilonis* Ishii showed almost similar types of functional response. Results of a linear regression between number of hosts parasitised and number of hosts exposed/day (log value) (Table 1a) indicated that functional response of *Trichogramma chilonis* Ishii population at 12 to 27 °C is type I. However, shape of the curves when plotted between number of hosts parasitised and number of hosts exposed/day shows *type II* functional response. Values of intercepts, slopes and correlation coefficients at each temperature regimen are shown in Table 16a.

Analysis of variance of the data displayed in Table 1a demonstrated that the response of the *Trichogramma chilonis* Ishii against the host *Helicoverpa armigera* (Hübner) is significantly influenced by both the host density ($F=41.71$, $P<0.001$) and temperature ($F=23.04$, $P<0.001$) (Table 1b).

At each host density, the number of hosts parasitised increased with increase of temperature (Figure 2) and the linear regression of number of hosts parasitised at each host density against temperatures revealed highly significant correlation coefficients [$Y_{(4\ \text{hosts})}=1.65+0.15 \log X$, $r=0.970^*$; $Y_{(8\ \text{hosts})}=3.338+0.30 \log X$, $r=0.978^*$; $Y_{(10\ \text{hosts})}=1.20 \log X-6.60$, $r=0.980^*$; $Y_{(20\ \text{hosts})}=1.79 \log X-5.85$, $r=0.977^*$; $Y_{(40\ \text{hosts})}=2.15 \log X-2.67$, $r=0.989^*$; $Y_{(60\ \text{hosts})}=4.59+2.16 \log X$, $r=0.983^*$; $Y_{(80\ \text{hosts})}=7.11+2.17 \log X$, $r=0.980^*$; $Y_{(120\ \text{hosts})}=10.07+2.11 \log X$, $r=0.998^*$; $^*P < 0.001$].

DISCUSSION

Data of the present investigation revealed that the number of host parasitised increased rapidly with increase in number of hosts, up to10 hosts / female. Thereafter, the parasitisation rate continuously decreased reaching almost a plateau at 120 hosts. The shape of the curve resembles a typical *type II* functional response of Holling (1959a, b). (Wang and Ferro, 1998) observed that the egg-parasitism was positively correlated with egg density in case of *Trichogramma ostriniae* (Peng & Chen) which either exhibits the *type II* or *type III* functional response depending on temperature. Similarly, (Vargas and Nishida, 1982) observed that rate of parasitism increased both by high density of *Heliothis* eggs and by high temperature for *Trichogramma chilonis* Ishii on sweet corn. (Tran and Hassan, 1986) observed that the rate of parasitism by *Trichogramma evanescens* Westwood reached 40-76.9% depending on the population density of the pest in the area. Similar reports were also submitted by (Ashraf *et al.,* 1992) and (Yadav *et al.,* 2001) in case of *Trichogramma chilonis* Ishii. (Reay-Jones *et al.,* 2006) studied the functional response of three strains of *Trichogramma chilonis* Ishii on two host eggs, *Galleria mellonella* (Linnaeus) and *Chilo sacchariphagus* Bojer and observed *type III* functional response of the parasitoid on *Galleria mellonella* (Linnaeus) and *type II* functional response on *Chilo sacchariphagus* Bojer. (Fathipour *et al*., 2003) reported that the type of laboratory host has no important effect on the functional response of *Trichogramma embryophagum* (Hartig). (Reay-Jones *et al.,* 2006) suggested that the low rate of detected parasitism at low host densities as observed in most of the case may be due to incomplete pupal development due to superparasitism rather than lack of parasitism, thus explaining the *type III* functional response.

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REFFERENCES

Allahyari, H., Fard, P.A. and Nozari, J. 2004. Effects of host on functional response of offspring in two populations of *Trissolcus grandis* on the Sunn pest. .J. Appl. Entomol., 128: 39-43.

Ashraf, M., Fatima, B., Hussain, T. and Quereshi, Z. A.1992. Effect of oviposition substrate and host density on parasitism and progeny production of *Trichogramma chilonis* (Ishii). Science International, Lahore*,* 4(4): 415- 416.

Faria, C. A., Torres, E. J. B., Farias, A. M. E. 2000. Functional response of *Trichogramma pretiosum* Riley (Hymenoptera: Trichogrammatidae) to *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) eggs: effect of host age. Anais da Sociedade Entomológica do Brasil, 29 (1): 85-93.

Fathipour, Y., Haghani, M., Attaran, M., Talebi, A. A. and Moharramipour, S. 2003. Functional response of *Trichogramma embryophagum* (Hym.: Trichogrammatidae) on two laboratory hosts. Journal of Entomological Society of Iran, 23 (1): 41-54.

Foerster, M. R. and Foerster, L. A. 2009. Effects of temperature on the immature development and emergence of five species of Trichogramma. Biocontrol, 54: 445–450.

Force, D. C. and Messenger, P. S. 1964. Fecundity, reproductive rates, and innate capacity for increase of three parasites of *Therioaphis maculate* (Buckton). Ecology, 45: 706-715.

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

Hassell, M.P. 1978. *The Dynamics of Arthropod Predator- Prey Systems.* Princeton University Press, Princeton, NJ.

Hassell, M.P. 2000. *The Spatial and Temporal Dynamics of Host Parasitoid Interactions*. Oxford University Press, London, UK.

Hirashima, Y., Miura, K., Miura, T. and Hasegawa, T. 1990a. Studies on the biological control of the diamond black moth *Plutella xylostella* (L.). Effect of temperature on the development of the eggs of the parasitoid *Trichogramma chilonis.* Sci. Bull. Fac. Agric. Kyushu University, 44: 81-87.

Hirashima, Y., Miura, K., Miura, T. and Matsuda, S. 1990b. Studies on the biological control of the diamond back moth *Plutella xylostella* Linnaeus. 5. Functional responses of the egg parasitoids *Trichogramma chilonis* and *Trichogramma ostriniae* to host densities. Science Bulletin of the Faculty of Agriculture, Kyushu University*,* 44(3):89-93.

Holling, C. S. 1959a. The components of predation as revealed by a study of small-mammal predation of the European pine sawfly. Can. Entomol., 91: 293-320.

Holling, C. S. 1959b. Some characteristics of simple types of predation and parasitism. Can. Entomol., 91: 385-398.

Holling, C.S., 1966. The functional response of Invertebrate predators to prey density. Mem. Entomol. Soc. Can. 48, 1–86.

Honek, A. and Kocourek, F. 1990. Temperature and development time in insects: a general relationship between thermal constants. Zool. Jb. Syst., 117: 401–439.

Juliano, S. A. 1982. Influence of host age on host acceptability and suitability for a species of *Trichogramma* (Hymenoptera: Trichogrammatidae) attacking aquatic dipteral. The Canadian Entomologist, 114 (8): 713-720.

Kalyebi, A., Overholt, W. A., Schulthess, F., Mueke, J. M. and Sithanantham, S. 2006. The effect of temperature and humidity on the bionomics of six African egg parasitoids (Hymenoptera, Trichogrammatidae). Bull. Entomol. Res., 96: 305–314.

Karimiyan, Z. 1998. Biology and ecology of *Trichogramma brassicae* in rice fields of Guilan province. 150 pp., M.Sc. Thesis, Guilan University, Iran.

Lashgari, A. A., Talebi, A. A., Fathipour, Y. and Moharamipour, S. 2004. Study on the functional response of *Trichogramma brassicae* (Hym.: Trichogrammatidae) on three host species in laboratory condition. In: 16th Proceedings of Plant Protection, Tabriz, Iran. pp. 35.

Lopez, C. R. and Morrison, P. K. 1980. Effect of high temperature on *Trichogramma pretiosum* programmed for field release. J. Econ. Ent., 73: 667-670.

Mills, N. J. and Lacan, I. 2004. Ratio dependence in the functional response of insect parasitoids: evidence from *Trichogramma minutum* foraging for eggs in small host patches. Ecological Entomology, 29: 208- 216.

Moezipour, M., Kafil, M. and Allahyari, H. 2008. Functional response of *Trichogramma brassicae* at different temperatures and relative humidities. Bulletin of Insectology, 61 (2): 245-250.

Oaten, A. and Murdoch, W. W. 1975. Functional response and stability in predator-prey systems. The American Naturalist, 109: 289-298.

Ratte, H. T. 1985. Temperature and insect development, pp. 33–66. In Environmental Physiology and Biochemistry of Insects (Ed. Hoffmann, K.H.):. Springer, Berlin.

Reay-Jones, F. P. F., Rochat, J., Goebel, R. and Tabone, E. 2006. Functional response of *Trichogramma chilonis* to *Galleria mellonella* and *Chilo sacchariphagus* eggs. Entomologia Experimentalis et Applicata, 118(3):229-236.

Reznik, S.Y. and Vaghina, N. P. 2006. Temperature effects on induction of parasitization by females of *Trichogramma principium* (Hymenoptera, Trichogrammatidae). Entomological Review, 86(2): 133–138.

Reznik, S.Y., Voinovich, N. D. and Vaghina, N. P. 2009. Effect of temperature on the reproduction and development of *Trichogramma buesi* (Hymenoptera: Trichogrammatidae). Eur. J. Entomol., 106: 535–544.

Rogers, D. J. and Hassell, M. P. 1974. General models for insect parasite and predator searching behaviour: interference. J. Anim. Ecol., 43:239-253.

Singh, J., Brar, K. S., Shenhmar, M., Kaur, S., Kaur, S., Joshi, N. and Singh, I. 2002. Evaluations of *Trichogramma brasiliense* Ashmead, nuclear polyhedrosis virus and endosulfan for the management of *Helicoverpa armigera* (Hübner) on tomato. Proceedings of the Symposium on Biological Control of Lepidopteran Pests (Eds. P.L. Tandon, C.R. Ballal, S.K. Jalali and R.J. Rabindra), 17-18 July 2002, Bangalore, pp. 337-340.

Tandon, P.L. and Bakthavatsalam, N. (2003). Parasitization efficiency of *Trichogramma chilonis* Ishii on *Helicoverpa armigera* (Hübner) eggs-influence of pigeonpea genotypes, pp. 75-78. In *Biological Control of Lepidopteran Pests. Proceedings of the Symposium of Biological Control of Lepidopteran Pests*, July 17-18, 2002, Bangalore, India (Eds. Tandon, P. L.;Ballal, C. R.;Jalali, S. K.;Rabindra, R. J.).

Tran, L. C. and Hassan, S. A. 1986. Preliminary results on the utilisation of *Trichogramma evanescens* Westw. To control the asian corn borer, *Ostrinia furnacalis* Guenee in the Philippines. J. Appl. Ent., 101: 18-23.

Vargas, R. I. and Nishida, T. 1982. Parasitization by *Trichogramma chilonis* Ishii (Hymenoptera: Trichogrammatidae) of corn earworm eggs on sweet corn in Hawaii. Proceedings, Hawaiian Entomological Society, 24(1): 123-126.

Wang, B. and Ferro, D. N. 1998. Fuctional response of *Trichogramma ostriniae* (Hymenoptera:Trichogrammatidae) to *Ostrinaea nubilis* (Lepidoptera: Pyralidae) under laboratory and field conditions. Environ. Ent*.,* 27:752-758.

Wang, B., Ferro, D. N., Wu, J. and Wang, S. 2004. Temperature dependent development and oviposition behavior of *Trichogramma ostriniae* (Hymenoptera: Trichogrammatidae), a potential biological control agent for the European corn borer (Lepidoptera: Crambidae). Environ. Entomol., 33: 787–793.

Yadav, R.C., Singh, S.P., Jalali, S.K. and Rao, N.S. (2001). Effect of host egg density on parasitism and adult emergence in *Trichogramma chilonis* Ishii (Hymenoptera: Tricogrammatidae) in two systems. *Journal of Biological Control*, 15(1):11-14

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