Pest Management in Horticultural Ecosystems,
Vol. 9, No. 1 pp 13 - 17

LIFE TABLE CHARACTERISTICS OF *Trichogrammatoidea bactrae* Nagaraja AT DIFFERENT TEMPERATURES ON EGGS OF *Plutella xylostella* (Linnaeus)

S. K. JALALI, S. P. SINGH and T. VENKATESAN

Project Directorate of Biological Control, Post Bag No. 2491, Bellary Road
Bangalore - 560 024, India

ABSTRACT : Life table of *Trichogrammatoidea bactrae* Nagaraja, an egg parasitoid of *Plutella xylostella* (Linnaeus) was studied at different temperatures in the laboratory. Highest net reproductive rate was obtained at 25°C. At temperatures 15° to 20°C parasitoids exhibited Slobodkin's Type 1 response to mortality indicating that in lower temperatures mortality acts more heavily on the old individuals. At 25° and 30°C, parasitoids exhibited Type III response, which refers to constant mortality rate and at 33° and 35°C they exhibited Type IV response indicating mortality acts most heavily on the young individuals. Parasitoid was able to double its population in 2.64 and 2.23 days at 25° and 30°C, however, it took 3.79 to 9.9 days and 4.0 to 4.36 days at temperatures <20°C or >33°C to double its population. Very low reproductive rate, survival and finite rate of increase obtained at temperatures below 20°C or above 30°C indicated that this parasitoid could be used in the field in narrow range of temperature.

Key Words : Life table, *Plutella xylostella, Trichogrammatoidea bactrae*

INTRODUCTION

Plutella xylostella (Linnaeus) (Lepidoptera : Yponomeutidae) is a major defoliating caterpillar that hampers the successful cultivation of cabbage. *Plutella xylostella* is parasitised by trichogrammatids in various countries (Okada, 1989; Klemm *et al.*, 1990; Guo *et al.*, 1999; Yadav *et al.*, 2001). Jalali *et al.*, (2001) reported *Trichogrammatoidea bactrae* Nagaraja as most potential egg parasitoid for field use in India out of several species tested and recorded 55% reduction in larval population in net-house trial. However, *T. bactrae* should be released without being subjected to cold storage (Krishnamoorthy and Mani, 1999). The release of trichogrammatids in the field at Bangalore, Pune and Anand resulted in significant reduction in larval population and higher yield compared to insecticidal treatment (PDBC, 2001-2002). In any integrated pest management programme, trichogrammatids fit as a key input because these potential parasitoids could be mass produced for large scale use in the field.

The construction of life tables is vital for determining the expectations of life and understanding population dynamics of a species. The changes in the population survival curve describing the distribution of mortality with age was described by Slobodkin (1962), who recognised four types of mortality curves to differentiate species based on mortality distribution.

An attempt was made in the present study to critically assess the biological potential of *T. bactrae* by preparing fertility schedule at various temperatures. Such study will enable to know their potential in different temperature conditions.

MATERIALS AND METHODS

The culture of *P. xylostella* was raised in the laboratory on mustard seedlings. About 100 pupae were kept in insect rearing cages (30 cm^3) for moth emergence. A bouquet of cabbage leaves was kept inside the cage for egg laying. Moths were provided with water and 50% honey solution on cotton swabs. The bouquet was changed everyday and eggs up to 16-20 hold were utilised for the experiment. The eggs laid on the leaf were counted and the leaf was cut in to small bits and stapled on 6 x 2 cm paper card. Each egg card containing about 50 eggs was placed in glass vial (15 x 2.5 cm). One pair of newly emerged adult parasitoid was released in each glass vial for 24 hours. A fine streak of 50% diluted honey was provided as adult food. This process was repeated till all females died. The experiment was conducted in BOD incubators maintained at 15°, 20°, 25°, 30°, 33° and 35°C and was replicated 10 times. The age specific survival (l_x) and age specific fecundity (m_x) at each pivotal age (x) were worked out daily for entire reproductive period to prepare fertility table as outlined by Southwood (1976). The life table statistics was constructed as detailed by Andrewartha and Birch (1954) and Southwood (1976).

Net reproductive rate (R_O) = $\sum l_x m_x$

Approximate duration of generation (T_c) = $\sum x l_x m_x$

Approximate intrinsic rate of increase (r_c) = $\log_e R_O / T_c$

Precise intrinsic rate of increase (r_m) = $e^{-rm x} l_x m_x = 1$

Precise generation time (T) = $\log_e R_O$ / rm

Finite rate of increase (λ) = antilog$_e r_m$

Weekly multiplication rate = $(\lambda)^7$

Number of estimated females in F_2 = $(R_O)^2$

Doubling time (DT) = $\log_e 2 / r_m$

The age specific longevity (l_x) and fecundity (m_x) was plotted against the age (x) and the distribution of mortality was determined by shape of curve as described by Slobodkin (1962).

RESULTS AND DISCUSSION

The age specific survival and fecundity of *T. bactrae* at different temperatures are given in Figs. 1 and 2. *Trichogrammatoidea bactrae* had maximum life span of 32 and 23 days at 15° and 20°C and in that immature stage occupied 23 and 16 days, respectively. The oviposition started on 25th and 17th day and maximum fecundity was attained on the first day of oviposition. The survival curve at both these temperatures exhibited Slobodkin's Type 1 response, where mortality acts most heavily on old individuals. At 25° and 30°C, life span was 15 and 11 days, respectively of which immature stages occupied 10 and 7.5 days, respectively. The oviposition started on 12th and 8th day and maximum age specific fecundity was attained on the first day after oviposition. At both these temperatures parasitoids exhibited Slobodkin's Type III response, where mortality rate is almost constant with time. At 33° and 35°C, total life span of *T. bactrae* was 12 and 11 days, of which immature stages lasted 7 and 8 days, respectively and parasitoids produced maximum progeny on first day itself. At both these temperatures parasitoids exhibited Slobodkin's Type IV response, where mortality acts most on young ages (Figs. 1 and Fig. 2). The age specific fecundity of *T. bactrae* was always at a maximum on the first day after emergence. This is in agreement with the results of previous studies on other species of *Trichogramma* (Nagarkatti and Nagaraja, 1978; Singh and Jalali, 1994).

Table 1: Life table statistics of *T. bactrae* at different temperatures

Particulars	Temperature (in °C)					
	15	20	25	30	33	35
R_o	5.7	22.3	23.2	16.4	4.7	3.6
T_c	25.4	17.4	12.1	9.0	9.0	8.0
R_c	0.069	0.178	0.203	0.310	0.172	0.160
r_m	0.070	0.183	0.262	0.311	0.173	0.159
T	25.02	17.0	12.0	9.0	9.0	8.0
λ	1.07	1.20	1.29	1.36	1.18	1.17
Weekly multiplication rate	1.72	4.30	7.67	11.70	3.76	3.51
No. of estimated females in F_2	32.5	497.3	538.2	268.9	22.1	12.9
Doubling time	9.90	3.79	2.64	2.23	4.00	4.36

Life table statistics presented in Table 1 revealed that higher net reproductive rate was at 20° and 25°C, temperature below 20° and above 30°C was lethal for the parasitoid. The low values obtained at temperature above 30°C can be explained on the basis of Type IV mortality response curve, where most of the mortality occurred 1 day after parasitoid emergence. The temperature below 20°C is known to be unsuitable for most of trichogrammatids (Nagarkatti and Nagaraja, 1978). Similar variation in net reproductive rate due to temperature has been reported earlier (Narango, 1993; El-Hafez, 1995).

Approximate intrinsic rate of increase (r_c) was with 0.203 and 0.310 at 25° and 30°C and corresponding r_m values were 0.262 and 0.311, respectively. The values of reproductive potential obtained in the present study are higher than those obtained by Klemm and Schmutterer (1992) in Taiwan for *T. bactrae* strain obtained from Thailand but lower than that reported by Wuhrer and Hassan (1993) in Germany. The low Rc and r_m values at higher temperatures could be due to reduced longevity and male biased sex-ratio. Cabello and Vargas (1988) reported that temperature above 30°C was lethal for parasitoid survival and reproductive rate. The finite rate of increase (λ) was 1.20, 1.29 and 1.36 at 20°, 25° and 30°C, respectively, suggesting that the population increased at an average by 12.0, 12.9 and 13.6% each day. The population at these temperatures could multiply by 4.30, 7.67 and 11.70 times every week. The hypothetical female population in F_2 generation could be 497.3, 538.2 and 268.9, respectively. The parasitoids doubled its generation in least time 2.23 days at 30°C and longest in 9.9 days at 15°C.

Results of the study indicated that parasitoid is capable of producing more population between 20°C and 30°C and therefore could be useful in the field in this range.

ACKNOWLEDGEMENT

Authors are thankful to Dr. Y. Lalitha, Technical Officer for help rendered during the experiment.

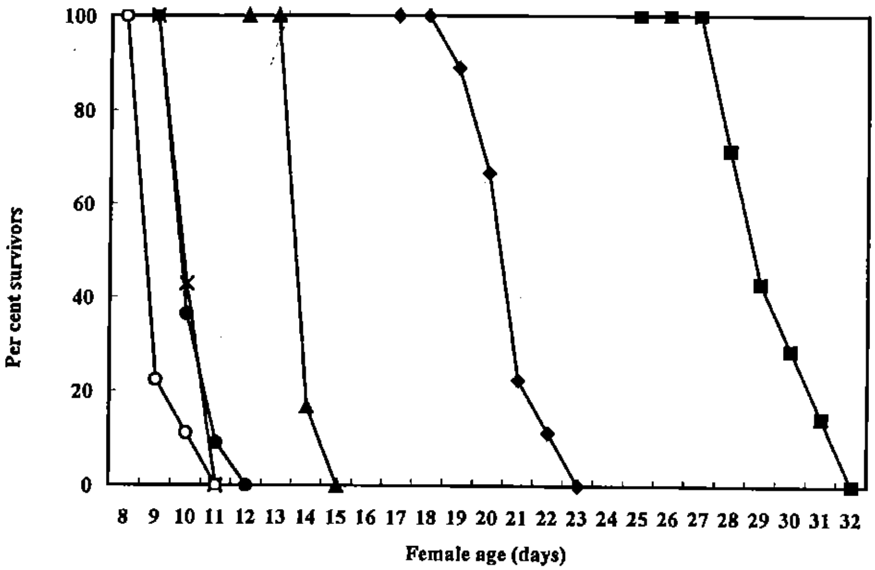

Fig. 1. Survivorship curves for females of *T. bactrae* at various temperatures

15°C 20°C 25°C 30°C 33°C 35°C

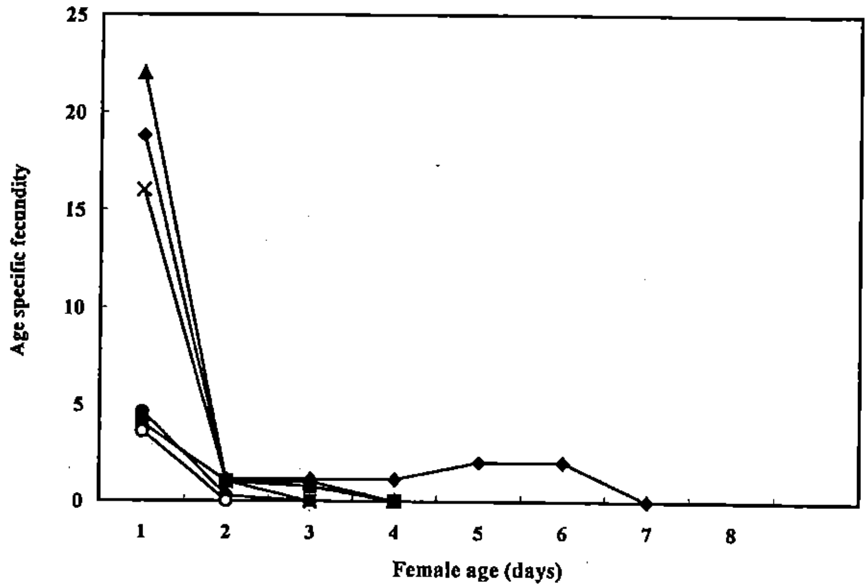

Fig 2. Age specific fecundity of *T. bactrae* at various temperatures

15°C 20°C 25°C 30°C 33°C 35°C

REFERENCES

Andrewartha, H.G. and Birch, L.C. 1954. *The Distribution and Abundance of Animals.* University of Chicago Press, Chicago, pp. 782.

Cabello, T. and Vargas, P. 1988. The effect of temperature on the bionomics of *Trichogramma cordubensis* (Hym. : Trichogrammatidae). Colleques I' INRA, No. **43**: 155-164.

El-Hafez, A.A. 1995. A comparison of thermal requirements and some biological aspects of *Trichogramma evanescens* Westwood and *Trichogrammatoidea bactrae* Nagaraja reared from eggs of pink and spiny bollworms. *Annals of Agricultural Sciences* (Cairo), **40**: 901-902.

Guo, M.F., Zhu, D.F. and Li-Ying, L. 1999. Selection of *Trichogramma* species for controlling the diamondback moth, *Plutella xylostella* (L.). *Entomologia Sinica,* **6**: 187-192.

Jalali, S.K., Singh, S.P. and Venkatesan, T. 2001. Choice of suitable trichogrammatid species for suppression of diamondback moth *Plutella xylostella* (Linnaeus) (Lepidoptera : Yponomeutidae) on cabbage. *Shashpa,* **8**: 161-166.

Klemm, U., Guo, M.F., Lai, L.F. and Schmutterer, H. 1990. Selection of effective species or strains of Trichogramma egg parasitoids of diamondback moth. In: *Proceedings of the Second International Workshop on Diamondback Moth and other Crucifer Pests,* Tainan, Taiwan, December 10-14, 1990, pp. 317-323.

Klemm, U. and Schmutterer, H. 1992. Selection of effective egg-parasitoids of the genera of Trichogramma and Trichogrammatoidea (Hymenoptera : Trichogrammatidae) and diamondback moth control in Taiwan. *Mitteilungen der Deutschen Gesellschaft fur Allgemeine and Angewandte Entomologie,* **8**: 82-86.

Krishnamoorthy, A. and Mani, M. 1999. Effect of low temperatures on the development of *Trichogrammatoidea bactrae* Nagaraja. *Insect Environment,* **5**: 78.

Nagarkatti, S. and Nagaraja, H. 1978. Experimental comparison of laboratory reared vs. wild type *Trichogramma confusum* (Hym.: Trichogrammatidae). I – Fertility, fecundity and longevity. *Entomophaga,* **23**: 129-136.

Naranjo, S.E. 1993. Life history of *Trichogrammatoidea bactrae* (Hymenoptera : Trichogrammatidae), an egg parasitoid of pink bollworm (Lepidoptera : Gelechidae) with emphasis of performance at high temperature. *Environmental Entomology,* **22**: 1051-1059.

Okada, T. 1989. Parasitoids of diamondback moth, *Plutella xylostella* (L.) (Lepidoptera : Yponomeutidae) species and seasonal change of parasitism in cabbage fields. *Japanese Journal of Applied Entomology and Zoology,* **33**: 17-23.

PDBC 2001-2002. *Annual Report for the year 2001-2002.* pp. 138-140. Project Directorate of Biological Control, Bangalore.

Singh, S.P. and Jalali, S.K. 1994. *Trichogrammatids. Technical Bulletin* No. 7, 93 pp., PDBC, Bangalore

Slobodkin, L.B. 1962. *Growth and Regulation of Animal Populations.* New York, 104 pp.

Southwood, T.R.E. 1976. *Ecological Methods with particular Reference to the Study of Insect Populations.* Chapman and hall, London pp. 391.

Wuhrer, B.G. and Hassan, S.A. 1993. Selection of effective species / strains of *Trichogramma* (Hym. : Trichogrammatidae) to control the diamondback moth *Plutella xylostella* L. (Lep.: Plutellidae), *Journal of Applied Entomology,* **116** : 80-85.

Yadav, D.N., Jha, A. and Devi, P.K. 2001. *Trichogramma chilonis* (Hymenoptera : Trichogrammatidae) on *Plutella xylostella* (Lepidoptera : Plutellidae). *Indian Journal of Agricultural Sciences,* **71**, 69-70.

[MS received 8 April 2002; revised 21 May 2003]