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Suitability of *Trichogrammatoidea bactrae* Nagaraja as an egg parasitoid of the diamondback moth *Plutella xylostella* (Linnaeus)

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ABSTRACT: **Laboratory evaluation of *Trichogrammatoidea bactrae* Nagaraja reared on *Corcyra cephalonica* (Stainton) as an egg parasitoid of *Plutella xylostella* (Linnaeus) was carried out at 26±1°C and 50-80 percent relative humidity. From each parasitized egg of *C. cephalonica*, up to 2 parasitoids emerged and there were almost equal chances of getting 1 or 2 parasitoids. Each female parasitized a mean of 4.6 and 6.4 eggs of *P. xylostella* and *C. cephalonica* during its mean survival of 1.7 and 2.3 days, respectively, and mean fecundity was 6.3 and 9.1 with a female biased sex ratio (64.6 and 68.6 percent females). The parasitoid failed to emerge from 45.9 and 38.9 percent parasitized eggs of *P. xylostella* and *C. cephalonica*. During post-embryonic development, 38.1 and 31.9 per cent mortality was observed and maximum mortality was in the pupal stage.**

KEY WORDS: *Corcyra cephalonica*, egg parasitoid, *Plutella xylostella*, *Trichogrammatoidea bactrae*

The diamondback moth, *Plutella xylostella* (Linnaeus) [Yponomeutidae] is a key pest of cole crops and is cosmopolitan in distribution. In cold dry areas of Himachal Pradesh, the pest has been reported to cause serious damage to cabbage seed crop, while in mid hills, it damages cabbage as well as cauliflower seed crops (Bhalla and Dubey, 1986). Generally, insecticides are used to suppress this pest but it often develops resistance to a variety of insecticides (Raju, 1996). Natural enemies substantially kill a larger proportion of the population and may eliminate up to 70 percent larvae and pupae of the pest (Chauhan *et al.*, 1997). So far, no parasitoid is known to attack its egg under natural conditions in India.

Trichogrammatids constitute one of the most important groups of biocontrol agents used for the suppression of several lepidopterous pests of various crops. On the basis of egg laying capacity and strong preference for *P. xylostella* eggs, Wuhrer and Hassan (1993) selected *Trichogramma chilonis*, *T. pintoi* and *Trichogrammatoidea bactrae* among 47 strains of *Trichogramma* and 2 strains of *Trichogrammatoidea* as good biological control agents. Singh *et al.* (1992) made an attempt to evaluate efficacy of *T. bactrae* against diamondback moth. In the present communication, *T. bactrae* has been evaluated as an egg parasitoid of *P. xylostella*.

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MATERIALS AND METHODS

For raising the culture of *P. xylostella*, its pupae were collected from field and kept in the laboratory for adult emergence. The culture was multiplied on cabbage or cauliflower leaves. The nucleus culture of *Trichogrammatoidea bactrae* was procured from the Project Directorate of Biological Control, Bangalore. *T. bactrae* was multiplied on *C. cephalonica* eggs and the latter species in turn was reared on crushed maize. From laboratory raised culture of *T. bactrae*, parasitized eggs were isolated and each was separately put in small glass tubes (6x1.5cm). These vials were kept in the culture room (temperature 26±1°C) for adult emergence. After adult emergence, contents of the vial were examined under stereoscopic binocular microscope to determine the sex and number of parasitoids emerged from each egg.

To study biological parameters of the parasitoid on eggs of *P. xylostella* and *C. cephalonica*, a small strip was cut from each trichocard and was put into the glass vial for adult emergence. Freshly emerged adults were separated, sexed and a pair was introduced in each vial. Eggs of *P. xylostella* laid on the tissue paper wrapped around the neck of the conical flask at the junction of petiole of the cauliflower/cabbage leaf with the flask were carefully removed and a bit of the tissue paper containing 20-25 eggs was glued on a thick paper strip (4 X 1cm). Also, 20-25 eggs of *C. cephalonica* were glued on 4 X 1cm strips. These were exposed to ultra-violet rays for 45 minutes in irradiation chamber to kill the embryo without damaging the egg structure. On each strip, 3-4 fine streaks of honey were applied and were introduced in the glass vial containing a pair of *T. bactrae*. After 24 hours, the strip was removed without disturbing the parasitoids and kept in an other marked vial for adult emergence. A new strip was introduced into each vial at 24-hour interval until death of the female parasitoid. Such observations were recorded on 60 females of *T. bactrae* on eggs of *P. xylostella* and 45 females on eggs of *C. cephalonica*. Since the parasitoid lays its minute egg(s) inside the egg of the host, it is difficult to count the exact number of eggs laid by the female. For recording fecundity, therefore, it was presumed that egg hatch was cent percent. Upon dissection, the blackened eggs without parasitoid emergence hole provided information about the stage of development of the parasitoid at which death occurred. Even, parasitized eggs with emergence hole were also dissected to record the presence of any dead stage of the parasitoid in it. The total live and dead progeny of each parasitoid was considered as its fecundity.

After emergence from parasitized eggs, adults were carefully removed, counted and sexed. When adult emergence had ceased, the strip was removed from the vial and eggs of the host were observed under stereoscopic binocular microscope to count the number of parasitized eggs. The parasitized eggs were categorized as those with and without parasitoid emergence hole. These were shifted to a cavity block containing 70 percent alcohol and dissected under microscope to record the developing stage (larva, pupa or adult) of the parasitoid at which mortality had occurred. The data on parasitization, development and adult emergence were arranged to determine mortality in immature stages, number of adults formed and sex ratio of emerged adults. The data were analyzed by using Fisher's t-test.

RESULTS AND DISCUSSION

In the laboratory maintained culture, adult emergence was from 70 percent of the parasitized *C. cephalonica* eggs. From 48 percent eggs one parasitoid emerged of either sex (male from 6.5% and female from 41.5% parasitized eggs) and from rest two parasitoids emerged (2 males from 5.2%, 2 females from 19.5%, and one each of both sexes from 27.3% parasitized eggs). Thus from each egg, on an average 1.5 parasitoids emerged and there was preponderance of females (70.9% of total emerged adults). Hutchison *et al.* (1990) occasionally recovered two small adults of *T. bactrae* per egg of *Pectinophora gossypiella* (Saunders) but in the laboratory, they often found one *T. bactrae* larva developing in one host egg when each female was provided more than 40 eggs. Under field conditions, Supharngkasen (1979)

recovered two or more parasitoids of *Trichogramma chilonis* Ishii and *T. bactrae* from over 50 percent of parasitized eggs of *Helicoverpa armigera* (Hübner) collected from cotton localities in Thailand. However, Manjunath (1972) obtained mostly one parasitoid of *Trichogrammatoidea armigera* from each parasitized *C. cephalonica* egg. In the present case, chances of getting one or two parasitoids per egg were almost equal.

Although each female was provided with 20 to 25 eggs, the number of parasitized eggs did not exceed 12 in case of *C. cephalonica* and 10 in case of *P. xylostella*. On an average, a female parasitized 6.4 and 4.6 eggs of these two respective hosts at 26±1°C during its lifetime of 2.35 and 1.67 days, respectively. This number is quite low as compared to the parasitization capacity of *T. bactrae fumata* which parasitized 49 eggs of *C. cephalonica* during 3-10 days of adult life (Lim, 1986) and *T. armigera*, which parasitized 33-115 (average 59) eggs during its survival for 4-11 (average 7) days (Manjunath, 1972). Adults emerging from *C. cephalonica* eggs survived for longer duration (56.1h) than those emerging from *P. xylostella* eggs (40.4 h). Longevity of *T. bactrae* obtained in the present study was similar to that reported by Hutchison *et al.* (1990).

The mean fecundity of 9.1 on *C. cephalonica* was significantly higher than that of 6.3 on eggs of *P. xylostella* (Table 1). Adult emergence was 6.2 and 3.9 from respective eggs of *C. cephalonica* and *P. xylostella*, parasitized by a female of *T. bactreae*. The parasitoid emergence took place from 61.1 and 54.1 percent parasitized eggs, respectively. Naranjo (1993) reported a modest fecundity of 14.23 at 30-35°C and a peak fecundity of 55 per female at 25°C on *P. gossypiella*. According to El-Hafez (1995) optimum temperature for fecundity of 24/female in case of *T. bactrae* is 22-28°C. However, in the present study, a fecundity was very low on both hosts, though the temperature was optimum (26±1°C).

The parasitoid failed to emerge from 38.9 and 45.9 percent parasitized eggs of *C. cephalonica* and *P. xylostella*, respectively. The mortality during post-embryonic development was 2.9, 18.8 and 9.4 percent in larval, pupal and adult stage in eggs of *C. cephalonica* and 3.4, 21.9 and 12.9 percent, respectively, in eggs of *P. xylostella*. Thus, 31.1 and 38.1 percent of fecundity was lost during post-embryonic development in these two respective hosts. The overall mortality was significantly higher in eggs of *P. xylostella*. Mortality trend in pupal stage was higher in both host-eggs. From all these facts, it emerges that eggs of *C. cephalonica* are superior to those of *P. xylostella* for development and biological performance of *T.*

Table 1. Relative performance of *T. bactrae* on eggs of *C. cephalonica* and *P. xylostella*

Parameter (per female)	*C. cephalonica* Mean ±SE (Range)	*P. xylostella* Mean±SE (Range)	Calculated value of t
Eggs parasitized	6.4± 0.5 (1-12)	4.6± 0.3 (1-10)	3.041*
Eggs with exit hole (%)	61.1± 4.6 (25-100)	54.1± 4.3 (20-100)	1.106
Adults emerged from eggs with exit hole	7.1± 0.6 (1-14)	4.7± 0.4 (1-11)	3.123*
Parasitoids emerged from all parasitized eggs	6.2± 0.7 (0-14)	3.9± 0.4 (0-11)	3.003*
Fecundity	9.1± 0.8 (2-19)	6.3± 0.5 (1-15)	3.099*
Longevity (h)	56.1± 1.1 (40-70)	40.4± 0.6 (35-52)	12.741*
Females in the progeny (%)	68.6± 2.5 (55-74.2)	64.6 2.1 (51-86.2)	1.526

Calculated value of t marked with * indicates significant difference between two means at p= 0.01 in Fisher's t-test

bactrae. There was preponderance of females (68.6 and 64.6 %) among the adults emerged from eggs of *C. cephalonica* and *P. xylostella*. Hutchison *et al.* (1990) and Naranjo (1993) observed that the proportion of females (51.6-77.5% and 61.0-69.0% in their respective studies) did not change appreciably in relation to temperature indicating no differential mortality of the sexes in *T. bactrae*. Singh and Jalali (1994) have also tabulated life table statistics for various *Trichogramma* and *Trichogrammatoidea* species and even in *Trichogramma*, sex-ratio is in favour of the female.

These statistics reveal that the stock of *Trichogrammatoidea bactrae* tested in the study is a short lived egg-parasitoid with low fecundity as compared with other species of this genus and *Trichogramma*. This does not seem to be a very promising material for suppression of *P. xylostella*. There is a need to find out a strain or species that is better for control of *P. xylostella*.

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