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# Role of egg parasitoid, *Trichogrammatoidea bactrae* Nagaraja alone and in combination with dichlorovos in the management of *Plutella xylostella* (Linnaeus) on cabbage

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**ABSTRACT:** **The optimum release dosage of *Trichogrammatoidea bactrae* Nagaraja and its comparative efficacy alone and in combination with dichlorvos against diamondback moth (DBM), *Plutella xylostella* (Linnaeus) on cabbage was worked out. Results of the study on the percentage parasitization under different host-parasitoid ratios revealed that the maximum DBM egg parasitization (83.0%) was recorded in the ratio 100 (eggs): 5 (females), which was on par with other higher ratios of 100:10 to 100:20. The release of *T. bactrae* twice (2 and 5 days after DBM moth release) proved as the most effective treatment in significantly reducing the larval population (4.89 larvae per plant) in comparison to two sprays of dichlorvos (0.05%) (14.54 larvae per plant). The results indicated the efficacy of *T. bactrae* in suppressing DBM on cabbage and calls for further evaluation in field trials.**

**KEY WORDS:** Cabbage, dichlorvos, efficacy, *Plutella xylostella*, *Trichogrammatoidea bactrae*

## INTRODUCTION

The diamondback moth (DBM), *Plutella xylostella* (Linnaeus) is a major limiting factor for successful cultivation of cabbage causing yield loss to the extent of 44.6 per cent (Krishnaiah, 1980). Cultural practices, plant resistance, sex pheromone, microbial and chemical control measures have been tried to suppress the pest incidence, but none of these have given satisfactory results. The indiscriminate use of insecticides has resulted in serious problems like development of resistance, environmental contamination, residual toxicity, and hazards to non-targeted fauna (Talekar and Shelton, 1993). DBM has developed resistance to more than 46 insecticides including organophosphates, carbamates and synthetic pyrethroids and has been reported as the first crop pest to develop resistance to *Bacillus thuringiensis* formulations (Miyata *et al.*, 1992). There is a need to search for alternate approaches like augmentation of natural enemies for the effective management of the DBM. Among the parasitoids, *Trichogrammatoidea bactrae* Nagaraja is reported to be an efficient egg parasitoid, which could parasitize up to 89.6 per cent in the laboratory and bring about 55.0 per cent

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pest suppression in the glasshouse (Jalali *et al.*, 2001). The standardization of host-parasitoid population ratio of *P. xylostella* and *T. bactrae* is essential to recommend the field release dosage. Hence, the present investigation was undertaken to determine the optimum dosage of *T. bactrae* release and assess the efficacy of this parasitoid alone and in combination with a standard chemical insecticide (dichlorvos) against *P. xylostella*.

## MATERIALS AND METHODS

The experiments were carried out under laboratory and potted plant conditions during September to December 2003 at Project Directorate of Biological Control, Bangalore using cabbage variety 'Shristi'.

### Laboratory determination of optimum release dosage of *T. bactrae* on eggs of *P. xylostella* on cabbage

Twelve hour-old eggs of *P. xylostella* procured from the laboratory were utilized for the experiment. The leaf bit containing hundred (100) eggs was placed in test tubes (20x4cm) for parasitization. Fine streaks of honey solution (50%) were provided as adult food in each test tube. The eggs in each tube were exposed in $T_1$ to one mated female of parasitoid (100:1), in $T_2$ to five females (100:5), in $T_3$ to ten females (100:10), in $T_4$ to fifteen females (100:15) and in $T_5$ to twenty females (100:20). Each treatment was replicated five times. The females were allowed to parasitize for 24 hours and the leaf bits with parasitised eggs were kept in fresh tube for further development and emergence. Observations on developmental period, number of adult parasitoids emerged and percentage parasitization were made. The experiment was conducted at 26±2°c temperature and 65±5 per cent relative humidity.

### Potted plant evaluation of *T. bactrae* alone and in combination with dichlorvos against *P. xylostella* on cabbage

The cabbage variety 'Shristi' was raised in the earthen pots following all recommended agronomic practices except plant protection measures. Three potted cabbage plants were kept in the net cage (80x75x75cm) for each treatment. Each treatment was replicated five times. In both the experimental and control net cages, twenty pairs of freshly emerged moths of DBM were released and these pots were used for imposing the treatments. The treatments imposed were $T_1$ – *T. bactrae* adults released twice i.e., 2 and 5 days (each time @ 5 adults/plant) after release of DBM moths; $T_2$ – *T. bactrae* released once (@ 5 adults/plant) 2 days after moth release, followed by a spray of dichlorvos 76 EC (0.05%) 7 days later; $T_3$ – two sprays of dichlorvos 76 EC (0.05%) given 7 and 10 days after release of moths and $T_4$ – untreated control. Five days after release of moths, net cages were removed and pots were kept for further observation. The number of healthy DBM eggs was counted in all the leaves of the potted plants prior to insecticide application to determine the percentage parasitization due to *T. bactrae*.

Observations of the surviving larval pest population in both treated and untreated potted plants were recorded on 1, 3, 5 and 7 days after insecticide applications. The data obtained for per cent parasitism was transformed to arcsine transformation and that of number of larvae by $\sqrt{x+0.5}$.

## RESULTS AND DISCUSSION

### Determination of optimum dosage of *T. bactrae* release on eggs

The per cent parasitism in all the host-parasitoid ratios from 100:5 to 100:20 were on par with each other but was significantly different from the ratio 100:1 (Table 1). The parasitism in higher parasitoid ratios ranged from 71.5 to 83.0 per cent in comparison to 40.8 per cent in lower ratio. The adult emergence increased with increase in parasitoid number and maximum adult emergence (98.6 %) was obtained from 100:20 ratio indicating that more than one adult emerged from a single egg. The mean number of adults obtained per egg was 0.73, 0.72, 0.78, 1.06 and 1.37 in the five ratios, respectively indicating super parasitism in higher ratios. Developmental period of *T. bactrae* and number of

**Table 1. Parasitizing efficiency of *T. bactrae* at different host-parasitoid ratios on *P. xylostella* eggs**

| Ratio | Mean parasitization (%) | Mean developmental period of parasitoid (days) | Mean adult parasitoid emerged / egg | Mean parasitoid emerged (%) | Mean Percent DBM larvae emerged |
|---|---|---|---|---|---|
| 100:1 | 40.8 (39.6)[b] | 8.4 | 0.73 | 29.8[c] | 12.4 |
| 100:5 | 83.0 (69.1)[a] | 8.2 | 0.72 | 60.0[b] | 5.7 |
| 100:10 | 71.5 (60.1)[a] | 8.2 | 0.78 | 56.4[b] | 7.0 |
| 100:15 | 79.0 (63.4)[a] | 8.2 | 1.06 | 83.8[a] | 3.5 |
| 100:20 | 71.5(58.1)[a] | 8.3 | 1.37 | 98.6[a] | 1.5 |
| SEM± | 5.6 | 0.6 | | 10.0 | 3.4 |
| CD (p = .05) | 16.7 | NS | | 30.1 | NS |

Figures in parentheses are arcsine-transformed values.
NS = Non significant

DBM larvae hatching from unparasitized eggs was not significantly different between treatments. The variation in parasitism and increase in adult emergence found in the different ratios may be due to inherent differences in the parasitoid. This indicates that with increase in the number of adults, eggs were superparasitised. Jalali *et al.* (2001) found that *T. bactrae* parasitized 89.6 per cent of DBM eggs and was best compared to all other species tested against this pest.The maximum DBM larval hatching (12.4%) was recorded in the ratio of 100:1, while the ratio of 100:20 minimum larval hatching (1.5%). This may be attributed to lower/higher parasitization of DBM eggs as a result of lower/ higher ratio of host: parasitoid. The present findings suggest that 100:5 ratio is a suitable density for further field investigations as it recorded highest per cent parasitization of eggs and least larval hatch.

### Efficacy of *T. bactrae* release alone and in combination with dichlorvos

All the treatments were significantly superior to untreated control in reducing larval population of DBM (Table 2). The number of unparasitized eggs recorded in the treatment with release of *T. bactrae* twice was significantly less (51.4/plant) as compared to 164.6, 239.2 and 264.0 in other treatments. Maximum percentage reduction of healthy eggs (80.53) over untreated control was observed in treatment with two releases of *T. bactrae* ($T_1$), followed by 37.7 per cent in one release of *T. bactrae* ($T_2$). This variation was due to the releases of *T. bactrae* coinciding with egg laying by DBM. The results of the present study for the level of parasitization by *T. bactrae* were in conformity with the findings of Jalali *et al.* (2001) who reported 89.6 per cent parasitism of DBM eggs caused by the same species in the laboratory. The larval population of DBM was lowest (2.75 larvae/plant) in the treatment with two releases of *T. bactrae* followed by its combination with dichlorvos treatment (4.25 larvae/plant) at 1 DAT, which were on par. Similarly, at 3 and 5 DAT with two releases of *T. bactrea* was found to be the most effective treatment against the pest recording lowest larval population of 4.8 and 6.0 per plant, respectively, followed by combined application with dichlorvos. The two releases of *T. bactrae* were observed to be superior over other treatments up to 7 days after treatment, whereas, dichlorvos application alone showed its inferiority to other treatments in reducing the larval population in all the observation intervals.

**Table 2. Efficacy of *T. bactrae* alone and in combination with dichlorvos against *P. xylostella* on cabbage**

| Treatment | Mean unparasitized eggs of DBM at 1DBT | Mean larval population/plant | | | | Pooled mean | Reduction in larval population over control (%) |
|---|---|---|---|---|---|---|---|
| | | 1 DAT | 3 DAT | 5 DAT | 7 DAT | | |
| $T_1$. *T. bactrae* @5 adults / plant twice | 51.40 (7.17) [a] | 2.75 (1.80) [a] | 4.80 (2.30) [a] | 6.00 (2.55) [a] | 6.00 (2.51) [a] | 4.89 (2.29) [a] | 89.49 |
| $T_2$. *T. bactrae* @ 5 adults /plant once + one spray of dichlorvos (0.05%) | 164.60 (12.84) [b] | 4.25 (2.17) [a] | 7.20 (2.77) [b] | 7.40 (2.81) [ab] | 8.80 (3.04) [b] | 6.91 (2.70) [a] | 85.15 |
| $T_3$. Two sprays of dichlorvos (0.05%) | 239.20 (15.45) [c] | 12.75 (3.61) [b] | 15.20 (3.96) [c] | 9.80 (3.21) [b] | 20.40 (6.45) [c] | 14.54 (4.31) [b] | 68.75 |
| $T_4$. Untreated control | 264.00 (16.24) [c] | 36.50 (6.04) [c] | 48.00 (6.95) [d] | 50.60 (7.16) [c] | 51.00 (7.17) [d] | 46.53 (6.83) [c] | - |
| SEM± | 0.38 | 0.21 | 0.14 | 0.11 | 0.17 | 0.34 | - |
| CD (p = 0.05) | 1.17 | 0.81 | 0.43 | 0.34 | 0.52 | 1.08 | - |

Figures in parentheses are $\sqrt{x + 0.5}$ transformed values.
DAT = Days after treatment
DBT = Day before treatment

The pooled data also revealed that release of *T. bactrae* @ 5 adults/plant twice proved the most effective with the lowest larval population of 4.89 against 46.53 per plant in untreated control. The effectiveness of *T. bactrae* releases alone may be attributed to its greater parasitising efficiency occurring in the egg stage of DBM. Reports by Petcharat (1999), He *et al.* (2001) and Jalali *et al.* (2001) indicated higher per cent parasitization of DBM eggs by *T. bactrae*. The inefficacy of dichlorvos may be due to its low persistent nature. The failure of dichlorvos spray in the suppression of DBM population observed in the present study agrees with the results of Srinivasan and Krishna Kumar (1986) and Kalra and Sharma (2000). On the basis of over all efficacy of different treatments against DBM, the percentage reduction of larval population over untreated control was estimated as 89.49, 85.15 and 68.75 in *T. bactrae* alone, combined with dichlorvos and dichlorvos alone treatments, respectively.

The results indicated that *T. bactrae* is a very efficient parasitoid for suppression of DBM on cabbage and should be used in field trials to determine its efficiency.

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