Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Vol 6 Special issue [2] 2017: 452-459

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD
Global Impact Factor 0.533
Universal Impact Factor 0.9804
NAAS Rating 4.95

FULL LENGTH ARTICLE **OPEN ACCESS**

Documentation of parasitoid complex on brinjal shoot and fruit borer, *L*eucinodes *orbonalis* Guenee

Murali, S[1]., Jalali, S. K[2]., Kariyanna, B[4]., Shylesha, A. N[2]., Shivalinga Swamy, T. M[2]. and Gandhi Gracy, R[3]

[1]Scientist - B, CSB, RSRS, Jammu - 181101, J & K, India
[2]Principal Scientist, NBAIR, Bengaluru - 560024, Karnataka, India
[3]Scientist, NBAIR, Bengaluru - 560024, Karnataka, India
[4]Student, NBAIR, Bengaluru - 560024, Karnataka, India
Corresponding email: dr.mmrl@rediffmail.com

ABSTRACT

The investigation to document parasitoids which are attacking brinjal shoot and fruit borer, L. orbonalis a major pest of brinjal crop. To study this infested fruits collected from sprayed and unsprayed areas kept under caged condition to observe emergence of parasitoids. A total of 16 species of parasitoids were recorded on L. orbonalis consisting of Ichneumonidae (5 species), viz., Trathala flavoorbitalis, Isotima javensis, Xanthopimpla sp., Indeterminate Cryptinae and nr. Goryphus sp., Pteromalidae (3 species) viz., Spalangia gemina, Spalangia sp. and Pachyneuron aphidis, Braconidae (2 species) viz., Phanerotoma sp. and Indeterminate Braconidae, Trichogrammatidae (6 species), viz., Trichogramma achaeae, T. japonicum, T. chilotraeae, T. chilonis, Trichogramma sp. and Trichogrammatoidea bactrae. Trathala flaororbitalis was recorded as most dominant parasitoid, the number of females emerged from Attur Farm, Chikkaballapur and Doddaballapur was 4.48, 2.80 and 2.77, respectively, whereas for another important parasitoid, indeterminate Braconidae, population recorded was 3.18, 2.34 and 1.97, respectively. The larval parasitoid population was 35.9 and 61.4 per cent higher in unsprayed area (Attur Farm) compared to two sprayed areas. Among egg parasitoid, T. chilonis was most dominant species, however atleast four them, viz., Trichogramma sp., T. chilotrare and Trichogrammatoidea bactrae were recorded for the first time on L. orbonalis. In unsprayed area the population was 107-120 per cent higher when compared to sprayed areas.

Key words: *Parasitoids, L. orbonalis, sprayed areas, unsprayed area, brinjal*

Received 02.07.2017 Revised 19.08.2017 Accepted 29.08.2017

INTRODUCTION

Eggplant (*Solanum melongena*) is one of the most important vegetables in South and South-East Asia. It is grown on over 678,000 ha, which is about 37% of the world eggplant area, with a production of 10.50 million t (FAO, 2007). Eggplant fruit and shoot borer (EFSB), Leucinodes orbonalis Guenée (Lepidoptera: Pyrallidae) is one of the most destructive pests on eggplant in South and Southeast Asia. Larvae of this insect bore inside plant shoots and fruits adversely affecting plant growth, yield and fruit quality, and thus making it unfit for human consumption. The yield reduction could be as high as 70% (Islam and Karim, 1991; Dhandapani et al., 2003). Hence, the farmers in the region rely exclusively on the application of chemical insecticides to combat EFSB which has resulted in a tremendous misuse of pesticides in an attempt to produce damage-free marketable fruits.

The shoot and fruit borer is reported to be parasitized by number of parasitoids (Krishnamoorthy and Mani, 1998), among them, *Trathala flavor- orbitalis* was recorded as one of the important parasitoids causing considerable larval parasitization. The information on seasonality of natural enemies is scanty, particularly their availability in sprayed and unsprayed conditions. However, no attempts have ever been made to explore, mass multiply and utilize parasitoids under field conditions for extensive control of BSFB in India.

MATERIAL AND METHODS:

The documentation of natural enemy diversity was carried out in two systems, one unsprayed for which crop was raised at research farm of NBAIR, Bengaluru, at their Yelahanka Campus, Attur Farm and another at sprayed situation at farmers field at Doddaballapur and Chikkaballapur. The crop was raised/ observed from June, 2013 to June, 2014, for one year. At NBAIR research farm, plot was prepared by ploughing and cross-ploughing followed by laddering. All the plots were prepared with proper proportions of manure and fertilizers. The plot size was prepared 8 × 8 m having 75 × 60 cm plant spacing as control plot. The variety which we have used for experimentation was MAHYCO-11 throughout the year. For comparison from control plot, farmer fields were selected at Doddaballapur and Chikkaballapur districts. At farmers' field, the crop stage selected was 35 days after transplanting of the crop and plot size was 8 × 8 m was selected irrespective of the plant spacing and variety grown by the farmers. For parasitoids against the BSFB, 50 infested fruits were collected each time from both systems, *i.e*., unsprayed and sprayed systems and these fruits were carried to the laboratory and kept under caged condition for the emergence of moths and the parasitoids. After collection, specimens were identified with the help of specialists. The sampling was done once in 10 days in both unsprayed and sprayed fields, thus 36 observations were recorded in a year. The relative abundance of dominant species of parasitoids was worked out by using the following formula after pooling all the data and expressed in percentage.

$$\text{Relative abundance of species A} = \frac{\text{Number of species}}{\text{Total number of species in the crop}} \times 100$$

The analysis of mean comparisons between sprayed and unsprayed areas Bonferroni method has been used. The data was transformed to square root transformation before analysis by repetitive measures of ANOVA.

RESULTS:

Parasitoid emergence pattern from sprayed and unsprayed areas

The results of the observations recorded during 2013-14 under two conditions *i.e.,* unsprayed area at Bengaluru (Attur Farm) and sprayed areas at Chikkaballapur and Doddaballapur are presented here under.

3.1.1 Diversity of parasitoids occurring in brinjal crop

The results of the present investigation revealed that totally 16 species of parasitoids were recorded on brinjal fruit and shoot borer, *L. orbonalis* (Table 1), among them the family wise species composition was as follows: Ichneumonidae (5 species), *viz*., *Trathala flavoorbitalis*, *Isotima javensis, Xanthopimpla* sp., Indeterminate Cryptinae and *nr. Goryphus* sp., Pteromalidae (3 species), *viz*., *Spalangia gemina*, *Spalangia* sp. and *Pachyneuron aphidis,* Braconidae (2 species), *viz*., *Phanerotoma* sp. and Indeterminate Braconidae, Trichogrammatidae (6 species), *viz*., *Trichogramma achaeae*, *T. japonicum, T. chilotraeae, T. chilonis, Trichogrammatoidea bactrae* and *Trichogramma* sp. By observing the faunal composition of parasitoids highest number of species was observed at unsprayed area compared with sprayed area.

Relative abundance of parasiotoids in brinjal crop

Emergence of *Trathala flavoorbitalis*

During *Kharif* season, the average number of females that emerged were significantly more in unsprayed area as compared to the sprayed conditions. The mean number of females was found to be 2.94, 3.32 and 6.30 at Doddaballapur, Chikkaballapur and Attur Farm, respectively. The analysis of *t*-test showed that there significant differences could be observed between both sprayed and unsprayed area, *i.e.,* Chikkaballapur and Attur Farm (*t*-value= 12.26; *P* = 0.0001) and Doddaballapur and Attur Farm (*t*-value = 15.25; *P* = 0.0001) (Table 2). When means were compared with Bonferroni method, it was observed that area 1 and 3 were non-significantly different, whereas 1 and 2 and 2 and 3 were significantly different from each other (Table 3). Similar results were obtained during *Rabi* and Summer seasons under sprayed and unsprayed conditions showed significant differences between populations of *Trathala flavor-orbitalis* (Table 3).

Emergence of indeterminate braconid parasitoid

During *Kharif* season, the average number of parasitoids that emerged from *L. orbonalis* larvae was more in unsprayed area as compared to sprayed conditions. The number of females was found for 2.11, 2.39 and 4.42 at Doddaballapur, Chikkaballapur and Attur Farm, respectively. The analysis of *t*-test showed that significant differences were observed between both sprayed and unsprayed areas, *i.e.,* Chikkaballapur and Attur Farm (*t*-value = 10.15; *P* = 0.0001) and Doddaballapur and Attur Farm (*t*-value 9.43; *P* = 0.0001) (Table 2). Means when compared with Bonferroni method indicated that, all the areas were significantly different with each other (Table 4). During *Rabi* season, parasitoid emergence was

significantly more in unsprayed area when compared with sprayed area and results obtained during Summer season 1 and 2, 1 and 3 were non-significant whereas 2 and 3 showed significant differences between them (Table 4).

Emergence of Trichogrammatids

During *Kharif* season, the average number of trichogrammatids that emerged from the field-collected in unsprayed area, *viz*., Attur Farm was significantly more as compared to those in sprayed areas. The mean number of adults that emerged from Doddaballapur, Chikkaballapur and Attur Farm was 4.72, 4.74 and 9.81, respectively. The analysis of *t*-test indicated significant difference between both sprayed and unsprayed areas, *i.e.,* Chikkaballapur and Attur Farm (*t*-value = 5.78; *P* = 0.0001) and between Doddaballapur and Attur Farm (*t*-value = 5.86; *P* = 0.0001) (Table 2). Means were compared with Bonferroni method indicated that there was a non-significant difference between area 1 and 3, whereas a significant difference was observed between 1 and 2 and 2 and 3 (Table 5). Similar significant differences were observed for *Rabi* and Summer seasons for the occurrence of trichogrammatids under sprayed and unsprayed conditions (Table 5).

Relative abundance of different trichogrammatid fauna in brinjal crop

a) At Attur Farm

During *Kharif* season, maximum number of adults were recorded for *Trichogramma chilonis* (21.58 adults), followed by *Tr. Bactrae* (13.42 adults) and minimum number of adults were recorded for *T. japonicum* (4.67 adults) (Table 6). Among the *Trichogramma* species, maximum relative abundance was found in case of *Trichogramma chilonis* (36.69%), followed by *Tr. Bactrae* (22.80%), and lowest species composition was observed in *T. japonicum* (7.93%) (Table 6).

Similarly, during *Rabi* season, maximum mean number of trichogrammatid adults were recorded in case of *T. chilonis* (16.50 adults), followed by *Tr. bactrae* (8.50 adults) and minimum mean number of adults was recorded in case of *T. chilotraeae* (4.50 adults) (Table 6). Among the *Trichogramma* species maximum relative abundance was recorded in case of *T. chilonis* (35.23 %), followed by *Tr. bactrae* (18.15 %) and lowest species composition was observed for *T. chilotraeae* (9.61 %) (Table 6).

During Summer season, maximum number of trichogrammatid species was recorded in case of *T. chilonis* (17.17 adults), followed by *Tr. bactrae* (9.25 adults) and minimum number of trichogrammatids was recorded in case of *T. japonicum* (5.08 adults) (Table 6). Among the *Trichogramma* species maximum relative abundance was found in case of *T. chilonis* (34.74 %), followed by *Tr. bactrae* (18.72%) and *T. japonicum* which showed the least species composition (10.29 %) (Table 6).

b) At Chikkaballapur

During *Kharif* season, maximum number of trichogrammatids were recorded in case of *T. chilonis* (10.67 adults), followed by *Tr. bactrae* (6.08 adults) and minimum number was in case of *Trichogramma* sp. (2.25 adults) (Table 7). Among the *Trichogramma* species maximum relative abundance was observed in case of *T. chilonis* (37.54 %), followed by *Tr. bactrae* (21.41 %) and lowest species composition was observed in case of *Trichogramma* sp. (7.92 %) (Table 7).

Similarly, during *Rabi* season, maximum number of trichogrammatids were recorded in case of *T. chilonis* (10.08 adults), followed by *Tr. bactrae* (6.33 adult) and minimum number of trichogrammatids was recorded in case of *Trichogramma* sp. (4.50 adult) (Table 7). The relative abundance was highest for *T. chilonis* (40.07 %), followed by *Tr. bactrae* (25.17 %) and lowest species composition was observed in case of *Trichogramma* sp. (6.62 %) (Table 7).

During Summer season, maximum number of trichogrammatids were recorded in case of *T. chilonis* (10.42 adults), followed by *Tr. bactrae* (6.83 adults) and minimum number of trichogrammatids was recorded in case of *Trichogramma* sp. (1.67 adults) (Table 7). The relative abundance was highest for *T. chilonis* (39.56 %), followed by *Tr. Bactrae* (25.95 %) and lowest species composition was observed for *Trichogramma* sp. (13.15 %) (Table 7).

c) At Doddaballapur

During *Kharif* season, maximum number of trichogrammatids was recorded in case of *T. chilonis* (10.75 adults), followed by *Tr. bactrae* (6.33 adults) and minimum number of trichogrammatids recorded was in case of *Trichogramma* sp. (2.33 adults) (Table 8). The maximum relative abundance was in case of *T. chilonis* (37.94 %), followed by *Tr. bactrae (*22.35 %) and lowest species composition was observed in *Trichogramma* sp. (8.24 %) (Table 8).

Similarly, during *Rabi* season, maximum number was recorded for *T. chilonis* (10.17 adults), followed by *Tr. bactrae* (6.08 adults) and minimum mean number of trichogrammatids was recorded in case of *T. chilotraeae* and also in case of other *Trichogramma* sp. (2.08 adults) (Table 8). Among the *Trichogramma* species maximum relative abundance was as in case of *Trichogramma chilonis* (39.48 %), followed by *Tr. Bactrae* (23.62 %) and lowest species composition was observed incase of *T. chilotraeae* and other *Trichogramma* sp. (8.09 %) (Table 8).

During Summer season, maximum number of trichogrammatids were recorded in case of *T. chilonis* (10.58 trichogrammatids), followed by *Tr. bactrae* (6.83 trichogrammatids) and minimum number of trichogrammatids was recorded incase of *T. chilotraeae* (1.83 trichogrammatids) (Table 8). Among the *Trichogramma* species maximum relative abundance was found in case of *T. chilonis* (39.56 %), followed by *Tr. bactrae* (25.55 %) and lowest species composition was observed in *T. chilotraeae* (6.85 %) (Table 8).

DISCUSSION

The results of the present investigation suggests that 16 species of parasitoids were recorded, among them 5 species belonged to Ichneumonidae, *viz*., *Trathala flavor-orbitalis*, *Isotima javensis, Xanthopimpla* sp., Indeterminate Cryptinae and *nr. Goryphus* sp., 3 species of Pteromalidae, *viz*., *Spalangia gemina*, *Spalangia* sp. and *Pachyneuron aphidis,* Braconidae (2 species) *viz*., *Phanerotoma* sp. and Indeterminate Braconidae and 6 species of Trichogrammatidae, *viz*., *Trichogramma achaeae, T. chilotraeae, T. japonicum, T. chilonis, Tr. bactrae* and *Trichogramma* sp. Several studies carried out in different time-line suggests occurrence of different parasitoids parasitizing *L. orbonalis*. Along with *T. flavo-orbitalis,* few other Ichneumonids were also recorded like *Pristomerus testaceous* Morl. (Ayyar, 1927), *Eriborus argentiopilosus* (Tewari and Sardana, 1987), *Xanthopimpla punctata* (Navasero and Calilung, 1990), *Eriborus sinicus* (Talekar, 1995) and *Diadegma apostate* (Tewari and Sardana, 1987) were also reported earlier. However, they were not found to occur in Tamil Nadu. Other records earlier suggest occurrence of braconids, *viz., Chelonus* sp. (Navasero and Calilung, 1990), *Bracon* sp. (Tewari and Sandana, 1987), *Bracon greeni* (Venkatraman *et al.,* 1948), *Bracon chinensis* (Nair, 1967) and *Phanerotoma* (Tewari and Moorthy, 1984). In a review it was reported that sixteen parasitoids, three predators and entomopathogens occurred on *L. orbonalis* all over the world (Khorsheduzzaman *et al.,* 1998) and among them *T. flavor-orbitalis* and *Phanerotoma* sp. as most important parasitoids, while Srivastava and Butani (1998) observed that none of natural enemies play any significant role in keeping *L. orbonalis* damage under reasonable control, especially in South Asia.

Among various larval parasitoids *T. flavo-orbitalis* was recorded as most important species constituting about 60 per cent of larval parasitoids. *T. flavo-orbitalis* has been recorded as major parasitoid of *L. orbonalis* in Sri Lanka, Gujarat (India) and Bangladesh, with maximum parasitism of 61.7 per cent (Alam *et al*., 2003) and in *Goryphus nursei* was recorded in Uttar Pradesh, mostly during winter season, with maximum parasitism of 7 *per cent*. Srinivasan (2008) also reported several parasitoid attacking *L. orbonalis* in nature and observed that *Trathala flavo-orbitalis* effectively reduces the population. Like in the present study, Yasodha and Natarajan (2009) recorded twelve parasitoids belonging to two super families, *viz*., Ichneumonoidea and Chalcidoidea emerged from field collected *L. orbonalis* larvae during their survey.

Under Chalcidoidea, seven species, *viz*., *Brachymeria lasus* (Chalcididae), *Antrocephalusmitys* (Chalcididae), *Spalangia irregularis* (Pteromalidae), *Spalangia endius* (Pteromalidae), *Endius* sp. (Pteromalidae) and *Spalangia* sp. (Pteromalidae) and *Trichogramma* sp. (Trichogrammatidae) were identified. *Brachymeria obscurata* and *Brachymeria* sp. were earlier reported by Navasero and Calilung (1990) on the larvae and pupae of *L. orbonalis*. Except *Brachymeria,* all others were reported for the first time on *L. orbonalis* while, *S. irregularis* and *Spalangia* sp. have been reported for the first time in India.

In Nepal, Kafle (1970) documented the endo-parasitoids, such as *Camptothlipsis* sp., *Campyloneurus mutator* Fabricius, *Chelonus* sp. and *Cremastus* (*Trathala*) *flavo-orbitalis* (Cameron) (Hymenoptera) as natural enemies of the *L. orbonalis*. Present results showed that the emergence of parasitoid *Trathala flavor-orbitalis* was highest when compared to other predators and agreement with study reported by Nagalingam (2006). *T. flavor-orbitalis* has also been recorded as important parasitoid in different countries such as Hawaii and several places in USA (Swezey, 1926), in Sri Lanka (Sandanayake and Edirisinghe, 1992), in Bangladesh (Alam and Sana, 1964) and Nepal (Kafle, 1970).

The results of the present investigation revealed that totally 6 species of Trichogrammatids were recorded on *L. orbonalis* were *T. achaeae, T. chilotraeae, T. japonicum, T. chilonis, Tr. bactrae* and *Trichogramma* sp. The present investigation was agreement with study reported that in vegetable ecosystem the egg parasitoids are mainly Trichogrammatids and recorded *Trichogramma chilonis* as most important species (Krishnamoorthy, 2012), however, *Trichogramma* sp., *T. chilotraeae, T. japonicum* and *Trichogrammatoidea bactrae* were recorded for the first time on *L. orbonalis*.

ACKNOWLEDGEMENTS:

The authors wish to thank the authorities of National Bureau of Agricultural Insect Resources (NBAIR), Bengaluru - 560024, Karnataka, India for their facilities to undertake this work. We also extremely thankful to **Dr. Ankita Gupta**, Scientist (Entomology), NBAIR, Bengaluru for identification of parasitoids**.**

We acknowledge all technical staff who assisted their help in successful completion of work and also farmers who have cooperated for collection of field samples at different places.

REFERENCES

1. Alam, A. Z. and Sana, D. L., 1964, Biology of *Leucinodes orbonalis* Guenee in East Pakistan. In: *Review of Research*, Division of Entomology, 1947-64. Dhaka: Agriculture Information Service, Department of Agriculture, p. 192-200.
2. Alam, S. N., Rashid, M. A., Rouf, F. M. A., Jhala, R. C., Patel, J. R., Satpathy, S., Shivalingaswamy, T. M., Rai, S., Wahundeniya, I., Cork, A., Ammaranan, C. and Talekar, N. S., 2003, Development of an integrated pest management strategy for eggplant fruit and shoot borer in South Asia. Technical Bulletin, AVRDC. The World Vegetable Center, Shanhua, Taiwan, **28**: 1-66.
3. Ayyar, T. V. R., 1927, The parasitic hymenoptera of economic importance noted from South India*. Bull. Entomol. Res*., **18**: 73-78.
4. Dhandapani, N., Shelkar, U. R. and Murugan, M. 2003. Bio-intensive pest management in major vegetable crops: An Indian perspective. Journal of Food, Agriculture and Environment, 1(2): 330-339.
5. FAO, 2007. FAOSTAT data 2005. http://www.fao.org (accessed on 28 August 2007).
6. Islam, M. N. and Karim, M. A. 1991. Management of the brinjal shoot and fruit borer, *Leucinodes orbonalis* Guen, (Lepidoptera: Pyralidae) in field. In: Annual Research Report 1990-91. Entomology Division, Bangladesh Agric. Res. Inst. Joydebpur, Gazipur, 44 - 46 PP.
7. Kafle, G. P., 1970, New records of some insects and non-insects parasites of *Leucinodes orbonalis* Guenee in Nepal. *Nepalese Journal of Agriculture,* **5**: 99-103.
8. Khorsheduzzaman, A. K. M., Ibrahim Ali, M., Mannan, M. A., Ahmad, A. and Karim, M. A., 1998, Component technologies of IPM package for brinjal shoot and fruit borer for Bangladesh: A Review. *Bangladesh J. Agric. Res.,* **23**(4): 593-606.
9. Krishnamoorthy, A. and Mani, M., 1998, New record of parasitoid, *Diadegma apostata* (G.) on brinjal shoot and fruit borer. *Insect Environ.,* **4**(3): 87.
10. Krishnamoorthy, A., 2012, Exploitation of egg parasitoids for control of potential pests in vegetable ecosystems in India. *Comunicata Scientiae*, **3**(1): 1-15.
11. Nagalingam, T., 2006, Association of parasitoid, *Trathala flavoorbitalis* with brinjal shoot and pod borer, *Leucinodes orbonalis* in the mid country region of Sri Lanka. *Sri Lankan J. Agric. Sci.,* **43**: 124 -132.
12. Navasero, M. V. and Calilung, V. J., 1990, Biology of the egg plant fruit and shoot borer, *Leucinodes orbonalis* Guenee (Lepidoptera: Pyralidae) in Philippines. *Philip Entomol*., **8**: 749-760.
13. Sandanayake, W. R. M and Edirisinghe, J. P., 1992, *Trathala flavoorbitalis*: Parasitization and development in relation to host stage attacked. *Insect Sci. Appl.*, **13**(3): 287-292.
14. Srinivasan, R., 2008, Integrated Pest Management for eggplant fruit and shoot borer (*Leucinodes orbonalis*) in south and Southeast Asia: Past, Present and Future. *J. Biopest.*, **1**(2):105-112.
15. Srivastava, K. P. and Butani, D. K., 1998, Pest management in vegetables. Part 1. Houston, USA: Research Periodical and Book Publishing House. p. 294.
16. Swezey, O. H., 1926, Recent introductions of beneficial insects in Hawaii. *J. Econ. Entomol.,* **19**: 714-720.
17. Talekar, N. S., 1995, Integrated insect and disease management (IPM) for environment – friendly production of safe vegetables. Publication No.00-505 Shanhua, Taiwan: Asian Vegetable Research and Development Center. p. 16.
18. Tewari, G. C. and Moorthy, P. N. K., 1984, New records of two parasites of brinjal shoot and fruit borer, *Leucinodes orbonalis* Guen. *Entomon,* **9**: 63-64.
19. Tewari, G. C. and Sardana, H. R., 1987, *Eriborus argenteopilosus* (Cameron) - a new parasite of *Leucinodes orbonalis* Guen. *Entomon,* **12**: 227-228.
20. Venkatraman, T. B., Gupta, S. N. and Negi, P. S. 1948, Preliminary trials in the propagation of *Bracon* (*Microbracon*) *greeni* Ashmead on unnatural hosts. *Proceedings of the Indian Academy of Science*, **27**: 92-104.
21. Yasodha, P. and Natarajan, N., 2006, Seasonal abundance of *Trathala flavo-orbitalis* Cameroon (Hymenoptera: Ichneumonidae), a predominant parasitoid of *Leucinodes orbonalis* Guenee (Lepidoptera: Pyraustidae). *J. Plant Prot. Environ.,* **3**(2): 103-108.

Table 1. Parasitoid fauna recorded during the investigation at both unsprayed and sprayed areas during 2013-14

Sl. No.	Species	Type of parasitoid	Taxanomic position	
			Order	Family
1	*Trathala flavoorbitalis* Cameron, 1907	Larval and pupal	Hymenoptera	Ichneumonidae (5)*
2	*Isotima javensis* (Rohwer)**	Larval and pupal		
3	*Xanthopimpla* sp.**	larval and pupal		
4	Indeterminate cryptinae**	larval		
5	*nr. Goryphus* sp.**	Pupal		
6	*Spalangia gemina* Boucek, 1963**	Pupal		Pteromalidae (3)*
7	*Spalangia* sp.	Pupal		
8	*Pachyneuron aphidis* Bouché, 1834	larval		

9	*Phanerotoma* sp.**	Larval		Braconidae (2)*
10	Indeterminate Braconidae	Larval and pupal		
11	*Trichogramma achaeae* Nagaraja and Nagarkatti	Egg		Trichogrammatidae (6)*
12	*Tr. bactrae* Nagaraja	Egg		
13	*T. chilonis* Ishii	Egg		
14	*T. japonicum* Ashmead	Egg		
15	*T. chilotraeae* Nagaraja and Nagarkatti	Egg		
16	*Trichogramma* sp.	Egg		

*Note: *- Parasitoids only collected from unsprayed area*

Table 2. Independent sample *t-test* for comparison of parasitoids that emerged from sprayed and unsprayed areas during 2013-14

No. of observations		*Kharif*			*Rabi*			Summer		
		Chikkaballapur	Attur Farm	Doddaballapur	Chikkaballapur	Attur Farm	Doddaballapur	Chikkaballapur	Attur Farm	Doddaballapur
		Trathala flavororbitalis								
Female	Mean ± SD	3.32±0.52	6.30±0.66	2.94±0.38	2.28±0.33	4.24±0.55	2.29±0.84	2.81±0.88	2.98±0.20	3.11±0.70
t- value		12.263 (0.0001)			10.545 (0.0001)			5.663 (0.0001)		
(*P* value)			15.256(0.0001)			6.732(0.0001)			6.627 (0.0001)	
		Indeterminate Braconidae								
Female	Mean ± SD	2.39±0.47	4.42±0.51	2.11±0.68	1.94±0.40	2.25±0.59	1.75±0.51	2.70±0.59	2.88±0.28	2.06±0.56
t- value		10.159(0.0001)			11.506 (0.0001)			0.944(0.355)		
(*P* value)			9.431(0.0001)			12.214 (0.0001)			4.522(0.0001)	
		***Trichogramma* sp.**								
Female	Mean ± SD	4.74±0.85	9.81±2.91	4.72±0.72	4.19±0.76	7.81±1.69	4.29±0.92	4.39±0.87	8.24±1.62	4.46±0.90
t- value		5.78 (0.0001)			6.76 (0.0001)			7.24 (0.0001)		
(*P value*)			5.86 (0.0001)			6.34 (0.0001)			7.07 (0.0001)	

Table 3. The pair wise comparison of mean difference of *Trathala flavoorbitalis* variation at different locations under sprayed and unsprayed areas during 2013 - 14

(I) area	(J) area	*Kharif*			*Rabi*			Summer		
		Mean Difference (I-J)	Std. Error	Sig.[a]	Mean Difference (I-J)	Std. Error	Sig.[a]	Mean Difference (I-J)	Std. Error	Sig.[a]
1	2	0.552*	0.086	0.000	0.446*	0.081	0.000	0.503*	0.077	0.000
	3	0.026	0.044	0.571	0.082	0.051	0.124	0.113*	0.050	0.034
2	1	0.552*	0.086	0.000	0.446*	0.081	0.000	0.503*	0.077	0.000
	3	0.577*	0.081	0.000	0.365*	0.092	0.001	0.390*	0.070	0.000
3	1	0.026	0.044	0.571	0.082	0.051	0.124	0.113*	0.050	0.034
	2	0.577*	0.081	0.000	0.365*	0.092	0.001	0.390*	0.070	0.000
S. Em±		0.38			0.39			0.32		
CD @ 5%		1.11			1.14			0.94		
CV %		42.94			55.51			40.73		

*Note: * The mean difference is significant at the 0.05 level*

1 - (Chikkaballapur – sprayed area)

2 - (Attur Farm – unsprayed area)

3 - (Doddaballapur - sprayed area)

Table 4. The pair wise comparison of mean difference of Braconid wasp population variation at different locations under sprayed and unsprayed areas during 2013 - 14

(I) area	(J) area	*Kharif*			*Rabi*			Summer		
		Mean Difference (I-J)	Std. Error	Sig.[a]	Mean Difference (I-J)	Std. Error	Sig.[a]	Mean Difference (I-J)	Std. Error	Sig.[a]
1	2	0.503*	0.077	0.000	0.115*	0.044	0.018	0.088	0.056	0.133
	3	0.113*	0.050	0.034	0.026	0.045	0.568	0.075	0.039	0.071

2	**1**	0.503*	0.077	0.000	0.115*	0.044	0.018	0.088	0.056	0.133
	3	0.390*	0.070	0.000	0.141*	0.063	0.036	0.163*	0.052	0.005
3	**1**	0.113*	0.050	0.034	0.026	0.045	0.568	0.075	0.039	0.071
	2	0.390*	0.070	0.000	0.141*	0.063	0.036	0.163*	0.052	0.005
S. Em±		0.32			0.25			0.23		
CD @ 5%		0.94			0.73			0.67		
CV %		46.84			42.14			35.27		

*Note: * The mean difference is significant at the 0.05 level*

1 - (Chikkaballapur - sprayed area)

2 - (Attur Farm - unsprayed area)

3 - (Doddaballapur - sprayed area)

Table 5. The pair wise comparison of mean difference of trichogrammatids variation at different locations under sprayed and unsprayed areas during 2013 - 14

(I) area	(J) area	*Kharif*			*Rabi*			Summer		
		Mean Difference (I-J)	Std. Error	Sig.[a]	Mean Difference (I-J)	Std. Error	Sig.[a]	Mean Difference (I-J)	Std. Error	Sig.[a]
1	**2**	1.550*	0.311	0.001	1.075*	0.279	0.004	1.225*	0.164	0.000
	3	0.075	0.092	0.434	0.050	0.128	0.705	0.100	0.183	0.599
2	**1**	1.550*	0.311	0.001	1.075*	0.279	0.004	1.225*	0.164	0.000
	3	1.475*	0.262	0.000	1.025*	0.259	0.003	1.125*	0.198	0.000
3	**1**	0.075	0.092	0.434	0.050	0.128	0.705	0.100	0.183	0.599
	2	1.475*	0.262	0.000	1.025*	0.259	0.003	1.125*	0.198	0.000
S. Em±		0.72			0.63			0.41		
CD @ 5%		2.31			1.95			1.23		
CV %		21.2			19.2			31.5		

*Note: * The mean difference is significant at the 0.05 level*

1 - (Chikkaballapur – sprayed area)

2 - (Attur farm – unsprayed area)

3 - (Doddaballapur - sprayed area)

Table 6. Relative abundance of different parasitoid trichogrammatids in unsprayed area of brinjal crop at Attur Farm

*Trichogramma*tids	*Kharif*			*Rabi*			Summer		
	Total	Mean± SD	% species composition	Total	Mean± SD	% species composition	Total	Mean± SD	% species composition
T. achaeae	93	7.75±2.60	13.17	81	6.75±2.14	14.41	75.00	6.25±1.36	12.65
T. chilotraeae	59	4.92±1.00	8.36	54	4.50±1.00	9.61	62.00	5.17±1.27	10.46
T. chilonis	259	21.58±6.27	36.69	198	16.50±4.60	35.23	206.00	17.17±3.76	34.74
Tr. bactrae	161	13.42±5.52	22.80	102	8.50±2.24	18.15	111.00	9.25±2.38	18.72
T. japonicum	56	4.67±2.23	7.93	70	5.83±1.34	12.46	61.00	5.08±0.90	10.29
***Trichogramma* sp.**	78	6.50±2.11	11.05	57	4.75±0.97	10.14	78.00	6.50±1.83	13.15
Total	706.00	58.83±17.47	100.00	562.00	46.83±10.12	100.00	593.00	49.42±9.71	100.00

Table 7. Relative abundance of different parasitoid trichogrammatids in sprayed area of brinjal crop at Chikkaballapur

*Trichogramma*tids	*Kharif*			*Rabi*			Summer		
	Total	Mean± SD	% species composition	Total	Mean± SD	% species composition	Total	Mean± SD	% species composition
T. achaeae	45.00	3.75±1.48	13.20	35.00	2.92±1.31	11.59	39.00	3.25±1.42	12.34
T. chilotraeae	30.00	2.50±1.00	8.80	23.00	1.92±0.51	7.62	22.00	1.83±0.58	6.96
T. chilonis	128.00	10.67±2.19	37.54	121.00	10.08±1.56	40.07	125.00	10.42±2.02	39.56
Tr. bactrae	73.00	6.08±1.44	21.41	76.00	6.33±1.37	25.17	82.00	6.83±1.47	25.95
T. japonicum	38.00	3.17±1.59	11.14	27.00	2.25±1.66	8.94	28.00	2.33±1.67	8.86
***Trichogramma* sp.**	27.00	2.25±0.97	7.92	20.00	1.67±0.78	6.62	20.00	1.67±0.78	6.33
Total	341.00	28.42±5.11	100.00	302.00	25.17±4.57	100.00	316.00	26.33±5.28	100.00

Table 8. Relative abundance of different parasitoid trichogrammatids in sprayed area of brinjal crop at Doddaballapur

Trichogrammatids	*Kharif*			*Rabi*			Summer		
	Total	**Mean± SD**	**% species composition**	**Total**	**Mean± SD**	**% species composition**	**Total**	**Mean± SD**	**% species composition**
T. achaeae	41.00	3.42±1.51	12.06	37.00	3.08±1.56	11.97	42.00	3.50±1.45	13.08
T. chilotraeae	30.00	2.50±1.00	8.82	25.00	2.08±1.08	8.09	22.00	1.83±0.94	6.85
T. chilonis	129.00	10.75±1.48	37.94	122.00	10.17±1.75	39.48	127.00	10.58±1.83	39.56
Tr. bactrae	76.00	6.33±1.37	22.35	73.00	6.08±1.68	23.62	82.00	6.83±1.75	25.55
T. japonicum	36.00	3.00±1.76	10.59	27.00	2.25±1.14	8.74	23.00	1.92±0.79	7.17
***Trichogramma* sp.**	28.00	2.33±1.15	8.24	25.00	2.08±1.08	8.09	25.00	2.08±1.08	7.79
Total	340.00	28.33±4.33	100.00	309.00	25.75±5.51	100.00	321.00	26.75±5.38	100.00

CITATION OF THIS ARTICLE

Murali, S., Jalali, S. K., Kariyanna, B., Shylesha, A. N., Shivalinga Swamy, T. M. and Gandhi Gracy, R. Documentation of parasitoid complex on brinjal shoot and fruit borer, *L*eucinodes *orbonalis* Guenee. Bull. Env. Pharmacol. Life Sci., Vol 6 Special issue 2, 2017: 452-459