Acta Scientific Agriculture (ISSN: 2581-365X)

Volume 2 Issue 3 March 2018

Review Article

Utilization of Trichogrammatid Egg Parasitoid in Pest Management

Navik OS* and Richa Varshney

ICAR- National Bureau of Agricultural Insect Resources, Bengaluru, Karnataka, India

***Corresponding Author:** Navik OS, ICAR- National Bureau of Agricultural Insect Resources, Bengaluru, Karnataka, India.

Received: December 30, 2017; **Published:** February 19, 2018

Abstract

Trichogrammatid egg parasitoid widely used in the biological control of lepidopteran pests. The great diversity of *Trichogramma* have been reported worldwide over 230 species parasitizing the different eggs of over 200 insect species belonging to 70 different families. Among, *Trichogramma* and *Trichogrammatoidea* are amenable for laboratory mass production on factitious hosts. Development of a tolerant strain for the different stresses, though genetic improvement considered very useful which improved their survival and performance to manage the insect-pests in field conditions. This development made easy to integrate trichogrammatids with other method of control and component in the integrated pest management practices. The present studies information pertaining to the information on most utilized species of trichogrammatids and their utilization have been discussed.

Keywords: Trichogrammatids; Egg Parasitoid; Pest Management

Introduction

Trichogrammatids (*Chalcidoidea: Trichogrammatidae*) represent a large group of minute parasitic wasp which parasitizing the eggs of holometabolous order mainly *lepidoptera* and of *Hemiptera, Orthoptera* and *Thysanoptera* [1]. It includes very small to minute insects, ranging in size from 0.2 - 1.0 mm. The members of this family are easily recognized by the three segmented tarsi. A few trichogrammatids parasitize the eggs of aquatic hosts, such as *Dytiscidae, Notonectidae* or *Odonata*, whilst the egg is beneath the surface of the water [2-5]. Species of Trichogrammatidae have been used extensively in biological control programs of various pests, particularly, Lepidoptera, resulting in an enormous economic importance. Mainly, *Trichogramma* and *Trichogrammatoidea*, have been studied extensively and intensively all over the world for their use in biological control. These include the earlier work of Flanders (1929) who enabled to large scale multiplication of *Trichogramma* on the eggs of *Sitotroga cerealella* (Olivier), since, then trichogrammatids being used in the management of pests from various agroecosystem.

Over 230 species and subspecies of *Trichogramma* known worldwide parasitizing the eggs of over 200 insect species belonging to 70 different families [6]. Among the *Trichogramma*, in India most dominant and common species is *Trichogramma chilonis* Ishii. Other species also observed commonly are *Trichogramma japonicum* Ashmead, *Trichogramma achaeae* Nagaraja and Nagarkatti and *Trichogramma pretiosum* Riley [7]. Apart from *Trichogramma*, the other genus used in biological control is *Trichogrammatoidea*. The species belonging to these genera are amenable for laboratory mass production on factitious hosts like a rice moth (*Corcyra cephalonica* Stn.), paddy moth (*Sitotroga cerealella*), and the flour moth (*Ephestia* spp.) and are being used for biological control of noxious lepidopterous pests of crops worldwide [8]. Though they are very small in size but their size did not prevent to exploit them in biological control insects- pests because of (1) Their short life cycle, may complete within 8 - 10 days from egg laying to adult emergence; (2) having high breeding potential able to lay eggs for 6 - 7 days actively; (3) they produces high number of female progenies (60 - 90%); (4) for their adaptation of the factitious laboratory host for mass multiplication. The mass production of trichogrammatids in Indian conditions, mainly adapted rice moth *C. cephalonica* is the best host, accepted by most of *Trichogramma* species [8].

The managing the pest thorough non-chemical way by releasing the trichogrammatids mainly, *Trichogramma* against the lepidopteran pests [9]. Development of a tolerant strain for the different stresses, though genetic improvement considered very useful to survive and perform to manage the pests either in high temperature condition or heavily insecticide sprayed field. The development of low temperature adapted form of *T. chilonis* at 18 - 24°C could be utilized in a cooler month for pest control. This form could parasitized 58% eggs of *Corcyra* eggs than non-adapted stain (17.2%) and having better host searching ability under low temperature conditions [10]. While, temperature tolerant form of *T. chilonis* were also developed and evaluated in the field at higher temperature (32 - 40°C) provided 50% parasitism with high fecundity and adult longevity [11]. The insecticide-tolerant strains of *T. chilonis* for five groups of insecticides, namely, organochlorine, organophosphate, a synthetic pyrethroid, oxadiazine, and spinosyn, provided 40-85% parasitism compared to laboratory reared population [12,13].

The *Trichogramma* have been world's most widely used parasitoid in augmentative biological control programs. The large scale release act as a biological insecticide which target only the pests without harming the other natural fauna and flora. Some of the species used widely utilized for the management of crop pests mentioned here.

Trichogramma chilonis Ishii

The most common species of *Trichogramma* being used in the management of lepidopteran pest in India. Release of *T. chilonis* at 50, 000/ha for 11 - 12 times in sugarcane from July to October reduced stalk borer incidence by 55 - 60% [14]. Also release of 100,000 eggs/ha each at weekly intervals starting 30 days after transplanting against the rice leaf folder proven effective in rice [15]. In cotton, release of *T. chilonis* at 150,000/ha per week from July to October against cotton bollworm complex under IPM schedule was effective with reduction of insecticides and increase in cotton yield [16]. The efficacy of *T. chilonis* was more when release at the three day intervals compared to five day intervals against the *Chilo partellus* (Swinhoe) infesting fodder maize in Karnataka [17]. However, in chickpea *T. chilonis* was not effective in controlling *Helicoverpa armigera* (Hubner) [18]. Weekly release of *T. chilonis* in tomato far a six times recorded minimal damage of H. armigera and the higher yield in Tamil Nadu condition, while, in Kashmir it was found that *T. chilonis* released at 130,000/ha resulted in the least fruit damage [19,20]. In brinjal, release of the this egg parasitoid at 50,000/ha on 30 and 60 DAT resulted percentage shoot and fruit borer damage was significantly less and fruit yield was maximum [21]. The efficacy of egg parasitoid *T. chilonis* checked in cauliflower against diamond back moth (DBM), *Plutella xylostella* (L.) by releasing at 150,000 eggs/ha were superior to quinalphos with 45.81% larval reduction [22], while, in cabbage the seasonal parasitism recoded upto 55% on eggs of *P. xylostella* [23]. The release of *T. chilonis* in combination with other parasitoids was more effective in lowering larval populations of Earias vitella (Fab.) and H. armigera after three releases and resulted higher yield of Okra [24]. The release of *T. chilonis* at 100,000/ha was effective against *H. armigera* infesting chili and appeared to be a promising strategy without application of any insecticides under different IPM module in Karnataka [25]. In recent, insecticide resistance egg parasitoid, *T. chilonis* utilized for the management of *H. armigera* in tomato showed insecticide tolerant strain could parasitize 50.8% eggs during winter and 39.0% in summer, whereas, the susceptible strain of parasitoid unable to parasitized under sprayed system condition [26].

Trichogramma japonicum Ashmead

Trichogramma japonicum mainly used for the management of rice stem borer and top shoot borer of sugar cane. Release of *T. japonicum* at 50,000 eggs/ha recommended and was observed effective in reducing the incidence of rice stem borer, *Scirpophaga incertulas* (Walker) [27]. However, weekly release at higher rate 100,000 eggs/ha for seven times starting from 30 days after transplanting was reported more effective than release at lower doses [28,29]. *T. japonicum* also was observed parasitizing the eggs of internode borer, Proceras indicus Kapur, in sugarcane and parasitism in the field noticed from 7 - 55% [30]. The release of *T. japonicum* in sugarcane against top shoot borer, *Scirpophaga excerptalis* Walk reduced attack by about 15 % [31]. However, release of *T. japonicum* in Punjab about six times of 10-day intervals at 50,000/ha against *S. excerptalis* showed that the incidence of top borer was significantly [32]. The temperature-tolerant strain of *T. japonicum* at 100,000/ha released at weekly interval was evaluated against top shoot borer of sugarcane, results indicated that it suppressed the third brood of top borer significantly [33].

Trichogramma pretiosum Riley

This species used mainly for management of *H. armigera* infesting tomato. The field evaluation study indicated that release of *T. pretiosum* (thelytokous- having only females) at 50,000 /ha at weekly interval for a five times in tomato against *H. armigera* noticed effective with parasitism of 43.20% [34]. While, releasing of T. pretiosum at a higher rate of 100,000 parasitized eggs/ha at 15-day intervals was found to be effective in controlling *H. armigera* [35]. It also evaluated against the invasive tomato leaf miner, *Tuta absoluta* (Meyrick), which parasitized about 51.1% eggs [36].

Trichogramma achaeae Nagaraja *and* Nagarkatti

The *T. achaeae* was noticed parasitizing the egg of invasive tomato leaf miner, *T. absoluta* in the tomato fields. It was evaluated for their parasitizing efficiency on eggs *T. absoluta* resulted 5% egg parasitism [36]. It also used in cotton (non Bt) against the bollworms and okra fruit borer. Release of six times in cotton at 150,000 adults/ha weekly interval and 50,000/ha in vegetable recommended.

Trichogramma embryophagum Hartig

This egg parasitoid useful against the apple codling moth, *Cydia pomonella* (Linnaeus) infesting apple. The weekly release of parasitoid recommended which start from first moth catches to till pest eggs observed in the field. The innundative release of *T. embryophagum* against either weekly release or sequential release during June-July was found useful in suppressing the infestation of codling moth of apple. Releasing at doses of 2000 to 5000 adults per tree reported 10.9 to 22.4% parasitism resulted significant reduction in pest population and increased in yield [37].

Trichogrammatoidea bactrae Nagaraja

It mainly used for the management of cruciferous pest, diamond back moth, *P. xylostella*, cotton pink bollworm, *Pectinophora gossypiella* Saunders. This also observed parasitizing the eggs of a tomato leaf miner, *T. absoulta*. The efficiency of parasitization to eggs of *T. absoluta* was recorded 68.2% in the evaluation study [36]. A release of *Tr. bactrae* at 50,000 adults per release for a six week recommended for the effective control of diamondback moth, *P. xylostella* [38].

Trichogramma brassicae Bezdenko

An exotic egg parasitoid, *T. brassicae* has been evaluated against DBM on cabbage and inundative release of 6 lakh adults per hectare was effective with a very less larval population [39]. However, Release of *T. brassicae*, 100,000 adults per hectare for three times under BIPM in cauliflower against Pieris brassicae (L.) reduced the incidence and increased the yield. However, Release of *T. brassicae,* 100,000 adults per hectare for three times under BIPM in cauliflower against *P. brassicae* reduced the incidence and increased the yield [37].

The trichogrammatids could be integrated with other method of control by keeping in view of their indirect benefits. Trichogrammatids having a very meager impact on the other natural enemies, these made to integrate with the IPM program. Conservation of *Trichogramma* by using friendly crop management practices which encourage parasitoid population and their impact on pest

populations. The plant spacing, plant volatile, plant structure and colour influence the performance of parasitoids. However, plants influence the behavior and activity of parasitoids by providing the food such as nectar for adults and also affect the nutritional quality of the host eggs for progeny development [40]. The ample availability of floral resources which enhances the adult fecundity and longevity of parasitoids in the field. Intercropping of coriander in a sugarcane field indicated highest activity of *Trichogramma* and highest parasitization of shoot borer eggs [41]. Growing a trap crop, cover crop or strip crop around the field kept unsprayed act as refuges which enhance and conserve the trichogrammatids. Trap crops like maize, sorghum, pearl millet, and marigold along with a cotton crop resulted maximum parasitization of *H. armigera* [42]. The semiochemicals used to manipulate the behaviour of natural enemies either spraying on the crops or thought tritrophic interaction help to modifying the environment and make it favorable for the *Trichogramma* like spraying of sugar at weekly interval improved egg parasitism by *T. brassicae* of *Pieris rapae* L. and *Trichoplusia ni* (Hubner) in cabbage [43]. Also, using tritrophic interaction tactics between parasitoid, *T. chilonis* and *H. armigera* in pigeon pea genotypes, the extent of egg parasitism on pods in of different cultivar varied 1.2 - 8.3% and on leaves parasitism varied from 5.0 - 29% [44]. However, kairomone from cuticular extract of adult of rice stem borer *S. incertulas* enhances host parasitization by *T. japonicum* [45]. The release of trichogrammatids can be harmonized with the use of pesticides by knowing their compatibility. Integrating these parasitoids with chemical insecticides is quite difficult. However, development of pesticide-tolerant strains of *Trichogramma* could be the way to integrate the chemical insecticides and biological control agents. An endosulfan-tolerant strain of *T. chilonis* has been developed in India and marketed under the trade name of 'Endogram' and further in recent development of multiple insecticide tolerance strain of *T. chilonis* to the different group of insecticides namely, organochlorine, organophosphate, synthetic pyrethroid, oxadiazine, and spinosyn [12,46,47].

Conclusion

Trichogrammatids are the commonly used egg parasitoids in biological control and constitute an important component in the integrated pest management practices. The diversity of these egg parasitoids reported across the world and effectively employed for pest control in different crops. Trichogrammatids, notably *Trichogramma* and *Trichogrammatoidea* are amenable in mass production and ability to control the pests at egg phase made them an efficient biological control agent. Therefore, conservation of trichogrammatids through adapting different cropping system, utilization of semiochemicals and development of tolerant strains to adapt climatic stress and insecticidal pressure have made them to integrate with other methods in the management of crop pests.

Bibliography

1. "Hymenoptera of the world: An identification guide to families". Goulet, H and Huber, JT. editors. Agriculture Canada, Ottawa, Ontario (1993): 680.

2. Henriksen KL. "Notes upon some aquatic Hymenoptera". *Annales de Biologie Lacustre* 11 (1922): 19-37.

3. Lubbock J. "On two aquatic Hymenoptera, one of which uses its wings for swimming". *Transactions of the Linnean Society of London* 24.2 (1864): 135-142.

4. Matheson R and Crosby CR. "Aquatic Hymenoptera in America". *Annals of the Entomological Society of America* 5.1 (1912): 65-71.

5. Noyes JS. "Universal Chalcidoidea Database". World Wide Web electronic publication (2003).

6. Jalali SK., *et al*. "Trichogrammatids". Ecofriendly Pest Management for Food Security (2016): 139-181.

7. Lalitha Y., *et al*. "Seasonal diversity, mass rearing and application of trichogrammatids in India". 14th IOBC-MRQA Workshop: Maas Rearing High Quality Invertebrate for Multiple Purpose. Merida, Yucatan, Mexico (2017).

8. Nagaraj AH. "Mass Production of Trichogrammatid Parasitoids". In. Sithanantham S., *et al*. (ed), Biological control of insect Pests using egg parasitoids (2013): 175-189.

9. Lalitha Y., *et al*. "Parasitoids and predator for the management of pests: rearing, release and conservation". National symposium on Biodiversity and Natural Resources for sustainable Development (BNRSD-2017). Chaudhary Charan Singh University, Meerut (2017): 22.

10. Jalali SK., *et al*. "Adaptive performance of Trichogramma chilonis Ishii at low temperature". *Annals of Plant Protection Sciences* 14.1 (2006a): 5-7.

11. Jalali SK and Singh SP. "Temperature dependent developmental biology of maize stalk borer Chilo partellus (Swinhoe) (Lepidoptera: Pyralidae) and its natural enemies". *Indian Journal of Entomology* 68.1 (2006b): 54-61.

12. Jalali SK., *et al*. "Field efficacy of multiple insecticides tolerant strain of Trichogramma chilonis Ishii against American bollworm, Helicoverpa armigera (Hübner) on cotton". *Indian Journal of Plant Protection* 34.2 (2006c): 173-180.

13. Jalali SK. "Effect of abiotic stresses on natural enemies of crop pests and mechanism of tolerance to these stresses". *Indian Farming* 64.2 (2014): 102-105.

14. Shenhmar M., *et al*. "Effectiveness of Trichogramma chilonis Ishii for the management of Chilo auricilius Dudgeon on sugarcane in different sugar mill areas of the Punjab". In: Tandon, P.L., *et al*. (Eds.), Biological Control of Lepidopteran Pests-Proceedings of the Symposium of Biological Control of Lepidopteran Pests. Society for Biocontrol Advancement, Bangalore (2003): 333-335.

15. Kaur R and Brar KS. "Evaluation of different doses of Trichogramma species for the management of leaf folder and stem borer on basmati rice". *Journal of Biological Control* 22.1 (2008): 131-135.

16. Brar KS., *et al*. "Evaluation of biocontrol based IPM modules for the control of bollworm complex on cotton". *Journal of Insect Science* 14. 1/2 (2001): 19-22.

17. Jalali SK and Singh SP. "Biological control of Chilo partellus (Swinhoe) in fodder maize by inundative releases of parasitoids". *Indian Journal of Plant Protection* 31.2 (2003): 93-95.

18. Mandal SMA and Mishra BK. "Evaluation of some biocontrol agents against Helicoverpa armigera (Hubner) in chickpea". *Journal of Plant Protection and Environment* 1.1-2 (2004): 27-29.

19. Amutha M and Manisegaran S. "Evaluation of IPM modules against Helicoverpa armigera (Hubner)". *Annals of Plant Protection Sciences* 14.1 (2006): 22-26.

20. Khan AA. "Exploitation of Trichogramma chilonis Ishii for suppression of Helicoverpa armigera (Hubner) in tomato". *Journal of Insect Science* 24.3 (2011): 254-258.

21. Suresh K., *et al*. "Management of brinjal shoot and fruit borer through nutritional manipulation". *Journal of Entomological Research* 31.3 (2007): 191-196.

22. Lad SK., *et al*. "Efficacy of microbials and bioagents for the management of Plutella xylostella (L.) on cauliflower". *Journal of Soils and Crops* 19.1 (2009): 129-134.

23. Shukla A and Kumar A. "Seasonal activity of egg parasitoid, Trichogramma chilonis Ishii on diamondback moth, Plutella xylostella (Linn.) infesting cabbage (Lepidoptera: Plutellidae)". *Uttar Pradesh Journal of Zoology* 24.3 (2004): 277-280.

24. Thanavendan G and Jeyarani S. "Biointensive management of okra fruit borers using braconid parasitoids (Braconidae: Hymenoptera)". *Tropical Agricultural Research* 21.1 (2009): 39-50.

25. Gundannavar KP. "Development of integrated pest management modules for chilli pests". *Karnataka Journal of Agricultural Sciences* 20.4 (2007): 757-760.

26. Jalali SK., *et al*. "Management of Helicoverpa armigera (Hübner) on tomato using insecticide resistance egg parasitoid, Trichogramma chilonis Ishii in farmers' field". *Indian Journal of Horticulture* 73.4 (2016): 611-614.

27. Pandey S and Choubey MN. "Management of yellow stem borer, Scirpophaga incertulas in rice". *Agricultural Science Digest* 32.1 (2012): 7-12.

28. Kaur R., *et al*. "Large-scale evaluation of bio-intensive management for leaf folder and stem borer on basmati rice". *Journal of Biological Control* 21.2 (2007): 255-259.

29. Kumar S and Khan MA. "Bio-efficacy of Trichogramma spp. against yellow stem borer and leaf folder in rice ecosystem". *Annals of Plant Protection Sciences* 13.1 (2005): 97-99.

30. Venugopal S., *et al*. "Notes on Trichogramma japonicum Ashm., an egg parasite of internode borer (Proceras indicus Kapur) of sugarcane in Madras State". *Indian Journal of Agricultural Sciences* 38 (1968): 874-875.

31. Anonymous. Proceedings of the national seminar on pests and diseases management and nutritional disorders in sugarcane. Deccan Sugar Institute, Pune (1986): 96.

32. Anonymous. Biological suppression of sugarcane pests. Annual progress report 2004-2005. Project Directorate of Biological Control, Bangalore (2005): 56-57.

33. Anonymous. Biological suppression of sugarcane pests. Annual progress report 2003-2004. Project Directorate of Biological Control, Bangalore (2004): 57-82.

34. Singh J., *et al*. "Evaluations of Trichogramma brasiliense Ashmead, nuclear polyhedrosis virus and endosulfan for the management of Helicoverpa armigera (Hubner) on tomato". In: Tandon PL., *et al*. (Ed.), Biological Control of Lepidopteran Pests-Proceedings of the Symposium of Biological Control of Lepidopteran Pests. Society for Biocontrol Advancement, Bangalore (2003): 337-340.

35. Kumar D., *et al*. "Effectiveness of IPM module for tomato in the farmers' field of Ranchi district". *Journal of Research, Birsa Agricultural University* 15.1 (2003): 125-128.

36. Ballal CR., *et al*. "The new invasive pest Tuta absoluta (Meyrick) (Lepidoptera: Gelechiidae) in India and its natural enemies along with evaluation of Trichogrammatids for its biological control". *Current Science* 110.10 (2016): 2155-2159.

37. Lalitha Y., *et al*. "Current status of Trichogramma in India". In Biological control of pest using Trichogramma: Current status and perspective. (Etd. Vinsion *et al*.) Northwest A and F University press (2015): 186-250.

38. Krishnamoorthy A. IPM package for tomato with safe pesticide residue. IIHR Extension folder (NATP) (2003): 03.

39. PDBC. Annual progress report 2008-09. AICRP on biological control of crop pests and weeds. Project Directorate of Biological Control, Bangalore (2009): 279.

40. Romeis J., *et al*. "Habitat and plant specificity of Trichogramma egg parasitoids-underlying mechanisms and implications". *Journal of Basic and Applied Ecology* 6.3 (2005): 215-236.

41. Rachappa V and Nair LK. "Integrated management of early shoot borer, Chilo infuscatellus (Snellen) in sugarcane". *Annals of Plant Protection Sciences* 12.2 (2004): 248-253.

42. Virk JS., *et al*. "Role of trap crops in increasing parasitization efficiency of Trichogramma chilonis Ishii in cotton". *Journal of Biological Control* 18.1 (2004): 61-64.

43. Lundgren JG., *et al*. "Comparison of Trichogramma brassicae (Hymenoptera: Trichogrammatidae) Augmentation with organic and synthetic pesticides for control of cruciferous Lepidoptera". *Environmental Entomology* 31.6 (2002): 1231-1239.

44. Tandon PL and Bakthavatsalam N. "Parasitization efficiency of Trichogramma chilonis Ishii on Helicoverpa armigera (Hubner) eggs influence of pigeon pea genotypes". In: Tandon PL., *et al*. (Ed.), Biological Control of Lepidopteran Pests-Proceedings of the Symposium of Biological Control of Lepidopteran Pests. Society for Biocontrol Advancement, Bangalore (2003): 75-78.

45. Usha Rani P., *et al*. "Kairomones extracted from rice yellow stem borer and their influence on egg parasitization by Trichogramma japonicum". *Journal of Chemical Ecology* 33.1 (2007): 59-73.

46. Jalali SK., *et al*. "Development of endosulfan tolerant strain of an egg parasitoid Trichogramma chilonis Ishii (Hymenoptera: Trichogrammatidae)". *Indian Journal of Experimental Biology* 44.7 (2006d): 584-590.

47. Singh SP. "Augmentative biocontrol in India". In: Singh SP, Murphy ST, Ballal CR (eds) Augmentative biocontrol - proceedings of the ICAR-CABI workshop. Project Directorate of Biological Control, Bangalore (2001): 1-20.

Volume 2 Issue 3 March 2018