Indian Journal of Entomology 86(1): 192-195 (2024) DoI. No.: 10.55446/IJE.2023.907

BIOLOGICAL CONTROL OF PINK BOLL WORM *PECTINOPHORA GOSSYPIELLA* (SAUNDERS) BY *TRICHOGRAMMATOIDEA BACTRAE* NAGARAJA IN COTTON

I Padma Shree[1], M Muthuswami[2]*, K Senguttuvan[3], S Rajeswari[4] and N Manikanda Boopathi[5]

[1]Department of Agricultural Entomology; [2]Office of the Registrar; [4]Department of Cotton, [5]Department of Plant Biotechnology, Tamil Nadu Agricultural University (TNAU), Coimbatore 641003, Tamil Nadu, India
[3]Regional Research Station (TNAU), Vridhachalam 606001, Tamil Nadu, India
*Email: mmsagricbe@gmail.com (corresponding author): ORCID ID 0000-0002-2549-0718

ABSTRACT

An experiment was conducted at the Department of Cotton, Tamil Nadu Agricultural University, Coimbatore to evaluate the field efficacy of an egg parasitoid, *Trichogrammatoidea bactrae* Nagaraja through inundative releases against *Pectinophora gossypiella* (Saunders) in cotton for two successive field trials during Kharif 2021 and 22. The parasitisation efficacy of *T. bactrae* was tested in the cotton ecosystem and the results revealed that the parasitism on the eggs was found be on par with that observed with NSKE 5% concentration (24.63%), neem formulation 1500 ppm 1% concentration (24.10%), *Pongamia* extract 5% concentration (23.13%), *Jatropha* extract 5% concentration (23.93%) and were found the safest to *T. bactrae*. The emamectin benzoate 5 SG at 190g/ ha (19.49%) and clorantraniliprole 18.5 SC at 150 mL/ ha (15.26%) were on par with each other. Results suggested that among the insecitcides tested emamectin benzoate 5 SG and chlorantraniliprole 18.5 SC were safer to *T. bactrae* and inundative release of *T. bactrae* can achieve sizeable control of *P. gossypiella,* hence it can be integrated with other components for IPM.

Key words: *Gossipium hirsutum*, *Pectinophora gossypiella, Trichogrammatoidea bactrae,* biological control, NSKE, neem formulation, *Pongamia*, *Jatropha*, emamectin benzoate, clorantraniliprole, flubendiamide, spinosad

Cotton (*Gossipium hirsutum* L.) is the most important commercial crop grown in India. Cotton is cultivated in 134.77 lakh hectares in India with a production of 460 kg lint/ ha and ranks first in production with 365.00 lakh bales (ICAR-AICRP, 2019-20). Among cotton bollworms, the *Pectinophora gossypiella* (Saunders) (Lepidoptera: Gelechiidae) is a pest of great economic importance in many cotton-growing countries causing yield loss both in terms of quantity as well as quality. It is a worldwide key pest of cotton and its larvae burrow into cotton bolls to feed on the seeds (Sarwar, 2017). The feeding damage allows other insects and fungi to enter the boll and cause additional damage (Shrinivas et al., 2019). Mostly, farmers rely upon chemicals to get rid of these serious pests, but pesticides have not provided a long term solution for their management. A sharp decline (70 to 80%) in the numbers of predatory species occurred in cotton field post chemical applications which was reported by El-Heneidy et al. (1987). As opposed to this approach, biological control is a major component in integrated pest management. It has been considered as a sustainable, economic, environmental-friendly and host specific (Bale et al*.,* 2008). The egg parasitoid, *Trichogrammatoidea bactrae*, was imported into California from Queensland, Australia during 1985 as a potential biological control agent of PBW (Hutchison et al*.,* 1990, Naranjo et al*.,* 1992). *T. bactrae* is widely distributed in the orient (India, Pakistan, China, Malaysia, Taiwan and Indonesia). It is adapted to terrestrial humid habitats and is known to attack various pests of cotton, sugarcane, fruits and vegetables (Nagaraja, 1978). The development from egg to adult was ranging from 8-9 days. The mean total number of *Corcyra chephalonica* eggs parasitized by fed, mated and virgin parasitoids was 49.0 and 48.7%, respectively (Lim, 1986). Female fecundity and longevity were related directly to temperature (Malik, 2000). Regardless, the optimum temperature for fecundity ranged between 22 and 28°C. Generally the highest numbers of progeny (24.86 and 24.48 adults/ female) were produced at 25 and 28°C (El-Hafez, 1995). In this context, study was conducted to evaluate the efficacy of the egg parasitoid, *T. bactrae* as a biocontrol agent for suppressing the *P. gossypiella* (PBW) population in cotton.

MATERIALS AND METHODS

An experiment was conducted at the Department of Cotton, Tamil Nadu Agricultural University, Coimbatore (11.0167N, 76.9350E) to evaluate the field efficacy of an egg parasitoid, *T. bactrae* through inundative releases against *P. gossypiella* in cotton for two successive field

trials during kharif, 2021 and 2022. The parasitoid was released at different application stages of cotton (viz., flowering and boll formation stages). Cotton Bollgard II crop was grown as irrigated crop. The experiment was laid out in randomized complete block design. The egg parasitoid, *T. bactrae* which had been reared on egg cards of the *Corcyra* in the laboratory, was released in the field. The egg card was cut in to small pieces and stapled to the upper side of a cotton leaf with egg side down, in the middle portion of the plant to evaluate parasitoid activity in experimental plot. Egg cards were turned towards the leaves' surface to avoid being eaten by predators (Naranjo et al., 1993). The release of egg parasitoid *T. bactrae* @ 40000/ ha at 15 days interval 3 times from 45 days after sowing (as per recommendation) for the duration of the season (Malik, 2001). The *P. gossypiella* incidence started at flowering stage (45 days) as indicated by the rosette flowers. The occurrence of *P. gossypiella* adults was monitored using Delta traps (Pectino-Lure (SL), Gaiagen Technologies Private Ltd., Bengaluru) @ 12 per ha. The presence and establishment of the parasitoids in the cotton fields was confirmed using egg cards of *P. gossypiella* moth prepared as described above. These cards were left in the field for 24 hours and then brought back to the laboratory. The assessment was repeated every week. In addition, a field infestation of *P. gossypiella* was recorded at weekly intervals. The mean of data were recorded and mean of the two trials data were analysed using SPSS software version 22 with appropriate transformations.

RESULTS AND DISCUSSION

The preliminary studies of the investigation, showed no parasitised eggs in *P. gossypiella* egg cards before the *T. bactrae* release. The results suggested that *T. bactrae* is not present naturally in the field. The eggs recovery was also calculated. The unrecovered eggs were probably be destroyed by predators (Henneberry and Clayton, 1982). The parasitisation efficacy of *Trichogrammatoidea bactrae* was tested in the cotton ecosystem and the results revealed that the parasitism percent of *T. bactrae* on the eggs of *P. gossypiella* was found to be on par at NSKE 5% concentration (24.63%), neem formulation 1500 ppm 1% concentration (24.10%), *Pongamia* extract 5% concentration (23.13%), *Jatropha* extract 5% concentration (23.93%) and emamectin benzoate 5 SG at 190g/ ha (19.49%) and were found the safest to *T. bactrae*. Whereas among the treatments, emamectin benzoate 5 SG at 190g/ ha and chlorantraniliprole 18.5 SC at 150 mL/ ha (15.26%) were on par with each other. Followed by spinosad 45 SC at 220 mL/ ha (11.30%) and flubendiamide 39.5 SC at 125 mL/ ha (10.45%) were on par and were found to be unsafe to the parasitisation of *T. bactrae* (Table 1).

Asha et al. (2019) conducted laboratory studies to evaluate the parasitising efficacy of four *Trichogramma* species against the eggs of *P. gossypiella* and found that the maximum parasitism (>87%) was observed in case of *T. bactrae*. El-Wakeil et al. (2006) stated that no side effects in the adult emergence of *Trichogramma* spp. due to several neem products. Similarly, Sharma and Aggrawal (2019) concluded that botanicals and biopesticides were harmless to slightly harmful with respect to adult emergence of *Trichogramma* sp. which is in agreement with the present results of NSKE, neem formulation, *Jatropa* extract, and *Pongamia* extract on *T. bactrae.* The adult emergence and per cent parasitisation were greatly influenced by insecticides as compared to neem products which were relatively safer to these egg parasitoids (Srinivasan et al., 2001). Perera et al. (2015) revealed that *T. bactrae* was a promising candidate to be promoted as a biocontrol agent of rice leaf folder, over 35-66% parasitism was achieved at laboratory conditions. However, Malik (2001) observed that when *T. bactrae* was released in cotton field, the total parasitism in *P. gossypiella* eggs was 14.72 and 18.53 respectively. Luo et al. (2014) described the same trend in the parasitisation of the inundative release in the field. The present results are in accordance with Malik (2001) and it is suggested that the egg parasitoid, *T. bactrae* proved as an effective biological agent and can be used in IPM of cotton for the management of *P. gossypiella* (El-Hafez and Nada, 2000). Combinations of biological agent *Trichogramma* and chemical control had also been proved to be successful for the management of *P. gossypiella* (Sarwar, 2017).

Emamectin benzoate 5 WG considered to be highly safe to the honey bee/ non-target insects (Husain et al., 2014; Thangavel et al., 2016). Preetha et al. (2009) conducted safety study experiments in the laboratory based on nine insecticides, namely, imidacloprid, thiamethoxam, chlorantraniliprole, clothianidin, pymetrozine, ethofenprox, BPMC, endosulfan and acephate were tested to determine their toxicity against *Trichogramma sp.* by glass vial residue bioassay. Based on the risk quotient assessment, only chlorantraniliprole was found to be safe to *Trichogramma* sp. Spinosad 2.5 SC at the recommended dosage (17.5 a.i./ ha) was found to be extremely toxic to immature and adults of *T. bactrae* (Jalali and Ramani, 2001). Though parasitism rates may seem not enough for the complete

Table 1. Parasitisation efficiency of *Trichogrammatoidea bactrae* after release against pink bollworm in cotton ecosystem (Kharif, 2021-22)

Treatment	Pink bollworm eggs tested in the field (Nos)*	Eggs recovered from the field (Nos)*	Number of parasitised eggs (Nos)*	Parasitism* (%)
T1 - NSKE @ 5%	100	89.33	22.00	24.63 (29.75)a
T2 - Neem formulation 1500 ppm @ 1%	100	83.00	20.00	24.10 (29.40)a
T3 - *Pongamia* extract @ 5%	100	89.33	20.67	23.13 (28.75)a
T4 - *Jatropha* extract @ 5%	100	78.00	18.67	23.93 (29.29)a
T5 - Emamectin benzoate 5 SG @ 190 g/ ha	100	78.67	15.33	19.49 (26.20)ab
T6 - Flubendiamide 39.5 SC @ 125 ml/ ha	100	73.33	7.67	10.45 (18.86)c
T7 - Spinosad 45 SC @ 220 ml/ha	100	76.67	8.67	11.30 (19.65)c
T8 - Chlorantraniliprole 18.5 SC @ 150 ml/ ha	100	83.00	12.67	15.26 (23.00)b
T9 - Control	100	77.33	20.33	26.29 (30.85)a
SEd	-	-	-	2.5729
CD (p=0.05)	-	-	-	5.4056

*Mean of three replications and mean of two trials; In a column, means followed by different letters are significantly different (p=0.05) as per Tukey HSD test

management of the *P. gossypiella*, inundative release of *T. bactrae* achieved sizeable control of *P. gossypiella* (Mahalakshmi and Prasad, 2020). To avoid economic damage by *P. gossypiella* in cotton, cotton growers could follow Integrated Pest Management by integrating biological control methods with other management practices viz., cultural methods, pheromone mass trapping methods and chemical control.

ACKNOWLEDGEMENTS

The authors thank the Department of Cottton and the Department of Agricultural Entomology of Tamil Nadu Agricultural University, Coimbatore for providing research facilities and support

FINANCIAL SUPPORT

No financial support.

AUTHOR CONTRIBUTION STATEMENT

I Padma-Shree: For collection, analysis and interpretation of data; drafting the manuscript; M Muthuswami: Advisor for the research work and for drafting the manuscript; K Senguttuvan: Advisor for the research work and for drafting the manuscript; S Rajeswari: Advisor for the research work and providing research facilities; N Manikanda Boopathi: Advisor for the research work and drafting the manuscript structure.

CONFLICT OF INTEREST

No conflict of interests.

REFERENCES

Asha S, Naik V C B, Neharkar P S, Ughade J D, Sant S S. 2019. Parasitizing potential of four *Trichogramma* species on the eggs of pink bollworm, *Pectinophora gossypiella* (Saunders). Journal of Pharmacognosy and Phytochemistry 8(5): 857-859.

Bale J S, Van-Lenteren J C, Bigler F. 2008. Biological control and sustainable food production. Philosophical Transactions of the Royal Society B: Biological Sciences 363(1492): 761-776.

El-Hafez A A, Nada M A. 2000. Augmentation of *Trichogrammatoidea bactrae* Nagaraja in the IPM programme for control of pink bollworm, *Pectinophora gossypiella* (Saund.) in Egypt. Proceedings of Beltwide Cotton Conferences, National Cotton Council, San Antonio, USA, 2000. pp. 1009-1015.

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 the pink and spiny bollworms. Annals of Agricultural Science (Cairo) 40(2): 901-912. https://www.cabdirect.org/cabdirect/abstract/19961108682

El-Heneidy A H, Abbas M S, Khidr A A. 1987. Comparative population densities of certain predators in cotton fields treated with sex pheromones and insecticides in Menoufia Governorate, Egypt. Bulletin of the Entomological Society of Egypt 16: 181-190.

El-Wakeil N E, Gaafar N M, Vidal S. 2006. Side effect of some neem products on natural enemies of Helicoverpa (*Trichogramma* spp.) and *Chrysoperla carnea*. Archives of Phytopathology and Plant Protection 39(6): 445-455. https://doi.org/10.1080/03235400500356160

Henneberry T J, Clayton T E. 1982. Pink bollworm: seasonal oviposition, egg predation, and square and boll infestations in relation to cotton plant development. Environmental Entomology 11(3): 663-666.

Husain D, Qasim M, Saleem M, Akhter M, Khan K A. 2014. Bioassay of insecticides against three honey bee species in laboratory conditions. Cercetari Agronomice in Moldova 47(2): 69-79.

Hutchison W D, Moratorio M, Martin J M. 1990. Morphology and biology of *Trichogrammatoidea bactrae* (Hymenoptera: Trichogrammatidae), imported from Australia as a parasitoid of pink bollworm (Lepidoptera: Gelechiidae) eggs. Annals of the Entomological Society of America 83(1): 46-54.

ICAR-AICRP (Cotton) Annual Report (2019-20) ICAR - All India Coordinated Cotton Improvement Project on Cotton, Coimbatore, Tamil Nadu, India - 641 003.

Jalali S K, Ramani S. 2001. Toxicity of spinosad to natural enemies of Diamond back moth, *Plutella xylostella* (Linn.) (Lepidoptera: Yponumeutidae). Proceedings of the second international work shop on diamond back moth and other cruciferous pests, Taiwan, 2001. pp. 222.

Lim G T. 1986. Biological studies on *Trichogrammatoidea bactrae fumata* Nagaraja in the laboratory. Journal of Applied Entomology 101(5): 48-54. https://doi.org/10.1111/j. 1439-0418.1986.tb00832.x

Luo S, Naranjo S E, Wu K. 2014. Biological control of cotton pests in China. Biological Control 68: 6-14.

Mahalakshmi M S, Prasad N V V S D. 2020. Field potential of *Trichogrammatoidea bactrae* Nagaraja as an egg parasitiod against pink bollworm, *Pectinophora gossypiella* (Saunders) in cotton. Journal of Biological Control 34(3): 223-226.

Malik F M. 2000. Life table studies of *Trichogrammatoidea bactrae* (Hymenoptera: Trichogrammatidae) an effective biological agent of Pink bollworm (*Pectinophora gossypiella*, Lepidoptera: Gelechiidae) of cotton (*Gossypium* spp.). Pakistan Journal of Biological Science 3(12): 2106-2108.

Malik M F. 2001. Biological control of pink bollworm (*Pectinophora gossypiella*, Lepidoptera: Gelichiidae) by *Trichogrammatidea bactrae* (Hymenoptera: Trichogrammatidae) in cotton (*Gossypium barbadense*). Online Journal of Biological Sciences 1(6): 488-489.

Nagaraja H. 1978. Studies on *Trichogrammatoidea* (Hymenoptera: Trichogrammatidae). Oriental Insects 12(4): 489-529. https://doi.org/10.1080/00305316. 1978.10432534

Naranjo S E, Gordh G, Moratorio M. 1992. Inundative release of *Trichogrammatoidea bactrae* for biological control of pink bollworm. Cotton, A College of Agriculture Report 110-16.

Naranjo S E. 1993. Life history of *Trichogrammatoidea bactrae* (Hymenoptera: Trichogrammatidae), an egg parasitoid of pink bollworm (Lepidoptera: Gelechiidae), with emphasis on performance at high temperatures. Environmental Entomology 22(5): 1051-1059. https://doi.org/10.1093/ee/22.5.1051

Perera M C D, Hemachandra K S, Sirisena U G A I. 2015. *Trichogrammatoidea bactrae* (Hymenoptera: Trichogrammatidae): a potential biocontrol agent of rice leaf folder. Tropical Agricultural Research 26(3): 537 - 546.

Preetha G, Stanley J, Suresh S, Kuttalam S, Samiyappan R. 2009. Toxicity of selected insecticides to *Trichogramma chilonis*: assessing their safety in the rice ecosystem. Phytoparasitica 37(3): 209-215. https://doi.org/10.1007/s12600-009-0031-x

Sarwar M. 2017. Pink bollworm *Pectinophora gossypiella* (Saunders) (Lepidoptera: Gelechiidae) and practices of its integrated management in cotton. International Journal of Plant Science and Ecology 3(1): 1-6.

Sharma S, Aggarwal N. 2019. Safety assessment of selected biopesticides and botanicals on *Trichogramma* spp. (Hymenoptera: Trichogrammatidae) in fields. Indian Journal of Experimental Biology 57: 443-449. http://nopr.niscpr.res.in/handle/123456789/47436

Shrinivas A, Hanchinal S, Hurali S, Beldhadi R. 2019. Comparative biology of pink bollworm, *Pectinophora gossypiella* (Saunders) (Lepidoptera: Gelechiidae) on different hosts. Journal of Entomology and Zoology Studies 7(1): 1053-1060.

Srinivasan G, Babu P C, Murugeswari V. 2001. Effect of neem products and insecticides on the egg parasitoids, *Trichogramma* spp. (Trichogrammatidae: Hymenoptera). Pesticide Research Journal 13(2): 250-253.

Thangavel K, Baskaran R K, Suresh K. 2018. Evaluation of toxicity of Emamectin benzoate 5 WG on immature stages of egg parasitoid, *Trichogramma chilonis*. Annals of Plant Protection Sciences 26(1): 217-218.

(Manuscript Received: November, 2022; Revised: April, 2023;
Accepted: April, 2023; Online Published: April, 2023)
Online First in www.entosocindia.org and indianentomology.org Ref. No. e23907