Website : www.asthafoundation.in
Frontiers in Crop Improvement
Vol 9 : 2216-2219 (Special Issue-V) December 2021 Print ISSN : 2393-8234 Online ISSN : 2454-6011
Astha Foundation, Meerut (U.P.) India

Residual Toxicity of Some Insecticides to *Trichogrammatoidea bactrae* Nagaraja on Eggs of Different Bollworms

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Abstract

The present investigation on Residual toxicity of some insecticides to *Trichogrammatoidea bactrae* Nagaraja on eggs of different bollworms was carried out at Bio-control Laboratory, Department of Agricultural Entomology, College of Agriculture, Latur (VNMKV, Parbhani), Maharashtra-India during 2018-19. The data on median lethal concentrations of nine different insecticides to the adults of *Tr. bactrae* revealed that among the insecticides tested in dry film vial residue bioassay, spinosad exhibited highest toxicity to *Tr. bactrae* adults with LC_{50} value of 0.0103 and 0.0104 ml a.i. per *l* at 24 and 48 h interval of exposure, respectively followed by chlorantraniliprole (LC_{50}=0.0180 and 0.0181 ml a.i. per *l*), diflubenzuron (LC_{50} =0.0296 and 0.0265 mg a.i. per *l*), emamectin benzoate (LC_{50} =0.0321 and 0.0284 mg a.i. per *l*), indoxacarb (LC_{50} =0.0626 and 0.0627 ml a.i. per *l*), cyantraniliprole (LC_{50} =0.1120 and 0.1129 ml a.i. per *l*), lambda-cyhalothrin (LC_{50} =0.1579 and 0.0911 ml a.i. per *l*), quinalphos (LC_{50} =0.1743 and 0.1749 ml a.i. per *l*) and azadirachtin which was found to be least toxic to the adults of *Tr. bactrae* with LC50 value of 2.1831 and 1.4806 ml a.i. per l. Based on Risk Quotient values, among the different insecticides, azadirachtin was found to be harmless however; spinosad and diflubenzuron was found to be highly dangerous insecticide to the adults of Tr. bactrae.

Key words *: Residual toxicity, some insecticides, Trichogrammatoidea bactrae*

Introduction

Trichogrammatids are smallest insects, ranging in size from 0.2 to 1.5 mm, solitary or gregarious idiobiont endoparasitoids of insect eggs. The family Trichogrammatidae is represented by over 800 described species in approximately 90 genera worldwide and is recognized from all vegetated terrestrial habitats (Pinto, 2006). Use of *Trichogrammatoidea* sp. in different pest control programme proves satisfactory as it gives high level of pest suppression in the field (Malik, 2001a; Liu *et al*., 2004; Krishnamoorthy, 2012 and Mohamed *et al*., 2016). However, the success of its release depends upon the factors such as interaction with target host, strain released and different biological characters that determine the efficacy of parasitism (Bourchier and Smith, 1996).

Attempts to suppress insect-pest populations by biological control measures have often failed because of deleterious effects of chemicals on the beneficial insects (Kapuge *et al*., 2003). Moreover, majority of farmers usually adopt a faulty procedure of release of Trichogrammatids, without due consideration of safe waiting periods of insecticides for the parasitoids after chemical sprays. The contact toxicity and impact of chemical residues on Trichogrammatids have been examined in numerous studies using protocols developed by International Organization for Biological Control of Noxious Plants and Animals (IOBC) and West Palaearctic Region Section (WPRS) working group (Hassan *et al*., 1998). However, scanty information is available on safe waiting periods for the release of *Tr. bactrae* after insecticidal application.

Materials and Methods

The egg parasitoid *Tr. bactrae* maintained on eggs of *C. cephalonica*. The insecticides which are commonly being used for the control of bollworms on cotton were selected and purchased from the local market (Table 1). The commercial formulations of various insecticides were diluted with distilled water to obtain the desired concentrations. Plastic vial residue method was followed to assess the residual toxicity of insecticides to *Trichogrammatoidea* species as per the standard procedure proposed by Hassan *et al*. (1998) with slight modi?cation. The vials were coated evenly with 0.5 ml of each concentration (one lower than recommended, one recommended and one higher than recommended) of 9 different insecticides and dried thoroughly. As a control, distilled water was used. The ten newly emerged adults of *Tr. bactrae* were released in the treated plastic vial. After 4 hr of exposure, the wasps were placed in a clean test tube and mortality was recorded at 24 and 48 hr after treatment (HAT). The experiment was replicated three times. Necessary corrections were made for natural mortality in the control as per Abbott (1925) for *Tr. bactrae* bioassays.

Table-1 : Details of insecticides assayed in the experiment.

Sr. No.	Common name with formulation	Recommended dosages (per 10 liter water)	Concentration of insecticide (Per cent)	Sr. No.	Common name with formulation	Recommended dosages (per 10 liter water	Concentration of insecticide (Per cent)
1.	Azadirachtin 0.03% EC	50 ml	0.00015	6.	Lambda-cyhalothrin 5% EC	10 ml	0.0040
2.	Chlorantraniliprole 18.5% SC	3 ml	0.0055	7.	Spinosad 45% SC	1.6 ml	0.0070
3.	Cyantraniliprole 10.26% OD	12 ml	0.0123	8.	Quinalphos 25% EC	20 ml	0.05
4.	Emamectin benzoate 5% SG	2.7 g	0.00135	9.	Diflubenzuron 25% WP	6 mg	0.015
5.	Indoxacarb 15.8% EC	6.7 ml	0.0105	10.	Control (Distilled water)	-	-

Abbott's formula : Corrected per cent mortality

$$= \frac{T - C}{100 - C} \times 100$$

Where,

T = Per cent mortality in treatment

C = Per cent mortality in control

Then the data were subjected to probit analysis by Finney (1971) using computer software Polo Plus 1.0 (LeOra software) to obtain the value of median lethal concentration (LC_{50}) for each insecticide.

Calculation of Risk Quotient : Environmental risk assessment of pesticides and other chemicals often uses the Risk Quotient (RQ) method (deterministic approach) to express risk quantitatively. An RQ typically is calculated by dividing an environmental exposure value by a toxicity end-point value. Therefore, the RQ is a ratio of exposure to effect. The RQ then can be used by risk analysts and other decision makers to assess whether the value exceeds any predetermined threshold levels of concern (Peterson, 2006). This ratio is a simple, screening-level estimate that identified high- or low-risk situations. In this method, the estimated environmental concentration (EEC) is compared to an effect level, such as an LC_{50} (the concentration of a pesticide where 50 per cent of the organisms die) (EPA, 2016). Risk Quotients for the insecticides were calculated from the LC_{50} values based on the formula given below.

Risk Quotient

$$= \frac{\text{Recommended field rate (mg or ml a.i. per ha)}}{LC_{50} \text{ of beneficial insect (mg or ml a.i. per } l\text{)}}$$

Results and Discussion

The data revealed that among the insecticides tested in dry film vial residue bioassay, spinosad exhibited highest toxicity to *Tr. bactrae* adults with LC_{50} value of 0.0103 ml a.i. per *l* at 24 h interval of exposure followed by chlorantraniliprole (LC_{50}=0.0180 ml a.i. per *l*), diflubenzuron (LC_{50} =0.0296 mg a.i. per *l*), emamectin benzoate (LC_{50} =0.0321mg a.i. per *l*), indoxacarb (LC_{50} =0.0626 ml a.i. per *l*), cyantraniliprole (LC_{50} =0.1120 ml a.i. per *l*), lambda-cyhalothrin (LC_{50} =0.1579 ml a.i. per *l*), quinalphos (LC_{50} =0.1743 ml a.i. per *l*) and azadirachtin was found to be least toxic to the adults of *Tr. bactrae* with LC_{50} value of 2.1831 ml a.i. per *l*.

The data revealed that among the insecticides tested in dry film vial residue bioassay, spinosad was found to be most lethal insecticide to *Tr. bactrae* adults with LC_{50} value of 0.0104 ml a.i. per *l* at 48 h interval of exposure followed by chlorantraniliprole (LC_{50} =0.0181 ml a.i. per *l*), diflubenzuron (LC_{50} =0.0265 mg a.i. per *l*), emamectin benzoate (LC_{50} =0.0284 mg a.i. per *l*), indoxacarb (LC_{50} =0.0627 ml a.i. per *l*), lambda-cyhalothrin (LC_{50} =0.0911 ml a.i. per *l*), cyantraniliprole (LC_{50} =0.1129 ml a.i. per *l*), quinalphos (LC_{50} =0.1749 ml a.i. per *l*), however azadirachtin was found to be least toxic to the adults of *Tr. bactrae* with LC_{50} value of 1.4806 ml a.i. per *l*.

These results are analogous with the findings of Osman *et al*. (2014) who evidenced that residues of emamectin benzoate caused the highest percentages of mortality of *Tr. bactrae* (65 per cent) followed by chlorantraniliprole (60 per cent), spinosad (55 per cent), lufenuron (35 per cent) and *Bt* (10 per cent). Perera and Hemachandra (2014) evidenced that mortality of *Tr. bactrae* significantly varied across the insecticides and the stage of *Tr. bactrae.* Fipronil caused highest mean mortality of all stages of *Tr. bactrae* followed by chlorfluazuron and azadirachtin. Wang et al. (2010) revealed that residues of betacypermethrin, diafenthiuron, avermectins, spinosad, chlorfenapy, fipronil and cartap exhibited 89.31-100 per cent mortalities in *Tr. bactrae* adults. Djuwarso *et al*. (1999)

Table-2 : Median lethal concentration and Risk Quotient of different insecticides to *Tr. bactrae.*

Insecticides	Period (h)	LC_{50} (mg or ml a.i. per *l*)	90% Fiducial limits of LC_{50}		LC_{90} (mg or ml a.i. per *l*)	X^2 Value	Risk Quotient	Category
			Lower limit	Upper limit				
Azadirachtin 0.03% EC	24	2.1831	0.15387	30.9726	93.9622	0.0033	0.34	Harmless
	48	1.4806	0.01365	142.6824	4065.445	0.0702	0.51	Harmless
Chlorantraniliprole 18.5% SC	24	0.0180	0.00456	0.07137	0.4513	0.0349	1666.66	Moderately toxic
	48	0.0181	0.00462	0.07125	0.0006	0.0425	1657.45	Moderately toxic
Cyantraniliprole 10.26% OD	24	0.1120	0.05030	0.24964	1.1005	0.0110	535.71	Slightly toxic
	48	0.1129	0.05060	0.25198	0.0115	0.0114	531.44	Slightly toxic
Emamectin benzoate 5% SG	24	0.0321	0.01926	0.05358	0.0803	0.0011	264.80	Slightly toxic
	48	0.0284	0.01960	0.01370	0.0107	0.3333	299.29	Slightly toxic
Indoxacarb 15.8% EC	24	0.0626	0.05545	0.07071	0.0791	0.1277	1198.08	Moderately toxic
	48	0.0627	0.05560	0.07060	0.0496	0.1282	1196.17	Moderately toxic
Lambda-cyhalothrin 5% EC	24	0.1579	0.03420	0.72909	2.4178	0.0145	95.00	Slightly toxic
	48	0.0911	0.03350	0.24816	0.0053	0.0171	164.65	Slightly toxic
Spinosad 45% SC	24	0.0103	0.00663	0.01624	0.0233	0.2706	7281.55	Dangerous
	48	0.0104	0.01623	0.20567	0.0046	0.2943	7211.54	Dangerous
Quinalphos 25% EC	24	0.1743	0.12441	0.24441	0.4018	0.0193	1147.44	Moderately toxic
	48	0.1749	0.12508	0.24462	0.0759	0.0202	1143.51	Moderately toxic
Diflubenzuron 25% WP	24	0.0296	0.02197	0.04004	0.0698	0.0014	2533.78	Dangerous
	48	0.0265	0.01215	0.05816	0.0046	0.0756	2830.18	Dangerous

investigated that sihalotrin residues had negative effect on *Tr. bactrae bactrae* in *E. zinckenella* eggs. Chlorpyriphos was highly toxic to the immature stage of parasitoid in the *C. cephalonica* eggs and failed to record adult emergence. Monocrotophos and Deltametrin were safer than the others if sprayed on immature stage 1-3 days old in *C. cephalonica* eggs. Hassan and Graham-Smith (1995) revealed that *Tr. bactrae* was highly sensitive to endosulfan and fenvalerate, however *B. thuringiensis* found harmless.

Risk quotient of different insecticides : The data revealed that among the eight insecticides tested, spinosad and diflubenzuron were found to be “dangerous” to the adult of *Tr. bactrae* with highest Risk Quotient values of 7281.55, 7211.54 and 2533.78, 2830.18 at 24 and 48 h interval of exposure, respectively. However, chlorantraniliprole was observed to be “moderately toxic” to the adults of *Tr. bactrae* with Risk Quotient values of 1666.66 and 1657.45 at 24 and 48 h interval of exposure, respectively followed by indoxacarb (1198.08 and 1996.17), quinalphos (1147.44 and 1143.51). However, cyantraniliprole, emamectin benzoate and lambda-cyhalothrin were exhibited to be “slightly toxic” to *Tr. bactrae* adults with Risk Quotient values of 535.71 and 531.44, 264.80 and 299.29 and; 95.00 and 164.65 at 24 and 48 h interval of exposure, respectively. Amongst the insecticide tested, azadirachtin was found to be “harmless” to the adults of *Tr. bactrae* with very less Risk Quotient values of 0.34 and 0.51 at 24 and 48 h interval of exposure, respectively.

More or less similar results were obtained by Chunke (2017) who revealed that based on the Risk Quotient values, spinosad was found to be “dangerous”, chlorantraniliprole, quinalphos and indoxacarb were “moderately toxic”, cyantraniliprole, emamectin benzoate and lambda-cyhalothrin were “slightly toxic” and; azadirachtin was “harmless” to *T. chilonis* adults. Shankarganesh *et al*. (2013) indicated that adults of egg parasitoids, *T. chilonis* and *T. brasiliensis* when exposed to nine different insecticides by glass vial residue method, lambda-cyhalothrin, and indoxacarb were more toxic to *T. chilonis*. However, *T. brasiliensis* was more sensitive to indoxacarb than other insecticides. Based on the Risk Quotient value, lambda-cyhalothrin and indoxacarb were observed dangerous to *T. chilonis* and *T. brasiliensis*. Analogously, Anoop Kumar *et al*. (2013) reported that lambda-cyhalothrin was found highly toxic to the adult wasps of *T. chilonis* with 100 per cent mortality within 2 h of exposure.

Conclusion

Based on Risk Quotient values, among the different insecticides, azadirachtin was found to be harmless however; spinosad and diflubenzuron was found to be highly dangerous insecticide to the adults of *Tr. bactrae.* The present study was conducted under laboratory conditions in which insects were subjected to high pressure of insecticide. However, under field condition, the insecticide may have less negative impact on parasitoids. Since, natural enemy can take advantage of natural shelter, avoiding treated areas and other means. Therefore, further studies needs to be carried out to determine insecticides which can be used safely under field conditions without disrupting the ecological balance.

References

1. Abbott, W.S. 1925. A method of computing the effectiveness of an insecticide. *J. Econ. Entomol*., 18 (2): 265-267.
2. Anoop, Kumar., Singh, N. N., Dharmendra Kumar and Awaneesh Chandra. 2013. Safety evaluation of insecticides field doses on adult wasp of *Trichogramma chilonis* Ishii. *Bioinfolet.,* 10 (4B): 1254-1256.
3. Bourchier, R.S. and Smith, S.M. 1996. Influence of environmental conditions and parasitoid quality on field performance of *Trichogramma minutum*. *Entomologia Experimentalis et Applicata*, 80 (3): 461-468.
4. Chunke, S.S. 2017. Biology of *Trichogramma Chilonis* (Ishii) on eggs of different host eggs. M.Sc. (Agri.) Dissertation submitted to Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani-India (Unpublished).
5. Djuwarso, T., Tengkano, W., Koswanudin, D. and Damayanti, D. 1999. Potensi *Trichogrammatoidea bactrae bactrae*, Parasitoid Telur Penggerek Polong Kedelai. In Proc. Seminar Nasional Perhimpunan Entomologi Indonesia, Tantangan Entomologi Abad XXI, Bogor: 29-45.
6. EPA, 2016. Technical overview of ecological risk assessment: risk characterization. Pesticide sciences and assessing pesticide risks (www.epa.gov).
7. Finney, D.J. 1971. Probit Analysis, 3rd ed. Published by Cambridge University Press, 32 E. 57th St., New York, NY, 10022: 333.
8. Hassan, E. and Graham-Smith, S. 1995. Toxicity of endosulfan, esfenvalrate and *Bacillus thuringiensis* on adult *Microplitis demolitor* Wilkinson and *Trichogrammatoidea bactare* Nagaraja. *J. Plant Diseases and Prot*.,102 (4): 422-428.
9. Hassan, S.A., Hafes, B., Degrande, P.E. and Herai, K. 1998. The side-effects of pesticides on the egg parasitoid *Trichogramma cacoeciae* Marchal (Hymenoptera:Trichogrammatidae), acute dose-response and persistence tests. *J. Appl. Entomol*., 122: 569-573.
10. Kapuge, S.H., Mcdougall, S. and Hoffmann, A.A. 2003. Effects of methoxyfenozide, indoxacarb, and other insecticides on the beneficial egg parasitoid, *Trichogramma brassicae* (Hymenoptera: Trichogrammatidae) under laboratory and field conditions. *J. Econ. Entomol*., 96: 1083.
11. Krishnamoorthy, A. 2012. Exploitation of egg parasitoids for control of potential pests in vegetable ecosystems in India. *Comunicata Scientiae*, 3 (1): 1-15.
12. Liu, Shu-sheng, Larry Cooper, Richard R. Llewellyn, Marlene Elson-Harris, John Duff, Michael J. Furlong and Myron P. Zalucki. 2004. Egg parasitoids of the diamond back moth, *Plutella xylostella* (L.) (Lepidoptera: Plutellidae), from south-east Queensland. *Aust. J. Entomol*., 43: 201-207.
13. Malik, M. F. 2001. Some biological attributes of *Trichogrammatoidea bactrae*, (Hymenoptera: Trichogrammatidae), at high temperatures in pink bollworm (*Pectinophora gossypiella*, Lepidoptera: Gelechiidae) eggs. *J. Biol. Sci*., 1 (6): 485-487.
14. Mohamed, Hend O., A.H. E-Heneidy, Abd-Elalim G. Ali and Azza A. Awad. 2016. Non-chemical control of the pink and spiny bollworms in cotton fields at Assuit Governorate, Upper Egypt, II- Utilization of the egg parasitoid, *Trichogrammatoidea bactrae* Nagaraja. *Egypt. J. Biol. Pest Control,* 26 (4): 807-813.
15. Nagaraja, H. 1978. Studies on *Trichogrammatoidea* (Hymenoptera: Trichogrammatoidea). *Oriental insects*, 12 (4): 489-530.
16. Osman, M.A.M., Mandour, N.S., Abd El-Hady, M.A. and Sarhan, A.A. 2014. Susceptibility of four Trichogrammatid parasitoids to some bio-rational insecticides used to control tomato leaf miner *Tuta absoluta* (Lepidoptera, Gelechiidae). *J. Appl. Plant Protection; Suez Canal Uni.,* 2: 31-38.
17. Perera, M.C.D. and Hemachandra, K.S. 2014b. Effects of insecticides on egg parasitoid *Trichogrammatoidea* Nagaraja (Hymenoptera: Trichogrammitidae) under laboratory conditions. In proceedings of the Peradeniya Univ. *Int. Res. Sessions*, Sri Lanka, 18: 444.
18. Peterson, Robert KD. 2006. Comparing ecological risks of pesticides: the utility of a Risk Quotient ranking approach across refinements of exposure. *Pest Management Sci*., 62 (1): 46-56.
19. Pinto, John. D. 2006. A review of the New World genera of Trichogrammatidae (Hymenoptera). *J. Hymenoptera Res*., 15: 38-163.
20. Shankarganesh, K., Paul, Bishwajeet and Gautam, R.D. 2013 studies on ecological safety of insecticides to egg parasitoids *Trichogramma chilonis* (Ishii) and *Trichogramma brasiliensis* (Ashmead). *Nati. Acad. Sci. Lett.,* 36 (6):581-585.
21. Wang, D.S. Lv, L.H. He, Y.R. Qin, S.S. Pan, F. 2010. Effect of conventional insecticides on *Trichogrammatoidea bactrae*. *Chinese Bull. Entomol*., 47: 379-383.