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Evaluation of safety of some new insecticides to per cent parasitisation and survival of *Trichogramma japonicum*

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Abstract
Some new insecticides *viz.*,chlorantraniliprole 18.5 SC (0.005%), flubendiamide 20 WG (0.005%), buprofezin 25 SC (0.05%), Lambda cyhalothrin 5 EC (0.003%), thiamethoxam 25 WG (0.005%), dinotefuran 20 SG (0.006%), thiacloprid 21.7 SC (0.021%) and azadirachtin 5% w/w (0.002%) were tested to know their effect on per cent parasitisation of UV irradiated and unirradiated *Corcyra cephalonica* eggs by Parasitoid *Trichogramma japonicum* and to assess the residual toxicity of these insecticides on adult *T. japonicum* under laboratory conditions. The results indicated that lambda cyahalothrin was most harmfulcausing maximum reduction in parasitisation, whereas minimum reduction in per cent parasitisation were observed under insecticide treatments azadirachtin, buprofezin, flubendiamide and chlorantraniliprole in both UV irradiated and unirradtiated eggs of *Corcyra cephalonica*. However, the insecticides differed considerably in their residual toxicity towards *T. japonicum*. Amongst them, azadirachtin was recorded safest followed by chlorantraniliprole and buprofezin, whereas lambda cyhalothrin most affected survival of *T. japonicum* causing maximum adult mortality upto 10 days.

Keywords: *Trichogramma japonicum*, parasitisation, insecticides, residual toxicity, *Corcyra cephalonica*

1. Introduction

Natural enemies have been utilised in management of insect pests for centuries. Despite long history of using natural enemies, the term biological control was used for the first time in 1919 by late Harry Smith of the University of California [16]. Biological control of insect pest is advantageous because it is safe and poses no threat to human health and it is also environment friendly. Among the various bio control agents, *Trichogramma spp.* are most important egg parasitoid which are commonly distributed worldwide. These are minute endoparasitoids of insect eggs having size range from 0.2 to 1.5 mm. within the genus *Trichogramma* there are 145 described species worldwide. Amongst the various species of *Trichogramma*, *Trichogramma japonicum* (Ashmead) is an important egg parasitoid and promising natural enemy of lepidopteran enemy in paddy crop [12] and is widely used in Integrated Pest Management (IPM) of many important insect pests.

Despite of the importance of biological control the use of organic synthetic insecticides continues to be an important tool in Integrated Pest Management Programme (IPM). But indiscriminate use of chemical insecticides may harm the effectiveness of natural enemies including *Trichogramma*. Some of the earlier studies reported negative effect on *Trichogramma*, whereas some studies showed lethal and sublethal effect. Insecticides are usually considered to cause high risk to beneficial insect species [2]. Therefore, present study for evaluation of safety of some new insecticides on *Trichogramma japonicum* is of much importance to know the effect of newer chemicals on the per cent parasitisation of *T. japonicum*and their residual toxicity for adult *T. japonicum* under laboratory conditions.

2. Materials and Methods

Laboratory studies were carried to find out the residual toxicity and safety of some new insecticides on parasitisation capacity of *Trichogramma japonicum*in the biocontrol laboratory, Entomology section, College of Agriculture, Nagpur during year 2017-18. The host insect *Corcyra cephalonica* and the parasitoid *T. japonicum* were reared under controlled room temperature and relative humidity conditions ranging between 26 ± 2 ^{0}C and 60 ± 5%, respectively and commercial formulation of the insecticides were obtained from the market.

Table 1: Treatment details

Treatment No.	Treatment Name	Concentration
T1	Chlorantraniliprole 18.5 SC	0.005%
T2	Flubendiamide 20 WG	0.005%
T3	Buprofezin 25 SC	0.05%
T4	Lambdacyhalothrin 5 EC	0.003%
T5	Thiamethoxam 25 WG	0.005%
T6	Dinotefuran 20 SG	0.006%
T7	Thiacloprid 21.7 SC	0.021%
T8	Azadirachtin 5% w/w	0.002 %
T9	Control	-

To obtain *Corcyra cephalonica*eggs throughout the experimental period, *Corcyra* culture was maintained on sorghum based artificial diet with following ingredients *viz*., crushed sorghum grains (2.5 kg), groundnut kernel powder (100 g), yeast powder (5 g), micronized wettable sulphur 80% (5 g) and streptomycin sulphate (5g) in one plastic tub. The freshly obtained Corcyra eggs were sieved and kept under UV irradiation for 45 minutes. Thus, UV irradiated and unirradiated eggs of *C. cephalonica*were used for conducting the experiment. The treatments were given by following methods suggested by Santaram G and Kumarswami [13].

2.1 To assess the safety of newer insecticides on per cent parasitisation of UV irradiated and unirradiated eggs of *Corcyra cephalonica* by *Trichogramma japonicum*

U.V. irradiated and unirradiated fresh eggs of *Corcyra cephalonica*were glued to the egg cards separately (@50eggs per card strip). The cards were then cut into small strips of 5.0x2.0cm and dipped in test insecticides for 5 seconds. For control, water was used instead of insecticides. The treated egg cards were shade dried. The card strips containing U.V. exposed and unexposed eggs were kept separately in glass vials of about 15.0 x 2.5cm size @ one card strip per vial for each treatment and replication. Each treatment was then labelled properly with details such as name of the treatment, concentration of insecticides, date and time of application. The treated egg-cards were exposed to adults of *Trichogramma japonicum* (@5:1 host: parasitoid ratio) for 24 hrs for parasitization. Each treatment was replicated thrice and experiment was conducted at laboratory condition. The egg-cards were examined for parasitization after 5thday of parasitoid release and the number of parasitized eggs was counted under stereo zoom microscope and per cent parasitisation was worked using following formula.

$$\text{Per cent parasitisation} = \frac{\text{Number of eggs parasitised}}{\text{Total Number of eggs exposed}} \times 100$$

The per cent reduction in parasitism (RP) was determined for each insecticide by the equation,

RP (%) = (1-f/t) x100

Where,

f = average number of parasitized eggs in the insecticide treatment

t = average number of parasitized eggs in the control treatment. [5]

On the basis of percent reduction in parasitisation, insecticides were classified in different categories as suggested by IOBC/WPRS [17]

Toxicity class	categorization	% reduction either in parasitisation
Class 1	Harmless	<30
Class 2	Slightly harmful	30-79
Class 3	Moderately Harmful	80-99
Class 4	Harmful	>99

2.2 To study the residual toxicity of newer insecticides against adults of *Trichogramma japonicum*

The effect of insecticide residues on survival of adult *Trichogramma japonicum* were studied by glass vial bioassay method. For this purpose the glass vials measuring about 15x4cm size were used. Sufficient quantities of insecticidal solution at recommended concentration of each insecticide were prepared in acetone. A thin uniform film of each insecticide were applied to each vial by taking 1 ml of spray liquid in it and quickly rotating by hand, so that vials get uniformly coated with the insecticides. The treated vials were shade dried to have insecticide residues as a dry film. A batch of glass vials treated with acetone was kept as control. After drying of insecticides, 25 newly emerged adults of *Trichogramma japonicum* were released inside each vial at an interval of 1st, 5th and 10th days after treatment to vials to test the residual toxicity. The adults were then exposed to insecticide residues for 4 hrs and per cent mortality was calculated on the basis of total number of adults released and number of adult dead.

The data obtained on per cent parasitisation were subjected to statistical analysis after appropriate transformation for interpretation of results.

3. Results and Discussion

3.1 Effect on per cent parasitisation

3.1.1 Assessment of safety of newer insecticides on per cent parasitisation of UV irradiated eggs of *Corcyra cephalonica* by *Trichogramma japonicum*

The data presented in table 2 stated that number of UV exposed eggs of *Corcyra cephalonica* parasitized by *Trichogramma japonicum* under different insecticidal treatment shows different results as compare to control (water spray) with 92.00 per cent parasitisation, whereas maximum per cent parasitisation was observed under flubendiamide with 75.33 per cent followed by azadirachtin>buprofezin>chlorantraniliprole>thiacloprid >thiamethoxam >dinotefuran with 70.00, 66.66, 64.66, 62.00, 60.66 and 59.33 per cent respectively. However lowest per cent parasitisation was observed under lambda cyhalothrin with 1.67 per cent. Hence as per the IOBC classificationflubendiamide 20 WG, chlorantraniliprole 18.5 SC, buprofezin 25 SC and azadirachtin 5% w/w were categorized under class “harmless” whereas, thiamethoxam 25WG, thiacloprid 21.7 SC and dinotefuran 20 SG were categorized as “Slightly harmful”. However, maximum reduction in parasitisation was recorded under lambda cyhalothrin 5 EC (98.20 per cent) hence categorized as “Moderately harmful”.

The findings of present study are in accordance with Madhusudhanan *et al.* [8] recorded 84.16, 80.20 and 80.04 per cent parasitisation under flubendiamide 20 WG at 50, 60 and 70 g a.i. ha^{-1} dose, whereas 75.86 per cent parasitisation was recorded from chlorantraniliprole 18.5 SC and Hussain et. al. [6] recorded highest emergence 17.8- 70.5 per cent under chlorantraniliprole. However, Chao *et al.* [1] also reported buprofezin safer for parasitisation of *T. japonicum*, whereas Madhusudhanan *et al.* [7] reported significant reduction in per centage of ovipositing females with thiamethoxam and dinotefuran with 42.2±2.3 and 43.1±7.1 per cent reduction respectively. El-wakeil *et al.* [3] Studied side effects of different neem products at concentrations of 2, 1, 0.5 and 0.25 per cent and reported that there were no serious side effects of this neem based insecticides on parasitism rates of *Trichogramma spp.* and is in agreement with the present findings. However, Pazini *et al.* [10] categorised lambda cyhalothrin+thiamethoxam and lambda cyhalothrin as “Harmful” according to IOBC classification with 100 per cent reduction in parasitism in both, whereas 0.1 and 9.7 per cent reduction in parasitisation from chlorantraniliprole and flubendiamide respectively.

3.1.2 Assessment of safety of newer insecticides on per centparasitisation of UV unirradiated eggs of *Corcyra cephalonica* by *Trichogramma japonicum*

The data presented in table 2 demonstrate that highest 96.00 parasitisation per cent were recorded from control (water spray). However the maximum reduction in parasitisation was recorded under lambda cyhalothrin (98.00 per cent) and minimum in flubendiamide with 12.5 per cent reduction in parasitisation whereas, 23.7, 25.7, 27.1, 32.0, 33.4 and 34.1 per cent reduction in parasitisation were recorded from azadirachtin, buprofezin, chlorantraniliprole, thiacloprid, thiamethoxam and dinotefuran respectively.

Among the insecticides tested lambda cyhalothrin 5EC (0.003%) recorded maximum reduction in per cent parasitisation (98.00 per cent) hence categorised as “Moderately harmful” as per the IOBC classification whereas, thiacloprid 21.7 SC (0.0021%), thiamethoxam 20 WG (0.006%) and dinotefuran 20 SG (0.006%) were classified as “slightly harmful”. However, flubendiamide 20 WG (0.005%), azadirachtin (0.002%), chlorantraniliprole 18.5 SC (0.005%) and buprofezin 25 SC (0.05%) least affected the parasitisation by *Trichogramma japonicum* and categorized as “Harmless”.

The results presented in table 2 indicate that the order of selectivity of insecticides towards per cent parasitisation in UV irradiated and unirradiated eggs of *Corcyra cephalonica* by *Trichogramma japonicum* were almost same. However the parasitism rates were recorded relatively higher in UV unirradiated eggs as compared to the UV irradiated eggs. It might be due to the acceptability of host eggs with live embryo by the parasitoid over those with killed embryos, as stated by Paul *et al.* [9].

Table 2: Assessment of safety of newer insecticides on per cent parasitisation of UV irradiated and unirradiated eggs of *Corcyra cephalonica* by *Trichogramma japonicum*

Treatment no.	Treatment name	UV irradiated eggs		UV unirradiated eggs		Score
		Mean per cent parasitisation	Per cent reduction in parasitisation (%RP)	Mean per cent parasitisation	Per cent reduction in parasitisation (%RP)	
T_1	Chlorantraniliprole 18.5 SC	64.66 (53.49)	29.80 (33.09)	70.00 (56.79)	27.10 (31.37)	Harmless
T_2	Flubendiamide 20 WG	75.33 (60.20)	18.20 (25.25)	84.00 (66.42)	12.50 (20.70)	Harmless
T_3	Buprofezin 25 SC	66.66 (54.79)	27.60 (31.69)	71.33 (57.61)	25.70 (30.46)	Harmless
T_4	Lambda cyhalothrin 5 EC	1.67 (7.27)	98.20 (82.29)	2.00 (8.13)	98.00 (81.87)	Moderately harmful
T_5	Thiamethoxam 25 WG	60.66 (51.12)	34.10 (35.73)	64.00 (53.13)	33.40 (35.30)	Slightly harmful
T_6	Dinotefuran 20 SG	59.33 (50.36)	35.60 (36.63)	63.33 (52.71)	34.10 (35.73)	Slightly harmful
T_7	Thiacloprid 21.7 SC	62.00 (51.94)	32.70 (34.88)	65.33 (53.91)	32.00 (34.45)	Slightly harmful
T_8	Azadirachtin 5% w/w	70.00 (56.79)	24.00 (29.33)	73.33 (58.89)	23.70 (29.13)	Harmless
T_9	Control (Water)	92.00 (73.57)	-	96.00 (78.46)	-	
‘F test’			Sig.		Sig.	
S.E.(m)			1.34		1.44	
C.D. at 5%			3.90		4.20	

(Figures in parentheses are arc sine values)

3.2 Residual effect of newer insecticides on adult *T. japonicum*

The data presented in Table 3 represent the effect of residual toxicity of different insecticides to the adults of *Trichogramma japonicum* exposed during 1st, 5th and 10th day after bioassay treatment to glass vials. The data recorded indicates that the order of toxicity was constant during all the observations recorded, whereas the ascending order of insecticides as per their residual toxicity found was azadirachtin<chlorantraniliprole<buprofezin<flubendiamide<thiacloprid<thiamethoxam<dinotefuran<lambda cyhalothrin. However, no mortality reported from control.

Among the tested insecticides azadirachtin found the safest of all insecticides with adult mortality per cent 26.64, 20.00, 8.00 pecent followed by chlorantraniliprole with 28.00, 21.32, 9.32 per cent and buprofezin with 29.32, 26.64, 12.00 per cent at 1st, 5th and 10th days after treatment respectively. However lambda cyhalothrin caused 100 per cent mortality of adult *T. Japonicum*upto 10 days and classified as Harmful to adult wasps as per IOBC classification, whereas dinotefuran caused 100 per cent mortality upto 5 days and recorded 98.68 per cent mortality at 10th day and hence classified as moderately harmful to harmful followed by thiamethoxam classified as moderately harmful with 98.68, 97.32, 96.00 per cent adult mortality at 1st, 5th and 10th days after treatment respectively. However, flubendiamide and thiacloprid were categorised as slightly harmful with 49.32, 36.00, 30.64 and 56.00, 46.64, 33.32 per cent mortality respectively. Thus all the insecticides under present study were categorised under slightly persistent as per the IOBC classification as all the insecticides showed toxicity from lesser extent with harmless (azadirachtin, chlorantraniliprole, buprofezin) to higher extent with harmful (lambda cyhalothrin) insecticides upto 10 days after treatment to the glass vials.

The results recorded under the present study were found in line with the works carried out by earlier researchers. Among them Uma *et al*. [18] reported chlorantraniliprole as safest to *Trichogramma japonicum* adults with 21.25 per cent adult mortality at 24 hrs after treatment and also recorded thiamethoxam as slightly to moderately toxic whereas, buprofezin (25.00% mortality) as harmless and flubendiamideas slightly harmful with 37.50 per cent adult mortality. Zhao *et al*. [19] reported highest toxicity to adult *T. japonicum* under thiamethoxam and lambda cyhalothrin, Insect growth regulators were classified as safe to *Trichogramma japonicum*. Fand *et al*. [4] reported neem oil 1% as safer with 45.33, 25.33 and 28.00 per cent adult mortality at 1st, 5th and 10th days after treatment respectively. Li *et al*. [7] recorded that thiamethoxam and dinotefuran possess extremely high risk to adult wasps of *T. ostriniae* and Preetha *et al*. [11] reported chlorantraniliprole as harmless as well as thiamethoxam as most toxic compound to adult of *T. chilonis.* Sidi *et al*. [15] reported azadirachtin as safer to *T. papilionis* with minimum 13.4 per cent adult mortality and Sattar *et al*. [14] also reported mortality per cent of adult *T. chilonis* under different insecticides viz. flubendiamide and neem oil after 0, 5, 15, and 25 days and observed 34, 21, 11, 9 per cent and 25, 20, 12, 8 per cent mortality respectively.

Table 3: Effect of residual toxicity of insecticides on *Trichogramma japonicum*

Treatment no.	Treatment name	% mortality of adult *T. japonicum*		
		1st day	5th day	10th day
T1	Chlorantraniliprole 18.5 SC	28.00	21.32	9.32
T2	Flubendiamide 20 WG	49.32	36.00	30.64
T3	Buprofezin 25 SC	29.32	26.64	12.00
T4	Lambda cyhalothrin 5 EC	100.00	100.00	100.00
T5	Thiamethoxam 25 WG	98.68	97.32	96.00
T6	Dinotefuran 20 SG	100.00	100.00	98.68
T7	Thiacloprid 21.7 SC	56.00	46.64	33.32
T8	Azadirachtin 5 % w/w	26.64	20.00	8.00
T9	Control (acetone)	0	0	0
'F test'		Sig.	Sig.	Sig.
S.E. (m)		0.70	0.67	0.64
C.D.@5%		2.04	2.65	1.88

4. Conclusion

As per the results obtained under the present study, it can be concluded that azadirachtin, buprofezin, flubendiamide and chlorantraniliprole were found safe towards per cent parasitisation of *T. japonicum* on previously treated *C. cephalonica* eggs, whereas azadirachtin, chlorantraniliprole and buprofezin showed minimum residual toxicity and least persistence among the other insecticides thus these insecticides can be included in IPM programmes without any or less adverse effects. However lambda cyhalothrin was found harmful during both per cent parasitisation and residual toxicity study. Hence it can be concluded that spray of lambda cyhalothrin should be avoided before and after the release of parasitoid in the field.

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