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Effect of some newer insecticides on parasitisation by *Trichogramma* species under laboratory condition

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Abstract
The experiment was conducted in order to study the toxicity of different insecticides on percent parasitization and adult mortality of different *Trichogramma* species under laboratory condition during year 2015-2016 in the Bio-control Laboratory, Department of Entomology, PGI, Dr. PDKV, Akola. Experiment was conducted with four different insecticides (Chlorantraniliprole 18.5%SC, Flubendiamide 480SC, Diafenthiuron 50% WP and Azadirachtin 10000 ppm) and a control on three different species of *Trichogramma viz; T. chilonis*, *T. pretiosum* and *T. japonicum* in Factorial completely randomized Block design of experiment. Effect of these insecticides on percent parasitization of *Trichogramma* species was studied. Results revealed that Chlorantraniliprole, Flubendiamide, Diafenthiuron and Azadirachtin found harmless when irradiated *Corcyra* eggs were exposed to *Trichogramma* spp. and had 59.80%, 68.06%, 58.20%, 72.93% parasitization, respectively. While Chlorantraniliprole (59.49%) and Diafenthiuron (59.02%) registered as slightly harmful on unirradiated *Corcyra* eggs as per the IOBC protocol.

Keywords: *Trichogramma chilonis*, *Trichogramma pretiosum*, *Trichogramma japonicum*, Chlorantraniliprole, Flubendiamide, Diafenthiuron, Azadirachtin, parasitization, mortality

Introduction
The use of *Trichogramma* species in many crop ecosystems has achieved appreciable pest control success and its role in the biological control programme of pest management is well understood (Smith, 1996; Sorokina, 1999; Hussain *et al*., 2010) [14, 15, 7]. By the establishment of Bio-intensive Pest Management Programs (BIPM), bio-control agents, such as *Trichogramma* species are integrated with other control methods without affecting the efficiency of bio-control agents (Tiwari and Khan, 2004) [18]. *Trichogramma* can survive into a wide range of temperature and gave successful control of lepidopteran pests in many crops. Application of selective insecticides to control pests could be useful in conservation of natural enemies associated with crops. The insecticides that are widely used to control different pests can affect the effectiveness of these beneficial agents. It is not fully clear, to what extent insecticides are harmful for other non-target organisms. More understanding of pest natural enemy insecticide interaction is needed to formulate more effective integrated pest management strategies (Preetha *et al.,* 2010) [9]. Some new insecticides are potentially more toxic to the target pest but not to natural enemies, thus playing significant role in conservation of biological control agents in agricultural environments. In some pest management systems, pesticides that have been used as selective shown harmful effects on beneficial species (Hill and Foster, 2000) [6]. Work of the previous researchers like Charles *et al*. (2000) [1], Ughade *et al.* (2002) [9], Preetha *et al.* (2009) [10] and Sattar *et al*. (2011) [12] indicated toxic effects of different insecticides on *Trichogramma.*
The integration of biological and chemical control tactics requires a thorough understanding of effects on biological control agents. A step-wise assessment, moving from laboratory to field with proper consideration of both direct and sub-lethal effects is recommended in the screening of pesticides against biological control agents (Crafts 1990). Thus the objective of this study was to determine the effect of some newer insecticides on percent parasitization of three different *Trichogramma* species.

Materials and Methods

The experiments were carried out in the Bio-control Laboratory, Department of Agricultural Entomology, Dr. Panjabrao Deshmukh Krishi Vidyapeeth Akola, Maharashtra. Three different *Trichogramma* strains viz., *Trichogramma chilonis*, *Trichogramma pretiosum* and *Trichogramma japonicum* were imported from NBAIR, Bengaluru. The strains were then raised in the laboratory on the *Corcyra cephalonica*. Field Recommended Concentrations (FRCs) of the insecticides *viz*, Chlorantraniliprole 18.5% SC (3ml/10L), Flubendiamide 480SC (2.5ml/10L), Diafenthiuron 50%WP (6gm/10L) and Azadirachtin 10000 ppm (20ml/10L) were tested against the bio-control agent in laboratory conditions. The experiments were carried out using standard methods developed by Santharam and Kumaraswami (1985) [11].

Effect of newer insecticides on parasitization

U.V. irradiated and unirradiated fresh eggs of *Corcyra cephalonica* were glued to the egg cards (@50eggs per card strip). The cards were cut into small strips of 5.0x 2.0cm and dipped in test insecticide. For control, water was used instead of insecticides. The treated egg cards were shade dried. The card strips kept in glass vials of about 15.0 x 2.5cm size @ one card strip per vial for each treatment and replication provided with honey streak on back side of egg-card strip. Each treatment was then labeled properly with details such as name of the treatment, concentration of insecticides, date and time of application etc. The treated egg-cards were exposed to adults of different *Trichogramma* species (@5:1 host: parasitoid ratio) till 24 hrs for parasitization. The egg-cards were examined for parasitization after 5thday of parasitoid release and the numbers of parasitized eggs were counted under Nikon make SMZ800 stereozoom microscope and accordingly percent parasitization was worked out by using following formula.

$$\text{Percent parasitization} = \frac{\text{Number of eggs parasitised}}{\text{Total number of eggs exposed)}} \text{x100}$$

Statistical analysis

The data on parasitization was transformed appropriately before analysis in two way ANOVA. Means are separated by using FCRD at 5% level of probability (Gomez and Gomez, 1984). On the basis of percent mortality/ reduction in parasitism or adult emergence and insecticides were classified in different categories of IOBC/WPRS (Sterk et. al., 1999) [16] as below.

Classification of toxicity level according to IOBC/WPRS

Toxicity Class	Categorization	%mortality/ reduction in either parasitism or emergence
Class 1	Harmless	<30
Class 2	Slightly harmful	30-79
Class 3	Moderately harmful	80-99
Class 4	Harmful	>99

Results and Discussion

Effect of insecticides on parasitism by *Trichogramma* spp. on irradiated *Corcyra cephalonica*

Factor A (Insecticides)

The findings (Table1) indicate that insecticidal treatments had significant effect on the percent parasitisation by three different *Trichogramma* species over untreated control. T3-Diafenthiuron 50% WP registered comparatively lower parasitisation (58.20%) followed by T1-Chlorantraniliprole 18.5% SC (59.80%). Somewhat higher parasitisation was noticed in T2-Flubendiamide 480SC (68.06%). The least effect on parasitisation was caused by T4-Azadirachtin 10000ppm with maximum parasitisation (72.93%). It means that among the all insecticides Azadirachtin was found more safer. Although the insecticidal treatments were statistically differed from each other but, according to IOBC classification of toxicity level all the four insecticides found harmless (class-1) to the *Trichogramma* species used for experimentation. El-Wakeil *et al*. (2006) [3] reported that there was no serious side effect on parasitism and emergence rates of *T. pretiosum* (Riley) when treated with neem products and hence the results of present investigation are in corroboration with the present findings. Hussain *et al*., (2012) [8] reported that Flubendiamide 480SC observed to be safer compared to Chlorantraniliprole against *Trichogramma* which is in accordance to the present findings.

Factor B (Species)

The data in Table 1 revealed that significant difference in tolerance to insecticides was found among the three *Trichogramma* species. Percent parasitisation in all the species ranged from 62.54-77.97%.*T. japonicum* recorded somewhat lowest parasitisation (62.54%). However, it was found at par with *T. chilonis* 63.10% parasitisation. Whereas, *T. pretiosum* had highest parasitisation (77.97%). Giraddi and Gundannavar (2006) [4] reported *T. Pretiosum* as relatively more tolerant compared to the *T. chilonis* and *T. Japonicum* which is in tune to the present investigation.

Interaction (Factor A x B):

Non-significant effect of different insecticides on three different *Trichogramma* species combination was recorded (Table1). However, Diafenthiuron 50%WP on *T. japonicum* recorded lowest parasitisation (51.09%).Whereas, Azadirachtin 10000ppm on *T. pretiosum* registered highest percent parasitization (82.21%). In water dip control highest parasitisation recorded in *T. pretiosum* (86.60%).

Effect of insecticides on parasitism by *Trichogramma* spp. on unirradiated *Corcyra cephalonica*

Factor A (Insecticides)

The insecticidal treatments applied on unirradiated eggs of *Corcyra* significantly affected the percent parasitisation of different *Trichogramma* species (Table 2). Among the five treatments, comparatively lower parasitisation was recorded in T3-Diafenthiuron 50% WP (59.02%) which was followed by T1-Chlorantraniliprole 18.5% SC (59.49%). Both the T3 and T1 were found at par with T2-Flubendiamide 480 SC (65.20%). T4-Azadirachtin 10000 ppm had significantly highest parasitization (69.46%). Diafenthiuron 50% WP and Chlorantraniliprole 18.5%SC observed to be slightly harmful (Class-2) and Flubendiamide 480 SC and Azadirachtin 10000 ppm recorded as harmless (class-1) according to IOBC classification of toxicity level.

Harmlessness of Flubendiamide to *T. chilonis* was also reported by Hussain *et al.* (2012) [8] and Singh *et al.* (2015) [13]. The safeness of neem products to *Trichoramma* as compared to insecticides based on the rate of parasitisation has been reported by Thakur & Pawar, (2000) [17].

Factor B (Species)

None of the *Trichogramma* species had shown significant difference in tolerance to insecticide toxicity (Table 2).

However, the lowest parasitisation was recorded in *T. japonicum* (65.62%) followed by *T. pretiosum* (69.01%) and highest parasitisation was recorded in *T. chilonis* (70.16%) in case of unirradiated *Corcyra* eggs.

Interaction (Factor AxB)

Non-significant effect of different insecticides on three different *Trichogramma* species recorded (Table 2). However, Diafenthiuron 50% WP recorded lowest parasitisation (50.01%) in *T. Chilonis.* Whereas, Azadirachtin 10000 ppm had highest parasitisation 71.80% in *T. pretiosum.*

Table 1: Effect of insecticides on parasitism by *Trichogramma* spp. on irradiated *Corcyra cephalonica*

Factor A / Factor B	T1 Chlorantraniliprole 18.5%SC	T2 Flubendiamide 480 SC (39.35%w/w)	T3 Diafenthiuron 50% WP	T4 Azadirachtin 10000 ppm	T5 Control (Water)	Mean (Species)
S1 *Trichogramma chilonis*	53.42 (46.72)	60.00 (50.79)	52.83 (46.63)	66.13 (54.42)	83.58 (66.22)	63.10 (52.96)
S2 *Trichogramma pretiosum*	74.00 (59.38)	81.00 (64.20)	70.69 (57.24)	82.21 (65.07)	86.60 (68.54)	77.97 (62.89)
S3 *Trichogramma japonicum*	52.00 (46.14)	63.20 (52.66)	51.09 (45.62)	70.46 (57.13)	75.95 (60.66)	62.54 (52.44)
Mean (Insecticides)	59.80 (50.75)	68.06 (55.88)	58.20 (49.83)	72.93 (58.87)	82.04 (65.14)	

(Figures in parentheses are Arc sin transformed values)

Table: Anova

Factors	'F' test	SE(m)±	CD at 5%	CV%
Factor A (Insecticides)	Sig	0.28	0.84	1.55
Factor B (Species)	Sig	0.21	0.65	
Interaction (AxB)	NS	0.48	-	

Table 2: Effect of insecticides on parasitism by *Trichogramma* spp. on unirradiated *Corcyra cephalonica*

Factor A / Factor B	T1 Chlorantraniliprole 18.5SC	T2 Flubendiamide 480 SC (39.35%w/w)	T3 Diafenthiuron 50 WP	T4 Azadirachtin 10000 ppm	T5 Control (Water)	Mean (Species)
S1 *Trichogramma Chilonis*	65.66 (54.15)	62.96 (52.54)	67.02 (55.14)	70.07 (56.86)	85.12 (67.38)	70.16 (57.79)
S2 *Trichogramma pretiosum*	72.69 (58.40)	71.78 (57.94)	60.04 (50.42)	71.80 (57.96)	88.74 (70.74)	69.01 (59.75)
S3 *Trichogramma japonicum*	60.12 (50.85)	61.88 (51.90)	50.01 (45.02)	66.52 (54.66)	89.61 (71.47)	65.62 (55.25)
Mean (Insecticides)	59.49 (54.47)	65.20 (54.13)	59.02 (53.03)	69.46 (56.49)	87.82 (69.86)	

(Figures in parentheses are Arc sin transformed values)

Table: Anova

Factors	'F' test	SE(m)±	CD at 5%	CV%
Factor A (Insecticides)	Sig	0.32	0.96	1.73
Factor B (Species)	NS	0.24	-	
Interaction (AxB)	NS	0.55	-	

Conclusion

From the present investigations, it is concluded that the insecticides tested *viz.,* Chlorantraniliprole18.5%SC, Flubendiamide 480SC and Azadirachtin 10000 ppm found safer. Whereas, Diafenthiuron 50% WP was slightly harmful for parasitization by all the three *Trichogramma* species. UV irradiation did not show significant effect on parasitization by all the three *Trichogramma* species viz., *T. chilonis*, *T. pretiosum* and *T. japonicum*.

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