International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(5): 3324-3327

Received: 28-07-2019
Accepted: 30-08-2019

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Effect of different insecticides on parasitization potential of *Trichogramma chilonis* under laboratory condition

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Abstract
The present investigation was undertaken in the Biocontrol laboratory, Entomology section, College of agriculture, Nagpur during 2016-2017 to study the safety of some insecticides viz. Chlorantraniliprole 18.5 SC, Diafenthiuron 50 WP, Cartap hydrochloride 50 SP, Spiromesifen 22.9 SC, Thiamethoxam 25 WG, Clothiandin 50 WDG, Flonicamid 50 WG, Azadirachtin 1500 ppm towards parasitization potential of *Trichogramma chilonis* on both UV irradiated and unirradiated eggs of *Corcyra cphalonica.* Amongst all the insecticides under present study, chlorantaniliprole, diafenthiuron and thiomethoxam were found harmless towards parasitization and could be used safely before release of *T chilonis* in the field. Whereas, clothianidin, flonicamid and azadirachtin were found slightly harmful and affected the parasitisation rate of Corcyra eggs by *T chilonis*. However, Cartap hydrochloride and spiromesifen recorded highest reduction in parasitisation and should not be used in field prior to release of the parasitoid.

Keywords: *Trichogramma chilonis*, *Corcyra cephalonica*, parasitization potential, UV irradiated eggs. unirradiated eggs

Introduction
Trichogramma are minute hymnopteran wasps that are endoparasitoids of insect eggs and polyphagous in nature (Flanders, 1960). *Trichogramma* are unique to the size limit of how small an insect can be, which would be determined by how few neurons they can fit in their central nervous system, yet exhibit a complex behaviour to sustain their life. Smaller and very uniform structure of female *Trichogramma* causes difficulty in identifying the separate species. For differentiation of different species, taxonomists rely upon examination of males using features of their antennae and genitalia (Nagarkatti and Nagaraja, 1971) [7]. The first species of *Trichogramma* was recorded by CV Riley in North America during 1871. The tiny wasps that emerged from eggs of the Viceroy butterfly was named as *Trichogramma minutum* by him firstly (Knutson, 2005) [4]. According to Universal Chalcidoidea database. The number of *Trichogramma* species is over 200 but as of 1960 only some 40 species of *Trichogramma* had been described so far.
Trichogramma spp. is used widely in IPM programmes on many important pests of different crops mostly on lepidopterous pests. Application of different insecticide on these parasitoids significantly reduces their effectiveness by decreasing their parasitization potential and population growth. Several researchers have reported some detremental effects of insecticides on populations of the parasitoid *Trichogramma* earlier, whereas increase in the performance of parasitoids has also been recorded. However, sub-lethal effects of insecticides can severely reduce the performance of biological control agents. (Takada, 2001; Vieira, 2001; Delepuech, 2005; Desenux, 2007) [15, 16, 1]. Therefore, the present study *i.e.* safety of newer insecticides against *Trichogramma spp.* is of much importance to know the safeness of new chemicals against performance of parasitoid *Trichogramma chilonis* for sustainable pest management.

Materials and method
The present investigation was carried out in the Biocontrol laboratory, Entomology section, College of Agriculture, Nagpur, Maharashtra during June-Dec of 2016. The rearing of the host insect and parasitoid was done under controlled room temperature and relative humidity conditions ranging between 24 ± 2 ^{0}C and 60 ± 5%.

Mass multiplication of *Trichogramma* was done in the laboratory to obtain healthy culture of the test parasitoid. To obtain the eggs of *Corcyra cephalonica* throughout the experimental period, rearing of rice moth was done in the laboratory. The culture was maintained on Sorghum based artificial diet Ultraviolet irradiated and unirradiated eggs of *Corcyra cephalonica* were used for conducting the experiment. The treatments were given by following the method suggested by Santharam and Kumaraswami (1985).
UV irradiated and unirradiated fresh eggs of *Corcyra cephalonica* were glued to the egg cards separately (@ 50 eggs per card strip). The cards were cut into small strips of 5.0x 2.0 cm 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 UV 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 etc. The treated egg-cards were exposed to adults of *Trichogramma chilonis* (@ 5:1 host: parasitoid ratio) for 24 hrs for parasitization. Each treatment was replicated thrice and experiment was conducted in laboratory condition. The egg-cards were examined for parasitization after 5th day of parasitoid release and the number of parasitized eggs were counted under stereozoom microscope and percent parasitisation were worked by using following formula.

$$\text{Percent parasitization} = \frac{\text{Number of eggs parasitised}}{\text{Total Number of eggs exposed}} \times 100$$

The percent 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. (Hassan *et al*., 2000).
On the bases of percent mortality/percent reduction in parasitization/adultemergence, insecticides were classified in different categories as suggested by IOBC/WPRS (Sterk *et al*., 1999) [10].

Table 1: On the bases of percent mortality/percent reduction

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

The data so obtained on percent parasitization, percent related to various parameters under study were subjected to statistical analysis after appropriate transformation for interpretation of the result.

Statistical analysis
Percent mortality was calculated by using the no of live and dead adults and mortality was corrected by using Abbott's formula. Corrected mortality percent recorded was further analyzed using CRD through STPR.

Result and Discussion
A) Effect of newer insecticides on percent parasitisation of UV irradiated eggs of *Corcyra cephalonica* by *Trichogramma chilonis.*
The data contained in table 1 demonstrate that, the average no. of UV exposed eggs parasitized by *T chilonis* under different treatment differed significantly in comparision to control (92.00 percent). Maximum number of eggs parasitized were observed under thiamethoxam (84.66 percent) followed by diafenthiuron > chlorantraniliprole > flonicamid > azadirachtin > clothianidin > spiromesifen > cartap hydrochloride with 81.33, 67.33, 62.00, 59.33, 52.00, 14.66, and 8.00 percent respectively. The average no of eggs parasitized under thiamethoxam was statistically at par with diafenthiuron but significantly more than chlorantraniliprole, flonicamd, azadirachtin.
The result envisages that the insecticides thiamethoxam and diafenthiuron equally favoured greater percent of egg parasitisation followed by chlorantraniliprole, flonicamid, azadirachtin and clothianidin. However, spiromesifen and cartap hydrochloride greatly affected the paratisation by *T chilonis.* The findings of present study are in accordance with the findings of Preetha *et al*., (2010) [5] with 88.59 percent parasitisation in thiamethoxam 25 WG @25 GAS/HA. Ranjith *et al.,* (2016) [6] observed different rates of parasitisation in diafenthiuron 50 WP NS (Natural Source) and ES (Existing Source) *viz.* 82.06 percent, 73.31, 70.12, 62.43, 66.30 percent @ 0.8, 1.2, 1.6, 3.2, 1.6 g/l respectively. Khan *et al*., (2015) [2] recorded lowest parasitism (2.4 percent) in spiromesifen whereas no significant reduction in parasitisation was recorded in chlorantraniliprole. Takada *et al.,* (2001) [11] observed cartap hydrochloride as highly toxic to all stages of the parasitoid. Kumar *et al.,* (2016) [3] reported parasitisation of 0 to 8.67 percent when treated with cartap hydrochloride (0.1%) along with Ha NPV (0.2%). Sattar *et al.,* (2011) [9] classified azadirachtin as slightly harmful towards parasitisation (64.4%) by *T chilonis.* Lyson *et al.*, (2003) [6] also observed 50-60% parasitisation in azadirachtin treated eggs of *E.kuhniella.* Neemazal® 3,000 ppm solution had relatively low residual toxicity to *T cacoeciae* [1] adults and was slightly harmful to the capacity of parasitism (Saber *et al*., 2005) [7].
As per the IOBC classification, chlorantraniliprole (0.005%), diafenthiuron (0.06%) and thiamethoxam (0.04%) were categorized as "harmless" as they did not show any significant effects on percent parasitization whereas clothianidin (0.02%), flonicamid (0.015%) andazadirachtin 1500ppm (0.05%) are categorized as "slightly harmful" towards parasitisation by *T Chilonis.* Among all the insecticide cartap hydrochloride (0.1%) and spiromesifen (0.03%) showed maximum reduction in parsitisation by *T Chilonis* was categorized under "moderately harmful".

B) Effect of different insecticides on percent parasitisation of UV unirradiated eggs of *Corcyra cephalonica* by *Trichogramma chilonis.*
The data presented in table 2 revealed that significantly highest egg parasitisation (94.00 percent) was recorded in control (water spray) followed by thiamethoxam and diafenthiuron with 90.00 and 88.66 percent respectively, which were found statistically at par. Among the remaining insecticides, chlorantraniliprole recorded 73.33 percent

parasitisation followed by flonicamid, azadirachtin and clothianidin with 64.66, 63.33, 62.00 percent parasitisaton, respectively. However spiromesifen and cartap hydrochloride supported minimum parasitisation of 19.33 and 10.00 percent, respectively.

The results revealed that the chlorantraniliprole (0.005%), diafenthiuron (0.06%) and thiamethoxam (0.04%) did not show any significant effects on percent parasitization and categorized as "harmless" whereas clothianidin (0.02%), flonicamid (0.015%) and azadirachtin 1500ppm (0.05%) were categorized as "slightly harmful" towards parasitisation by *T chilonis*. Amongst all the insecticide cartap hydrochloride (0.1%) and spiromesifen (0.03%) showed maximum reduction in parsitisation by *T chilonis* categorized as "moderately harmful". The order of selectivity of insecticide towards parasitism in both UV irradiated and UV unirradiated eggs were almost same. The rate of parasitism was observed relatively higher in UV unirradiated as compared to the irradiated eggs.

Table 2: Effect of newer insecticides on percent parasitisation of UV irradiated *Corcyra cephalonica* eggs by *Trichogramma chilonis.*

Treatment no.	Treatment name	concentration	R1	R2	R3	Mean	Percent reduction in parasitisation over control	Score
T_1	Chlorantraniliprole18.5 SC	0.005%	68.00 (55.55)	64.00 (53.13)	70.00 (56.79)	67.33 (55.12)	26.81 (31.18)	Harmless
T_2	Diafenthiuron 50 WP	0.06%	82.00 (64.90)	84.00 (66.42)	78.00 (62.03)	81.33 (64.38)	11.59 (19.82)	Harmless
T_3	Cartap hydrochloride 50SP	0.1%	8.00 (16.43)	6.00 (14.18)	10.00 (18.43)	8.00 (16.43)	91.30 (72.85)	Moderately harmful
T_4	Spiromesifen 22.9 SC	0.03%	14.00 (21.97)	18.00 (25.10)	12.00 (20.27)	14.66 (22.46)	84.06 (66.42)	Moderately harmful
T_5	Thiamethoxam 25 WG	0.005%	88.00 (69.73)	86.00 (68.03)	80.00 (63.43)	84.66 (66.89)	7.97 (16.32)	Harmless
T_6	Clothiandin 50 WDG	0.002%	52.00 (46.14)	56.00 (48.45)	48.00 (43.85)	52.00 (46.14)	43.47 (41.21)	Slightly harmful
T_7	Flonicamid 50 WG	0.015%	62.00 (51.94)	60.00 (50.77)	64.00 (53.13)	62.00 (51.94)	32.60 (34.82)	Slightly harmful
T_8	Azadirachtin (1500 ppm)	0.005%	58.00 (49.60)	56.00 (48.45)	64.00 (53.13)	59.33 (50.36)	35.51 (36.57)	Slightly harmful
T_9	Control (Water spray)		92.00 (73.57)	94.00 (75.82)	90.00 (71.57)	92.0 (73.57)	-	
'F test'						Sig.		
S.E. (m)						1.83		
C.D at 5%						5.32		

Table 3: Effect of newer insecticides on percent parasitisation of UV unirradiated eggs of *Corcyra cephalonica* by *Trichogramma chilonis.*

Treatment No.	Treatment Name	Concentration	R1	R2	R3	Mean	Percent reduction in parasitisation over control	Score
T_1	Chlorantraniliprole18.5 SC	0.005%	76.00 (60.67)	70.00 (56.79)	74.00 (59.34)	73.33 (58.89)	21.98 (27.90)	Harmless
T_2	Diafenthiuron 50 WP	0.06%	88.00 (69.73)	92.00 (73.57)	86.00 (68.03)	88.66 (70.27)	5.68 (13.94)	Harmless
T_3	Cartap hydrochloride 50SP	0.1%	10.00 (18.43)	12.00 (20.27)	8.00 (16.43)	10.00 (18.43)	89.36 (70.91)	Moderately harmful
T_4	Spiromesifen 22.9 SC	0.03%	20.00 (26.57)	22.00 (27.97)	16.00 (23.58)	19.33 (26.06)	79.43 (63.01)	Moderately harmful
T_5	Thiamethoxam 25 WG	0.005%	94.0 (75.82)	90.00 (71.57)	86.00 (68.03)	90.00 (71.57)	4.25 (11.83)	Harmless
T_6	Clothiandin 50 WDG	0.002%	60.00 (50.77)	68.00 (55.55)	58.00 (49.60)	62.00 (51.94)	34.04 (35.67)	Slightly harmful
T_7	Flonicamid 50 WG	0.015%	68.00 (55.55)	64.00 (53.13)	62.00 (51.94)	64.66 (53.49)	31.21 (33.96)	Slightly harmful
T_8	Azadirachtin (1500 ppm)	0.005%	68.00 (55.55)	62.00 (51.94)	60.00 (50.77)	63.33 (52.71)	32.62 (34.82)	Slightly harmful
T_9	Control (Water spray)		96.00 (78.46)	94.00 (75.82)	92.00 (73.57)	94.00 (75.82)		
'F test'						Sig.		
S.E. (m)						1.98		
C.D at 5%						5.77		

Conclusion

As per the results obtained from the present investigation, we conclude that chlorantraniliprole, diafenthiuron and thiomethoxam were found safe towards parasitization of *T chilonis* on previously treated host eggs of *C cephalonica*. Whereas, clothianidin, flonicamid and azadiracthin were found slightly harmful towards parasitization. In azadiracthin it may be due to its antifeedancy and oviposition detterent nature. Amongst all the insecticide cartap hydrochloride and spiromesifen caused highset reduction in percent parasitization of *T chilonis* and categorized as moderately harmful.

Considering ecofreindliness, it can be concluded from the present study that insecticides chlorantraniliprole, diafenthiuron and thiomethoxam were found most safe towards parasitisation capacity of the parasitoid on previously treated host eggs and can be taken successfully during the IPM programmes.

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