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Effect of insecticide residues on the adult survival rate of *Trichogramma chilonis* under laboratory condition

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Abstract
The present investigation was carried out in the biocontrol laboratory, entomology section, college of agriculture, Nagpur during 2016-2017 to study the residual toxicity 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 up to 10 days on the adult survival rate of *Trichogramma chilonis* through glass vial bioassay method. On the basis of IOBC categorization on persistency, insecticides were classified. All the treatments under present study showed relatively higher per cent of toxicity as compared to control. Amongst all the insecticides, cartap hydrochloride and thiamethoxam were found most harmful causing 100 per cent mortality among the adults during all the days under observation. Whereas, clothianidin and flonicamid were found slightly harmful to moderately harmful causing 45.77 and 37.77 per cent adult mortality respectively. However, Diafenthiuron and chlorantraniliprole were found slightly harmful to harmless to adults causing 18.22 and 16.88 per cent mortality respectively. Azadirachtin and spiromesifen were found most safe with an adult mortality rate of 6.22 and 8.93 per cent respectively. As per the IOBC classification on persistence, Azadirachtin and spiromesifen were classified as slightly persistent. Residual toxicity of both the insecticides lasted up to 10 days.

Keywords: Trichogramma adults, insecticide, residual toxicity, persistence

Introduction
Trichogramma is minute polyphagous wasps that are endoparasites of insect eggs [2]. Trichogramma is one of around 80 genera from the family Trichogrammatidae, with over 200 species worldwide. [1, 7, 13]. Although there are several groups of egg parasitoids commonly employed for biological control throughout the world, Trichogramma has been most extensively studied. [17]. In India, about 26 trichogrammatids are recorded of which *Trichogramma chilonis* Ishii is of significant importance [15]. The inundative or inoculative releases of *Trichogramma spp.* in the field to reduce the pest population which ultimately reduces the reliance on chemicals for the control of lepidopteron insect pest of field crops. *Trichogramma chilonis* is one among the most commonly used egg parasitoid used in India against many pests including cotton bollworm. Different IPM modules have been developed for the management of cotton pests. Several insecticides that are widely used to suppress various pests can disrupt the effectiveness of these beneficial agents. The adverse impact of insecticides on natural enemies can be mitigated through a choice of insecticide, dosage or timing of insecticide application.
Biological control and selective insecticide proved to be compatible with the tactics in Integrated pest management [3]. Integrating biological control with selective pesticides can minimize the likelihood of pest resurgence and possibly reduce the no of pesticide application [5]. A key principle of integrated pest management (IPM) is to maximize pest control from natural mortality factors such as predators and parasitoids. These are supplemented where necessary with pesticides, which should be used in a way that minimizes the disruption of biological control agents. It is important that chemical agents, spray thresholds, and application schedules are compatible with natural enemies [8]. Therefore, the present study was carried out to study the residual effect and persistence of different insecticides against *Trichogramma chilonis* to know the suitable interval to be maintained for the release of parasitoid after application of insecticides as well as to find out the most compatible insecticide to be integrated with the egg parasitoid during the development of IPM schedules.

2. 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 on factitious host *Corcyra cephalonica* to obtain a healthy culture of the test parasitoid. The initial culture was obtained from the already established culture of *T. chilonis* in the laboratory. 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 a sorghum-based artificial diet. The Corcyra eggs thus found from laboratory culture were sterilized by exposing to U.V. light (15 watts for half an hour) to kill the embryo. The large egg cards (15 cm x 7.5 cm) were divided into 10 rectangles (3 cm x 2 cm) and a thin layer of diluted Acacia gum was applied for pasting the Corcyra eggs sprinkled uniformly on the card @ 1 cc per card. The card was kept in a large polythene bag (30 cm x 20 cm) containing nucleus egg cards (the adults about to emerge from parasitized eggs) at a ratio of 1:6 to fresh eggs for parasitization. Adults were allowed to parasitize the eggs for two days, on the fourth day parasitized eggs turned black in color. At this stage, egg cards strip of suitable size was kept for adult emergence in separate test tubes and emerged adults were utilized for bioassay. Newly emerged adults were provided with 50 per cent honey solution in the form of a honey streak as adult food inside the test tube.

The effect of insecticide residues on the survival of adult *Trichogramma chilonis* was studied by glass vial bioassay method. For this purpose, the glass vials measuring about 15x4cm size were taken. Sufficient quantity of insecticidal solution at the recommended concentration of each insecticide was prepared in acetone. A thin uniform film of each insecticide was 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, 20-25 newly emerged adults of *Trichogramma chilonis* 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 exposed to insecticide residues for 4 hrs and observations were recorded on the number of dead and live adults. On the basis of no of adults found to be dead the per cent mortality was counted by dividing the no of dead adults with total no of adults released and multiplied by 100. Corrected mortality can be calculated by adopting the Abbotts formula.

Abbott's formula P_t = Po−Pc/100−Pc x100

2.1 Where

Pt= Corrected per cent mortality
Po= Observed per cent mortality in the treatment
Pc= Observed per cent mortality in control.

Table 1: The toxicity duration of harmful

Toxicity Class	Category	Duration of harmful activity (days)
Class A	Short-lived	<5
Class B	Slightly persistent	5-15
Class C	Moderately persistent	16-30
Class D	Persistent	>30

Classification of insecticide persistency was determined according to the duration of the toxic activity of the compounds, that is, the interval of time in which its residue caused 30 % mortality which is the minimum level of toxicity as described for laboratory tests by IOBC. Accordingly, categories developed by members of the IOBC/WPRS Working Group for the evaluation of harmful activity duration (persistence) of insecticides against predators and parasitoids under laboratory conditions [12].

3. Statistical Analysis

Per cent mortality was calculated by using the no of live and dead adults and mortality was corrected by using Abbott's formula. Corrected mortality per cent recorded was further analyzed using CRD through STPR.

4. Results and Discussion

The results obtained were presented in Table-2. The order of toxicity remained the same during all the days under observation. The order of residual toxicity found was cartaphydrochloride> thiamethoxam >clothianidin> flonicamid> Diafenthiuron> chlorantraniliprole >spiromesifen >azadiracthin> control.

From the results shown in Table No- 2, it is evident that cartap hydrochloride and thiamethoxam caused 100% death among adults up to 10 days. While azadirachtin and spiromesifen were found safest to the adults as they caused less mortality as par with control. Daifenthiuron and chlorantraniliprole were slightly harmful to harmless during the residual period whereas clothianidin and flonicamid were slightly harmful to moderately harmful during the whole residual period in this experiment.

Earlier different workers tested the residual toxicity and persistence of different insecticide against *T. chilonis*. Singhamuni *et al.* [11] reported neem to be safest to the adults of *T. chilonis* causing a less mortality (7%). Takada *et al.* [14] reported cartap as highly toxic to *T. dendrolimi.* Hussain *et al.* [4] observed the survival percentage of adults in case of chlorantraniliprole up to 24 hours and found it as harmless. Khan *et al.* [6] studied the toxicity of insecticide chlorantriniliprole, spiromesifen and flonicamid against adults of *T. pertiosum* and regarded as harmless as it caused less than 10 per cent mortality. Preetha *et al.* [9] studied the residual toxicity of 3 neonicotinoid compound thiamethoxam, chlorantraniliprole, clothianidin and found thiamethoxam as the most toxic compound to the adults whereas chlorantraniliprole was harmless and clothianidin was slight to moderately harmful. Uma *et al.* [16] found adult mortality of 21.25% and 40.00% in chlorantraniliprole and thiamethoxam respectively through bioassay method. William and Price [18] also reported thiamethoxam as toxic to Trichogramma adults. Sidi *et al.* [10] tested the effects of insecticide residue of azadirachtin on *T. papilionis* and found azadirachtin as safer insecticide causing 13.4% mortality.

As per the IOBC classification on persistence, all the insecticides under experiment will be categorized as slightly persistent as all the insecticide showed toxicity from a lesser extent to a larger extent up to 10 days under study.

Table 2: Effect of insecticide residues on adults of *Trichogramma chilonis* up to 10 days.

Tr. No.	Treatments	Concentration	No of adults released in each vial	Corrected mortality (%)			Mean
				1st day	5th day	10th day	
T1	Chlorantraniliprole18.5SC	0.005%	25	24	21.33	5.33	16.88
T2	Diafenthiuron 50WP	0.06%	25	30.66	16	8	18.22
T3	Cartap hydrochloride 50 SP	0.1%	25	100	100	100	100
T4	Spiromesifen 22.9 SC	0.03%	25	16	10.81	0	8.93
T5	Thiamethoxam 25WG	0.005%	25	100	100	100	100
T6	Clothianidin 50WDG	0.002%	25	54.66	49.33	33.33	45.77
T7	Flonicamd 50WG	0.015%	25	50.66	36	26.66	37.77
T8	Azadirachtin (1500ppm)	0.005%	25	10.66	8	0	6.22
T9	Control (water spray)	-	25	0	0	0	0
F test				Sig.	Sig.	Sig.	
S.E.(m)				0.92	0.79	0.54	
C.D at 5%				2.70	2.30	1.58	

5. Conclusion

Cartap hydrochloride and thiamethoxam were found most toxic towards the adults of *Trichogrammatid chilonis*. Mortality of adults in the glass vials treated with cartap hydrochloride occurred within 4 hours up to 15 days. Use of those insecticides should be avoided along with *T. chilonis.* Whereas, azadirachtin and spiromesifen were found safe towards adults of *Trichogramma chilonis.* Residual toxicity of both the insecticide prolonged up to 10 days. So these two insecticides can be successfully implemented during IPM programmes along with *Trichogramma chilonis.* Waiting period must be maintained for the release of adults of *T. chilonis* after insecticide spray. Care should be taken while incorporating the insecticides along with the biocontrol agents during formulation of IPM schedules.

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