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TOXICITY OF SELECTIVE INSECTICIDES AGAINST *TRICHOGRAMMA CHILONIS*

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ABSTRACT

Entomotoxic potential of selective insecticides against *Trichogramma chilonis* Ishii was performed at the Toxicology Laboratory of Entomological Research Institute, Ayub Agriculture Research Institute (AARI), Faisalabad. Six insecticides viz., spinetoram, lufenuron, chlorantraniliprole, indoxacarb, flubendiamide and emamectin benzoate were tested against *Trichogramma chilonis*. After 3 and 24 hours of exposure to immature and adult stages of *T. chilonis* the observations were made. Egg card and dipped surface residue bioassays were used, to determine the mortality rate of immature and mature life stages of *T. chilonis*, respectively. The treatments flubendiamide, chlorantraniliprole, indoxacarb, and lufenuron are found relatively safe, whereas spinetoram and emamectin benzoate showed a high level of toxicity. After four hours, chlorantraniliprole and lufenuron showed low toxicity, flubendiamide and indoxacarb demonstrated moderate toxicity, while spinetoram and emamectin benzoate demonstrated significant toxicity for adults.

Key words: *Trichogramma chilonis*, parasitoids, egg card bioassay, leaf dipped surface residue bioassay, emamectin benzoate, toxicity, entomotoxic potential, indoxacarb, flubendiamide, safety

Presently, the major crops are in a threatening phase due to the attack of various pests. These pests are causing a major decline in crop yield and their economic value. In this perspective, pesticides have attained much popularity to control insect pests over the last few decades. Pesticides enable farmers to boost crop yields by minimizing losses caused by plant diseases, foraging pests that feed on crop plants, and other factors. Chemical plant protection is very inexpensive and effective, that's why pesticides are so prevalent in agriculture (Bernhardt et al., 2017; Lechenet et al., 2017; Hedlund et al., 2020). Excessive pesticide usage, on the other hand, has been linked to environmental and health hazards, as well as the development of insecticide resistance (Jallow et al., 2017; Fletcher et al., 2020; Serrano et al., 2020). The use of chemical pesticides undermines the ecological integrity and biodiversity of ecosystems (Wyckhuys et al., 2023; Klich et al., 2020). Chemical plant protection techniques kill several beneficial insects, including *Trichogramma chilonis* and earthworms (Bart et al., 2018; Treder et al., 2020, Paiva et al., 2021). Therefore, there is a need to solve this problem by using the most effective and environment-friendly application. For this purpose, biological control agents are preferred over chemical pesticides. Biological control of insect pests is advantageous over chemical control because it poses no harmful impacts on food quality, human health, and the environment. Natural enemies are used in biological control to manage insects, weeds, and diseases. Biological control is naturally in practice for centuries but humans to control the cottony-cushion scale in California citrus (Caltagirone et al., 1981) introduced initially the beetle *R. cardinalis* and parasitic fly *C. iceryae*.

Trichogramma chilonis Ishii is naturally found in almost every terrestrial and marine ecosystem. It parasitizes insect eggs, usually the eggs of moths and butterflies. Trichogramma wasps attack some of the most important caterpillar pests of field crops, nuts, fruits, and forest trees. Utilizing a higher concentration of *T. chilonis* against *H. armigera* in the field resulted in effective control. To reduce the population of *H. armigera* larvae, it is recommended to release a sufficient number of eggs in the field at regular intervals (Nisar et al., 2020). Trichogramma wasps parasitize eggs of butterflies and moths (Lepidoptera), lacewings (Neuroptera), beetles (Coleoptera), flies (Diptera), true bugs (Hemiptera) and other wasps (Hymenoptera)

(Shah et al., 2015). The entomologists in the early 1900s began to the mass rear of *T. chilonis* for insect control after recognizing the potential of these insects as biological control agents. Trichogramma may be easily cultivated on moth eggs in a laboratory setting. Trichogramma is developed by incubating the eggs of an insect, typically a moth, from which the wasp will emerge. Trichogramma's most common insect hosts are the rice meal moth (*Corcyra cephalonica*), the angoumois grain moth (*Sitotroga cerealella*), and the Mediterranean flour moth (*Ephestia kuehniella*). All three moths are cultured easily and inexpensively on wheat or other cereals; however, Sitotroga is more suitable for large-scale production (Zeinalzadeh et al., 2016; Hameid, 2018; Sadat et al., 2021). The purpose of this study was to evaluate the selective toxicity of same insecticides against *T. chilonis* under laboratory conditions.

MATERIALS AND METHODS

In the current study, six insecticides viz., spinetoram (80 ml/ acre), lufenuron (200 ml/ acre), flubendiamide (50 ml/ acre), emamectin benzoate (200 ml/ acre), chlorantraniliprole (50 ml/ acre), and indoxacarb (175 ml/ acre) were tested against immature and mature life stages of *T. chilonis* in the toxicology laboratory of the Entomological Research Institute, Faisalabad. The experiment was conducted in complete randomized design (CRD) with five replications. The above mentioned insecticides were selected because the farmer commonly use them. The recommended field dose was taken with the help of a micropipette. It was added to 500 ml of water in a beaker and then mixed thoroughly with a pipette. This solution was used to check the mortality rate of *T. chilonis* at egg and adult stages. The control treatment was also maintained where only tap water was sprinkled. To investigate the cytotoxicity of insecticides against *T. chilonis*, an egg card bioassay was conducted to check the effect of parasitism. The quantification of the impact of insecticides on *Sitotroga cerealella* parasitized eggs was assessed throughout the developmental stages of *T. chilonis*, as *T. chilonis* parasitizes the eggs of *Sitotroga cerealella* (Ahmad et al., 2021). Five randomly selected egg cards, each having 40 parasitized eggs, were dipped in each for ten sec on the 1st, 2nd, 3rd, 4th, 5th, 6th, and 7th life stages of parasitized eggs. Dried egg cards were placed in a small glass petri dishes (5 cm dia and 0.5 cm deep). These petri dishes were held at a constant temperature of 25± 2 ºC and relative humidity of 65± 5 RH until emergence. The eggs were then observed under the microscope. Dipped surface residue bioassay was used to check the efficacy of insecticide exposure on the survival rate of the adults. Ventilated glass bioassays were used in chambers with a measurement of 15 x 4 cm. Further, Whatman filter papers were drenched in each insecticide solution for treatment and were dried. These filter papers were kept in the tube of glass bioassays to fully expose the treatment. After exposure to insecticides, the number of alive and dead wasps were counted. Data was analyzed by using the SPSS software.

RESULTS AND DISCUSSION

After the completion of experiment, results were analyzed by comparing the mean mortality of *T. chilonis* (Table 1). Insecticides with the highest means were found to be the least toxic, while those with the lowest means were considered the most toxic. On immature

Table 1. Toxicity of insecticides against *T. chilonis*

Treatments	Day 1	Day 2	Day 3	Day 4	Day 5	Day 9
Flubendamide	17.200B	8.8000BC	4.2000BC	1.6000BCD	2.2000BC	21.200B
Chlorantraniliprole	12.600B	12.400B	5.4000BC	1.8000BCD	2.2000BC	18.00B
Spintoram	0.8000C	1.8000C	0.4000C	0.8000CD	0.6000C	2.000C
Lufenuron	10.200B	8.4000BC	9.8000B	3.0000B	3.0000B	18.800B
Indoxacarb	14.600B	10.600B	8.0000B	0.2000D	1.8000BC	22.4000B
Emamectin benzoate	1.2000C	5.2000BC	3.8000BC	2.4000BC	0.8000BC	11.600BC
Treatments		After 3 hr			After 24 hr	
Flubendamide		82.000A			64.000B	
Chlorantraniliprole		78.000A			58.000B	
Spintoram		52.000B			34.000C	
Lufenuron		74.000A			58.000B	
Indoxacarb		76.000A			56.000B	
Emamectin benzoate		42.000B			22.000C	

Means sharing same letters in a column statistically non-significant.

stages, lufenuron and chlorantraniliprole were less toxic by whereas flubendiamide and indoxacarb were moderate toxic, and spinetoram and emamectin benzoate were highly toxic. Asrar et al. (2019) conducted a study on the toxicity of seven insecticides viz., voliam flexi, chlorantraniliprole, flonicamid, lufenuron, nitenpyram, belt and pyriproxyfen against *Trichogramma chilonis*. Based on egg card bioassay results, coragen, 55 Nylar, Belt, nicotinamid and voliam-flexi were labeled as slightly harmful against *T. chilonis*. While, on the basis of dipped surface residue bioassay, lufenuron caused 28% mortality and categorized as harmless while the rest were categorized as slightly harmful Flubendamide and chlorantraniliprole were relatively less toxic to *T. chilonis* with mortality of 82 and 78, respectively. Spintoram, lufenuron, indoxacarb and emamectin benzoate revealed % of 52, 74, 76 and 42, respectively. At 24 hr, flubendamide, chlorantraniliprole and lufenuron were relatively less toxic (Figs. 1, 2). Checking the toxicity of pesticides against *T. chilonis* led to the conclusion that flubendiamide, chlorantraniliprole, indoxacarb, and lufenuron are safe for *T. chilonis*, while spinetoram and emamectin benzoate showed high toxicity. Chlorantraniliprole and lufenuron had low toxicity, flubendiamide and indoxacarb had moderate toxicity, while spinetoram and emamectin benzoate had high toxicity for adults.

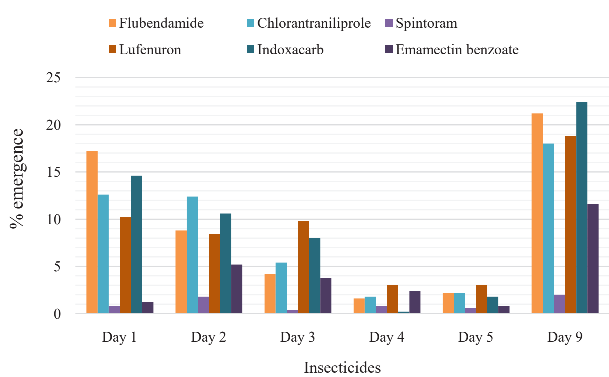

Fig. 1. Effect of insecticides on the emergence of *T. chilonis*

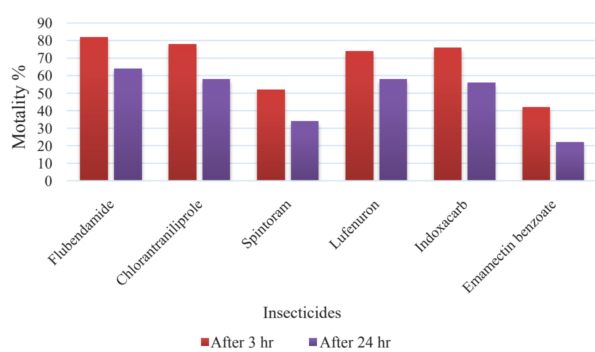

Fig. 2. Mortality of adults of *T. chilonis*

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AUTHORS CONTRIBUTION STATEMENT

Zainab Manzoor conducted the trial and prepared the manuscript. Muhammad Asrar and Dilbar Hussain supervised the whole study. Usama Saleem and Saddam Hussain analyzed the data. Zeeshan Javed and Muhammad Kashif Aziz proofread the manuscript. Maria Khalid and Ansa Tariq established the format of this manuscript according to the Indian Journal of Entomology.

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CONFLICT OF INTEREST

No conflict of interest.

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