Safety evaluation of Spirotetramat 150 OD against predator *Chrysoperla zastrowisillemi* (Esberson Peterson) (Neuroptera: Chrysopidae) under laboratory conditions

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ABSTRACT

The selective toxicity of three doses *viz.,* 1.25, 2.5, 3.75 mL/L ofspirotetramat 150 OD against the life stages of *Chrysoperlazastrowisillemi* was studied under *in vitro* conditions. The higher dose of tested insecticide caused 28.88% mortality and hence spirotetramat can be considered 'harmless' to *C. z. sillemi* as per the categorization of IOBC (International Organization on Biological Control). There was no adverse effect of spirotetramat 150 OD over the egg hatching percentage, rate of pupation, adult emergence and fecundity of *C. z. sillemi*and hence considered as a safer molecule to be integrated with chrysoperla in insect management programs.

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MS History: 26.9.2014 (Received)-25.05.2015 (Revised)-30.05.2015 (Accepted)

Key words: Spirotetramat, hatching percentage, *Chrysoperlazastrowisillemi*, percent pupation

Citation: Nicholas Romano, Noor Mursyida binti Ayob, S.M. Nurul Amin, and Mohd Salleh Kamarudin. **2015**. Acute and sub-chronic toxicity of a trypsin-modulating oostatic factor (TMOF) on the growth, body composition and histopathology of red hybrid tilapia, *Oreochromis* sp. as a non-target organism**.** *Journal of Biopesticides*, **8**(1):52-55.

INTRODUCTION

Chrysoperla zastrowi sillemi (Neuroptera: Chrysopidae) is a generalist predator of soft bodied sucking insects like aphids, mealy bugs, immature scales, whiteflies, thrips, spider mites and other sucking insect pests (Saminathan and Baskaran, 1999). The larvae of chrysoperla is a voracious predator of soft bodies insects and their adults were free living in nature feeding upon the pollen and nectar (Villenave *et al.*, 2005). *C. z. sillemi* predators has the immense potential in inundative release measures in insect management because of their ability to inhabit diverse habitats, shorter life cycle, easy mass multiplication and inherent ability to tolerate pesticides (Amarasekare and Shearer, 2013). The integration of chemical and biological control is an essential requirement for the success of an integrated pest management (IPM) program for arthropod pests (El-Wakeil and Vidal 2005). Use of safer insecticides that are selective towards the native natural enemy fauna is a pre-requisite for the development of successful integrated pest management strategy (Galvan *et al.*, 2005). Insecticides apart from causing direct mortality of natural enemies cause indirect lethal effects over physiology inhibiting their fecundity and reproduction of natural enemies (Desneux *et al.,* 2007). Spirotetramat is a new systemic insecticide acts as an inhibitor of lipid biosynthesis of homopteran sucking insects like aphids and mealy bugs (Planes *et al.*, 2013). *C. z. sillemi* being an efficient predator of sucking insects, safety evaluation of spirotetramat needs to be studied before integrating the insecticide in integrated pest management programs. The present study was undertaken to investigate the selective toxicity of spirotetramat 150 OD over the immature life stages of neuropteran predator, *C. z. sillemi*.

MATERIALS AND METHODS

Predator culture

Predator, *C. z. sillemi* was obtained from the insectary of National Bureau of Agriculturally Important Resources (NBAIR), Bangalore and maintained on mealybug, *Maconellicoccus hirsutus* in the laboratory. Adults were supplied with standard diet consisting of yeast, protein hydro lysate, fructose, honey and distilled water taken in equal proportion. The ingredients were mixed together to form a thick paste and placed over the top of the cloth covering the rearing container. A thin piece of sponge wet with water was placed inside the rearing trays as a source of water to the adults. The inner surface of the adult rearing boxes was lined with a layer of brown paper. The brown paper was checked regularly for the presence of eggs. The sheets with eggs were removed on daily basis. The larvae upon hatching were supplied with eggs and crawler stage of mealy bugs for the feeding. The predator was reared continuously for five generations on mealy bugs before the start of experiments.

Selective toxicity of Spirotetramat 150 OD on the larvae of *C. z. sillemi*

The relative toxicity of the spirotetramat 150 OD was recorded by the standard thin film method (Anonymous, 1994). Three doses of the insecticide *viz.*, 1.25, 2.5 and 3.75 mL/L and untreated control were used for the selective toxicity studies. For the preparation of the thin film, the plastic vials were dipped in the prepared insecticidal solution of required concentration for 2-5 seconds and dried for 5-10 minutes. Vials maintained without dipping in insecticide solution with the larvae of *C. z. sillemi* was considered as control. Fifteen second instar larvae of *C. z. sillemi* was released into the treated vials and allowed to remain in contact with the treated vials for 30 minutes. Later the larvae were collected using a fine hair brush and released into fresh plastic petri dishes and supplied with known number of mealybugs for feeding. The mortality of the predator larvae was observed 24, 48, 72 and 96 hours after exposure to the insecticides.

Toxicity studies of Spirotetramat 150 OD over the adults of *C. z. sillemi*

Five pairs of freshly emerged adults of *C. z. sillemi* was enclosed in a rearing boxes with its inner surface lined with brown paper and supplied with 10 percent sucrose solution prepared in three different concentration of spirotetramat 150 OD @ 1.25, 2.5, 3.75 mL/L. The brown paper was observed regularly for the presence of eggs and the total number of eggs laid by the adults was counted. The method described by Krishnamoorthy (1985) was followed to assess the effect of the spirotetramat against *C. z. sillemi* eggs. The brown paper strips containing stalked eggs were treated with three different concentrations of insecticides *viz.*, 1.25 mL/L, 2.5 mL/L and 3.75 mL/L using an atomizer. Each treatment was replicated six times with 15 eggs in each replication. The eggs sprayed with distilled water alone served as control. The number of grubs hatched from each treatment was recorded and per cent hatchability was worked out. The tested insecticide was classified based on the safety categories of IOBC (International Organization on Biological Control), Class I – Harmless (<30% mortality of natural enemy tested), Class II - Slightly harmful (30 – 79% mortality), Class III - Moderately harmful (80 – 98%mortality) Class IV – Harmful (>98% mortality).

Data analysis

The analysis of variance was carried out by completely randomized block design using SAS 9.3 software. The mean values of treatments were then separated using DMRT (Duncan Multiple Range Test).

RESULTS AND DISCUSSION

The toxicity of promising insecticide spirotetramat 150 OD over the larvae of neuropteran predator, *C. z. sillemi* was studied (Table 1). The lower dose of spirotetramat (1.25 mL/L) recorded significantly lower percent mortality (10.00) three days after treatment. The middle and higher dose of spirotetramatwas statistically on par with a percent mortality of 23.33 and 28.88, respectively. The results showed that spirotetramat was categorized as 'harmless' as per the IOBC classification of safety of insecticides on natural enemies. Mansour *et al.* (2011) reported that spirotetramat was rated as IOBC category I (harmless) towards vine mealy bug parasitoid, *Anagyrus* sp. near *pseudococci* (Girault) with no adverse effect on the development of the parasitoid pupal stage inside mealybug mummies or the survival of the emerged parasitoids. The effect of different doses of spirotetramat over the hatching percentage of eggs and rate of pupation of larvae of *C. z. sillemi* was also studied. There was significant difference in the effect of different doses of spirotetramat over the hatching percentage of eggs and rate of pupation of *C. z. sillemi*. The lower dose of spirotetramat recorded significantly highest hatching percentage of eggs. The mean hatching percentage of eggs recorded in the middle and highest dose of spirotetramat was statistically on par with each other (Table 2). Untreated control recorded highest hatching percentage of eggs of *C.*

z. sillemi. The percent pupation of *C. z. sillemi* was significantly highest in untreated control which was statistically on par with lower dose.

Table 1. Safety evaluation of promising insecticides on larvae of *Chrysoperla zastrowi sillemi*.

Treatments	**Dose (mL/L)**	**Cumulative percent mortality of larvae of Chrysoperla after 96 hours**
Spirotetramat 150 OD	1.25	10.00[c]
Spirotetramat 150 OD	2.5	23.33[a]
Spirotetramat 150 OD	3.75	28.88[a]
Untreated control	-	1.11[d]
CD (0.05)	-	6.99
CV %	-	36.66

The effect of spirotetramat over the adult emergence and fecundity of adults andpercent adult emergence from the treated pupae was found the highest in untreated control followed by the lower dose of spirotetramat. Control recorded highest mean fecundity of *C. z. sillemi* that was statistically on par with the lower dose of spirotetramat (209). Middle and higher dose of spirotetramat recorded mean fecundity of 178.50 and 108.83, respectively.

The observations made in the present study was in concurrent with the results of Vinothkumar *et al.* (2009) reported that higher dose of spirotetramat @ 75ga.i/ha was found safer to the natural enemies like spiders, coccinellids and chrysopids in cotton ecosystem. Lacewings has been integrated in IPM programmes of many sucking insect pests because they possess inherent ability to tolerate the insecticides during the larval stages (Medina *et al.*, 2001). *Chrysoperla* spp. was reported to harbor endosymbiotic yeast and bacteria in their gut and theses symbiotic microbes were reported to contribute for insecticide tolerance mechanism to the predator (Bakthavatsalam and Krishna Kumar, 2011). The present study concluded Spirotetramat150 OD as a safer insecticide to be integrated with chrysopid predators in insect management programs.

Table 2. Toxicity of Spirotetramat 150 OD over the immature stages of *C. z. sillemi*

Treatments	**Dose (mL/L)**	**Egg hatching %**	**Percent pupation**	**% adult emergence**	**Mean fecundity**
Spirotetramat 150 OD	1.25	86.67[a]	90.00[a]	71.11[b]	209.00[a]
Spirotetramat 150 OD	2.5	67.78[b]	76.67[b]	56.67[c]	178.50[b]
Spirotetramat 150 OD	3.75	58.89[b]	55.56[c]	49.99[c]	108.83[c]
Untreated control	-	95.56[a]	95.56[a]	98.89[a]	211.50[a]
CD (0.05)	-	12.56	7.54	8.26	23.70
CV %	-	13.51	7.89	9.91	11.12

Means followed by same letter are not significantly different DMRT (0.05).

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