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Effect of biopesticides on the morphometry and duration of larvae of *Chrysoperla zastrowi sillemi* in the subsequent generation

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Abstract
Efficacy of biopesticides; *Bacillus thuringiensis*, *Lecanicillium lecani*, *Beauveria bassiana*, azadirachtin and synthetic insecticide, fipronil (chemical check) and the untreated control (distilled water) were studied on the morphometry and duration of 3rd instar larvae in the subsequent generation of *Chrysoperla zastrowi sillemi* after first round treatment by two different methods, residue deposit and diet contamination methods under laboratory condition. In both the methods, lowest length (5.16 mm in residue deposit and 4.96 mm in diet contamination) and breadth (1.98 mm and 1.95 mm respectively in residue and diet contamination methods) were observed in fipronil treated 3rd instar larvae of subsequent generation followed by azadirachtin. Length and breadth of all the microbial treated 3rd instar larval stage of subsequent generation were almost at par with the untreated control. Maximum larval duration was observed in *Bacillus thuringiensis* (9.80 days) in residue deposit method and *Lecanicillium lecani* (9.85 days) in diet contamination method.

Keywords: *Chrysoperla zastrowi sillemi*, biopesticides, morphometry, synthetic insecticide, subsequent generation, residue deposit and diet contamination

1. Introduction
Biological control is an environmental friendly methods of control. In this context, green lacewings has a prominent role to play in managing insect pests as biological control. Entomopathogenic fungi, entomopathogenic bacteria, and botanicals, on the other hand, has proved itself as biological control agents against insects and can be used as part of integrated pest management systems. The usefulness of these components as effective control techniques is dependent not only on its effectiveness against insect pests, but also on their low toxicity to non-target insects. Considering both natural predators and biopesticides, the current investigation was carried out to see if the two may be combined in an IPM package and to assess the biopesticides' lethality in the immediate subsequent generation.

2. Materials and Methods
The laboratory experiment was conducted in the Biocontrol laboratory, Department of Entomology, College of Agriculture, OUAT, Bhubaneswar during 2020-21. For conducting the investigation, eggs of *Corcyra cephalonica*, the factitious host of *Chrysoperla zastrowi sillemi* were obtained from the parasitic breeding laboratory of Biocontrol Unit, Department of Entomology. *Chrysoperla zastrowi sillemi* adult were procured from the National Bureau of Agriculturally Important Insects (NBAII), Bengaluru, Karnataka, India. The adults were reared in controlled condition in Laboratory in 1L capacity glass jars and the stock culture is maintained. Before considering the effect of biopesticides on the larvae and pupae in the subsequent generation, the mortality effect of Biopesticides of the first instar larval stage of the current generation were taken into account by adopting the Residual deposit and the Diet contamination methods. In Residual Deposit method, inner surface of the glass petridishes were sprayed with different treatments separately at maximum recommended doses by means of a pneumatic polysprayer and air dried. In Diet Contamination Method, UV treated *Corcyra* eggs were sprayed with different treatments separately at the maximum field recommended doses and air dried. Larval mortality in both the methods were observed at 3rd, 5th, 7th day after treatment and mortality percentage were worked out. In order to determine the effect of biopesticides in subsequent generation, the survived larvae from the treatments were reared until it turned into adults. From that, the adults were reared and produced the next generation

(subsequent generation), thereby the morphometry and duration of the emerged larvae of the subsequent generation were observed and recorded.

3. Results and Discussion

3.1 Effect of biopesticides on 3rd instar larval size of subsequent generation of Chrysoperla zastrowi sillemi

Length of larvae varied from 5.16 to 5.76 mm and 4.96 to 5.68 mm in the pesticidal treatments in residue deposit and diet contamination methods respectively (Table 1). All the microbial treatments and untreated control were non-significant indicating microbial formulation had least effect on larval size. In both the methods significantly the lowest length was observed in the chemical check fipronil i.e. 5.16 mm and 4.96 mm in residue deposit method and diet contamination methods, respectively. The length of larvae in untreated control (5.80 mm and 5.72 mm in residue and diet contamination methods respectively) supported the findings of Sharma and Verma 1991 [6]. The size of the larvae affected by Bt in the present investigation supported the finding of Romeis *et al*. (2004) [4] i.e. Bt has no effect on Chrysoperla sps. However, length of larvae affected by fipronil and Azadirachtin was found to be significantly lower as compare to untreated control which indicated that these two formulations had higher residual toxicity on the target insect (green lacewing) in the subsequent generation. Breadth of the 3rd larval instar in subsequent generation in all the pesticidal treatments were statistically at par ranging from 1.98 to 2.14 mm and 1.95 to 2.16 mm in residue deposit and diet contamination methods, respectively (Table 1) and were significantly different from the untreated control. Sharma and Verma (1991) [6] conducted a similar experiment on larval size and found the breadth of larvae ranged between 1.76-2.21 mm which was in opine with the present findings. The minimum breadth observed in treatment Fipronil as well as azadirachtin on 3rd instar larvae of green lace wing clearly indicated that due to the toxic effect of the above two treatments the larval growth might had been drastically affected.

Table 1: Effect of biopesticides on 3rd instar larval size of subsequent generation of *Chrysoperla zastrowi sillemi.*

Treatment	Concentration	Dose	Residue Deposit Method		Diet Contamination Method	
			Length	Breadth	Length	Breadth
T_1-*Bacillus thuringiensis*	1.77x10^9 cfu/ml	2ml/L	5.76* (2.6)**	2.14* (1.7)**	5.49* (2.6)**	2.08* (1.7)**
T_2-*Lecanicillium lecani*	2.13x10^9 spores/ml	5ml/L	5.58* (2.6)**	2.11* (1.7)**	5.68* (2.6)**	2.13* (1.7)**
T_3-*Beauveria bassiana*	2.03x10^9 spores/ml	5ml/L	5.54* (2.6)**	2.07* (1.7)**	5.61* (2.6)**	2.10* (1.7)**
T_4-*Metarhizium anisopliae*	2.27x 10^9 spores/ml	5ml/L	5.57* (2.6)**	2.08* (1.7)**	5.63* (2.6)**	2.11* (1.7)**
T_5-Azadirachtin	1500 ppm	3ml/L	5.42* (2.5)**	2.06* (1.7)**	5.23* (2.5)**	2.04* (1.7)**
T_6-Fipronil(chemical check)	5 SC	2ml/L	5.16* (2.4)**	1.98* (1.7)**	4.96* (2.4)**	1.95* (1.7)**
T_7-Untreated control	-	-	5.80* (2.6)**	2.16* (1.9)**	5.72* (2.6)**	2.16* (1.8)**
SE(m)± CD(0.05)			0.003 0.009	0.003 0.008	0.004 0.012	0.003 0.008

DAT-Days after treatment. * Mean of three replications

**Figures in the parenthesis are square root transformed values

3.2 Effect of Biopesticides on the duration of larval stage of *Chrysoperla zastrowi sillemi* in subsequent generation

In residue deposit method the larval duration ranged from 8.75 to 9.80 days in the treatments as against 9.86 days in untreated control. The duration of larvae determined through diet contamination method varied from 8.70 to 9.85 days among the treatments as against 9.92 days in control. In residue deposit method, the treatments T_2 (*Lecanicillium le cani*) T_3 (*Beauveria bassiana*), T_4 (*Metarhizium anisopliae*), T_5 (*Azadirachtin*) were statistically at par and different significantly from the untreated control.

In case of diet contamination method, T_3 and T_4 were at par and significantly different from control, whereas, T_5 (Azadirachtin) was significantly different from the pesticidal treatments and the untreated control. Maximum larval duration registered by residue deposit method and diet contamination method was 9.80days in *Bacillus thuringiensis* (T_1) and 9.85days in *Lecanicillium lecani*, respectively while the lowest duration was observed in T_7 (Fipronil) (chemical check) in both the methods.

Geethalakshmi *et al.* 2000 [2] studied the biology of green lace wing and found that the larval duration was around 10.3days which was very much close to present results. There was slight decrease in larval duration observed in check chemical insecticides ie. Fipronil indicating that synthetic chemical might have produced negative impact on the larval duration in the subsequent generation.

Table 2: Effect of Biopesticides on the duration of larval stage of *Chrysoperla zastrowi sillemi*

Treatments	Concentration	Dose	Larval Duration	
			Residue Deposit Method	Diet Contamination Method
T_{1}- *Bacillus thuringiensis*	$1.77x10^{9}$ cfu/ml	2ml/L	9.80* (3.28)**	9.58* (3.25)**
T_{2}- *Lecanicillium lecani*	$2.13x10^{9}$ spores/ml	5ml/L	9.59* (3.25)**	9.85* (3.29)**
T_{3}- *Beauveria bassiana*	$2.03x10^{9}$ spores/ml	5ml/L	9.54* (3.25)**	9.77* (3.28)**
T_{4}- *Metarhizium anisopliae*	$2.27x\ 10^{9}$ spores/ml	5ml/L	9.56* (3.24)**	9.81* (3.28)**
T_{5}- Azadirachtin	1500 ppm	3ml/L	9.41* (3.23)**	9.34* (3.22)**
T_{6}- Fipronil	5SC	2ml/L	8.75* (3.12)**	8.70* (3.12)**
T_{7}- Untreated control	-	-	9.86* (3.29)**	9.92* (3.31)**
SE(m)± CD(0.05)			0.009 0.028	0.001 0.004

DAT-Days after treatment. * Mean of three replications

**Figures in the parenthesis are square root transformed values

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