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Research Article

Toxicity of insecticides to predators of rice brown planthopper: Wolf spider and carabid beetle

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ABSTRACT

Field toxicity of two insect growth regulators (IGR) viz. Award 40 SC (Buprofezin) and Haron 5 EC (Lufenuron) and one newer Thiacloprid viz. Calypso 280 SC against wolf spider, *Lycosa pseudoannulata* and carabid beetle, *Ophionea indica*, the predators of rice brown planthopper (BPH) was examined in the Entomology field laboratory, Bangladesh Agricultural University, Mymensingh. Effectiveness of insecticides was assessed on the basis of populations of wolf spider and carabid beetle under field condition at 1, 2, 3, 5 & 7 days after treatment. The abundances of wolf spider and carabid beetle were not changed significantly even when rice plants were treated with either Award or Haron. In contrast, Calypso 280 SC had significantly reduced wolf spiders (about 78%) and carabid beetle (about 57%) populations compared to the control. Therefore it is concluded from the present study that Award 40 SC @ 0.75 ml/L or Haron 5 EC @ 1.00 ml/L would be applied as the protector of predators of BPH in rice-ecosystem. On the other hand, Calypso 280 SC has adverse effects on the populations of wolf spider and carabid beetle in rice-ecosystem as well as other environmental components.

Key words: Insecticides, Predators, Rice brown plant hopper, *Lycosa pseudoannulata, Ophionea indica*

INTRODUCTION

Pesticides are major agents used to control agricultural pests. In Bangladesh, insecticides have been widely used for controlling insect's pests in most rice paddies and others. Intensive and extensive use of insecticides, however, has causal several problems: development of insecticides resistance in pest insects, environmental pollution and side effects on non-target organisms including the natural enemies of the target pests (Kiritani, 1979). Biswas *et al.,* (2006) evaluated the toxic action of two insecticides (Cypermethrin and Carbofuran) against *M. discolor* and *L. pseudoannulata,* where *L. pseudoannulata* was more susceptible to the insecticides than *M. discolor.* Use of selective insecticides that are less toxic to natural enemies and the natural enemies may suppress the pest populations, which in turn will reduce the rate of insecticide application.

Predation is the ecological process by which energy is transferred from living animal to living animal based on the behavior of a predator that captures and kills a prey before eating it. To effectively utilize the natural enemies as biological control agents, it is necessary to acquire the information about the effects of pesticides on them. Tanaka *et al.,* reported many insecticides, particularly phenthoate, imidacloprid and deltamethrin, were toxic to *C. lividipennis* and also evaluated the destructive effects of deltamethrin on the spider populations with induced a resurgence of the *N. lugens* population.

The wolf spider, *Lycosa pseudoannulata* (Boesenberg et strand) is one of the most important predators of BPH and can consume 15-20 adult plant hoppers per day (Samal and Misra, 1975). The feeding efficiency of *Lycosa pseudoannulata* has been estimated to be 24 nymphs or adults of *N. lugens* per day. *L. pseudoannulata* may serve as an effective biocontrol agent of BPH in Bangladesh. *Ophionea indica* (Coleoptera: Carabidae) is one of the important predator of nymph and adult of brown planthopper (Ali Khan and Yusuf, 1986). Both the grubs and adults of the carabid beetle are reported as an important predator of brown planthopper (Samal and Misra, 1984). It is found to maintain a good predator prey relationship between carabid beetle and brown planthopper (Bonn and Kleinwachter, 1999).

The most commonly practiced method of controlling brown planthopper in Bangladesh is the application of synthetic insecticides. Uses of synthetic insecticides providing temporary control and furthermore it is evident that the use of broad-spectrum pesticide has almost inevitably been followed by the development of pesticide resistance, pest resurgence and out breaks of secondary pest etc and especially on natural enemies (Luckmann and Metcalf, 1975; Husain, 1993). Hence, the present study was taken to evaluate the toxicity of insecticides on the abundances of two predators *Lycosa pseudoannulata* and *Ophionea indica* of BPH with different concentrations under field condition.

MATERIALS AND METHODS

The experiment was conducted in the field laboratory of the Department of Entomology, Bangladesh Agricultural

University (BAU), Mymensingh during the period from February to June, 2015. The experiment was conducted in a Randomized Complete Block Design (RCBD). The experiment consisting of 10 treatments while each of the treatment was replicated thrice. The whole experimental field was divided into 3 equal blocks and each block was then divided into 10 plots. Finally a total of 30 plots were made in the specified area for conducting the experiments. The size of a unit plot was 4.0 m X 2.5 m. Two adjacent unit plots and blocks were separated by 50 cm and 80 cm apart respectively. Plots were allocated randomly and they were separated in such way so that impact of treatments can be quantified.

The experiment was conducted with the rice variety, TN-1 (Taichung Native-1) as this variety is highly susceptible to BPH infestation. Ploughed soil was brought into desirable final tilth by four operations of ploughing and laddering with country plough and also by cross ploughing followed by laddering. Seedlings of TN-1 were collected from the farm of Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh. Collected seedlings were transplanted immediately in the main field on 2nd February, 2015. The plant spacing was followed as 20 cm x 15 cm. Eight (8) to ten (10) cm water was maintained by irrigation throughout the period of experiment because the test insect, *Nilaparvata lugens* is a water-loving insect. The boarder or boundary of each subplot was so high that irrigated water could not move from one plot to another plot.

Selection of treatments

Two IGR based biopesticides namely, Buprofezin and lufenuron and one synthetic insecticide of neo-nicotinoid were selected to determine the effects of mortality. There were ten treatments including control with three replications for each. The detailed specifications of treatments are presented in the table 1 with their doses, trade name and group.

All the treatments were applied according to the experimental specifications. Two consecutive sprays were given at 45 and 60 DAT (days after transplantation) with pneumatic knapsack sprayer. Spraying was done in the morning time to avoid bright sun shine. Data were collected on before treatment application and 1, 2, 3, 5 and 7 days after treatment (DAT) application. Data were also collected from untreated control plot.

Data were collected using the following parameters

The mean number of wolf spider and carabid beetle populations per hill was calculated using the following formula:

$$\text{\% Decrease over control} = \frac{Pc - Pt}{Pc} \times 100$$

Where,
Pt = Number of predators after treatment application
Pc = Number of predators without treatment application (Control)

Table 1: Specification of treatments of the selected insecticides

	Treatments	Active ingredients	Group
T_1	Award 40 SC @ 0.25 ml/L water	Buprofezin	Insect Growth Regulator
T_2	Award 40 SC @ 0.50 ml/L water	Buprofezin	Insect Growth Regulator
T_3	Award 40 SC @ 0.75 ml/L water	Buprofezin	Insect Growth Regulator
T_4	Haron 5 EC @ 0.50 ml/L water	Lufenuron	Insect Growth Regulator
T_5	Haron 5 EC @ 1.00 ml/L water	Lufenuron	Insect Growth Regulator
T_6	Haron 5 EC @ 1.5 ml/L water	Lufenuron	Insect Growth Regulator
T_7	Calypso 280 SC @ 0.50 ml/L water	Thiacloprid	Neo-nicotinoid
T_8	Calypso 280 SC @ 0.75 ml/L water	Thiacloprid	Neo-nicotinoid
T_9	Calypso 280 SC @ 1.00 ml/L water	Thiacloprid	Neo-nicotinoid
T_{10}	Control	-----	-----

The recorded data were compiled and tabulated for statistical analysis. Analysis of variance was done with the help of computer package MSTAT. The mean differences among the treatments were adjudged with Duncan's Multiple Range Test (DMRT) and Least Significant Difference (LSD) when necessary (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Abundances of wolf spider, *L. pseudoannulata* and carabid beetle, *O. indica* in rice- ecosystem following treated with different treatments

Abundances of wolf spiders, L. pseudoannulata and carabid beetles, O. indica in rice-ecosystem following treated with different concentrations of Award 40 SC

It was observed that the populations of wolf spiders and carabid beetles in rice-ecosystem were not changed significantly when rice plants were treated with different concentrations of Award 40 SC in comparison with that of control (Table 2). This result is consistent with the previous findings that Award 40 SC (Buprofezin) is harmless for on non-target organisms or natural enemies (Choi *et al.*, 1996; GuiFen and ChuanTao, 1996). It was also reported by Mendel *et al.*, (1994) that Buprofezin did not adversely affect egg hatch and larval development of *Elatophilus hebraicus* (Hemiptera: Anthocoridae). Deng *et al.*, (2008) also reported that Buprofezin had low toxicity to wolf spider, *Piratapiratoides*. The present finding was also supported by Thang *et al.*, (1987) where they have reported that Buprofezin had the least adverse effect on *L. pseudoannulata.*

Abundances of wolf spiders, L. pseudoannulata and carabid beetles, O. indicain rice-ecosystem following treated with different concentrations of Haron 5 EC

Like as Buprofezin, Haron 5 EC (Lufenuron) had no significant effects on the abundances of *L. pseudoannulata* and *O. indica* in rice-ecosystem (Table 3). Before treatment applications, wolf spiders and carabid beetles were approximately 3 and 2 per hill respectively and these numbers were not changed significantly even when rice plants were treated with different concentrations of Haron. This result suggests that Haron 5 EC (a chitin synthesis inhibitor) is safe for wolf spider and carabid beetle in rice-ecosystem. Aulakh and Butter (2009) used Lufenuron (Match 5 EC) @ 24, 50, 255 and 290 ppm against cotton bollworms particularly, *Helicoverpa armigera* (Hübner) proved safe to eggs and adults of *Chrysoper lacarnea* (Stephens) at all the dosages which helped in the conservation of natural fauna. The present findings is also supported by the Gogi *et al,*. (2006) where they have reported that Lufenuron and Buprofezin had the minimum or no effect on the predators in rice-ecosystem.

Abundances of wolf spiders, L. pseudoannulata and carabid beetles, O. indicain rice-ecosystem treated with different concentrations of Calypso 280 SC

Wolf spider and carabid beetle populations were significantly reduced after application of different doses of Calypso 280 SC ($P<0.01$, Table 4). Both natural enemies were reduced significantly at 1 DAT while the lowest numbers were recorded at 3 DAT and this reduction was persisted up to day 7. The similar trend was found in case of BPH mortality where 50% mortality was found at 1 DAT and reached at peak level by day 3.

Similar results were also obtained by Zeng *et al.,* (2010) where they have reported that spiders populations were decreased 42.86 to 60.90% at 7 DAT when Thiacloprid 48 SC was applied @ 45-63 g a.i./ha. Ullah and Jahan (2004) reported that carabid beetles, *O. Indica* populations were changed significantly compared to the control due to the application of Brifer 5 G and Azodrin 40 WSC. Neo-nicotinoid insecticides had a destructive effect on the populations of spiders, mirid bug and dryinid wasp (Tanaka *et al.,* 2000).

Table 2: Abundances of wolf spiders, *L. pseudoannulata* and carabid beetles, *O. indica* in rice-ecosystem following treated with different concentrations of Award 40 SC

Treatment	Mean number of *L. pseudoannulata* per hill at different DAT						Mean number of *O. indica* per hill at different DAT					
	Pre-treated populations	1 DAT	2 DAT	3 DAT	5 DAT	7 DAT	Pre-treated populations	1 DAT	2 DAT	3 DAT	5 DAT	7 DAT
Award 40 SC @ 0.25 ml/L	3.46	3.46	3.46	3.46	3.33	3.33	2.33	2.33	2.33	2.33	2.22	2.22
Award 40 SC @ 0.50 ml/L	3.36	3.36	3.36	3.36	3.16	3.16	2.00	2.00	2.00	2.00	1.95	1.85
Award 40 SC @ 0.75 ml/L	3.60	3.60	3.60	3.60	3.23	3.23	2.06	2.06	2.06	2.06	1.96	1.89
Control	3.73	3.73	3.73	3.73	3.66	3.66	2.30	2.30	2.30	2.30	2.20	2.20
P-level	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV%	3.43	3.43	3.43	3.43	1.99	1.99	3.16	3.16	3.16	3.16	6.16	6.16
SE (±)	0.08	0.08	0.08	0.08	0.11	0.13	0.08	0.08	0.08	0.14	0.13	0.13

In a column, means of similar letter (s) do not differ significantly. DAT = Days After Treatment, P-level = Probability Level, CV = Co-efficient of Variation, SE = Standard Error.

Table 3: Abundances of wolf spiders, *L. pseudoannulata* and carabid beetles, *O. indica* in rice-ecosystem following treated with different concentrations of Haron 5 EC

Treatment	Mean number of *L. pseudoannulata* per hill at different DAT						Mean number of *O. indica* per hill at different DAT					
	Pre-treated populations	1 DAT	2 DAT	3 DAT	5 DAT	7 DAT	Pre-treated populations	1 DAT	2 DAT	3 DAT	5 DAT	7 DAT
Haron 5 EC @ 0.50 ml/L	3.60	3.60	3.60	3.60	3.46	3.46	2.44	2.44	2.44	2.44	2.33	2.33
Haron 5 EC @ 1.00 ml/L	3.66	3.66	3.66	3.66	3.50	3.50	2.10	2.10	2.10	2.10	1.99	1.99
Haron 5 EC @ 1.50 ml/L	3.66	3.66	3.66	3.66	3.23	3.23	2.00	2.00	2.00	2.00	1.89	1.89
Control	3.66	3.66	3.66	3.66	3.66	3.66	2.30	2.30	2.30	2.30	2.20	2.20
P-level	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV%	2.69	2.69	2.69	2.69	1.59	1.59	2.25	2.25	2.25	2.25	3.74	3.74
SE (±)	0.03	0.03	0.03	0.04	0.09	0.11	0.10	0.10	0.10	0.12	0.10	0.10

In a column, means of similar letter (s) do not differ significantly. DAT = Days After Treatment, P-level = Probability Level, CV = Co-efficient of Variation, SE = Standard Error.

Table 4: Abundances of wolf spiders, *L. pseudoannulata* and carabid beetles, *O. indica* in rice-ecosystem following treated with different concentrations of Calypso 280 SC

Treatment	Mean number of *L. pseudoannulata* per hill at different DAT						Mean number of *O. indica* per hill at different DAT					
	Pre-treated populations	1 DAT	2 DAT	3 DAT	5 DAT	7 DAT	Pre-treated populations	1 DAT	2 DAT	3 DAT	5 DAT	7 DAT
Calypso 280 SC @ 0.50 ml/L	4.00	3.00^{b}	2.56^{b}	2.06^{b}	1.90^{b}	1.90^{b}	2.33	1.88^{b}	1.78^{b}	1.66^{b}	1.66^{b}	1.66^{b}
Calypso 280 SC @ 0.75 ml/L	3.83	2.66^{c}	2.06^{c}	0.90^{c}	0.83^{c}	0.83^{c}	2.11	1.55^{c}	1.16^{d}	0.99^{c}	0.99^{c}	0.99^{c}
Calypso 280 SC @ 1.00 ml/L	4.06	2.93^{b}	2.00^{c}	0.83^{c}	0.83^{c}	0.83^{c}	2.22	1.55^{c}	1.33^{c}	1.00^{c}	1.00^{c}	1.00^{c}
Control	3.73	3.73^{a}	3.73^{a}	3.73^{a}	3.66^{a}	3.66^{a}	2.30	2.30^{a}	2.30^{a}	2.30^{a}	2.30^{a}	2.30^{a}
P-level	NS	0.01	0.01	0.01	0.01	0.01	NS	0.01	0.01	0.01	0.01	0.01
CV%	1.41	2.23	3.64	5.67	21.58	21.58	3.76	5.09	2.66	3.80	3.80	3.80
SE (±)	0.08	0.23	0.40	0.68	0.67	0.67	0.05	0.18	0.25	0.31	0.29	0.29

In a column, means of similar letter (s) do not differ significantly. DAT = Days After Treatment, P-level = Probability Level, CV = Co-efficient of Variation, SE = Standard Error.

CONCLUSIONS

Minimum and/or selective use of insecticides in effective doses and frequencies would be helpful in the long run for the conservation and survival of predators *Lycosa pseudoannulata* and *Ophionea indica* in rice ecosystem for brown planthopper. Significant reduction of predators was observed through non-selective or direct chemical insecticide in respect of selective or IGR based insecticides causing adverse effects on natural enemies, environments and others. From the point of view, it could be concluded that, Buprofezin and Lufenuron can be applied as a safer and protector for the wolf spider and carabid beetle populations than Thiacloprid.

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