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Toxic Effects of Two Insecticides on Brown Plant Hopper, *Nilaparvata lugens* and its Predators *Micraspis discolor* and *Lycosa pseudoannulata*

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Abstract: The experiment was conducted in the net house and laboratory to determine the effectiveness of two insecticides viz., Cymbush (Cypermethrin) and Brifer (Carbofuran) on brown plant hopper, *Nilaparvata lugens* and the toxic action of these insecticides to the predators lady bird beetle, *Micraspis discolor* and wolf spider, *Lycosa pseudoannulata*. Effectiveness of the insecticides was assessed on the basis of percentage of corrected mortality of brown plant hopper, lady bird beetle and wolf spider under laboratory condition at 24, 48 and 72 h after treatment. Cymbush 10EC @ 0.05 kg a.i. ha^{-1}. caused 100% mortality of insect populations at different time intervals. All the doses of Brifer 5G caused a good mortality of N lugens at different time intervals and was effective at higher dose. Cymbush 10EC @ 0.04 kg a. i. ha^{-1}. and Brifer 5G @ 0.5 kg a.i. ha^{-1}. were found very effective against N. lugens. The effectiveness of Cymbush 10EC decreased and Brifer 5G increased with increasing time interval. Cymbush 10EC @ 0.05 kg a.i. ha^{-1}. was highly toxic and 0.01 kg a.i. ha^{-1}. was less toxic to both the predators. Brifer 5G @ 0.5 kg a.i. ha^{-1}. was least toxic to the predators. Between the two predators *L. pseudoannulata* was more susceptible to the insecticides than *M. discolor*.

Key words: Insecticides, brown plant hopper, predator, *Micraspis discolor*, *Lycosa pseudoannulata*

Introduction

Rice is the main stable food for more than two billion people in Asia and four hundreds of millions of people in Africa and Latin America (Anonymous, 1985). Rice covers about 74.35% of the total cropping area of Bangladesh. Rice is grown throughout the year in Bangladesh and it is an ideal host for many species of insect pests. In Bangladesh, 175 species of insect pests have been recorded on rice (Kamal, 1998). Rice suffers heavy losses every year due to attack of many pests, among these, the rice Brown Plant Hopper (BPH), *Nilaparvata lugens* is widespread and a threat to rice production in many parts of Bangladesh. The BPH was formerly a minor pest in most tropical countries of Asia.

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Following the introduction of insecticides and modern semi-dwarf rice varieties in the 1960's, *N. lugens* became the most devastating insect pest of rice in Asia. The large scale damaged by the pest has been reported from India, Indonesia, Philippines, SriLanka and Bangladesh since the early 1970's (Sogawa and Cheng, 1979). The BPH has become a major problem for rice production in several parts of Bangladesh in recent years. *N. lugens* is mainly a pest of irrigated rice, but it can also become abundant in rainfed environments. It is also a pest in upland rice (Reissig *et al.*, 1985). It infests the rice crop at all stages of plant growth. Low infestation causes reduced plant height, crop vigour, tiller production, while heavy infestation turns the plants yellow which dry up rapidly. At early infestation, round yellow patches appear which soon turn brownish due to drying up of the plants.

N. lugens is a vascular feeder and damages plants by sucking sap from the mesophyll and blocking the xylem and phloem by laying egg masses in the midribs of the leaf sheath and leaf blade. This feeding damage is commonly referred to hopper burn. The patches of infestation may spread out and cover the entire field. It also acts as a vector of the virus diseases viz., grassy stunt, ragged stunt and wilted stunt (Chen and Chiu, 1981).

Natural enemies are often important biocontrol agents of BPH in nature. More than 100 species of natural enemies of leafhoppers and plant hoppers have been reoprted (Dyck and Orlido, 1977). Predation is common among insects and some of the most successful cases of biological control have been possible through predators. The predacious coccinellid beetles, commonly known as lady bird beetles are considered to be of great economic importance in the agroecosystem. They have been soccessfully employed in the biological control of many injurious insects (Agarwala *et al.*, 1988; Nasiruddin and Islam, 1979). *Micraspis discolor* is one of the most important species of coccinellids which is found as a predator on nymphs and adults of BPH (Samal and Misra, 1985). Although *M. discolor* is widely distributed in Bangladesh and successfully survive and develop on BPH in rice field the activity or performance of this predator on this rice pest has not been evaluated properly. 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 *L. 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.

The most commonly used method of controlling BPH in Bangladesh is the application of insecticides which cause several problems such as development of insecticide resistance to pest insects, environmental pollution and undesirable effects on non-target organisms including the natural enemies of the target pests (Kiritani, 1979). Some insecticides have disrupted natural enemy complexes and induced resurgence of the target pests and outbreak of secondary pest (Heinrichs, 1994). In contrast, use of selective insecticides that are less toxic to natural enemies than to pests should conserve natural enemy populations and the surviving natural enemies may suppress the pest populations, which in turn will reduce the rate of insecticide application. Considering the above facts the present study was undertaken to ev aluate the effectiveness of two insecticides in controlling brown plant hopper under laboratory condition and to find out the dose of insecticides least toxic to the predators *Micraspis discolor* and *Lycosa pseudoannulata* under laboratory condition.

Materials and Methods

The experiment was carried out in the net house and laboratory of the Entomology Division, Bangladesh Institute of Nuclear Agriculture, Mymensingh, Bangladesh from March to July, 2002 to assess the effectiveness of two insecticides Brifer 5G (Carbofuran) and Cymbush 10EC (Cypermethrin) to adult stages of the predator lady bird beetle, Micraspis discolor (Fabricious) and wolf spider, Lycosa pseudoannulata (Boesenberg et Strand) in association with brown plant hopper, Nilaparvata lugens.

Collection and Rearing of Brown Plant Hopper, N. lugens

Gravid females of BPH were collected with the help of aspirator from infested rice fields of Bangladesh Agricultural University, Mymensingh. Immediately after collection, the insects were placed in test tube of medium size (15 cm in length). The mouth of the test tubes were then closed with pieces of fine nets and fastened with rubber bands. The collected insects were then brought to the net house of BINA and reared to build up a large population. The gravid females were immediately released on 30-40 days old rice plant of TN 1 variety grown in pots and then the pots were placed in a 0.75×0.5×0.2 m (length × breadth × height) tray which was filled with water to one third of its height, so that the soil could not dry. The potted rice plants were covered with 0.9 × 0.5 m (height x breadth) rearing cages. The plants were observed for egg laying everyday. For a continuous supply of 30-40 days old rice plants, TN 1 seeds were sown in seed beds at an interval of 15 days regularly starting well ahead of commencement to the experiment. Then 15-20 days old seedlings were transplanted in pots having 35 cm height and 25 cm diameter and containing 3.0-3.5 kg soil. The TN 1 plants (3 hills/pot were transplanted at the rate of 2 seedlings/hill) were allowed to grow for 30-40 days under net house condition. The pots were kept in another same size tray filled with water as previously described. All recommended cultural practices including fertilizer and insecticide application were followed for optimum plant growth. Sevin dust, an insecticide with least residual effect was used whenever necessary to protect the BPH from ants.

For egg laying purposes, adult BPH were released in caged-fresh rice plants on every Sundays and Wednesdays in every week. The gravid or adult female BPH were transferred from one used plant to another fresh plant with the help of an aspirator. After removal of the adults the plants were kept under the cages for a sufficient time so that the BPH eggs on these plants can hatch and reach the adult or gravid stage. Moreover, before using the plants for the egg laying of BPH, the outer leaf sheaths of each tiller were removed to eliminate any BPH populations from the plants. After hatching of eggs in to nymph, they were provided with sufficient food plants for their growth and development. As soon as most of the insects from the new hatching became adults, the females and the males were transferred to another cage with fresh plants twice a week as mentioned earlier. These insects were preserved in new cages with dates of egg laying marked on them. The BPH were provided with fresh plants for their food as and when necessary. In this way, BPH populations of uniform age were established and within 3-4 generations, sufficient numbers of insects became available for the production of required numbers of nymphs and adults for the different experiments.

Collection and Rearing of Lady Bird Beetle, M. discolor

The predator, *M. discolor* were maintained in the net house. Foe this purpose adult beetles were collected from rice field of the Bangladesh Agricultural University (BAU) farm, Mymensingh. The field collected beetles were reared in earthen pot (20 cm in height and 25 cm in diameter) covered with Mylar cage (Mylar cage : Hard plastic made cylindrical device. Its length is 45 cm and diameter 16 cm. The upper portion of the Mylar cage covered with nylon net. The net was attached with the cage by the help of gum). The third instar BPH on 30-40 days old potted rice plants were used as food for the beetle. Mating occurred inside the Mylar cage and the insects were allowed to lay eggs there. The eggs were separated in petridishes (11× 2 cm). After hatching of eggs, the grubs were transferred into test tube (20 cm). One grub was reared in each test tube providing the same food as supplied to their parents, the newly emerged adults were sexed and confined in pairs in test tube for mating and laying eggs.

Collection and Rearing of Wolf Spider, L. pseudoannulata

Some sexually mature adults of wolf spider, *L. pseudoannulata* and adult spider with egg sac were collected from the seed bed of the experiment rice plot of BINA, Mymensingh by using an aspirator. Each of the collected spiders was kept immediately in test tube individually. Since, the spiders are strongly cannibalistic in nature, they were confined individually in 15 cm × 7 cm glass pot. They were supplied with different stages of BPH as prey on one or two 12 cm long rice stem wrapped with wet cotton in the pot. All of the spiderlings became detached from the mother after 2-3 days of hatching. When newly hatched spiderlings were detached from her mother's back, they were transferred to another same sized pot. To minimize cannibalism, small pieces of rice straw were put inside the pots, thus giving chance to separate the spiderling from one another. Since, wolf spiders prefer to live at comparatively low temperature and shady area, they were reared in the laboratory at room temperature (27±2°C).

Net House Screening

To determine the corrected mortality percentage of BPH, lady bird beetle and wolf spider, an experiment was conducted in the net house of BINA. Seeds of TN1 rice variety were shown in the pot on 3rd March, 2002. The seedlings of 30-40 days were transplanted in plastic pot. The rice plants were grown in plastic pots and kept in net house. Cymbush 10EC was sprayed @ 0.05, 0.04, 0.03, 0.02 and 0.01 kg a.i. ha^{-1}. and Brifer 5 G was applied in the soil @ 0.5, 0.4, 0.3, 0.2 and 0.1 kg a.i. ha^{-1}. at 20 days after transplanting from seed bed. The experiment was laid out in a completely randomized design with three replicates.

Collection of Data on the Pest, N. lugens and the Predator, M. discolor and L. pseudoannulata

Toxicities of insecticides, Brifer 5G and Cymbush 10EC were determined at five dosages. Brifer 5G was applied @ 0.5, 0.4, 0.3, 0.2 and 0.1 kg a.i. ha^{-1}. and Cymbush 10EC was sprayed @ 0.05, 0.04, 0.03, 0.02 and 0.01 kg a.i. ha^{-1}. to adult stages of lady bird beetle and wolf spider and 3-4 instars of brown plant hopper. Water was applied as control. Each treatment had three replicates.

Ten adults of the predator ladybird beetle and wolf spider per replicate were treated separately at 24, 48 and 72 Hours After Treatment (HAT) with insecticides. The adult beetles and spiders were sprayed in caged TN1 rice plants in plastic pots infest with BPH in the net house. There were 2 hills (each hill contains 3 seedlings) in each pot. After 20 days after planting of the seedlings, BPH in different numbers (100-120) were released on the plant in the pot. The predator adults were released on to the BPH infested plants in separate pots 2-3 days after infesting and then insecticides were sprayed. The control pots with TN1 rice plants with BPH and predators were sprayed with water only. Mortality of adults of predators was recorded at 24, 48 and 72 HAT. At every time interval mortality of BPH sprayed with insecticides without association of predator adults in the net house was also obtain in the same way. All three parameters were conducted separately.

Recording of Corrected Mortality Percentage of Insects under Laboratory Condition

The counted mortality was converted in corrected mortality. Corrected mortality percent was calculated over control with following formula (Abbott's, 1925).

$$\text{Corrected mortality (\%)} = \frac{P' - T}{P - T} \times 100$$

Where,

P is the total population used

P is the mortality in treated area

T is the mortality in control

Statistical Analysis

Data obtained from the net house experiment in the laboratory were analyzed for two factors Completely Randomized Design. The means were compared according to Duncan's Multiple Range Test.

Results and Discussion

Effect of insecticides on the mortality of BPH, N. lugens

Mortality percentage of the pest, *N. lugens* by two insecticides at three different time intervals were recorded. Corrected mortality of BPH among various treatment ranged from 30 to 100% at 24, 36.7 to 100% at 48 and 53.3 to 100% at 72 HAT (Table 1). Mortality of BPH after 24 HAT with Cymbush 10 EC gave the highest mortality (100%) at both 0.05 and 0.04 kg a.i. ha^{-1}. and the lowest mortality (73.3%) at 0.02 and 0.01 kg a.i. ha^{-1}. On the other hand, in case of Brifer 5G, the highest mortality (73.3%) was recorded from 0.5 kg a.i. ha^{-1} and lowest mortality (30%) was recorded from 0.1 kg a.i. ha^{-1}. In all the treatments, mortality percentages were statistically dissimilar from each other in respect of high and low doses but identical mortality was found between low doses of Cymbush 10 EC and high doses of Brifer 5G.

All the two insecticides caused mortality of BPH in 48 HAT. Although all the insecticides had a remarkable effect on BPH, the overall effect of Cymbush 10EC at all the doses was found to be similar with Brifer 5G at high doses. A low dose of Cymbush 10EC gave better performance than the lower dose of Brifer 5G. The insecticide Cymbush 10EC caused mortality

Table 1: Mortality of brown plant hopper, *N. lugens* at different doses of two insecticides

	Rate (kg or L ha^{-1}.)		Corrected mortality (%)		
Insecticides	Formulated	a.i.	24 HAT	48 HAT	72 HAT
Brifer 5G	10	0.5	73.3 c	93.3 b	100.0
	8	0.4	70.0 cd	80.0 c	83.3
	6	0.3	63.3 d	66.7 d	73.3
	4	0.2	43.3 e	40.0 f	53.3
	2	0.1	30.0 f	36.7 f	53.3
Cymbush 10EC	0.5	0.05	100.0 a	96.7 a	100.0
	0.4	0.04	100.0 a	96.7 ab	76.7
	0.3	0.03	83.3 b	76.7 c	66.7
	0.2	0.02	73.3 c	63.3 d	63.3
	0.1	0.01	73.3 c	53.3 e	53.3
LSD at (0.05)			7.617	5.501	NS

Means followed by same letter in column are not significantly different., Values are average of three replications, HAT = Hours After Treatment

Table 2: Mortality of lady bird beetle, *M. discolor* at different doses of two insecticides

Insecticides	Rate (kg or L ha^{-1})		Corrected mortality (%)		
	Formulated	a.i.	24 HAT	48 HAT	72 HAT
Brifer 5G	10	0.5	26.7 e	33.3 d	33.3 d
	8	0.4	26.7 e	30.0 de	30.0 e
	6	0.3	23.3 e	23.3 e	26.7 f
	4	0.2	23.3 e	23.3 e	26.7 f
	2	0.1	6.7 f	10.0 f	10.0 g
Cymbush 10EC	0.5	0.05	100.0 a	76.7 a	60.0 a
	0.4	0.04	83.3 b	73.3 a	53.3 b
	0.3	0.03	63.3 c	63.3 b	46.7 c
	0.2	0.02	63.3 c	46.7 c	46.7 c
	0.1	0.01	53.3 d	33.3 d	26.7 f
	LSD at (0.05)		9.329	8.795	2.109

Means followed by same letter in column are not significantly different., Values are average of three replications, HAT = Hours After Treatment

ranging from 63.3 to 100% and Brifer 5G caused mortality ranging from 36.7 to 93.3%. In all the treatments mortality percentages were statistically dissimilar from each other in respect of high and low doses but identical results were found between low doses of Brifer 5G and higher doses of Cymbush 10EC.

Mortality percentages of BPH at 72 HAT at different doses of both insecticides did not differ significantly. The highest mortality percentage was observed as 100% at 24, 48 and 72 HAT of Cymbush 10EC treatment and for this reasons it may be said that Cymbush 10EC was highly effective to BPH. Brifer 5G was also effective to control N. lugens at 72 HAT. The effectiveness of two insecticides against BPH decreased considerably with the increase of time for Cymbush 10 EC but mortality increased by using Brifer 5G. The results were supported by Krishnaiah *et al*. (1982) and Anonymous. (1988 and 1991) by using various types of Cypermethrin and Carbamate insecticides including Carbofuran.

Effect of Insecticides on the Mortality of Lady Bird Beetle, M. discolor

Corrected mortality percentage of lady bird beetle among various treatments ranged from 6.7 to 100% at 24, 10 to 76.7% at 48 and 10 to 60% at 72 HAT is shown in Table 2. At 24 HAT, corrected mortality was highest (100%) at 0.05 kg a.i. ha^{-1} of Cymbush 10EC which was statistically dissimilar with all other treatments. There was no remarkable difference on the mortality of M. discolor among the doses of Brifer 5G. Lowest mortality was obtained from Brifer 5G @ 0.1 kg a.i. ha^{-1}. In the time, Cymbush 10EC caused mortality ranging from 53.3 to 100% and Brifer 5G caused mortality ranging from 6.7 to 26.7%.

At 48 HAT, Cymbush 10EC caused the highest mortality (76.7%) at 0.05 kg a.i. ha^{-1} and lowest mortality (33.3%) at 0.01 kg a.i. ha^{-1}. On the other hand, Brifer 5G caused the highest mortality (33.3%) at 0.5 kg a.i. ha^{-1} and lowest mortality (10%) at 0.1 kg a.i. ha^{-} .^{1}In all the treatments, mortality percentages were significantly different from each other in respect of high and low doses but identical results have found in first and second highest doses of Cymbush 10EC. In case of Brifer, first and second highest doses and second, third and forth doses were identical.

At 72 HAT, the hioghest mortality was found from higher doses of Cymbush 10EC and lowest mortality was found from the lowest dose of Brifer 5G. The highest mortality was recorded 100% at 24, 73.3% at 48 and 60% at 72 HAT from Cymbush 10EC. From the above findings it may be said

Table 3: Mortality of wolf spider, *L. pseudoannulata* at different doses of two insecticides

	Rate (kg or L ha^{-1})		Corrected mortality (%)		
Insecticides	Formulated	a.i.	24 HAT	48 HAT	72 HAT
Brifer 5G	10	0.5	30.0 e	33.3 de	40.0 b
	8	0.4	30.0 e	33.3 de	36.7 bc
	6	0.3	26.7 e	30.0 de	36.7 bc
	4	0.2	26.7 e	26.7 ef	30.0 cd
	2	0.1	16.7 f	20.0 f	23.3 d
Cymbush 10EC	0.5	0.05	100.0 a	83.3 a	63.3 a
	0.4	0.04	86.7 b	73.3 b	60.0 a
	0.3	0.03	73.3 c	56.7 c	43.3 b
	0.2	0.02	70.0 c	56.7 c	36.7 bc
	0.1	0.01	53.3 d	36.7 d	36.7 bc
	LSD at (0.05)		7.167	8.795	8.227

Means followed by same letter in column are not significantly different., Values are average of three replications, HAT = Hours After Treatment

that Cymbush 10EC was highly toxic to the predator lady bird beetle but brifer 5G did not reduce appreciably. It was also found that the toxic effect of Cymbush 10EC was reduced with the increase of time but this effect was evident incase of Brifer 5G. Sharma *et al.* (1991) found high toxicity by using Ripcord at 0.04 kg a.i. ha^{-1}. Rabbi *et al.* (1993) found 70% mortality by using Fastac 2 EC at 1 day after treatment and Rajendram (1994) showed Carbofuran did not appreciably reduce the insect predator population which support the result of present study.

Effect of Insecticides on the Mortality of Wolf Spider, L. pseudoannulata

Corrected mortality percentage of wolf spider, *L. pseudoannulata* among the treatments differed significantly and ranged from 16.7 to 100% at 24, 20 to 83.3% at 48 and 23 to 63.3% at 72 HAT (Table 3). Mortality data of wolf spider at 24 HAT, Cymbush 10EC showed a significant difference among the treatments. No insect survived when Cymbush 10EC sprayed at 0.05 kg a.i. ha^{-1}. The lowest number of wolf spider's mortality was found at 0.1 ka a.i. ha^{-1} of Brifer 5 g. Most of the doses of Brifer 5G had given statistically identical results.

At 48 HAT, Cymbush 10EC significantly reduced the number of wolf spider. The highest mortality (83.3%) was recorded from 0.05 kg a.i. ha^{-1} and lowest (36.7%) was recorded from 0.01 kg a.i. ha^{-1} of Cymbush 10EC. On the other hand, Brifer 5G caused the highest mortality (33.3%) at 0.5 kg a.i. ha^{-1} and lowest (20.0%) at 0.1 kg a.i. ha^{-1}. Similar and dissimilar results were found between high and low doses in both the insecticides. Most of the doses of Brifer 5G (0.5, 0.4, 0.3 and 0.2 kg a.i. ha^{-1}) and 0.03 and 0.02 kg a.i. ha^{-1} of Cymbush 10EC showed the identical mortality and others showed dissimilar mortality.

At 72 HAT, the effectiveness of Cymbush 10EC and Brifer 5G on wolf spider among the different treatments varied significantly. The highest mortality was recorded from the highest dose of Cymbush 10EC and lowest mortality was recorded from lowest dose of Brifer 5G. In all the treatments, most of the cases the results were statistically similar. From Cymbush 10EC, the highest mortality percentage 100, 83.3 and 63.3% were recorded at 24, 48 and 72 HAT, respectively. From the above findings it may be said that Cymbush 10EC was highly toxic to wolf spider but Brifer 5G did not cause much reduction of this spider. It was also found that the toxic effect of Cymbush 10EC was reduced with the increase of time but this effect was not evident in case of Brifer 5G. Similar results were obtained by Rahman and Uthamasamy (1983), Heinrichs *et al.* (1984), Fabellar and Heinrichs (1984), Thang *et al.* (1987) and Tanaka *et al.* (2000) by using same group of different insecticides. A contradictory result was found by Khusakul *et al.* (1979).

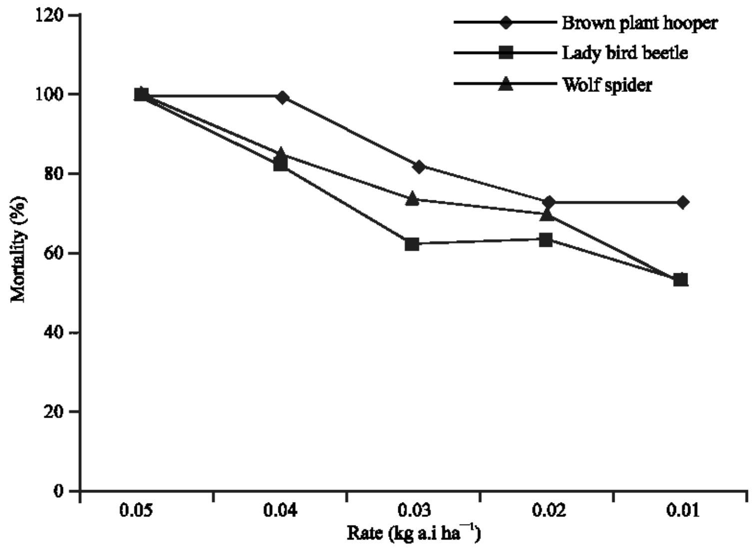

Fig. 1: Effect of Cymbush 10 EC on brown plant hopper and the predator lady bird beetle and wolf spider at 24 hours after treatment

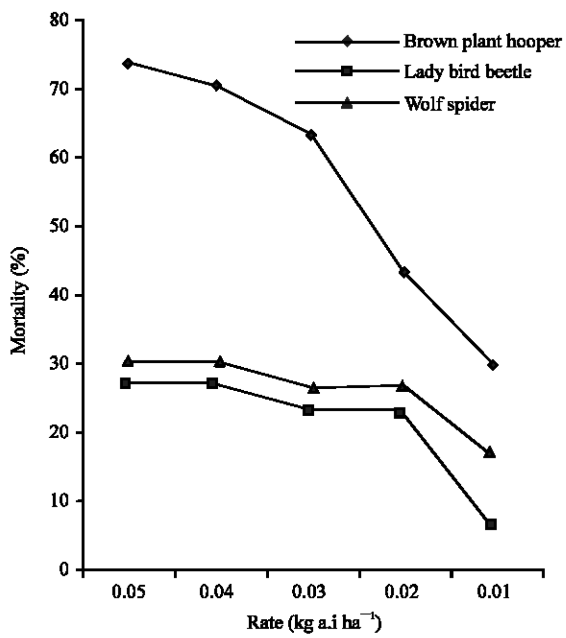

Fig. 2: Effect of Briefer 5G on brown plant hopper and the predator lady bird beetle and wolf spider at 24 h after treatment

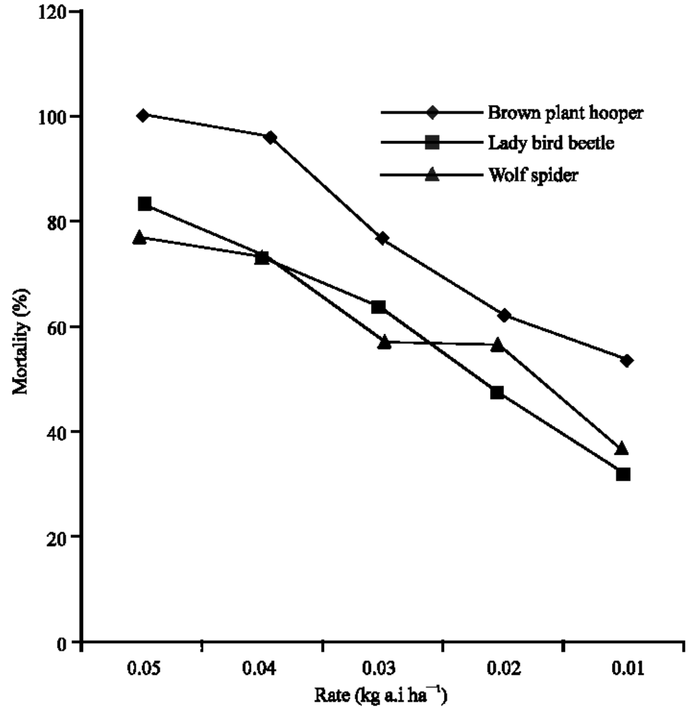

Fig. 3: Effect of Cymbush 10EC on the pest brown plant hopper and the predator lady bird beetle and wolf spider at 48 h after treatment

Comparative Effects of Insecticides on the Mortality of the Pest and Predators at 24 HAT

Cymbush 10EC caused 100% mortality of all the insects (Fig. 1) and Brifer 5G caused 70% of BPH and less than 30% of lady bird beetle and wolf spider's mortality (Fig. 2). These results indicated that both the insecticides were highly effective against BPH but between two insecticides Brifer 5G was more acceptable in respect of insect pest mortality and predator survivability as well as environmental safety.

Comparative Effects of Insecticides on the Mortality of the Pest and Predators at 48 HAT

Cymbush 10EC caused 100% mortality of BPH, less than 80% mortality of lady bird beetle and more than 80% mortality of wolf spider (Fig. 3). Brifer 5G caused above 90% mortality of BPH, less than 30% mortality of both the predator lady bird beetle and wolf spider (Fig. 4). All the treatments gave a significant response against the control of BPH.

Comparative Effects of Insecticides on the Mortality of the Pest and Predators at 72 HAT

Cymbush 10EC caused 100% mortality of BPH, more than 50% mortality of the predator lady bird beetle and 60% mortality of wolf spider (Fig. 5). Brifer caused 100% mortality of BPH, above 30% mortality of lady bird beetle and 40% mortality of wolf spider (Fig. 6). In this time Cymbush 10EC and Brifer 5G were highly effective to control BPH but Cymbush 10EC was slightly more toxic to the predators than Brifer 5G. These findings show that wolf spider is more susceptible to insecticides than lady bird beetle.

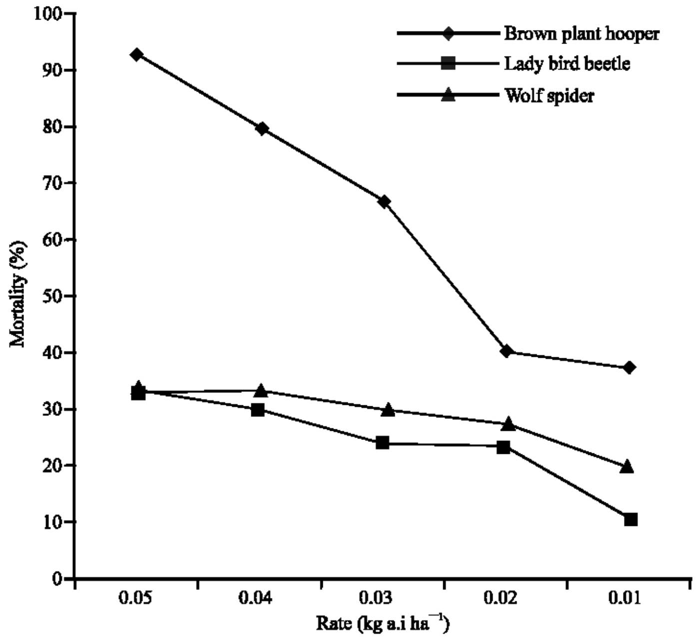

Fig. 4: Effect of Brifer 5G on brown plant hopper and the predator lady bird beetle and wolf spider at 48 h after treatment

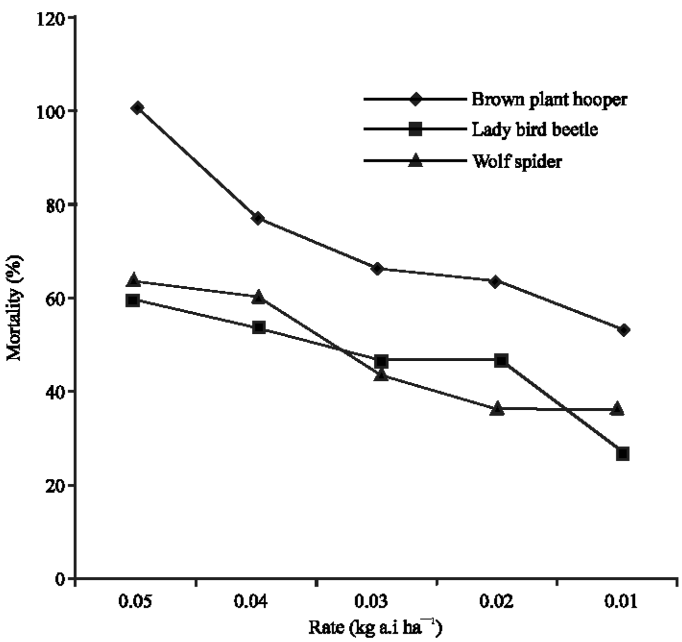

Fig. 5: Effect of Cymbush 10EC on the brown plant hopper and the predator lady bird beetle and wolf spider at 72 hours after treatment

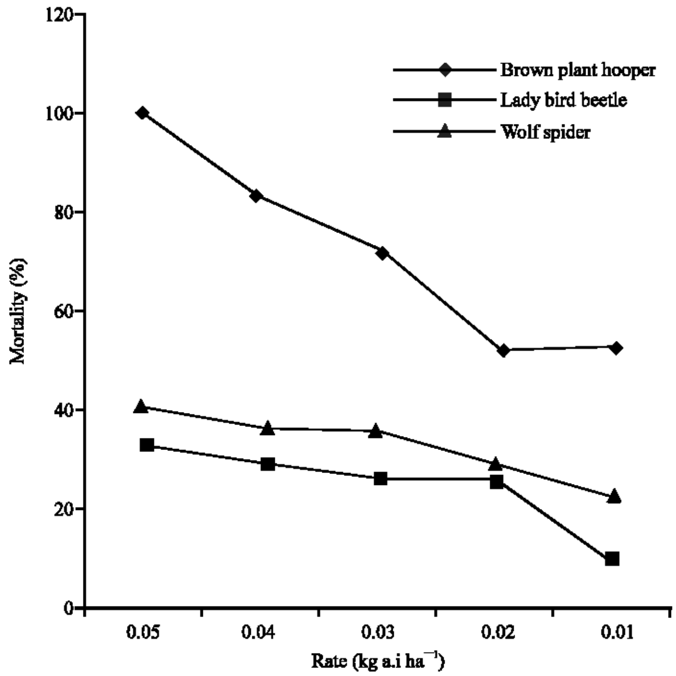

Fig. 6: Effect of Brifer 5G on brown plant hopper and the predator lady bird beetle and wolf spider at 72 h after treatment

The present study results revealed that Brifer 5G and Cymbush 10EC @ 0.4 and 0.01 kg a.i. ha^{-1}. doses were effective in killing brown plant hoppers. But Brifer 5G @ 0.4 kg a.i. ha^{-1} was most effective against BPH in respect of predator survivability as well as environmental safety and it could be recommended at the farmers level.

References

Abbott's, W.S., 1925. A method of computing the effectiveness of an insecticide. J. Econom. Entomol., 18: 265-267.

Agarwala, B.K., S. Das and M. Senchowdhuri, 1988. Biology and food relation of *Micraspis discolor* an aphidophegous coccinellid in India. J. Aphidol., 2: 7-17.

Anonymous, 1985. International Rice Research 25 Years of Partnership. Los Banos, Philippines.

Anonymous, 1988. Effect of 6 granular insecticides against brown plant hopper under green house condition, Boro and Aus. Annual Report. Gazipur: Bangladesh Rice Research Institute, pp: 173-174.

Anonymous, 1991. Efficacy evaluation of insecticide in green house. Annual Report. Gazipur: Bangladesh Rice Research Institute, pp: 104-105.

Chen, C.C. and R.J. Chiu, 1981. Rice wilted stunt in Taiwan. Intl. Rice Res. Newslett., 6: 13.

Dyck, V.A. and G.C. Orlido, 1977. Control of the brown plant hopper by natural enemies and timely application of narrow spectrum insecticides. In The brown plant hopper. Food and Fertilizer Technology Center for the Asian and Pacific Region. Taipei, pp: 58-72.

Fabellar, L.T. and E.A. Heinrichs, 1984. Toxicity of insecticides to predators of rice brown plant hoppers, *Nilaparvata lugens* (Stal.) (Homoptera: Delphacidae). Environ. Entomol., 13: 832-837.

Heinrichs, E.A., 1994. Impact of insecticides on the resistance and resurgence of rice plant hoppers. In: Demo, R.F. and T.J. Perfect (Eds.). Plant Hoppers: Their Ecology and Management. Chapman and Hall, New York, pp: (571-598).

Heinrichs, E.A., W.H. Reessing, S. Valencia and S. Chelliah, 1984. Rates and effect of resurgence inducing insecticides on populations of *Nilaparvata lugens* (Homoptera: Delphacidae) and its predators. Entomology, 11: 1269-1273.

Kamal, N.Q., 1998. Brown Plant Hopper (BPH), *Nilaparvata lugens* (Stal.) situation in Bangladesh. A. report of IPM ecology expert. DAE-UNDP/FAO IPM project, Khamarbari, Farmgate, Dhaka, Bangladesh.

Khusakul, V., R. Pattarasudi and P.H. Patirapanuson, 1979. Effects of granular insecticides on stem borers and their parasites and predators. Intl. Rice Res. Newslett., 4: 16-17.

Kiritani, K., 1979. Pest management in rice. Ann. Rev. Entomol, 24, 279-312.

Krishnaiah, N.V., M.B. Kalode and Y.R.B. Sarma, 1982. Toxicological investigation against brown plant hopper, *Nilaparvata lugens* (Stal.) in rice. Indian. J. Entomol., 44: 13-20.

Nasiruddin, M. and M.A. Islam, 1979. *Verania discolor* Fab. (Coleoptera : Coccinellidae) an effective predator on different species of aphids. Bangladesh J. Zool., 7: 69-71.

Rabbi, M.F., M. Haq, A.N.M. Karim and N.Q. Kamal, 1993. Efficacy of some insecticides against rice green leaf hopper, *Nephotettix virescens* (Distant) and their effect on lady bird beetle, *Micraspis discolor* Fab. Bangladesh. J. Ent., 3: 59-65.

Rajendram, G.F., 1994. Population sampling of plant hoppers, leaf hoppers and insect predators on broadcast rice treated with Carbofuran, in eastern Sri Lanka. Insect Science and its Application, 15: 139-143.

Raman, K. and S. Uthamasamy, 1983. Insecticide toxicity to natural brown plant hopper enemies. Intl. Rice Res. Newslett., pp: 8: 20.

Reissing, W.H., E.A. Heinrichs, J.A. Litsinger, K. Moody, L. Fiedler, T.W. Mew and A.T. Barrion, 1985. Insect pests of rice. In Illsutrated Guide to Integrated Pest Management in the rice in Tropical Asia. International Rice Research Institute. Los Banos, Philippines, pp: 175-186.

Samal, P. and B.C. Misra, 1975. Spiders:The most effective natural enemies of the brown plant hopper in rice. Rice Entomol. Newslett., 3: 31.

Samal, P. and B.C. Misra, 1985. Morphology and biology of the Coccinellid beetle *Verania discolor* Fab. (Coleoptera: Coccinellidae), a predator on rice brown plant hopper, *Nilaparvata lugens* (Stal.) Oryza, 22: 119-132.

Sharma, R.P., R.P. Yadav and R. Singh, 1991. Relative efficacy of some insecticides against the field population of bean aphid (*Aphis craccivora* Koch) and safety to the associated aphidophagous coccinellid complx occurring on *Lythyrus*, lentil and check pea crops. J. Entomol. Res., 15: 251-259.

Sogawa, K. and C.H. Cheng, 1979. Economic thresholds, nature of damage and losses caused by the brown plant hopper. In Brown plant hopper: Threat to rice production in Asia. IRRI Los Banos, Laguna, Philippines, pp: 369.

Tanaka, K., S. Endo and H. Kazano, 2000. Toxicity of insecticides to predators of rice plant hoppers: spiders, the mirid bug and the drynid wasp. Appl. Entomol. Zool., 35: 177-187.

Tang, M.H., O. Mochida, B. Morallo-Rejesus and R.P. Robles, 1987. Selectivity of eight insecticides to the brown plant hoppers, *Nilaparvata lugens* (Stal.) (Homoptera:Delphacidae) and its predator the wolf spider, *Lycosa pseudoannulata* Boes et stic. (Araneae: Lycosidae). Philippine Entomologist, 7: 51-66.