Journal of
Entomology

ISSN 1812-5670

Academic
Journals Inc.

www.academicjournals.com

Journal of Entomology 3 (2): 136-142, 2006
ISSN 1812-5670

Effectiveness of Different Approaches of Chemical and Biological Control Against Brown Plant Hopper, *Nilaparvata lugens* (Stal.)

M.A. Rahman and S.M.H. Jahan
Department of Entomology, Patuakhali Science and Technology University, Dumki, Patuakhali-8602, Bangladesh

Abstract: A field experiment was conducted to investigate the effectiveness of different approaches of chemical and biological control against Brown Plant Hopper, *Nilaparvata lugens* (Stal.). The insecticide carbofuran 5G was applied at 50 and 75 days after transplanting in need base and this insecticide at 25 and 75 days along with Ripcord 10EC at 50 days after transplanting was also applied in schedule base. Natural biological control had no insecticide application and the control was largely due to the activities of naturally occurring predators and parasitoids. High level of predatory spiders and lady bird beetles were found in the fields of natural biological control compared to field of need and schedule base protection. The population of natural enemies was minimum at 60 days after transplanting in schedule base protection when population of brown plant hopper was also high. Need base protection approach was found to be superior in terms of control approaches than that of schedule base protection and naturally biological control approaches. The benefit-cost ratio (1.48) and grain yield (4.45 t ha^{-1}) of need based protection were significantly higher than other control approaches.

Key words: *Nilaparvata lugens*, biological control, chemical control, yield

Introduction

Bangladesh is an agro-based country where almost 90% of the population in this country depends on rice as their major food (IRRI, 1981). The average rice yield in Bangladesh is only 1.83 t ha^{-1} (BBS, 2000) which is less than the world average (2.9 t ha^{-1}) and much below the highest country average (7.0 t ha^{-1}). One hundred seventy five species of insect pests have been identified in Bangladesh on rice (Kamal, 1998) which cause about 13% (BRRI, 1985). The estimated annual loss of rice in Bangladesh due to insect pest and diseases amounts to 1.5 to 2.0 million tons (Siddique, 1992). The Brown Plant hopper (BPH), *Nilaparvata lugens* is widespread and a menace to rice production in many parts of Bangladesh. The BPH was first recorded in 1969 in Bangladesh. The first outbreak of this pest occurred in April-May, 1976 on boro rice near Dhaka city (Alam and Karim, 1977). As off late, outbreak of BPH was recorded in Rajshahi, Gazipur, Mymensingh and Netrokona in transplanted aman rice. High incidence of BPH was observed in Netrokona and Nandigram (373/20 hill), which caused significant yield loss (Anonymous, 1997). BPH causes annual losses worth millions of dollars through its feeding activity results in hopper burn and reduction in yield (Dyck and Thoms, 1979). For instance, in Korea BPH damaged 240,000 million

Corresponding Author: M.A. Rahman, Department of Entomology, Patuakhali Science and Technology University, Dumki, Patuakhali-8602, Bangladesh Tel: 88044162678

ha of rice in 1991 and 100,000 ha in 1992. Approximately 90,000 metric tons of insecticides valued at 116 million dollars were applied to suppress insect pests in 1991, most of them were used for BPH control (Anonymous.,1992).

The brown plant hopper prefers rainfed and irrigated wetland fields to upland rice and direct-sown fields to transplanted fields. It damages the plant through the removal of plant sap and as a vector of rice viruses. As a result "hopper burn" and various virus diseases-grassy stunt, ragged stunt, and wilted stunt occur , respectively in rice field (Hibino,1979; Chen and Chiu, 1981). The most commonly used method of controlling BPH in Bangladesh is the application of insecticides. The application of insecticides, however, can cause several problems: development of insecticide resistant biotype, 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 (Heinrich *et al.,* 1984). 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. Keeping mind the idea of ageoecosystem the research program was undertaken to investigate the effectiveness of different approaches of chemical and biological control against Brown Plant Hopper, *Nilaparvata lugens*.

Materials and Methods

The experiments were carried out in three farmer's fields as replication at Narsingdi, Bangladesh during the Aman season of 3 August 2003 to 30 December 2003 to investigate the effectiveness of different approaches of chemical and biological control against Brown Plant Hopper, *Nilaparvata lugens* (Stal.). The rice variety BR2 3 (Dishari) was used as planting materials in this experiment. The experiment comprised three treatments viz., Natural biological control without insecticidal application throughout the crop season; Need based protection with application of Carbofuran 5G @ 0.5 kg a.i., ha^{-1} at 50 DAT and 75 DAT; Schedule based protection with application of Carbofuran 5G @ 0.5 kg a.i., ha^{-1} at 25 DAT and 75 DAT along with Ripcord 10EC @ 0.5 L ha^{-1} at 50 DAT at three different locations of farmer's field. Natural biological control, Need based protection and Schedule based protection treatments were located at eastern side of Bir pur, northern side of Baduarchar and eastern side of Poran para, respectively. The experimental plots for each treatment were divided into 5 plots in a location. The 5 hills were selected randomly from each plot for each treatment. Therefore, 25 hills were selected from 5 plots for each treatment. All agronomic practices were done as and when necessary from raising of seedling to harvesting the crop. Samples were taken at each sample date over the course of the growing season. Data were taken on pest infestation of BPH and natural enemies at fortnightly intervals. Data on number of brown plant hopper population (No./25 hills), predatory spider population (No./25 hills), number of lady bird beetle (5 double sweep nets per plot) and grain yield were collected and recorded. Estimation of population of pests and natural enemies were made based on visual counts per 25 hills in each plot. The collected data on various parameters were analyzed statistically with the help of computer package MSTATC, the significance of the mean difference was adjusted by the Duncan’s Multiple Range Test (DMRT) and Least Significant Difference (LSD) test, when necessary (Gomez and Gomez, 1984).

Results and Discussion

Effect of different control approaches for management of brown plant hopper and on natural enemy population of BPH

Thirty Days after Transplanting

The brown plant hopper population was found significantly ($p<0.01$) influenced by the application of different management tactics at 30 days after transplanting (Table 1). Based on field sample an increased number of brown plant hopper population (23.50 per 25 hills) was observed in need based protection but statistically similar result was found in Natural Biological Control (21.75 per 25 hills) and significant lowest population (18.0 per 25 hills) was observed in schedule based protection.. The increased number of BPH was observed without application of insecticide in the field. Similar result was found by Qinag *et al.* (1995) and Murthy *et al.* (1990).

The population density of natural enemies such as predatory spider and lady bird beetle was significantly influenced when the different management practices were applied at thirty days after transplanting (Table 2). The highest population of spider (6.50 per 25 hills) and lady bird beetle (9.0 per five double sweep nets) were found in natural biological control due to no insecticide application and the lowest population of spider (3.27 per 25 hills) and lady bird beetle (4.0 per five double sweep nets) were found in schedule based protection due to application of insecticide. Natarajan *et al.* (1988) reported that population of spider were higher in untreated than in treated fields with insecticides. Similar observations were recorded by Zhang *et al.* (1988).

Forty Five Days after Transplanting

The increased number of brown plant hopper (33.5 per 25 hills) and the lowest number of brown plant hopper population (26.5 per 25 hills) were found in Natural biological control and Schedule based protection, respectively (Table 1). The increased number of brown plant hopper due to without application of insecticide in natural biological control and need based protection and the decreased number of BPH due to application of insecticide were observed. Qiang *et al.* (1995) reported the similar results.

In case of population density of natural enemy the similar trends of insecticidal action were evident at 45 days after transplanting. The population of spider (11.50 per 25 hills) and ladybird beetle (10.5 per five double sweep nets) in natural biological control were higher than the other control approaches (Table 2). The lowest number of spider (4.50 per 25 hills) and ladybird beetle (6.50 per five double sweep nets) were encountered in schedule based protection due to application of insecticide. Similar results were found by Qi (1990). Pan and Liang (1992) stated that insecticides were more toxic to the spider.

Sixty Days after Transplanting

Among the different treatments, the highest number of brown plant hopper (128.25 per 25 hills) was found in schedule based protection which was significantly different from other treatments. The lowest number of brown plant hopper (52.25 per 25 hills) was found in need based protection due to judicious use of insecticide (Table 1). The increased population of brown plant hopper might be due to the injudicious use of insecticide. The injudicious use of insecticide increased the mortality of natural enemies and caused pest resurgence. Similar findings were recorded by Vardhani and Rao (2002); Dhudhasamail *et al.* (1992) and Zhang *et al.* (1988).

Table 1: Mean number of brown plant hopper at different days after transplanting with three management practices

	Mean No. of insects				
Treatments	30 DAT	45 DAT	60 DAT	75 DAT	90 DAT
Natural biological control	21.75[a]	33.50[a]	69.50[b]	52.50[c]	28.50[a]
Need based protection	23.50[a]	31.50[ab]	54.25[c]	29.50[b]	3.00[b]
Schedule based protection	18.00[b]	26.50[b]	128.25[a]	62.00[a]	5.50[b]
Level of significance	**	*	**	**	**

In a column figures with same letter or without letter (s) do not differ significantly whereas figures with dissimilar letter (s) differ significantly based on Duncan's Multiple Range Test; *, **Significantly different from zero at the 0.05 and 0.01 probability levels, respectively

Table 2: Mean number of natural enemies (predatory spider and ladybird beetle) in different treatment at different days after transplanting

	Mean No. of insects									
	30 DAT		45 DAT		60 DAT		75 DAT		90 DAT	
Treatments	Spider	LBB	Spider	LBB	Spider	LBB	Spider	LBB	Spider	LBB
Natural biological control	6.50[a]	9.00[a]	11.50[a]	10.5[a]	12.00[a]	11.00[a]	6.50[a]	9.00[a]	5.00[a]	6.00[a]
Need based protection	5.75[ab]	4.00[b]	8.00[b]	8.00[a]	5.00[b]	4.25[b]	4.25[b]	7.50[a]	3.50[b]	4.00[a]
Schedule based protection	3.75[b]	4.00[b]	4.50[c]	6.50[b]	4.50[b]	3.75[b]	4.00[b]	4.50[b]	2.75[b]	2.50[b]
Level of significance	*	**	**	**	**	**	**	**	*	**

In a column figures with same letter or without letter(s) do not differ significantly whereas figures with dissimilar letter(s) differ significantly based on Duncan's Multiple Range Test; *, **Significantly different from zero at the 0.05 and 0.01 probability levels, respectively

Table 3: Yield, cost of production and benefit from transplanted aman rice cultivation under three management practices

Treatment	Total cost of production (Tk./t)	Production ($t\ ha^{-1}$) Grain	Straw	Gross income (Tk./t)	Net income (Tk./t)	Benefit cost ratio
Natural biological control	25270	3.20	3.50	30550	5280	1.21
Need based protection	28729	4.45	4.88	42490	13771	1.48
Schedule based protection	29842	4.00	3.80	37900	8058	1.27

Straw at the rate Tk. 0.50 kg^{-1}, Grain at the rate Tk. 9.00 kg^{-1}

After 60 days of transplanting a sudden decline of the population of spider and ladybird beetle were observed in the rice field of need based and schedule based protection due to use of insecticides. Statistically identical population number was observed between them. The highest number of spider (12.0 per 25 hills) and ladybird beetle (11.0 per five double sweep nets) were found in natural biological control due to without application of insecticide (Table 2). Similar results were stated by Natarajan *et al*. (1980).

Seventy Five Days after Transplanting

Statistically significant difference ($p<0.01$) among different control approaches were absorbed at seventy five days after transplanting (Table 1). The highest population of brown plant hopper (62.0 per 25 hills) due to indiscriminate use of insecticide in schedule base protection and the lowest population of brown plant hopper (29.5 per 25 hills) due to judicious use of insecticide in need base protection were observed in rice field. Similar observation was found by Fui Fen and Chuan Tao (1996) Mandal and Somchoudhury (1994) and Zhang *et al*. (1988).

After seventy five days of transplanting, significantly highest spider (6.5 per 25 hills) and lady bird beetle (9.0 per five double sweep nets) populations were found in natural biological control due to natural condition and the lowest spider (4.0 per 25 hills) and lady bird beetle (4.5 per five double sweep nets) were found in schedule based protection due to the application of insecticide (Table 2). Statistically similar results were found in need based protection.

Ninety Days after Transplanting

After ninety days of transplanting the brown plant hopper population was significantly ($p<0.01$) influenced by different treatments (Table 1). The highest population of brown plant hopper (28.5 per 25 hills) was found in natural biological control and the lowest population of brown plant hopper (3.0 per 25 hills) was found in need based protection which was statistically similar to those (5.5 per 25 hills) found in schedule based protection. The decreased number of brown plant hopper was due to judicious application of insecticide and at that time the environment was unfavorable to brown plant hopper. Qiang *et al.* (1995) reported the similar results.

The observation of population density of spider and ladybird beetle at 90 days after transplanting were significant variation among the treatments (Table 2). The highest number of spider (5.0 per 25 hills) and lady bird beetle population (6.0 per five double sweep nets) were found in natural biological control and the lowest number of spider (2.75 per 25 per hills) and ladybird beetle (2.50 per five double sweep nets) were found in schedule based protection. The decrease number of spider and ladybird beetle due to the injudicious application of insecticides. Natarajan *et al.* (1988) stated that populations of coccinellids were higher in untreated than in treated fields with insecticides.

Yield and Cost-benefit Ratio

The Table 3 and Fig. 1 present estimated yield, cost of production and benefit from transplanted aman rice cultivation under three management practices. Data on grain yield revealed that need based protection treatment resulted in higher yields (4.45 t ha^{-1}) than Natural biological control (3.2 t ha^{-1}) and Schedule based protection (4.0 t ha^{-1}). Benefit cost ratio among different treatments also was higher (1.48) in need based protection.

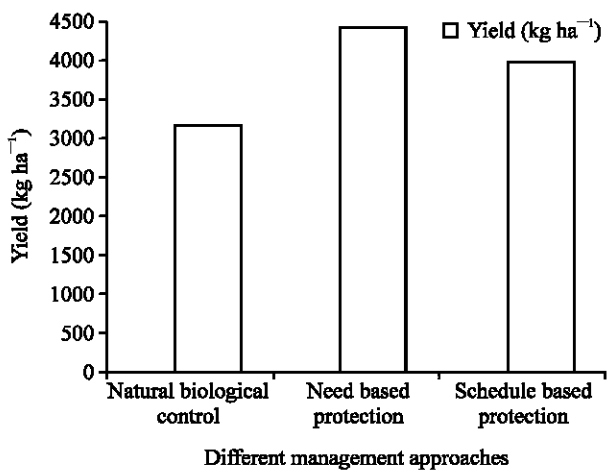

Fig. 1: Effect of different management approaches on the yield of BR 23 transplanted aman rice variety

References

Alam, S. and A.N.M.R. Karim, 1977. Brown plant hopper (*Nilaparvata lugens*) a probable threat to rice cultivation in Bangladesh. A paper presented at second Annual Bangladesh Science Conference. January 1977, BAU, Mymensingh.

Anonymous, 1992. Agrochemical Year Book. Agricultural Chemicals Association, Seoul, Korea.

Anonymous, 1997. Annual Internal Review for 1996. Insect Pest Management, Entomology. Division, Bangladesh Rice Research Institute, Gazipur-1701, pp: 1-47.

BBS (Bangladesh Bureau of Statistics), 2000. Year Book of Statistics of Bangladesh. Bur. of Stat. Statistics Divn., Ministry of Planning, Government of the Peoples' Republic of Bangladesh, pp: 136.

BRRI (Bangladesh Rice Research Institute), 1985. Annual Report for 1984. Bangladesh Rice Research Institute, Gazipur.

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

Dhudhasamail T., P. Silapasorn and C. Shoiwtipl, 1992. Effect of foliar spray insecticides on brown plant hopper (BPH) resurgence in rice. Intl. Rice Res. Newslett., 17: 20-21.

Dyck, V.A. and B. Thomas, 1979. The Brown Plant Hopper Problem. In. Brown Plant hopper: Threat to Rice Production in Asia. International Rice Research Institute, Los Banos, Laguna, Philippines, pp: 1-17.

Fui Fen, Z. and L. Chuan Tao, 1996. Trials on control of Plant hoppers with imidacloprid in fields. Plant Prot., 22: 48-49.

Gomez, K.A. and Gomez, A.A, 1984. Duncan's Multiple Range Test. Statistical procedures for Agricultural Research.2nd End., John Wiley and Sons, pp: 207-215.

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: Delphaacidae) and its predators. Entomology, 11: 1269-1273.

Hibino, H., 1979. Rice ragged stunt, a new virus disease occurring in tropical Asia. Rev. Plant Prot. Res., 12: 98-110.

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.

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

Mandal. S.L. and A.K. Somchoudhury, 1994. Effect of different commercial formulation of insecticides in conserving the predatory complex of brown plant hopper, *Nilaparvata lugens* Stal. Indian J. Entomol., 56: 425-428.

Murthy, M.M.K., D.V.S. Rao and K. Ramasubbaiah, 1990. Efficacy of carbofuran and certain other granular insecticides against insect pests of rice. Indian J. Entomol., 5: 200-204.

Natarajan, K., M.S. Venugopal and S. Chelliah, 1988. Brown Plant Hopper (BPH) Outbreak in Thanjavur District, Tamil Nadu. Intl. Rice Res. Newslett., 13: 26-27.

Pan, D.Y. and X.M. Liang, 1992. Safety study of pesticides on spiders, predatory natural enemies of pests, in paddy field. J. Hunan Agric, Col., 19: 234-239.

Qi, B., 1990. Population dynamics of spiders in rice fields and their effect in controlling rice plant hoppers. Jiangsu Agric. Sci., 4: 29-32.

Qiang, W., H. Lijuan, H. QiangLin, G.Z. Yan and X. XiaoLong, 1995. Contact toxicities of imidacloprid on rice brown plant hopper (*Nilaparvata lugens* Stal.). CRRN, Chinese Rice Res. Newslett., 3: 6-7.

Siddique, A.K.M.T., 1992. An over view of the ETL of rice pest and IPM scope in the content of modern variety rice production. In Proceeding of the Workshop on Experiences with Modern Rice Cultivation in Bangladesh. BRRI, Gazipur, pp: 33-45.

Vardhani, B.P. and K.T. Rao, 2002. Effect of normal and sub-normal application of insecticides on brown plant hopper and its predator. J. Applied Zool. Res., 13: 74-75.

Zhang, C.Z., L.F. Jiang and X.D. Fan, 1988. Effects of different insecticides on population fluctuations of the rice plant hopper and its natural enemies. Zhejiang Agric. Sci., 3: 123-127.