



Potentiality of light source and predator for controlling brown planthopper

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Abstract

Experiments were conducted at the net house and laboratory of the Entomology Division of Bangladesh Institute of Nuclear Agriculture (BINA) to determine the effectiveness of four light sources for light trapping, and performance of three predators for controlling brown plant hopper, *Nilaparvata lugens* (Stal.). The light intensity and sources were 30-50 lux (candle light), 80-100 lux (kerosene lamp), 180-200 lux (bulb) and 380-400 lux (energy saving lamp). The predators, ladybird beetle, carabid beetle and wolf spider, Light traps of 380-400 lux from energy saving lamp showed maximum effect in reducing the pest brown planthopper. Other light sources had little effect on brown planthopper. Light source of 30-200 lux reduced only a few brown planthopper. The predator wolf spider, *Lycosa pseudoannulata* consumed all the prey individuals of *Nilaparvata lugens* in three days exposure period indicating its high predation potentiality. Performance of ladybird beetle, *Micraspis discolor* was moderate and the carabid beetle, *Ophionea indica* was poor in controlling brown planthopper. The findings of these experiments indicate that light trapping with a source of 380-400 lux, predation by *Lycosa pseudoannulata* are the promising options in reducing brown planthopper population successfully and it could be an important part of IPM that is essential for the sustainable management of this deleterious brown planthopper in rice cultivation.

Key words: Rice, brown planthopper, light sources, predators, insect management

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Introduction

Rice (*Oryza sativa*) is the most important cereal crop in the world. It is also the main staple 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. It is also grown throughout the year in Bangladesh. It is an ideal host for many species of insect pests. In Bangladesh, about 175 species of insect pests have been recorded on rice (Kamal, 1998). Rice suffers heavy losses every year due to attack of many pests like maize crop (Alam *et al.*, 2019). Among them, the rice brown plant hopper, *Nilaparvata lugens* is wide spread and also a threat to

rice production in many parts of Bangladesh. But, the brown plant hopper was formerly a minor pest in most tropical countries of Asia. Brown plant hopper, *N. lugens* became the most devastating insect pest of rice day by day in Asia due to introduce of insecticides and modern semi-dwarf rice varieties in 1960's. It has become a major problem for rice production in several parts of Bangladesh in recent years. The Brown plant hopper infests the rice crop at all stages of plant growth as like aphid of maize (Alam *et al.*, 2018 & 2014). Low infestation causes reduced plant height, crop vigor, 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 called “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).

Insect pests are mainly controlled with synthetic insecticides over the last 50 years. But at present it is very difficult to control this insect because of injudicious uses of these chemicals this insects develop high level of resistance to almost all conventional insecticides. Beside this resistance development, conventional insecticides have negative effects on non-target organisms, including humans and the environment. In addition to their deleterious influence on the environment, the synthetic insecticides are more hazardous to handle, toxic residues in food products, and are not easily biodegradable. All these factors are threatened for environmental sustainability (Dhillon *et al.*, 2005). In modern agriculture people emphasis on organic food production in that perspective we should give importance on other strategies of pest control of IPM rather than chemical insecticides.

Insect light trap is one of the most effective tools for management of insect pests in organic agriculture. It is also effective method for reducing the population of insect pest as well as keeps the ecological system. The insect pests of all cereal crops, pulse crops, vegetable crops as well as horticultural crops can be mass trapped by using light traps (Holloway *et al.*, 2001; Intachat and Woiwod, 1999). Natural enemies are often important bio-control agents of brown plant hopper in nature. More than 100 species of natural enemies of leafhoppers and plant hoppers have been reported (Dyck and Orlido, 1977). Ladybird beetle, Carabid beetle, Wolf spiders are used as bio-control agent

against brown planthopper. Among various predators, Carabid beetle, *Ophionea indica* act as predator against brown plant hopper (Habu and Sadanaga, 1963; Wakisaka *et al.*, 1991). The predacious coccinellid beetles, commonly known as ladybird beetles are considered to be of great economic importance in the agro-ecosystem. They have been successfully employed in the biological control of many injurious insects (Agarwala *et al.*, 1988; Nasiruddin and Islam, 1979). *Micraspis discolor* species is one of the most important species of coccinellids which is found as a predator on nymphs and adults of brown plant hopper (Samal and Misra, 1985). The wolf spider, *Lycosa pseudoannulata* is another vital predator of brown plant hopper, and they can consume 24 nymphs or 15-20 adult hoppers per day (Samal and Misra, 1975). Application of insecticides, another method for controlling insect pest is used widely in Bangladesh. But it causes 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, Islam *et al.*, 2015). Considering the above facts, the present study was undertaken to investigate the efficacy of four light sources as attractant, and to evaluate the performance of three common predators for controlling brown plant hopper of rice.

Materials and Methods

The experiment was conducted at the net house and laboratory of the Entomology Division, BINA, Mymensingh, Bangladesh from March to July, 2016 to evaluate the effectiveness of insecticides for controlling brown plant hopper, *Nilaparvata lugens* of rice. The experiment was laid out in a completely randomized design with three replications.

Collection and rearing of brown planthopper: Gravid females of brown planthopper 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 0.75x0.5x0.2 m (length x breadth x 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 x 0.5 m (height x breadth) rearing cages. The plants were observed for egg laying every day. 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 @ 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 brown planthopper from ants.

For egg laying purposes, adult brown planthopper was released in caged-fresh rice plants on every Sundays and Wednesdays in every week. The gravid or adult female brown planthopper was 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 brown planthopper eggs on these plants can hatch and reach the adult or gravid stage. Moreover, before using the plants for the egg laying of brown planthopper, the outer leaf sheaths of each tiller were removed to eliminate any brown planthopper populations from the plants. After hatching of eggs, nymphs 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 brown planthopper was provided with fresh plants for their food as and when necessary. In this way, brown planthopper 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 ladybird beetle: The predator, *M. discolor* was maintained in the net house. For this purpose adult beetles were collected from rice field of the Bangladesh Agricultural University (BAU) farm, Mymensingh. The field collected beetles were reared in plastic pot (20 cm in height and 25 cm in diameter) covered with Mylar film cage (Mylar film cage: Hard plastic made cylindrical device). Its length is 45 cm and diameter 16 cm. The upper portion of the Mylar film cage covered with nylon net. The net was attached with the cage by the help of thread). The second instars brown planthopper on 30-40 days old potted rice plants were used as food for the beetle. Mating occurred inside the Mylar film cage and the insects were allowed to lay eggs there. The eggs were separated in petridishes (11 x 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: Some sexually mature adults of wolf spider, *L. pseudoannulata* and adult spider with egg sac were collected from the seed bed of the rice plot of BINA, Mymensingh by using net. 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 x 7 cm glass pot. They were supplied with

different stages of brown planthopper 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 ($27\pm 2^{\circ}\text{C}$). Later on the spiders were kept in Mylar film cage before using in experiments.

Collection and rearing of carabid beetle: The predator, *Ophionea indica* was maintained in the net house. For this purpose adult beetles were collected from rice field of the Bangladesh Agricultural University (BAU) farm, Mymensingh. The field collected beetles were reared in plastic pot (20 cm in height and 25 cm in diameter) covered with Mylar film cage. The 2nd instars brown planthopper on 30-40 days old potted rice plants were used as food for the beetle. Mating occurred inside the Mylar film cage and the insects were allowed to lay eggs there. The eggs were separated in petridishes (11 x 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.

Net house screening: To manage brown planthopper using different light sources an experiment was conducted in the net house of BINA. Ten brown planthoppers were taken in a Mylar film cage and put in the net house. After evening the Mylar film cage was removed and the light sources were provided. Different lux range was used in this experiment. Lux output was measured from different light sources with the help of Digital Lux Meter and the range was 30-400. Light output was 30-50 lux (candle light), 80-100 lux (kerosene lamp), 180-200 lux (bulb) and 380-400 lux

(energy saving lamp). After one hour the individuals of brown plant hopper attracted by light sources were counted. The same procedure continued in three days. The experiment was replicated three times.

To manage brown plant hopper by predators another experiment was conducted in the net house of BINA. Ten brown planthopper were taken in a Mylar film cage against one predator and put in the net house. The second instars brown planthopper were used as prey for the beetle and 4th & 5th instars for the spider. After 24, 48 and 72 hours the consumed individuals of brown plant hopper were counted. The experiment was laid out in a completely randomized design with three replications.

Collection of data: In studying the efficacy of light sources, number of attracted brown plant hopper was recorded one hour after setting the light of different intensity. The performance of predators the consumed brown planthopper individuals were recorded at 24, 48 and 72 hours after releasing the predators in Mylar film cage.

Statistical analysis: The obtained data were statistically analyzed to find out the significance of differences among the treatments. The mean values of all parameters were evaluated and analysis of variance was performed by MSTAT-C software package and the mean differences were adjudged by Duncan Multiple Range Test (Gomez and Gomez, 1984).

Results and Discussion

The present experiment was carried out using four light sources, three predators to manage brown planthopper, *N. lugens*. The results of the experiments were presented below and discussed with the experimental findings of other published reports.

Effect of light sources on brown planthopper: The efficacies of light sources were examined in the net house of BINA in reducing brown planthopper. In each three days 380-400 lux (energy saving lamp) showed the highest efficacy in attraction of brown planthopper and 30-50 lux (candle light) showed the lowest efficacy

in attraction of brown planthopper. In case of 380-400 lux percentage of brown planthopper attracted by light was 33.33% at 24 hours, 70% at 48 hours and 73.33% at 72 hours. In case of 30-50 lux percentage of brown planthopper attracted by light was 0% at 24 hours, 3.33% at 48 hours and 6.67% at 72 hours. In case of 80-100 lux percentage of brown planthopper attracted

by light was 3.33% at 24 hours, 6.67% at 48 hours and 6.67% at 72 hours. In case of 180-200 lux percentage of brown planthopper attracted by light was 16.67% at 24 hours, 23.33% at 48 hours and 33.33% at 72 hours that presented in Table 1. The result showed that the efficacy of light for reducing brown planthopper was energy saving lamp>bulb>kerosene lamp>candle light.

Table 1. Mean percentage of Brown planthopper attracted by different light sources under net house condition.

Lux output	Mean percentage of Brown plant hopper attracted by light sources at different interval of time		
	24 hrs	48 hrs	72 hrs
30-50 lux (Candle light)	0.00 d	3.33 d	6.67 c
80-100 lux (Kerosene lamp)	3.33 c	6.67 c	6.67 c
180-200 lux (Bulb)	16.67 b	23.33 b	33.3 b
380-400 lux (Energy saving bulb)	33.33 a	70.00 a	73.33 a
Control (dark for left one hour)	0.00 d	0.00 e	0.00 d
Level of significant	*	*	*
CV (%)	7.64	8.12	6.35
LSD	8.13	3.30	5.39

In first column shows different light intensity found from different light sources, In second column, means followed by different letters are significantly different. *means at 5% level of probability.

Effect of predators on brown plant hopper: Results of predation performance of three predations on brown planthopper, *N. lugens* are presented in Table 2.

Table 2. Predation performance of three predators on Brown planthopper at different interval of time under net house condition.

Name of predators	Percentage of Brown planthopper consumed by the predator at different time interval		
	24 hrs	48 hrs	72 hrs
Lady bird beetle	16.67 b	46.67 b	76.67 b
Carabid beetle	3.33 c	6.67 c	16.67 c
Wolf spider	96.67 a	100.0 a	100.0 a
Control	0.0 d	0.0 d	0.0 d
Level of significant	*	*	*
CV (%)	8.32	7.50	6.67
LSD	3.31	6.62	16.15

In column, means followed by different letters are significantly different. *means at 5% level of probability. 1:10 Predator: Prey ratio was used.

The results clearly revealed that all treated predators had significant effect on predation of brown plant hopper *N. lugens*, and the mean predation percentage of brown plant hopper were significantly different at 5% level of probability. Three predators' viz. ladybird beetle, carabid beetle and wolf spider were used for preying brown plant hopper at different time interval. Under considering the efficacy of three predators, Wolf spider gave the highest potentiality at 24 hours. It consumed 96.67% at 24 hours whereas, carabid beetle showed the lowest (3.33%) preying performance. Similar type of trend of result was found at 48 hours and they showed similar type of significant ($P \leq 0.05$). Among predators, Wolf spider gave the highest (100%) potentiality at 24 hours which was followed by 46.67% in Lady bird beetle whereas, Carabid beetle showed the lowest (6.67%) preying performance. After 72 hours of treatment, ladybird beetle consumed 76.67% brown planthopper and carabid beetle consumed 16.67% brown planthopper that presented in table 02. The predation percentage revealed that wolf spider is highly effective for controlling brown plant hopper. The present result is in agreement with the findings of Kumar and Velusamy (1997) and Heong *et al.* (1989).

Conclusion

A series of experiment were carried out in the net house and laboratory of Entomology Division, Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh to determine the efficacy of four light sources, three in managing brown planthopper, *N. lugens*. Four light sources (Candle light, Energy saving lamp, Bulb, Kerosene lamp), three predators (Ladybird beetle, Carabid beetle, Wolf spider) were used in the experiment.

Light trap, environmentally sound method for detecting and killing harmful insects. This eco-friendly light trap method is considered as an alternative to pesticides control. Four types of light sources were used to determine the efficacy. Among them 380-400 lux (energy saving lamp) showed better performance on

brown planthopper. The efficacy of four light sources was energy saving lamp > bulb > kerosene lamp > candle light. So it can be concluded from the results of the present study that among four light sources energy saving lamp would be an effective medium for reducing brown planthopper.

Biological control of insect pest is a unique method, which is being practiced in many countries of the world for the control of field and orchard pest. From the present awareness of researchers, it appears that in the distant future, biological control would surely play an important in controlling pest in Bangladesh. The results of the present study indicated that among the three predators, the predator wolf spider acted as an effective biological control agent on brown planthopper. Another two predator ladybird beetle and carabid beetle also acted as biological control agents. The efficacy of three predators was wolf spider > ladybird beetle > carabid beetle. It is concluded from the present study that the predator wolf spider can act as an effective biological control agent for brown planthopper.

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