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RICE GROWTH STAGES AND TEMPERATURE AFFECT THE ABUNDANCE OF LEAFHOPPERS AND PLANTHOPPERS

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ABSTRACT

Relative abundance of leaf and plant hoppers species regarding plant growth stages and temperature were studied in the rice variety BINA10 field at the research farm of Patuakhali Science and Technology University (PSTU) during October 2013 to April 2014. The percent relative abundance of leafhoppers was in the rank order of *M. dorsalis> C. brevis> N. virescens> N. malayanus> N. cincticeps> N. nigropictus* at seedling, early and maximum tillering stages while *N. virescens> C. brevis> M. dorsalis> N. nigropictus> N. malayanus> N. cincticeps* at reproductive stage. The percent relative abundance of planthoppers was in the rank order of *N. nervosa> N. lugens> S. furcifera* at seedling and reproductive stages while *N. lugens> N. nervosa> S. furcifera* at early tillering and *N. nervosa> S. furcifera* and *N. lugens* at maximum tillering stages. The abundance of all leafhopper species showed highly negative relationship with temperature. This relationship can be expressed by 81% (R^2=0.806) for N. *virescens*, 80% (R^2= 0.801) for *N. nigropictus,* 65% (R^2=0.653) for *N. cincticeps,* 60% (R^2=0.600) for *C. brevis* and 70% (R^2=0.698) for *M. dorsalis.* Among three planthopper species, population of *S. furcifera* showed highly negative relationship with temperature and this relationship can be expressed by 71% (R^2=0.707). The abundance of *N. nervosa* showed poor positive relationship with temperature. This relationship can be expressed by 3 % for *N. nervosa* (R^2=0.030). *N. lugens* showed poor negative relationship with temperature and this relationship can be expressed by 31% (R^2=0.310) for *N. lugens.*

Keywords: BINA dhan10, growth stage, leafhopper, planthopper, temperature

INTRODUCTION

Rice is the major cereal crop of the world and considered as staple food especially in Asian countries (Smil, 2005). It is mainly used for human consumption. Rice grain is

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a source of protein, oil, sugar (Ahmad, 1989) and its outer layer is rich in thiamin (vitamin B_1), deficiency of which results in a disease called "Beriberi" in human beings (Montgomery et al., 1980). The average yield of rice in Bangladesh is quite low which is 3.02 mt ha^{-1} (BBS, 2014) compared to other rice growing countries of the world. Two hundred sixty six insect species have been identified so far as pest of rice in Bangladesh (Islam et al., 2003). Of these, 42 species are considered as crucial insect pests. Among the key pests, both leaf and plant hoppers cause direct damage by feeding as well as by transmitting viruses. Green leafhopper is one of the most serious pests of rice both in the tropics and temperate zone known to be a vector of rice viruses and MLO- mycoplasma like organisms (Kawabe, 1986). Planthoppers especially brown planthopper (BPH) has become a serious pest of high yielding variety of rice (Alam et al., 1983). BPH remains at the base of the plant and suck sap from the mesophyll of all stages of the growing plant. It also blocks the xylem and phloem by laying egg masses in the midrib of the leaf blade and by this reduces the yield potentiality of rice plant (Wu et al., 2001). When the pest density becomes high, the plants turn yellow and dry up rapidly. At early infestation, round yellow patches appear which soon turn brownish due to the drying up of the plants. This condition is called Hopperburn. The patches of infestation then may spread out and cover the entire field.

The leaf hoppers feed on the leaves and upper parts of the rice plant, whereas the plant hoppers confine themselves to the basal parts. In the warm and humid tropics, different species of leafhoppers and planthoppers remain active year round, and their population fluctuates according to the availability of food plants, natural enemies and environmental conditions. Considering the above facts, the present study was undertaken to know the abundance of leaf and plant hoppers on different growth stages of rice variety BINA dhan10 at different temperature.

MATERIALS AND METHODS

The field study was undertaken in some selected rice fields in the research farm of Patuakhali Science and Technology University (PSTU) during October 2013 to April 2014. The laboratory works were carried out in the Department of Entomology, Patuakhali Science and Technology University, Dumki, Patuakhali on the taxonomic classification, identification of different species of rice leafhoppers and planthoppers. The rice variety BINA dhan10 was used as study material. The experiment was designed in a randomized complete block design with 3 replications. Each rice field was treated as treatment replication. In such a way, three rice fields were used as three replications in the study.

The different species of leafhopper and planthopper were collected by a fine mesh nylon sweep net. Sweeping was done from the plant canopy level including the interspaces between plants as well as close to basal region of the plants as far as possible. In each field, l0 complete sweeps were made to collect hopper populations.

Sampling was done at four stages of rice viz. seedling, early tillering (initial tillering), maximum tillering (prior to booting stage) and panicle initiation stage. Sampling was done during morning hours at all study fields on all sampling dates. The samples of l0 complete sweeps from each field were collected and preserved separately in labeled container. The samples were sorted, counted and identified in the laboratory of the Department of Entomology, PSTU under microscope. The relative abundance of leafhoppers and planthoppers were calculated.

Relative abundance

Relative abundance of insect pests was calculated using the following formula:

$$\text{Relative abundance (\%)} = \frac{\text{Total number individuals of each species}}{\text{Total number individuals of all species}} \times 100$$

The collected data were analyzed statistically by using the MSTAT-C computer package. The treatment means were compared by LSD test.

RESULTS AND DISCUSSION

Relative abundance of leafhoppers

The percent relative abundance of leafhoppers on BINA dhan10 was in the rank order of *M. dorsalis* (30.84%)> *C. brevis* (20.75%)> *N. virescens* (16.14%)> *N. malayanus* (11.52%)> *N. cincticeps* (9.22%)> *N. nigropictus* (8.65%) (Table 1). In early tillering stage, the percent relative abundance of leafhoppers on BINA dhan10 was in the rank order of *M. dorsalis* (35.48%)> *N. virescens* (29.03%)> *N. nigropictus* (12.90%)> *N. malayanus* (6.45%)> *N. cincticeps* (3.23%)> *C. brevis* (0%) (Table 1).

In maximum tillering stage, the percent relative abundance of leafhoppers on BINA dhan10 was in the rank order of *M. dorsalis* (48.48%)> *N. virescens* (21.21%)> *N. cincticeps* (12.12%)> *N. nigropictus* (3.03%) and *N. malayanus* (3.03%)> *C. brevis* (0%) (Table 1). In reproductive stage, the relative abundance of leafhoppers on BINA dhan10 was in the rank order of *N. virescens* (28.00%)> *C. brevis*(24.00%)> *M. dorsalis* (16.00%)> *N. nigropictus* (12.00%) and *N. malayanus* (12.00%)> *Nephotettix cincticeps* (8.00%) (Table 1).

Table 1. Relative abundance of leafhoppers per 10 complete sweeps at different growth stages of BINA dhan10

Leafhoppers	Seedling stage		Early tillering stage		Maximum tillering stage		Reproductive stage	
	No.	Relative abundance (%)	No.	Relative abundance (%)	No.	Relative abundance (%)	No.	Relative abundance (%)
Nephotettix virescens	56	16.14	9	29.03	7	21.21	7	28.00
Nephotettix nigropictus	30	8.65	4	12.90	1	3.03	3	12.00
Nephotettix cincticeps	32	9.22	1	3.23	4	12.12	2	8.00
Nephotettix malayanus	40	11.52	2	6.45	1	3.03	3	12.00
Coelidia brevis	72	20.75	0	0	0	0	6	24.00
Maiestas dorsalis	107	30.84	11	35.48	16	48.48	4	16.00
Total	347	-	31	-	33	-	25	-

Relative abundance of planthoppers

In seedling stage, relative abundance of planthoppers in rice ecosystem is presented in table 2. The percent relative abundance of planthoppers on BINA dhan10 was in the rank order of *N. nervosa* (40%)> *N. lugens* (35%)> *S.furcifera* (25%). In early tillering stage, the percent relative abundance of planthoppers in BINA dhan10 was in the rank order of *N. lugens* (60%)> *N. nervosa* (26.67%)> *S. furcifera* (13.33%) (Table 2).

In maximum tillering stage, the percent relative abundance of planthoppers on BINA dhan10 was in the rank order of *N. nervosa* (50%)> *S. furcifera* (25%) and *N. lugens* (25%) (Table 2). In reproductive stage, the relative abundance of planthoppers on BINA dhan10 was in the rank order of *N. nervosa* (44.44%)> *N. lugens* (33.33%) > *S. furcifera* (22.22%) (Table 2).

Table 2. Relative abundance of planthoppers per 10 complete sweeps at different growth stages of BINA dhan10

Planthoppers	Seedling stage		Early tillering stage		Maximum tillering stage		Reproductive stage	
	No.	Relative abundance (%)	No.	Relative abundance (%)	No.	Relative abundance (%)	No.	Relative abundance (%)
Nisia nervosa	8	40	4	26.67	10	50	4	44.44
Sogatella furcifera	5	25	2	13.33	5	25	2	22.22
Nilaparvata lugens	7	35	9	60	5	25	3	33.33
Total	20	-	15	-	20	-	9	-

Mean number of Leafhoppers in different growth stages of BINA dhan10

There was significant difference among the population of *Nephotettix virescens* in different growth stages of BINA dhan10 with mean ranged from 6.00 to 47.50 per 10 complete sweeps. Significantly the highest number of *N. virescens* was recorded in seedling stage (47.50) whereas reproductive stage showed the lowest population (6.00). No significant difference was at early tillering and maximum tillering stages 11.00 and 10.50, respectively (Table 3).

The mean number of *Nephotettix nigropictus* population in different crop growth stages of BINA dhan10 ranged from 5.50 to 59.50 per 10 complete sweeps. Significantly the highest number of *N. nigropictus* population was found in seedling stage (59.50) while the lower number of *N. nigropictus* population was recorded in reproductive stage (5.50). No significant difference was at early tillering and maximum tillering stages (Table 3).

The mean number of *Nephotettix cincticeps* population in different crop growth stages of BINA dhan10 ranged from 6.50 to 68.00 per 10 complete sweeps. Significantly the highest number of *N. cincticeps* population was found in seedling stage (68.00) while the lowest number of *N. cincticeps* population was recorded in early tillering stage (6.50). No significant difference was at maximum tillering and reproductive stages (Table 3).

The mean number of *Maiestas dorsalis* population in different crop growth stages of BINA dhan10 ranged from 7.50 to 93.50 per 10 complete sweeps. Significantly the highest number of *M. dorsalis* population was found in seedling stage (93.50) while the lowest number of *M. dorsalis* population was recorded in the maximum tillering stage (7.50). No significant difference was at early tillering and reproductive stages (Table 3).

The mean number of *Coelidia brevis* population in different crop growth stages of BINA dhan10 ranged from 4.50 to 55.00 per 10 complete sweeps. Significantly the highest number of *C. brevis* was found in seedling stage (55.00) while the lowest population was recorded in maximum tillering stage (4.50). No significant difference was at early tillering and reproductive stages (Table 3).

Table 3. Mean number of Leafhoppers in different growth stages of BINA dhan10

Growth stage	Mean number / 10 complete sweeps				
	Nephotettix virescens	*Nephotettix nigropictus*	*Nephotettix cincticeps*	*Maiestas dorsalis*	*Coelidia brevis*
Seedling stage	47.50a	59.50a	68.00a	93.50a	55.00a
Early tillering stage	11.00b	8.00b	6.50c	15.50b	5.50bc
Maximum tillering stage	10.50b	9.00b	9.50b	7.50c	4.50c
Reproductive stage	6.00c	5.50c	11.00b	16.50b	6.50b
LSD value	4.41	2.44	2.71	4.51	0.79
Level of significance	**	**	**	**	**
CV (%)	9.79	8.45	9.89	10.78	5.54

**= Significant at 5% level by LSD

Mean number of planthoppers as influenced by different growth stages of BINA dhan10

Nisia nervosa differed significantly among the four crop growth stages of BINA dhan10 with the mean ranged from 3.50 to 9.50 per 10 complete sweeps. The highest number of *Nisia nervosa* population was found in maximum tillering stage (9.50) which was statistically similar with reproductive stage (9.00). The lowest number of *Nisia nervosa* population was recorded in early tillering stage (3.50) followed by seedling stage (7.50) (Table 4).

Sogatella furcifera differed significantly among the four crop growth stages of BINA dhan10 with the mean ranged from 3.50 to 5.00 per 10 complete sweeps. Significantly the highest number of *S. furcifera* population was found in maximum tillering stage (5.00) while the lowest number of *S. furcifera* population was recorded in early tillering stage (3.50) which was statistically identical to reproductive stage (3.50) followed by the seedling stage (4.50) (Table 4).

Table 4. Mean number of planthoppers in different growth stages of BINA dhan10

Growth stage	Mean number / 10 complete sweeps		
	Nisia nervosa	*Sogatella furcifera*	*Nilaparvata lugens*
Seedling stage	7.50b	4.50b	9.50a
Early tillering stage	3.50c	3.50c	6.50c
Maximum tillering stage	9.50a	5.00a	8.00b
Reproductive stage	9.00a	3.50c	6.50c
LSD value	1.48	0.49	1.49
Level of significance	**	**	**
CV (%)	7.81	5.89	8.41

**= Significant at 5% level by LSD

Nilaparvata lugens differed significantly among the four crop growth stages of BINA dhan10 with the mean ranged from 6.50 to 9.50 per 10 complete sweeps. Significantly the highest number of *N. lugens* population was found in seedling stage (9.50) while the lowest number of *N. lugens* population was recorded in early tillering stage (6.50) which was statistically identical to reproductive stage (6.50) followed by the maximum tillering stage (8.00) (Table 4).

Relationship between temperature and abundance of leaf and plant hoppers species

Correlation between temperature and abundance of leaf and plant hoppers species is presented in Table 5. The abundance of all leafhopper species showed highly negative relationship with temperature. This relationship can be expressed by 81% (R^2=0.806) for N. *virescens*, 80% (R^2= 0.801) for *N. nigropictus*, 65% (R^2=0.653) for *N. cincticeps*, 60% (R^2=0.600) for *C. brevis* and 70% (R^2=0.698) for *M. dorsalis.* It indicated that population of different leafhopper species decreased with the increase of temperature. Similarly, the abundance of all planthopper species showed negative relationship with temperature. Among three planthopper species, population of *S. furcifera* showed highly negative relationship with temperature and this relationship can be expressed by 71% (R^2=0.707). The abundance of *N. nervosa* showed poor positive relationship with temperature. This relationship can be expressed by 3 % for *N. nervosa* (R^2=0.030). *N. lugens* showed poor negative relationship with temperature and this relationship can be expressed by 31% (R^2=0.310) for *N. lugens* (Table 5).

Table 5. Correlation between temperature and population abundance of different leafhopper and planthopper species

Laefhopper species	Regression equation	R^2
N. *virescens*	Y=-3.752x + 114.4	0.806
N. nigropictus	Y = -4.878x + 144.7	0.801
N. cincticeps	Y = -5.294x + 158.0	0.653
C. brevis	Y = -4.204x + 126.8	0.600
M. dorsalis	Y = -6.713x + 208.2	0.698
Planthopper species		
N. nervosa	Y = 0.139x + 3.208	0.030
S. furcifera	Y = -0.246x + 9.461	0.707
N. lugens	Y = -0.431 + 17.53	0.310

The findings of the present study are supported by Soekhardjan et al. (1974) who reported that, in general there is an increase in the level of green leafhopper infestion with the increase of the age of the rice plants. Sabir et al. (2006) found that the maximum population of whitebacked planthopper (*Sogatella furcifera* Horv.), green leafhopper (*Nephotettix cincticeps* Uhl.) and white leafhopper (*Cofana spectra* Dist.) per 10 net sweeps, respectively in October. Khan (2013) found that the highest percent relative abundance of green rice leafhopper (GLH) and spider. Among the insect pest species, the population of GLH and short horned grasshopper was most prevalent in the rice field. Among natural enemies, damsel fly, spider and *Ichneumonid* wasp were the most prevalent while mirid bug, lady bird beetle and ground beetle were low in rice habitat. The occurrence of insect pests and natural enemies was the highest in maximum tillering stage and the lowest in early tillering stage. Abundance of insect pests and their natural enemies were more in high yielding rice varieties namely accession no. 20 as compared to local rice cultivars *viz.* Lalmota, moulata (Khan, 2013). Srinavasa et al. (1991) reported 3 hopper pests of rice *viz. Nephotettix spp*., *Nilaparvata lugens* and *Scirpophaga incertulas.* They reported that *Nephotettix spp.* and *N. lugens* were present throughout the year but showed peaks of abundance in November and May; *S. incertulas* was also present throughout the year with low incidence in March, and had peaks in November and June. Sabir et al. (2006) stated that the maximum and minimum temperature and rainfall are vital for bringing a change in the population of green leafhopper, leaffolder, stem-borer, whitebacked planthopper and white leafhopper while relative humidity has shown a positive response on the population. Hafizal and Idris (2014)

reported that Delphacidae (planthopper) and Cicadelidae (leafhopper) population are main insect pests of rice plants. As phloem-feeder insects, their population abundance can be influenced by rice growth development and abiotic factors such as temperature and humidity. It was evident that the mean temperature and relative humidity were varied slightly during rice growth period but not significantly affecting the population abundance of both hoppers. Changes of temperature influenced the abundance of Delphacidae, but not cicadelids. The abundance of Delphacids and Cicadelids population among rice growth stages differed significantly and was positively correlated with rice growth stages. Delphacids and Cicadelids had the highest and lowest abundance during maturing and reproductive stages, respectively.

CONCLUSION

The highest populations of leaf hoppers were in seedling stage and the lowest in early tillering stage. The highest numbers of plant hoppers population were found in seedling stage and the lowest numbers were in reproductive stage. All leafhopper species and one plant hopper species *S. furcifera* showed highly negative relationships with temperature. Plant hopper species *N. nervosa* showed poor positive and *N. lugens* showed poor negative relationships with temperature.

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