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ABUNDANCE AND DIVERSITY OF INSECT PESTS ON BORO AND AMAN RICE IN SYLHET

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Abstract

The abundance and diversity of insect pest species was determined in boro rice field of Bangladesh Agricultural Development Corporation (BADC) farm (from November 2013 to April 2014) and in aman rice field of Agricultural Training Institute (ATI) farm (from May to November 2014) in Sylhet district. A total of 16 and 14 pest species were found in boro and aman rice field, respectively. In both rice fields, green leafhopper and white leafhopper were found as the most abundant species among all the recorded species at all rice growing stages (seedling, tillering and heading). Rice hispa was found most abundant at tillering and heading stage in boro rice, while it was abundant at heading stage in aman rice field. In boro rice field, rice bug was most abundant at heading stage and it was absent at seedling and tillering stages. Leaf roller, yellow stem borer, rice horned caterpillar and black bug were more abundant in boro rice and short-horned grasshopper, long-horned grasshopper, rice bug, and caseworm were more abundant in aman rice. In aman rice field, abundance of short-horned grasshopper gradually decreased from seedling to heading stage (35.00>11.89>8.33). In both rice fields, relative abundance (%) of green leafhopper was highest followed by white leafhopper, short-horned grasshopper, rice hispa, rice bug and others. The results indicated similar abundance and diversity of pest species in both boro and aman rice fields. Regardless of the rice seasons, the pest species and green leafhopper, white leafhopper, leaf roller, yellow stem borer, caseworm, rice bug, rice hispa and rice horn caterpillar were found more prevalent.

***Keywords*:** Rice plant, rice pest, biodiversity, rice season.

Introduction

Rice (*Oryza sativa* L.), commonly known as Asian rice is a cereal food plant belongs to the family Poacae. Rice provides more than 50% of consumed calories in Bangladesh, Cambodia, Myanmar, Laos, Vietnam and 20-44% of consumed calories in Thailand, Philippines, Malaysia, India, Nepal and Sri Lanka (Gianessi, 2014). Boro is the best rice-growing season in Bangladesh showing lowest pest attack and highest yield with irrigation. A total 13.8 million hectares of land are arable in Bangladesh. The aman, aus and boro rice occupies about 50%, 41% and 9% of rice cultivated area in Bangladesh. About 75% of the total cropped area and over 80% of the total irrigated area are under rice cultivation. Total boro rice production was 18.059 million metric tons from 4.707 million hectares of land and the total production of aman rice was12.21 million metric tons from 5.66 million hectares of land during 2009-2010 (BBS, 2013).

There are three rice growing seasons in Bangladesh, *viz*. boro (dry season rice, from November to April), aus (spring rice, from April to July) and aman (monsoon rice, from July to November) (Catling, 1992). The magnitude of insect damage varies depending on seasons, years and locations. The injury from feeding leads to damage symptoms of skeletonized and defoliated leaves, dead hearts, white heads, stunted and wilted plants and unfilled or pecky grains which ultimately affects the plant physiology leading to a considerable reduction in measurable yield, utility or economic return (Nasiruddin and Roy, 2012). A total of 159 species of rice insect pests have been recorded in

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Bangladesh, of which 20-23 species have been found to be more damaging (Alam, 1977), for example, brown plant hopper (*Nilaparvata lugens*), rice stem borer (*Sciropophaga* spp.), green leafhopper (*Nephotettix* spp.), white-backed plant hopper (*Sogatella furcifera*), rice gall midge (*Orseolia oryzae*), rice hispa (*Dicladispa armigera*), and rice leaf folder (*Cnaphalocrocis medinalis*) (Alam, 2013; Nasiruddin and Roy, 2012; Fatema *et al*., 1999; Kamal *et al*., 1993; BRRI, 2009). Rice stem borer can cause 95% yield loss and leaf folder can cause 63 to 80% yield loss. Some insects act as vectors and transmit viral diseases in rice crop and cause colossal yield loss. Brown planthopper transmits ragged stunt and grassy stunt viral diseases while green leafhopper transmits Tungro virus in rice crop (Gianessi, 2014). Some researchers have estimated that 120 to 200 million metric tons of rice grains are lost every year due to the attack of insects, diseases, and weeds in tropical Asia (Willocquet, 2004; Gianessi, 2014), incurring about 37% yield loss (Savary, 2000; Gianessi, 2014). Sanchez (1983) estimated 8.4 million tons yield loss due to insect pest infestation in the Philippines. In South and South East Asia, rice is grown in warm, humid environments which are favorable for the survival and spread of key insect pests such as yellow stem borer, leaf folders, brown planthoppers and green leafhoppers (Gianessi, 2014). Recently rice yield is declining slightly at global level due to diminishing land and water resources, increased attack of insect pests and diseases, global climatic change, environmental pollution and erosion of agricultural biodiversity partially due to the indiscriminate use of agrochemicals. The control of insect pests has often relied on the extensive use of insecticides, which kills the beneficial insects, develops resistant to other harmful insects, causes environmental pollution and health hazards (Drechsler and Settele, 2001; EJF, 2002; Heong and Escalada, 2005). A group of entomologists have been surveying the rice insect pests from several agro-ecological zones considering different rice crops, growing seasons and growth stages (BRRI, 2014). It is worth to mention that survey and monitoring of insect pest species in any ecosystem is a must to develop integrated pest management approaches. But inadequate efforts have been made to explore the abundance and diversity of rice insect pests particularly for the Sylhet region. Thus exploration of abundance and diversity of rice insect pests in Sylhet region is essential to develop effective management practices for rice insect pests. Keeping this in mind, the present study was undertaken to explore the abundance and diversity of insect pests in boro and aman rice fields in the Sylhet region.

Materials and Methods

The experiment was conducted to determine the abundance and diversity of insect pest species in boro rice field of Bangladesh Agricultural Development Corporation (BADC) farm (from November 2013 to April 2014) and aman rice field of Agricultural Training Institute (ATI) farm (from May to November 2014) in Sylhet district. The experimental field was located at 24.56° N latitude and 91.8° E longitude at an average elevation of 19 m above the sea level belonging to the Eastern Surma- Kushiyara Food Plain (i.e., Agro-Ecological Zone-20).

Insect pests in rice fields

Data of insect pests were collected from three boro rice fields and three aman rice fields from seedling stage at 15 days after sowing (DAS), tillering stage at 25 days after transplanting (DAT) and heading stage at 55 days after transplanting (DAT). Insect pest management practices were not adopted in the study fields. The insect species from rice fields were collected with a fine nylon cloth sweep net (30 cm dia.). Sweeping was done from the plant canopy level including the interspaces between plants as well as close to basal region as far as possible. In each field, 20 complete sweeps were made to collect the insect species from each growth stage with three replications. Sweeping was done in the morning from 9:00 to 11:00 am in all the experimental plots. The collected insect species were brought to the Laboratory of Entomology Department, Faculty of Agriculture. Afterwards, all pest species were sorted from each plot and preserved in a labeled container with 70% ethyl alcohol. The collected and preserved species were carefully counted and identified to common, family and order names. Taxonomic characters of the collected insect species were determined as per Borror *et al.* (1963), Richards and Davies (1977), and Heinrichs (1994). Besides, the collected insect species were identified with the help of various books and literature of Bangladesh Rice Research Institute (BRRI), Gazipur.

The relative abundance of insect pests was calculated using the following formula:

$$\text{Relative abundance (\%)} = \frac{\text{Total no. of individuals of each species}}{\text{Total no.of individuals of all species}} \times 100$$

Shannon-Weaver Diversity Index (H')

Shannon-Weaver Diversity Index (H') (Shannon and Weaver, 1963) was used to measure the diversity of insect pests for both the boro and aman rice seasons. The H' is the direct method of determining the diversity of different insect pests between two seasons. The H' value ranges from 0 to 1, where 1 indicates the maximum diversity. Jamago (2000) classified the diversity of mungbean based on morphological characters as high (H'= >0.750), moderate (H'= 0.50-0.75) and low (H'= < 0.50) diversity. The same classification of diversity was also used by other researchers (Emannuel, 2000; Kete, 2001; Thuy, 2002; Uddin *et al.,* 2005). The higher the diversity index, the more is the population diversity. Shannon-Weaver Diversity Index is defined by the following formula (Yu Li*et al.,* 1996).

$$H' = -\sum_{i=1}^{n} Pi * \log_2 (Pi)/\log_2 (n)$$

Where, P_i is the proportion of the total number of entries belonging to the i^{th} species and n is the numbers of insect pests. The relative frequencies for the different species were used to calculate the diversity index. The H' for each of the species was calculated using Microsoft Excel.

Equitability or Evenness

Equitability is considered a component of diversity, in that it provides an idea about the evenness of species distribution at a given site. Usually a positive correlation exists between diversity and equitability (Delong, 1975; Khan, 2013) i.e. a high equitability would indicate a high diversity and probably a 'healthy condition' of a fauna. Pielou's (1966) method of measuring equitability is most widely used. The computational formula is given below:

$$J = \frac{H}{\log_e S}$$

Where, H = Shannon's Index

S = Total species collected

The index value ranges from 0 to 1, with a value of 1 being the maximum possible evenness in the community.

Analysis of data

The data were analyzed using MSTAT-C Computer software (Russel, 1986). The analysis of variance (ANOVA) was calculated for interpretation of abundance results at different growth stages of boro and aman rice. The means were separated and compared using Least Significant Difference (LSD) test.

Results and Discussion

Abundance of insect pests in boro rice field

A total of 16 insect pest species namely green leafhopper (*Nepotettix nigropictus* and *N. virescens*), white leafhopper (*Cofana* spp.), brown planthopper (*Nilaparvata lugens*), stem borer (*Scirpopaga incertulas*), rice hairy caterpillar (*Dascychira secures*), swarming caterpillar (*Spodoptera litura*), rice hispa (*Dicladispa armigera*), sting bug (*Nezaria viridulla*), rice bug (*Leptocorisa acuta*), leaf roller (*Cnaphalocrocis medinalis*), caseworm (*Nymphula depunctalis*), short-horned grasshopper (*Oxya* spp.), long-horned grasshopper (*Tettigonia* spp.) and field cricket (*Brachytrupes portentosus*), rice horned caterpillar (*Melanitis leda*) and black bug (*Scotinophara coarctata*) were found to infest rice at three growth stages (Table 1).

The results showed that presence of insect pests gradually increased from seedling to heading stage (89< 185<196). Rice horned caterpillar was found prominent (23.22) at seedling stage followed by white leafhopper (19.33) and

green leafhopper (14.0) which was also prominent at tillering stage (38.67) and heading stage (46.89). Islam and Catling (2012) reported that green leafhoppers are present in all rice ecosystems throughout Bangladesh. The two species *N. virescens and N. nigropictus* were present in about equal numbers and have very similar seasonal incidence patterns. They were active throughout the year with two equal and distinct population peaks in April-June and October–November corresponding with the reproductive phase of boro and aman rice crop. Rice hispa was found plenty at tillering stage (23.0) while subsequently decreased at heading stage (15.44) as rice hispa scrape the epidermis of upper leaf. The results agree with the results of Amit *et al.* (2001) who found maximum population of adult and grubs of rice hispa in August when the crop was at mid-tillering stage. In fact in Sylhet, rice hispa population probably forms as integral part of an enormous contiguous population in neighboring Assam where hispa is also a major problem (Islam and Catling, 2012).Another important pest rice bug was found enormous at heading stage (42.33) but absent at other two growth stages because rice bug only feed on grain causing empty grain in milky and dough stage. In Gazipur, the incidence of rice bug was considerably higher in boro season than other seasons and the population peaked in the reproductive phase of the crop in each rice season (Islam and Catling, 2012). Similar results were also reported by Tsueda *et al.* (2002) who found 22 species of rice bugs in rice fields where *Stenotus bivittatus* was the important species showing pick abundance during the date of heading of early-ripening rice. They also reported that the population of bugs and rate of damaged rice was related to the area of heading rice. Leaf roller showed an increasing trend (2.78 < 10.11 < 13.44) and rice horned caterpillar showed a decreasing trend (23.22 > 12.33 > 4.89). Besides, yellow stem borer, black bug and caseworm also caused significant damage in boro rice field.

Table 1. Abundance of insect pests at different growth stages of boro rice

Common name of insect pests	Number of insect pests per 20 sweeps (Mean ± SE) at			LSD
	Seedling Stage	Tillering Stage	Heading Stage	
Green leafhopper	14.0 ± 1.15	38.67 ± 3.18	46.89 ± 2.80	6.28
White leafhopper	19.33 ± 6.38	34.56 ± 3.20	30.0 ± 2.96	10.52
Yellow stem borer	2.22 ± 0.62	9.89 ± 2.16	13.33 ± 1.45	3.09
Brown planthopper	1.56 ± 0.48	4.89 ± 0.99	3.33 ± 0.38	1.38
Rice hispa	1.33 ± 0.51	23.0 ± 0.58	15.44 ± 1.46	2.50
Sting bug	2.33 ± 0.80	5.44 ± 0.48	5.89 ± 0.48	1.22
Rice bug	0.0 ± 0.0	0.0 ± 0.0	42.33 ± 22.82	32.24
Leaf roller	2.78 ± 1.13	10.11 ± 0.80	13.44 ± 0.40	1.23
Caseworm	5.0 ± 1.50	9.11 ± 0.11	3.67 ± 0.95	2.17
Swarming caterpillar	2.44 ± 1.06	3.89 ± 0.87	2.78 ± 0.11	1.39
Rice hairy caterpillar	2.33 ± 0.38	4.22 ± 0.11	3.67 ± 0.40	0.51
Field cricket	2.22 ± 0.97	3.44 ± 0.44	2.56 ± 0.56	2.02
Short-horned grasshopper	0.44 ± 0.11	2.22 ± 0.48	2.44 ± 0.29	0.89
Long-horned grasshopper	2.0 ± 0.59	2.89 ± 0.29	2.0 ± 0.19	0.98
Rice horned caterpillar	23.22 ± 8.70	12.33 ± 0.69	4.89 ± 1.28	12.78
Black bug	7.78 ± 2.90	20.78 ± 2.70	3.0 ± 1.17	6.15
Total	89.00	185.00	196.00	

LSD calculated at 5% level of significance ($P< 0.05$)

Abundance of insect pests in aman rice fields

Fourteen (14) insect pest species *viz.*, green leafhopper (*Nephotettix nigropictus* and *N. virescens*), white leafhopper (*Cofana* spp.), brown planthopper (*Nilaparvata lugens*), stem borer (*Scirpopaga incertulas*), rice hairy caterpillar (*Dascychira secures*), swarming caterpillar (*Spodoptera litura*), rice hispa (*Dicladispa armigera*), sting bug (*Nezaria viridulla*), rice bug (*Leptocorisa acuta*), leaf roller (*Cnaphalocrocis medinalis*), caseworm (*Nymphula depunctalis*), short-horned grasshopper (*Oxya* spp.), long-horned grasshopper (*Tettigonia viridissima*) and field cricket (*Brachytrupes portentosus*) were found to attack at different growth stages of aman rice (Table 2). In aman

rice, insect pests increased from seedling to tillering (123.12<182.11) but subsequently decreased at heading stage (135.32) which is different from that of boro rice. Short-horned grasshopper was found highest (35.0) in abundance followed by green leafhopper (27.11) and white leafhopper (23.89) at seedling stage. In tillering stage, green leafhopper was also found highest (45.89) followed by white leafhopper (40.47) and long-horned grasshopper (22.56). Green leafhopper (29.44) and rice hispa (23.66) were found more abundant at heading stage. Green leafhopper, white leafhopper and long-horned grasshopper showed similar pattern of occurrence with highest abundance at tillering stage. An unpublished data of BRRI (2007) showed that two species of green leafhopper were active throughout the year with two equal and distinct population peaks in April-June and October-November corresponding with the reproductive phase of the boro and aman rice crops. The population of rice hispa increased gradually from seedling to heading stage (1.44<7.67<23.67). Moreover, short-horned grasshopper showed a decreasing trend from seedling to heading stage (35.00>11.89>8.33). These results indicate similar expression with those reported by Lanjar *et al.* (2002) who found the four grasshopper species *viz.*, rice grasshopper (*Hieroglyphus banian*), small green grasshopper (*Oxya nitidula*), surface grasshopper (*Chrotogonus trachypterus*) andsmall grasshopper (*Aiolopus thalassinus*) as abundant in aman rice field. The species *C. trachypterus* was recorded in maximum number (13 nymphs and 40 adults per observation) during July-October in a mean temperature of 37.95°C.

Table 2. Abundance of insect pests at different growth stages of aman rice

Common name of insect pests	Number of insect pests per 20 sweeps (Mean ± SE) at			LSD
	Seedling Stage	Tillering Stage	Heading Stage	
Green leafhopper	27.11 ± 8.04	45.89 ± 2.89	29.44 ± 1.09	11.02
White leafhopper	23.89 ± 7.13	40.67 ± 2.69	16.22 ± 1.39	9.26
Yellow stem borer	3.67 ± 0.19	12.0 ± 0.67	13.44 ± 1.16	1.46
Brown planthopper	1.78 ± 0.68	5.44 ± 1.09	4.44 ± 0.40	1.19
Rice hispa	1.44 ± 0.56	7.67 ± 0.88	23.67 ± 3.18	4.91
Sting bug	2.33 ± 0.78	3.44 ± 0.29	4.78 ± 0.59	1.58
Rice bug	0.0 ± 0.0	0.0 ± 0.0	10.78 ± 3.89	5.49
Leaf roller	2.78 ± 0.78	12.0 ± 2.34	7.11 ± 1.06	3.21
Case worm	6.67 ± 2.60	10.44 ± 0.78	4.0 ± 1.06	3.42
Swarming caterpillar	2.56 ± 1.25	4.0 ± 0.87	3.0 ± 0.11	1.45
Rice hairy caterpillar	2.89 ± 0.59	4.78 ± 0.95	3.89 ± 0.22	0.94
Field cricket	2.0 ± 0.59	1.33 ± 0.19	2.0 ± 0.11	0.85
Short-horned grasshopper	35.0 ± 11.57	11.89 ± 1.93	8.33 ± 1.84	17.68
Long-horned grasshopper	11.0 ± 3.51	22.56 ± 2.82	4.22 ± 1.35	6.46
Total	123.12	182.11	135.32	

LSD calculated at 5% level of significance ($P< 0.05$)

In comparison with boro and aman rice seasons, insect pest abundance was almost similar in pattern between the two rice seasons. This might have been occurred due to a minor variation in climatic conditions between the two seasons. Rice bug was found more abundant in boro rice than in aman. Black bug and rice horned caterpillar were absent in aman rice field. Short-horned and long-horned grasshopper were more abundant in aman rice than boro season. Other insect pests were found in both rice growing seasons with no significant differences in abundance.

The relative abundance of insect pests in boro rice was dominated by green leaf hopper (21.16%) followed by white leaf hopper (17.83%), rice bug (9.0%), short-horned grasshopper (8.60%), rice hispa (8.45%), long-horned grasshopper (6.71%), leaf roller (5.60%), yellow stem borer (5.41%), caseworm (3.80%), sting bug (2.93%), rice hairy caterpillar (2.20%), brown planthopper (2.08%), swarming caterpillar (1.94%), rice horned caterpillar (1.75%), field cricket (1.49%) and black bug (1.09%). In contrast to boro rice, relative abundance of aman rice insect pests was found as the following order: Green leafhopper (23.25%) > white leafhopper (18.34%) > short-horned grasshopper (12.54%) > long-horned grasshopper (8.58%) > rice hispa (7.44%) > yellow stem borer (6.61%) > leaf roller (4.97%) > caseworm

(4.77%) > brown plant hopper (2.65%) > rice hairy caterpillar (2.62%) > rice bug (2.45%) > sting bug (2.37%) > field cricket (1.26%) (Table 3).

Table 3. Relative abundance (%) of insect pests in both rice growing seasons

Common name of insect pests	Relative abundance (%)	
	Boro season	Aman season
Green leafhopper	21.16	23.25
White leafhopper	17.83	18.34
Yellow stem borer	5.41	6.61
Brown planthopper	2.08	2.65
Rice hispa	8.45	7.44
Sting bug	2.93	2.37
Rice bug	9.00	2.45
Leaf roller	5.60	4.97
Caseworm	3.80	4.77
Swarming caterpillar	1.94	2.17
Rice hairy caterpillar	2.20	2.62
Rice horned caterpillar	1.75	0.00
Black bug	1.09	0.00
Field cricket	1.49	1.26
Short-horned grasshopper	8.60	12.53
Long-horned grasshopper	6.71	8.58
Total	100.00	100.00

Diversity of insect pests in rice fields

Diversity of insect pests in boro and aman rice fields was measured as per Shannon-Weaver Diversity Index (H'). Diversity was at per both in boro and aman rice (H'= 0.87) indicated that high level of diversity was present in both the rice growing seasons in the Sylhet region. Diversity of insect pests was also determined by Equitability or Evenness which is a component of diversity. Evenness was 0.73 in boro rice and 0.76 in aman rice with maximum possible evenness of 1.0 (Pielou's, 1966). The result represents a high Equitability or Evenness which indicates insect pests are highly diversified in both rice growing seasons (Table 4).

Table 4. Diversity index of insect pests in two rice growing seasons

Seasons	Diversity index (H')	Evenness (J)
Boro	0.87	0.73
Aman	0.87	0.76

In respective rice growing seasons the species of insect pest *viz.*, green leafhopper, white leafhopper, yellow stem borer, rice bug, brown plant hopper, leaf roller and rice horn caterpillar were more abundant in rice fields of the Sylhet region. The abundance of rice insect pests increased with the progress of rice plant age, suggesting that rice farmers should adopt appropriate pest management practices from the very beginning the rice planting to check the pest population from reaching economic injury level. Rice farmers and other rice farm owners should also adopt effective management practices against the above insect pests as soon as they become appear in the crop field.

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