EVALUATION OF SOME IMPORTED HYBRID BORO RICE VARIETIES AGAINST MAJOR DISEASES UNDER NATURAL EPIPHYTIC CONDITIONS

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This is to certify that the thesis entitled "***EVALUATION OF SOME IMPORTED HYBRID BORO RICE VARIETIES AGAINST MAJOR DISEASES UNDER NATURAL EPIPHYTIC CONDITIONS***" submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of ***MASTER OF SCIENCE IN PLANT PATHOLOGY***, embodies the results of a piece of bonafide research work carried out by ***MD. MOMINUR RAHAMAN, REGISTRATION NO. 08-03207***, under my supervision and guidance. No part of this thesis has been submitted for any other degree in any other institutions.

I further certify that any help or sources of information received during the course of this investigation have been duly acknowledged.

Mrs. N. Akhtar

Dated: 08.05.2011
Dhaka, Bangladesh

Mrs. Nasim Akhtar
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Dedicated To

My Beloved Parents

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ABSTRACT

An investigation was carried out to evaluate imported hybrid rice varieties against major diseases under natural epiphytic conditions of Bangladesh during the boro season of 2008-09 at Sher-e-Bangla Agricultural University research farm. Fifteen hybrids (13 imported, 2 local) viz. Hira-1, Hira-2, ACI-1, Surma-1, Taj-1, Modhumoti-2, Krishan-2, Sonar Bangla-6, Richer-101, Moyna, Tia, Tinpata, Aloron , BRRI hybrid dhan-1, BRRI hybrid dhan-2 and 2 HYV check varieties viz. BRRI dhan-28 and BRRI dhan-29 were evaluated regarding disease incidence and severity at 3 stages and the effect of diseases on yield and yield contributing characters. Six field diseases viz. brown leaf spot (*Bipolaris oryzae*), leaf blast (*Pyricularia grisea)*, sheath blight (*Rhizoctonia solani)*, BLB (*Xanthomonas campestris pv. oryzae)*, narrow brown spot (*Cercospora oryzae*), and alternaria leaf spot (*Alternaria tenuissima*) were recorded and identified. The incidence and severity of diseases varied significantly from one another. The disease incidence and severity of brown spot at maturity stage were recorded from 15.51% to 25.85% and 0.64 to 4.15 (0-9 scale), respectively where Hira-2 and ACI-1 varieties showed good performance against the disease. In case of leaf blast, the disease incidence and severity ranged from 8.82% to 21.28% and 1.01 to 6.21 (0-9 scale), respectively at maturity stage where Hira-2 showed the lowest incidence (8.82%) and severity (1.01). Richer-101 showed the highest incidence (21.28%) and severity (6.21). Disease incidence and severity of sheath blight varied from 9.27% to 25.82% and 1.52 to 8.74 (0-9 scale), respectively at maturity stage where Hira-1, Hira-2 and ACI-1 showed better result against the disease. In case of BLB, the disease incidence and severity ranged from 13.28% to 28.92% and 1.21 to 8.72 (0-9 scale), respectively at maturity stage where Taj-1, Krishan-2, Aloron and Moyna were severely affected by this disease. In case of narrow brown leaf spot, the disease incidence and severity ranged from 6.27% to 12.23% and 1.10 to 5.84 (0-9 scale), respectively at maturity stage where the highest incidence (12.23%) and severity (5.84) was recorded on Modhumoti-2 and the lowest incidence (6.27%) and severity (1.10) was observed on ACI-1. Disease incidence and severity of alternaria leaf spot also varied from 13.27% to 32.12% and 1.42 to 3.00 (0-9 scale), respectively at maturity stage. The highest growth and yield contributing characters recorded on ACI-1, Hira-1 and Hira-2 considering plant height, panicle length, effective panicle and filled grain. Grain yield ranged from 4.50 t/ha to 10.77 t/ha. In case of hybrids, the highest grain yield (10.77 t/ha) was recorded on Hira-1. Hira-2 and ACI-1 also gave the better yield 9.72 t/ha and 9.70 t/ha respectively. The lowest grain yield (7.90 t/ha) was found in Krishan-2 which was statistically identical with Richer-101 (7.92 t/ha). It was observed that disease incidence and severity was gradually increased from flowering stage to maturity stage with the age of the plant. Minimum incidence and severity gave the maximum yield.

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LIST OF ABBREVIATED TERMS

ABBREVIATIONS	FULL WORD
ACI	Advance Chemical Industries
AEZ	Agro-Ecological Zone
Anon.	Anonymous
BARI	Bangladesh Agricultural Research Institute
BAU	Bangladesh Agricultural University
BBS	Bangladesh Bureau of Statistics
BLB	Bacterial Leaf Blight
BRRI	Bangladesh Rich Research Institute
cm	Centimeter
DAS	Days After Sowing
DAT	Days After Transplanting
DI	Disease Incidence
DMRT	Duncan's Multiple Range Test
e.g.	Example
et al.	And other
etc	Etcetera
FAO	Food and Agricultural Organization
g	Gram
ha	Hectare
hr	Hour
HYVs	High Yielding Varieties
Inst.	Institute
IRRI	International Rice Research Institute
J.	Journal
kg	Kilogram
Kg/ha	Kilogram per hectare
LAD	Leaf Area Diseased
LSD	Least Significant Difference
m	Meter
m^2	Square meter
ml	Milliliter
mm	Millimeter
Mn	Manganese
MP	Muriate of Potash
N	Nitrogen
NA	Nutrient Agar
No.	Number

LIST OF ABBREVIATED TERMS (cont'd)

ABBREVIATIONS	FULL WORD
PDA	Potato Dextrose Agar
pv.	Pathovar
RCBD	Randomized Complete Block Design
Res.	Research
RH	Relative Humidity
SAU	Sher-e-Bangla Agricultural University
T. Aman	Transplanted Aman
t/ha	Ton per hectare
Tk.	Taka
TSP	Triple Super Phosphate
UNDP	United Nations Development Program
viz.	Videlicet
Wt.	Wight
%	Percent
^{0}C	Degree Centigrade

Chapter 1
Introduction

CHAPTER 1

INTRODUCTION

Rice (*Oryza sativa*) is the most important cereal crop in Asia producing about 90% of the world production (IRRI, 2008). It is the most important cereal crop as well as staple food for about 144.5 million people of Bangladesh. Rice covers about 10.58 million hectare of area covering 80% arable land and accounts for 95% food grain production in Bangladesh (BBS, 2008).

Although rice is the staple food for people of Bangladesh, it's yield is relatively very low in the country compared to those of other rice growing countries. In Bangladesh 28.93 million tons of rice is produced in 10.58 million hectare of land with average yield around 2.74 t/ha; as where world average yield is 4.15 t/ha and average yield in Asia is 4.21 t/ha (BBS, 2008 and FAO, 2008). This result indicates that average per hectare production of rice in Bangladesh is extremely low compared to other rice growing countries of the world. So there is a huge scope to increase the yield of rice to fulfill the national demand. One of the best options available to the plant breeder is the hybrid rice. For its yield potential, hybrid rice has brought a great hope and aspiration to meet the challenging demand of food deficits of the 21st century (Fakir, 1998). To overcome the present yield ceiling of existing high yielding varieties (HYVs) of rice, hybrid rice seems to be highly attractive and available alternative.

In Bangladesh, hybrid rice has taken up significant land coverage due to active government attention, promotion of private seed companies and publication of mass media. In 2006-07, among the total 4.5 million hectares

of Boro cultivation, hybrid rice was promoted in 1.2 million hectares (BBS, 2008). There are several constraints of hybrid rice production in Bangladesh, Major constraints in hybrids rice adoption were identified as high cost of seed, requirement of more crop care and management, high pest and disease infestation (AAS, 1999). Among these, disease is considered as the major one. In Bangladesh, 31 different diseases are known to occur in rice (Ali, 2002). Out of 31 diseases, 10 diseases viz. brown spot, narrow brown spot, blast, sheath blight, sheath rot, bacterial leaf blight, stem rot, bakanae or foot rot, tungro, ufra are considered as the main constrain for rice production in Bangladesh which caused 10-15 % average yield loss (BRRI, 1999). Most of the diseases of rice are seed borne. In Bangladesh approximately 2.5 million tons of rice worth more than TK. 12000 millions is lost annually due to disease caused by only seed borne pathogens (Fakir *et al.*, 2003).

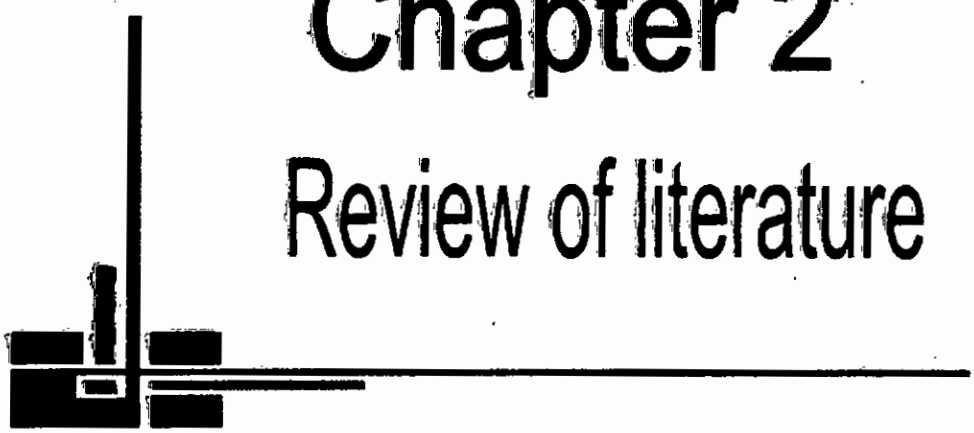
Brown spot disease of rice causing 40-60% yield reduction in Bangladesh (Mia, 1998). *Bipolaris oryzae (Drechlera oryzae)*, the pathogen of brown spot causes severe infection during the reproductive phase of the plant that causes both quantitative and qualitative losses (Klomp, 1977). Bacterial leaf blight (BLB) caused by *Xanthomonas oryzae pv. oryzae* may cause on an average of 20-30% yield loss depending on severity of infection (Ou, 1985). In Bangladesh, 10-30% yield loss caused due to BLB (Shahjahan *et al.*, 1992). Blast disease of rice caused by *Pyricularia oryzae* is the most important production constraint in modern rice cultivars in both the temperate and tropical rice growing countries (Ou, 1985). Epidemics of leaf and neck blast have been reoccurring a 3-4 years cycle in Bangladesh (Shahjahan *et al.*, 1991). Sheath blight of rice caused by *Rhizoctonia solani* causes yield reduction in susceptible rice cultivars in Bangladesh (Shahjahan *et al.*, 1986).

The land area of the country is decreasing gradually while population is increasing alarmingly. To fulfill the demand of increasing population, imported hybrid rice cultivation in Bangladesh increases remarkably by the last few years. Almost all of hybrid rice varieties are imported from abroad specially from China. Rice seeds are playing an important role to carry unwanted pathogens in quarantine aspect. Thus, the farmers using different hybrid rice varieties faced the difficulties of many diseases.

Recently BLB, BLS and blast disease appear seriously in the boro rice. Observation was made that those diseases extremely appear in the hybrid rice varieties. As the pathogens of BLB, BLS and blast are seed borne, there is a chance to transmit new races of the pathogen in the country by imported hybrid rice seed. Therefore, before import and release of hybrid rice varieties, it is of course, to be considered that varieties must be resistant to field diseases with other desirable qualities. Thus screening and selection of disease resistant imported hybrid rice varieties before mass production is an argent demand.

In view of the above facts the present piece of research has been carried out to fulfill the following objectives:

1) To determine disease incidence and severity of different field diseases of hybrid rice.
2) To determine the effect of different field diseases on yield and yield contributing characters of hybrid rice.



Chapter 2

Review of literature

CHAPTER 2

REVIEW OF LITERATURE

In this chapter an attempt has been made to review available information related to disease incidence and severity of major diseases and their effect on yield and yield contributing characters of rice.

2.1. Brown spot of rice

Bedi and Gill (1960) reported that the brown leaf spot disease of rice, caused by *Helminthosporium oryzae* occurs wherever rice is grown and caused considerable damage to the crop every year. In severe cases the spots may become numerous, the entire leaves may wither and panicles may get severely infected causing heavy sterility of blossoms.

Klomp (1977) observed that infection by *Drechslera oryzae* was most severe during the reproductive phase of the plant and susceptibility increased with plant age.

Copcv and Karaca (1983) stated that brown leaf spot with maximum incidence of 100% was caused mainly by *Helminthosporium oryzae* and *Helminthosporium monoceras* was mainly responsible for minute leaf spots.

Sharma *et al.* (1987) recorded that incidence of discoloration was higher (23%) in PR106 rice than in IR8 (19%).

Fakir *et al.* (1990) made a survey on the health status of rice seed of farmers of Sadar Thana, Mymensingh. They stated that seed borne infection by

Drechslera oryzae causing brown spot in rice was always higher than the recommended national seed health standard fixed for this pathogen.

Mondal *et al.* (1994) assessed an endemic upland rice field for leaf and grain spot incidence during aus season, 1992-93 at Charghat, and Rajshahi in Bangladesh. A positive correlation was obtained between the incidence of leaf spot and grain spot. Random sampling of spotted grains from sampled plots and subsequent isolation revealed predominance of *Bopolaris oryzae* (54.5%).

Saifulla (1994) reported that seventeen genotypes were screened in the field during kharif 1988 and 1989. Mean brown spot *(Bipolaris oryzae [Cochliobolus miyabeanus])* severity ranged from 23.0% in IR9924-34 to 36.5% in IR9924-14.

Rajput and Bartaria (1995) observed that a field experiment was conducted in Sarkanda, Bilaspur, Madhya Pradesh, India, during 1981 to screen 38 cultivars of rice against brown spot disease *(Drechslera oryzae (Cochliobolus miyabeanus])* in 2 soil types (light soil and medium soil) under 2 sowing methods (direct sowing and transplanting). The results showed that varieties Sattary, Poorva and BD-47 were resistant to brown spot in light as well as medium soils in both methods of sowing.

BRRI report (1997) on the population dynamics of micro flora in developing rice seed during T. aman season revealed that the incidence of different fungi varied with respect to variety and stage of seed collection. Mean incidence of *Bipolaris oryzae* was found to be increased progressively with the seed maturity. Irrespective of variety, significantly higher incidence of *Bipolaris oryzae* to be found at ripening stage.

Mia (1998) reported that there is positive relationship between brown leaf spotting and seed discoloration. He also added that the pathogen, *Bipolaris oryzae* caused dark to light brown spots on leaves, seed and in the coleoptile. In seed, the pathogen may be present in the husk, endosperm and embryo. Rate of seed infection varied with the disease severity in leaves. Under severe conditions, seed infection may be more than 80%.

Jha *et al.* (1999) evaluated fifty rice accessions which showed resistance to brown spot, caused by *Drechslera oryzae [Cochliobolus miyabeanus],* in a deep water ecosystem in North Bihar, India, during 1993-94. The collection proved to be a good source of resistant genes for the management of brown spot disease. Six accessions were rated highly resistant (score<3) and 9 accessions as resistant (score 3).

Payasi and Singh (2001) stated that twenty genotypes of early duration rice *(Oryza sativa)* were evaluated under direct seedling and transplanted conditions with three levels of nitrogen (0, 40 and 80 kg N/ha) in Madhya Pradesh, India during the rainy season of 1996-97 to assess their stability for disease resistance and yield. High yielding genotypes, namely, Tulsi, RWR 92-74-5 and Armada were identified as resistant for blast and brown spot diseases and high fertilizer responsive towards transplanted condition. Similarly, blast and brown spot susceptible genotypes Niwari and Vanprabha along with blast resistant genotype RWR 78-81-3 were widely adapted towards direct seeding conditions.

Rashed (2001) studied on twenty hybrids/lines/ varieties (Sonerbangla-1, sonerbangla-5,sonerbangla-6, sonerbangla-12, 262H, 283H, 284H, 287H, 291H, 305H, 306H, 311H, 312H, 317H, 321H, 352H, BINA 6, BR 14, BR 28, BR 29) of rice to find out the effect of incidence and severity of brown spot

(caused by *Bipolaris oryzae)* on the yield and yield contributing characters of boro rice at the filed of Bangladesh Agricultural University, Mymensingh during April to June, 2001. The incidence and severity of brown spot on different hybrids/lines/varieties varied significantly from one to another. Under natural epiphytic condition, incidence and severity were recorded from 30.75% to 62.75% and 25.25% to 47.50% respectively at 50 days after transplanting (DAT). The hybrid line 321H showed the maximum incidence (62.75%) and severity (47.50%) at 50 days after transplanting. The hybrid line 321H showed highest incidence (80.00%) and severity (77.00%). The lowest incidence (40.50%) and severity (45.00%) at 70 days after transplanting were recorded on the line 312H. In case of susceptible check variety, the maximum incidence (62.50%) and severity (61.80%) were recorded on variety BR 28 at 70 days after transplanting. The lowest incidence (46.75%) and severity (49.25%) were recorded from moderately resistant variety, BINA 6 at 70 days after transplanting. The yield of hybrid line 321H was lowest (3.54 ton/ha) and the highest (6.88 ton/ha) was obtained the line 312H. Incidence and severity of brown spot decrease considerable amount of yield and panicle length. Significantly higher number of healthy grains/panicle (138.50) was found in the line 312H and lower (73.50) in the line 321H. The highest number of spotted grains/panicle (20.47) was found in 321H and lower (4.30) in 312H. The highest number of discolored grains/panicle (24.77) was found in 321H and lower (4.03) in 312H. The highest number of unfilled grains/panicle (56.33) was found in 321H and lower (15.70) in 312H. Incidence and severity of brown spot at 70 days after transplanting of hybrids/varieties of boro rice showed significantly and negatively correlated with yield.

Alam (2007) conducted an experiment on the influence of disease incidence and severity on grain yield and grain quality of the rice (BRRI Dhan 29) was investigated in three different locations of CFS farm, Bangladesh

Agricultural University (BAU) during boro season (December, 2005 to May, 2006). Two diseases viz. brown spot and sheath blight were observed in the location of near weather yard, while only brown spot was observed in other locations viz. near agronomy farm and near CFS farm office. Among the three locations, severity of brown spot was lowest at the location of near weather yard and the highest at location of near CFS Farm office. Percent infection index of brown spot of rice varied significantly among the locations. The lowest infection index of brown spot (9.957 %) was obtained at maximum tillering stage and the highest infection index (36.36 %) was obtained at soft dough stage.

2.2. Leaf blast of rice

Gowda and Gowda (1982) conducted screening tests for 4 years with 25 cultivars under conditions of natural infection by blast *(Pyricularia oryzae).* A close parallel was observed between susceptibility to leaf blast and neck blast.

Koh *et al.* (1986) reported that 16 indica-japonica hybrids were highly resistant but with aging, the quantitative levels of resistance increased in all the cultivars, although the levels varied with the genotype. It was observed that with aging susceptibility changed to a resistant reaction on the upper leaves. The test cultivars became resistant to leaf blast, both qualitatively and quantitatively, as the plants matured.

Karki (1989) stated that of 848 rice entries evaluated for resistance to *Pyricularia oryzae* and 644 evaluated for resistance to *Xanthomonas campestris* pv. *oryzae* at 5 screening nurseries during 1985-87.Out of these entries 36 and 61 entries were resistant to blast and BLB, respectively. Of

these, 13 were resistant to both pathogens. Janaki, Laxmi and KAU1727 were considered useful donors for multiple resistances.

Hirano (1994) studied on the field resistance of rice varieties to blast disease. The author observed that rice varieties which had true resistance to blast (*Pyricularia oryzae* [*Magnaporthe grisea*]) became susceptible within a few years of their release. Field resistance thus was considered more important characteristic which breeding new varieties.

Han *et al.* (1995) investigated that the effect of severity of panicle blast disease on the leading cultivars of rice at 9 locations in Korea during the summer in 1993 with frequent rain and low temp. Incidence of panicle blast was 26% on Jinmibyeo, 23% on Chucheongbyeo and 40% on Odaebyeo.

Upadhyay *et al.* (1996) recorded that some 200 rice genotypes were grown under deep-water conditions (50-100 cm) during the rainy seasons of 1990-93. Of those screened none were found resistant. However, 18 genotypes showed moderate levels of resistance to brown spot and blast diseases.

Takeuchi (1997) developed a regression model for estimating yield loss of rice caused by panicle blast disease *Pyricularia oryzae* based on field experiments in 1991 and 1992. The model is $y = 0.764x+0.562$, where y and x are the percentages of yield loss and affected panicles, respectively. The model showed that apparent yield loss should not occur when <5% of panicles are affected by the disease. Thus, this level is proposed as the yield loss threshold in Hokkaido, Japan.

Sharma (1997) screened a total of 166 rice genotypes from breeding nurseries and yield trials in 1995/96 to identify sources of resistance to leaf

and neck blast disease (*Pyricularia grisea* [*Magnaporthe grisea*]). Leaf blast was studied at Lumle Agricultural Research Centre and neck blast at Arghaun testing sites. Some 84 entries were selected for leaf blast resistance. Genotypes LR88007-9C, NR10247-3-1-3-2-2, Radha 97 and Radha 96 had low blast incidence, while NR10288-15J-1J, Kala Namak and Seto Jhinuwa were highly susceptible. The leaf blast disease progression study on 12 fine/aromatic varieties revealed that the varieties differed considerably in development of disease over time. Genotypes AS 781-1 and Sabitri were completely free from blast while Jethobudho Arghaun had moderate rate of blast progression with slightly less terminal disease severity.

Surek and Beser (1997) were studied on the effect of blast disease, caused by *Magnaporthe grisea*, on 12 rice varieties and lines in field experiments at Edirne and Uzunkopru, Turkey, in 1995. Rice yield, total rice recovery, head rice and 1000-grain weight were determined. Significant differences in all characters studied were recorded for the 2 locations. The varieties with moderate susceptibility to node and neck blast (Ribe, TR-427, TR-489 and TR-765) differed less for yield and yield components between the 2 sites than the susceptible and highly susceptible varieties (Ergene, Serhat-92, TR-648, Ipsala and Surek-95). Blast infection in conjunction with environmental factors accounted for the smaller yields at Uzunkopru. Node and neck blast caused more damage to the varieties than did leaf blast because none of the varieties were even moderately resistant to it.

Kumar (2001) conducted an experiment in which twenty-eight bred restored lines and four standard checks varieties were screened for resistance to blast (*Pyricularia grisea*) under natural epiphytics in the field laboratory of Bangladesh Agricultural University, Mymensingh

during the T. Aman season and boro season. In case of blast disease, three were highly resistant, 12 resistant, 16 were moderately resistant and 1 was moderately susceptible at T. Aman season and at boro season 3 lines were found to be highly resistant, 8 resistant, 17 moderately resistant and 4 were moderately susceptible. Wide range, of variation was observed regarding resistance among the entries. Variations were also found on the basis of season. The disease severity ranged between 0% to 6.03 %. The highest disease severity (6.03%) was observed on accession numbers 74R and lowest (0.00%) was observed on 72R in boro season.

Bhat *et al.* (2003) carried out an experiment during 2000 and 2001 in Khudwani, Jammu and Kashmir, India, to determine the resistance of 18 elite rice genotypes against rice blast disease caused by *Magnaporthe grisea*. The genotype SKAU-105 exhibited high resistance while China-972, China-1007 and SKAU-98 were moderately resistant to leaf blast at tillering stage. The rest of the genotypes were susceptible. Only SKAU-98 and SKAU-27 showed resistance to nodal blast. A disease severity of more than 60% occurred on 12 genotypes but least severity was observed on SKAU-105. SKAU-23, which was susceptible at tillering stage, was immune to neck blast.

2.3. Sheath blight of rice

Tsai (1975) found that corresponding yield losses of 43% and 22.3% and 31.9% and 16.36% occurred due to infection at tillering and booting stages in the first and second crops, respectively.

Manian and Manibhushanrao (1980) reported that a total of 152 varieties, including entries from the International Sheath Blight Nursery and from the

All India Coordinated Rice Improvement resistance to *Corticium sasakii* under field conditions. A simple method of evaluating disease incidence according to the type of reaction was proposed. This method of evaluating resistance to *Corticium sasakii* in the field, using lesion length, infected sheaths/infected tiller and infected tiller/hill was simple. Five reaction types were distinguished.

Gokulapaian and Nair (1983) evaluated that of 10 rice varieties screened for resistance to *Rhizoctonia solani* in the field at Kerala, India, all were susceptible to sheath blight. It was observed that high nematode incidence encourage severe *Rhizoctonia* infection. Test cultivars Bharati and Rohini had significantly lower levels of disease intensity.

Dath (1985) observed that the reaction of 21 resistant or tolerant cultivars and 3 susceptible checks was re-evaluated using severity of leaf infection. A cultivar which was resistant to *Rhizoctonia solani* f. sp. *sasakii* [*Corticium sasakii*] with respect to 1 parameter fell into the susceptible grade when some other parameters were adopted and vice versa.

Shahjahan *et al.* (1986) studied in a farmer's field trial that yield losses were 31.0% and 28.0% and 28.7% at mean disease incidence (DI) of 4.8 and 5.0 in susceptible varieties BR2 and IR3, respectively in Bangladesh. Under inoculated condition BR1 and IR5 (two susceptible varieties) had a mean loss of 17.3% and 13.1%. Again, in separate experiments, BR1 had a loss of 14.0% during Aus and 15.4% in IR5 during Aman seasons at DI 5.0 and 5.4, respectively.

Rajan (1987) reported that percentage yield losses due to sheath blight, caused by *Rhizoctonia solani* at 3, 5, 7 and 9 disease scores on a scale of 0-9 were 16.8, 22.9, 36.2 and 48.4, respectively.

Singh *et al.* (1988) investigated that the pathogen normally attacked the leaf sheath and leaf blade but the symptoms were also found on emerging panicles which were chaffy, grayish brown and matted together by fungal mycelia. Numerous white and brown sclerotia were found on diseased panicles. They also induced the disease symptoms artificially through spraying the inoculum of the 5-day-old culture of the fungus on panicles, leaves and leaf sheaths of the susceptible cultivar IR-50.

Naidu (1989) inculcated eight varieties with sheath blight pathogen *R. solani* using a stem tape method and scored for yield. Grain yield losses varied from 49% in phalguna to 69.1% in Mansuri.

Dilla (1993) reported that the variation in yield losses ranged from 0.27 to 1.29 tons/ha in the dry season and 0.23 to 1.37 tons/ha in the wet season. Yield loss was strongly affected by the amount of inoculum but not by population density. The value ranged from 3.59 to 27.1% in wet season and 3.16 to 28.62% in the dry season. High nitrogen level and amount of inoculum markedly increased sheath blight severity and the same time enhanced high reduction on yield.

Ram *et al.* (1995) recorded that a large number of rice genotypes were screened for resistance to bacterial leaf blight (*Xanthomonas campestris* pv. *oryzae*) and sheath blight *(Rhizoctonia solani).* Of 73 promising genotypes, only two genotypes, IR 40 and KK2, exhibited resistance to sheath blight

both in laboratory and field screening tests. The genotypes CAMOR and IR29723-143-2-1 showed moderate resistance to sheath blight.

Sharma and Teng (1996) reported that two rice cultivars IR42 and IR72 were inoculated with *Rhizoctonia solani*. Disease development was found to be higher at later growth stage. Disease progress was faster at flowering and booting stages than at tillering and panicle initiation stages in both cultivars. The disease development was also higher at later growth stage and consequently the yield parameters also declined. The yield losses were high (34.83%) in flowering stage in both the cultivars than the other three stages.

Ali (2002) found that 30 *Rhizoctonia solani* isolates from rice caused disease on a range of rice cultivars, and also on sesame, mustard, mungbean, chickpea and wheat. He found that rice cultivar kaksail and BRRI dhan 32 were resistant to all 30 isolates of *Rhizoctonia solani*.

Alam (2007) conducted an experiment on the influence of disease incidence and severity on grain yield and grain quality of the rice (BRR1 Dhan 29) was investigated in three different locations of CFS farm, Bangladesh Agricultural University (BAU) during boro season. Maximum severity of sheath blight of rice (2.1 grade) was observed both in flowering and soft dough stage and minimum disease severity (0.8 grade) was observed at maximum tillering stage. Maximum infection index (28.90 %) of sheath blight of rice was recorded at soft dough stage and minimum (13.77 %) infection index was found at maximum tillering stage. It was found that sheath blight incidence decreased the yield by 31.78 %.

2.4. Bacterial leaf blight (BLB) of rice

Reddy and Shukla (1978) analyzed the loss in yield due to incidence of bacterial blight disease of rice. They studied the influence of *Xanthomonas campestris* pv. *oryzae* on yield and yield components of the susceptible CVs. Koruna, Sona and TNI when crop was infected at the panicle initiation stage, the yield reduction was 72..7% in Koruna and 43% in Sona. The loss in yield due to disease at flowering stage was only 25 and 28% in Sona and TNA, respectively.

Sharma and kaul (1984) reported that in pathogenicity test with *Xanthomonas campestris* pv. *oryzae* on 2 susceptible and 2 resistance rice cultivars all yield components were adversely affected to varying degrees at different growth stages, significant reduction in grain filled leaf to a high degree of seed sterility yield loss due to reduction in productive tiller number was high for susceptible varieties. In breeding for resistance increased fertile grain number rather than heavy grain weight should be considered.

Lu *et al.* (1990) stated that the effect of bacterial leaf blight (*Xanthomonas oryzae* pv. *oryzae*) on 8 rice hybrids was investigated in Hangzhow, China. Inoculation of susceptible hybrids at the booting stage decreased the number of filled grains/plant; 1000-grain wt. and grain yield, and increased the number of empty husks/plant.

Ashrafuzzaman (1992) has observed that the severity of BLB of rice is high in tropical Asia. He has also reported BLB as one of the most damaging disease in South East Asia and losses due to this disease vary from 6 to 60%.

Singh and Dodan (1995) conducted an experiment that a large number of rice genotype were screened for resistant to bacterial leaf blight (*Xanthomonas campestris* pv. *oryzae*) of 73 promising genotypes only 3 were constituting resistant to bacterial leaf blight during kharif 1992 and 1993 . Twelve entries showed moderate resistance to bacterial leaf blight.

Elings *et al.* (1997) adopted a systems analytical approach to increase the understanding of damage caused by *Xanthomonas oryzae* pv. *oryzae* and developed a tool that generates disease management recommendations. During the dry and wet season from 1991 and 1995, Field experiments were conducted at 3 locations in India and the Philippines to assess the consequence of various epidemics reduced amount of green leaf area, leading to reduced total above ground dry matter production and grain yield. They concluded after harvesting that in addition traditional disease management options such as use of tolerant cultivars and optimizing transplanting dates, careful nitrogen management is a possible tool limit spread of the bacterial leaf blight.

Kaushal and Ravi (1998) produced hybrids by using fourteen rice accessions resistant to bacterial leaf blight caused by *Xanthomonas oryzae* pv. *oryzae* and belonging to nine wild *oryzae* species representing three genomic groups. The reaction of the hybrids to bacterial leaf blight revealed the presence of both dominant and recessive genes in the wild gene pool. Four hybrids showed the resistance in the F_1 generation; hence they carried the dominant genes for resistance. Some of the hybrids are susceptible to bacterial leaf blight.

Zhang *et al.* (1998) carried out an experiment to control of bacterial leaf blight (*Xanthomonas oryzae* pv. *oryzae*) of rice. When rice seeds were soacked in a 50 mg/kg solution of zhongshengmycin in water for 48 hours before sowing in the field, disease severity was significantly reduced.

Ise *et al.* (1998) studied an experiment to test the resistance to bacterial leaf blight (*Xanthomonas oryzae* pv. *oryzae*) 16 lines in the pedigree of Asominori were screened. Only Saikai 85 displayed resistance to bacterial leaf blight isolates. In second study, Bacterial leaf blight field resistance of these lines, and their F_1 and F_2 was assessed using clip inoculation at heading. All F_1 plants were resistant to bacterial leaf blight isolates which were collected in Japan.

Ha *et al.* (1998) developed a variety Heugnambyeo. It was derived from a cross between Tamjinbyeo (resistant to major diseases) and Sanghaehyanghyeolria (a coloured Line). Heugnambyeo has medium late maturity, erect plant type, short height, resistant to bacterial leaf blight. This variety has more panicles, more spikelets/panicle and lower percentage of ripened grain. The yield of this variety is 4.97 t/ha. under normal cultivation.

He *et al.* (1998) developed a new hybrid rice Xie You 914 by crossing Xie Qing Zao A and T 914. The yield of Xie You 914 was 7100-7600 Kg/ha in different trials. It is resistant to rice bacterial leaf blight *(Xanthomonas oryzae).*The growth period is 136 days and plant height is 102.1 cm. The quality of the rice grain was rated as grade 11 according to the standards set by the ministry' of Agriculture, China.

Kumar *et al.* (1999) recorded the incidence and severity of bacterial leaf blight of rice caused by *X. oryzae pv. oryzae.* in an extensive disease survey in the 10 administrative blocks of the Balaghat district of Madhya Pradesh, India, during September 1993 to march 1994. Although the disease was present throughout the surveyed area, the greatest disease intensity was observed in Kirnapur block with disease severity ranging from 15-45% on the predominantly grown susceptible varieties IR 36 and Kranti. Variety IR 64 was free from the disease.

Zakaria (2001) conducted an experiment on effect of bacterial leaf blight on yield and yield contributing characters of 20 rice hybrids/varieties grown in Boro season also were studied the morphological, physiological, biochemical and pathological properties of some strains of *Xanthomonas oryzae* pv. *oryzae* in Bangladesh Agricultural University, Mymensingh from April 2000 to May, 2001. Under natural epiphytic conditions, maximum incidence (33.08%) and severity (33.87%) of bacterial leaf blight at 50 days after transplanting were recorded from the hybrid 352H and this hybrid had lowest yield (2.99 ton/ha). The minimum incidence (4.67%) and severity (4.73%) of bacterial leaf blight at 50 days after transplanting were recorded from the hybrid 291H and this hybrid showed the highest yield (6.76 ton/ha).In case of check varieties, highest incidence (34.05%) and severity (33.97%) of BLB at 50 days after transplanting were recorded from the variety BR11. The lowest incidence (4.58%) and severity (4.66%) of BLB at 50 days after transplanting were recorded from the variety BR29. The yield of the variety BR11 and BR29 were 3.03 and 5.67 t/ha respectively.

Sunder *et al.* (2004) investigated that the responses of 12 rice cultivars to bacterial leaf blight (*Xanthomonas oryzae pv. oryzae*) in Haryana, India

during the kharif season of 2002. Yield reduction in infected plants was in the range 1.9-33.6%. Yield reduction was minimum in HKR 97-93, PR-116 and PR 109 (in the range 1.9-3.1%), and maximum (33.6%) in HKR 46, followed by 25.3% in PR 106. A significant and positive correlation was observed between disease severity and grain yield reduction.

Rajarajeswari and Muralidharan (2006) examined the damage from natural epidemics of bacterial leaf blight (BLB) of rice caused by *Xanthomonas oryzae pv. oryzae* in 400 farmers' fields in four rice-growing districts of India during the wet seasons. One hundred contiguous farm fields were rated for BLB on a 0-9 scale. Disease prevalence at levels above the economic threshold (score >5) ranged from 7 to 39%. The spatial pattern of BLB development within and among rice hills was either random or uniform. On the representational farms, the mean BLB severity was 65-71%. Disease injury caused highly significant reductions in the well-filled grains harvested. In BLB epidemics, the most conservative estimates for production yield losses in districts were 3-16%. The production losses during the four epidemics were considerably different, ranging from 92 000 to 105 000 tons in Nellore, 30 000 to 36 000 tons in West Godavari, and 46 000 tons in Karnal to 22 000 tons in Rangareddy district.

2.5. Narrow brown leaf spot of rice

Saifulla (1993) stated that of 490 accessions studied in the field during kharif 1990, 39 proved resistant to blast (*Pyricularia oryzae* [*Magnaporthe grisea*]) and 270 were resistant to narrow brown leaf spot (*Cercospora oryzae*). IET1192 was the only entry resistant to leaf scald (*Monographella*

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Disease severity was higher in direct sown plants. The average disease severity was 27.3% and 29.5% at the mature and dough stages of direct sown rice, while these values were 23.8% and 26.2%, respectively in the transplanted rice.

2.6. Alternaria leaf spot of rice

Islam *et al.* (1994) conducted a survey on seed borne pathogens of rice in fifteen districts of Bangladesh. They examined seed health of 83 samples of rice collected from 15 district of Bangladesh by the blotter method of testing and found 7 fungal pathogens associated with rice grains. Incidence of these pathogens was found to vary with respect to location and source of collection. Farmer's seeds, in general, were infected more than those from Government farms. However, seed from Tabunia Farm, Pabna were heavily infected. Average incidence of *Drechslera oryzae* and *Trichoconis padwickii* (*Alternaria padwickii*) was much higher in the North of the country compared to the South.

Ilyas and Javaid (1995) examined 46 samples of rice seed. Among these, 30 yielded *Fusarium moniliforme,* 45 *Alternaria padwickii, 7 Alternaria longissima,* 41 *Drechslera oryzae,* 2 *Phoma* sp. and *Curvularia oryzae and Cesrcospora* sp.

Islam *et al.* (2000) observed significant variation in respect of germination (%) and pathogenic infection in different varieties and treatments in evaluating seed quality. Among the varieties, C-4 / Malagkit and IR59 had the higher percentage of germination in all treatments except chemical treatment. In case of pathogen, *Alternaria padwickii* was dominant, and its

incidence was the highest in best seed and farmer's original seed for all varieties except R30. There was no pathogen in chemically treated seeds. For both in soil and in between paper germination test, C-4 / Malaqkit had the highest percent of normal seedlings in all the treatments. The percent of abnormal seedlings of all varieties was statistically similar in-soil test but dissimilar for in between paper test. The percent of abnormal seedlings in between paper test and dead seeds for in-soil test were higher in case of IR 59 and R30. Among the treatments, the vigour and normal seedlings were the highest in best seed irrespective of varieties. The highest lethal seed infection was caused by *Fusarium moniliforme, Alternaria padwickii* and *Curvularia* spp. also caused lethal seed infection.

Hossain *et al.* (2000) collected seeds of rice varieties R 10, RC 20 and RC 28 from farmers of different locations in the Philippines during the dry season (January-June) of 1998 to identify the fungi associated with seeds and to evaluate the quality and purity of the seeds. The effects of different seed treatment practices on seed-borne mycoflora and on seed germination were also evaluated. A total of 19 fungal species were found to be associated with the seed samples wherein 17 were common between the 3 varieties. Among the 17 fungi, the frequency of *Alternaria tennis, Bipolaris oryzae, Fusarium solani, Nigrospora, Penicillium* and *Rhizopus* was less than 2% under the control treatment. The frequency of *Fusarium moniliforme, Phoma* sp., *Cercospora oryzae, Alternaria padwickii,* and *Alternaria longissima* varied from 2.0-14.6% under control treatment.

Mew and Gonzales (2002) described that Alternaria leaf spot (stackburn) disease of rice was caused by the pathogen *Alternaria padwickii (Trichoconis padwickii, Trichoconiella padwickii).*The disease was first

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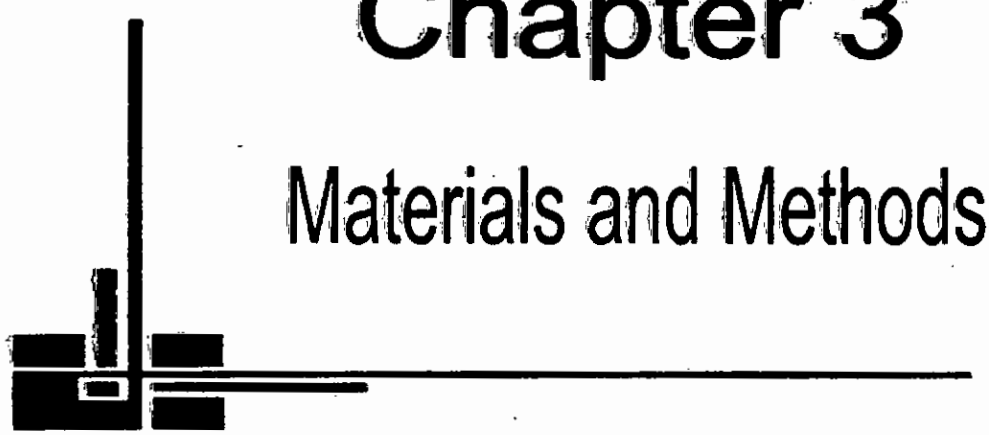
Mew and Gonzales (2002) described that Alternaria leaf spot (stackburn) disease of rice was caused by the pathogen *Alternaria padwickii* (*Trichoconis padwickii*, *Trichoconiella padwickii*).The disease was first

reported in the USA. The symptoms on rice leaves are large oval or circular spots with a pale brown center and distinct dark brown margin. Color of center eventually becomes white and bears minute black dots. The symptoms on grains are pale brown to whitish spots with black dots at the center and dark brown border. Roots and coleoptiles of germinating seedlings- dark brown to black spots that eventually coalesce. Small, discrete and black bodies are formed on the surface of the darkened area as decay proceeds. The importance in crop production: Stackburn leaf spot disease is not considered to be of economic importance. However, seed infection results in grain discolouration, which may reduce germination and lower grain quality. The disease potential of stackburm is very low and the yield loss caused by *Alternaria padwickii* in literature may be overestimated. The effect of infected seed on seed germination is not yet properly assessed.

Nahar (2003) studied with farmers' stored rice seeds of Bogra district and found *Bipolaris oryzae* (20.36%). *Fusarium moniliforme* (3.76%), *Fusarium oxysporum* (2.88%), *Trichoconis padwickii* (7.61%). *Alternaria alternata* (9.09%).



Chapter 3

Materials and Methods

CHAPTER 3

MATERIALS AND METHODS

In this chapter the details of different materials used and methodology followed during the experimental period are described.

3.1. Experimental Site

The experiment was conducted in the field of SAU (Sher-e-Bangla Agricultural University) farm allotted for the Department of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka-1207. (Appendix- I).

3.2. Experimental period

The experiment was carried out during the period form November 2008 to April 2009.

3.3. Soil type

The soil of the experimental plot was loam to clay loam in texture belonging to the Madhupur Tract (AEZ-28). The description of the Agro-Ecological Zone (UNDP and FAO, 1988) of the experimental site is sited below:-

Agro Ecological Region : Madhupur Tract (AEZ-28).
Land type : Medium high land.
General soil type : Non-Calcareous Dark gray floodplain soil
Soil series : Tejgaon
Topography : Up land
Elevation : 8.45
Location : SAU Farm, Dhaka.
Field level : Above flood level.

Drainage : Fairly good.

Firmness (consistency) : Compact to friable when dry.

The physical and chemical characteristics of the soil collected from Soil Resource Development Institute (SRDI), Farmgate, Dhaka and are presented below (For 0-14 cm depth): -

Particle size distribution:

Sand : 34%

Silt : 46%

Clay : 20%

Soil texture : Loam to clay loam.

3.4. Climate

The climate of the experimental area was of sub-tropical in nature characterized by high temperature associated with heavy rainfall during Kharif season (April to September) and scanty rainfall with moderately low temperature during Rabi season (October to March).

3.5. Weather

The data of monthly average temperature, relative humidity, rainfall and sunshine hours received at the experimental site during the period of the study have been collected from the surface synoptic Data card, Bangladesh Meteorological Department, Sher-e-Bangla Nagar, Dhaka and shown in Appendix- II.

3.6. Hybrid rice varieties used in this experiment

Altogether 15 hybrid rice varieties and two high yielding varieties (HYVs) as check varieties are used in this experiment. Detailed information of the used hybrid varieties and check varieties are given in Table 1.

Table1. Detailed information of the used hybrid varieties and check varieties of boro rice in the experiment

Sl. No.	Name of varieties	Line/Cross combination	Origin	Source of collection
1.	Hira-1	99-5	China (Imported)	Supreem Seed Co. Ltd.
2.	Hira-2	HS-273	China (Imported)	Supreem Seed Co. Ltd.
3.	ACI 1	F1 Seed	China (Imported)	ACI Limited
4.	Surma 1	F1 Seed	China (Imported)	Syngenta Bangladesh Ltd.
5.	Taj-1	GRA2/06	China (Imported)	National Seed Co. Ltd.
6.	Modumoti-2	WBR-2	China (Imported)	United Seed Co. Ltd.
7.	Krishan-2	S-2B/07	China (Imported)	Mukterpur Bhandar
8.	Sonar bangla-6	HTM-6	China (Imported)	Mallika Seed Co. Ltd.
9.	Richer-101	R-101	China (Imported)	Lal Teer Seed Co. Ltd.
10.	Moyna	HTM 303	China (Imported)	Lal Teer Seed Co. Ltd.
11.	Tia	HTM 707	China (Imported)	Lal Teer Seed Co. Ltd.
12.	Tinpata	T-40	China (Imported)	Tinpata Quality Seed Bangladesh Ltd.
13.	Aloron	HB-8	China (Imported)	BRAC Seed Enterprise
14.	BRRI hybrid dhan-1	IR58025A x BR827R	Bangladesh (Local)	Bangladesh Rice Res. Inst.
15.	BRRI hybrid dhan-2	BRRI A x BR168R	Bangladesh (Local)	Bangladesh Rice Res. Inst.
16.	BR 28	check variety	Bangladesh (Local)	Bangladesh Rice Res. Inst.
17.	BR 29	check variety	Bangladesh (Local)	Bangladesh Rice Res. Inst.

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2.	Hira-2	HS-273	China (Imported)	Supreem Seed Co. Ltd.
3.	ACI 1	F1 Seed	China (Imported)	ACI Limited
4.	Surma II	F1 Seed	China (Imported)	Syngenta Bangladesh Ltd.
5.	Taj-1	GRA2/06	China (Imported)	National Seed Co. Ltd.
6.	Modumoti-2	WBR-2	China (Imported)	United Seed Co. Ltd.
7.	Krishan-2	S-2B/07	China (Imported)	Mukterpur Bhandar
8.	Sonar bangla-6	HTM-6	China (Imported)	Mallika Seed Co. Ltd.
9.	Richer-101	R-101	China (Imported)	Lal Teer Seed Co. Ltd.
10.	Moyna	HTM 303	China (Imported)	Lal Teer Seed Co. Ltd.
11.	Tia	HTM 707	China (Imported)	Lal Teer Seed Co. Ltd.
12.	Tinpata	T-40	China (Imported)	Tinpata Quality Seed Bangladesh Ltd.
13.	Aloron	HB-8	China (Imported)	BRAC Seed Enterprise
14.	BRRI hybrid dhan-1	IR58025A x BR827R	Bangladesh (Local)	Bangladesh Rice Res. Inst.
15.	BRRI hybrid dhan-2	BRRI A x BR168R	Bangladesh (Local)	Bangladesh Rice Res. Inst.
16.	BR 28	check variety	Bangladesh (Local)	Bangladesh Rice Res. Inst.
17.	BR 29	check variety	Bangladesh (Local)	Bangladesh Rice Res. Inst.

3.7. Collection of seed samples

Altogether 17 seed samples (15 hybrids and 2 HYVs) of boro rice varieties were collected from different seed importer, BRRI and local market of Bangladesh.

3.8. Sprouting of seed

100g seeds of each variety were soaked in water in a basket for 16 hours. The seeds were then taken out of water and kept in gunny bags at room temperature for 72 hours for sprouting before sowing in seedbed.

3.9. Preparation of seedbed and sowing of seed

Seedbed was prepared by paddling the soil with the help of power tiller and harrow in the field of Sher-e-Bangla Agricultural University Farm. Sprouted seeds were sown in the wet seedbed on 19 November 2008. Proper care of seedlings were taken. Weeds were removed and irrigation was given in the seedbed as and when necessary.

3.10. Fertilizer application to the seedbed

Fertilizers were applied as per recommendation of Bangladesh Rice Research Institute (BRRI, 2007). As the land was rich in organic matters, therefore no manuring was done. The following doses of fertilizers were applied to the seedbed at 12 days after sowing (DAS) of seeds:

Fertilizers	Dose/m^2(g)	Dose/17m^2(g)
Urea (N_2)	7	119
TSP (P_2O_5)	4	68
MP(K_2O)	7	119

3.11. Land preparation

The land was prepared with the help of power tiller and harrow. The land was first opened on 10 November 2008 and ploughed. The final ploughing was performed with the help of power tiller followed by laddering in order to level the soil surface. Weeds and stubbles were removed from the land.

3.12. Fertilizer application to the main field

Fertilizers were applied as per recommendation of Bangladesh Rice Research Institute (BRRI), 2007. The following doses of fertilizers were applied to the plots:

Fertilizers	Dose/ha (kg)	Dose/ 550 m^2 (kg)
Urea (N_2)	270	15
TSP (P_2O_5)	150	9
MP(K_2O)	120	6.6
Gypsum (S)	70	3.85
Zinc Sulphate (Zn)	12	0.66
Cowdung	12000	660

All fertilizers except two-thirds of urea were incorporated with soil during final land preparation. Rest of the urea was applied in equal two installments at 30 and 45 days after transplanting.

3.13. Design of experiment

The experiment was carried out in a Randomized Complete Block Design (RCBD) with three replications. Each block comprised 17 unit plots and total number of unit plots were 51 (17 X 3). The size of the unit plot was 2.5m X 1.5m and the distance between plot to plot and block to block was 1.0 m and 1.5 m, respectively. The layout of this experiment was shown in Appendix- III.

Figure 1. Seedlings of hybrids and check varieties of boro rice grown in seed bed

Figure 2. Experimental plots of 17 hybrids and check varieties of boro rice

3.14. Transplanting of seedling

Thirty days old seedlings were uprooted from the seedbed very carefully and then transplanted on 18 December 2009 in the main field. In the field experiment, row to row spacing was maintained as 20 cm and that of hill was 15 cm. One seedling was transplanted in individual hill.

3.15. Intercultural operation

Weeding, irrigation and other intercultural operation were given in the field as and when necessary.

3.16. Assessment of the disease incidence in the field

Each plot was visited for recording the incidence. The disease incidence was recorded in the three growth stage of the plant namely flowering stage, milking stage and maturity stage. Data was recorded visually by observing the symptoms. Sixteen hills were randomly selected from each unit plot and the following parameters were considered for data collection-

(1) Number of tillers /hill

(2) Number diseased tillers /hill

(3) Percents leaf area diseased (LAD)

Disease incidence was calculated by the following formula (Rajput and Bartaria, 1995).

$$\text{Disease Incidence} = \frac{\text{Number of Diseased tillers}}{\text{Total Number of inspected tillers}} \times 100$$

3.17. Assessment of the disease severity in the field

Sixteen plants from each unit plot were randomly selected and tagged for grading the severity of diseases. The severity of six diseases viz. brown spot, narrow brown leaf spot, leaf blast , alternaria leaf spot, bacterial leaf blight (BLB), sheath blight were recorded following IRRI recommended grading scale (Standard Evaluation System for Rice). The disease severity was recorded in the three growth stage of the plant namely flowering stage, milking stage and maturity stage. The grade of different diseases is given below:

Brown spot: Disease severity of brown spot (*Bipolaris oryzae*) of rice was measured on a 0-9 scale of Standard Evaluation System for Rice (Annon. 1996). The scale is

0 = no incidence

1 = less than 1% leaf area affected

2 = 1-3% leaf area affected

3 = 4-5% leaf area affected

4 = 6-10% leaf area affected

5 = 11-15% leaf area affected

6 = 16-25% leaf area affected

7 = 26-50 leaf area affected

8 = 51-75 % leaf area affected

9 = 76-100% leaf areas affected

3.17. Assessment of the disease severity in the field

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6 = 16-25% leaf area affected

7 = 26-50 leaf area affected

8 = 51-75 % leaf area affected

9 = 76-100% leaf areas affected

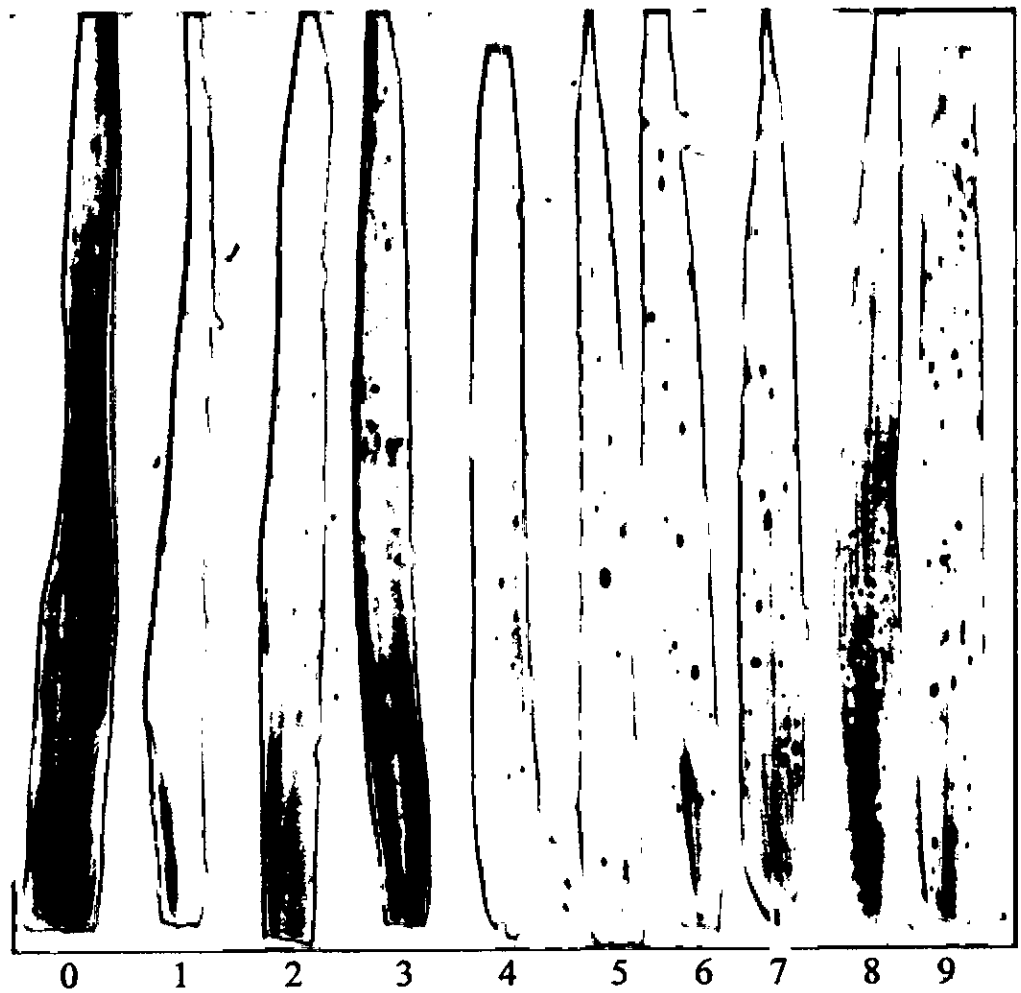


Figure 3. Leaves showing (0-9) ratting scale of brown spot severity

Narrow brown leaf spot: Disease severity of narrow brown spot (*Cercospora oryzae*) of rice was measured on a 0-9 scale of Standard Evaluation System for Rice (Annon. 1996).

0 = no incidence

1 = less than 1% leaf area affected

3 = 1-5% leaf area affected

5 = 6-25% leaf area affected

7 = 26-50 leaf area affected

9 = 51-100% leaf area affected

Leaf Blast: Disease severity of leaf blast (*Pyricularia grisea*) of rice was recorded by Singh (2000) used a 0-9 scale.

0 = no lesion observed

1 = 1% leaf area covered

3 = 10% leaf area covered

5 = 25% leaf area covered

7 = 50% leaf area covered

9 = more than 50% leaf area covered

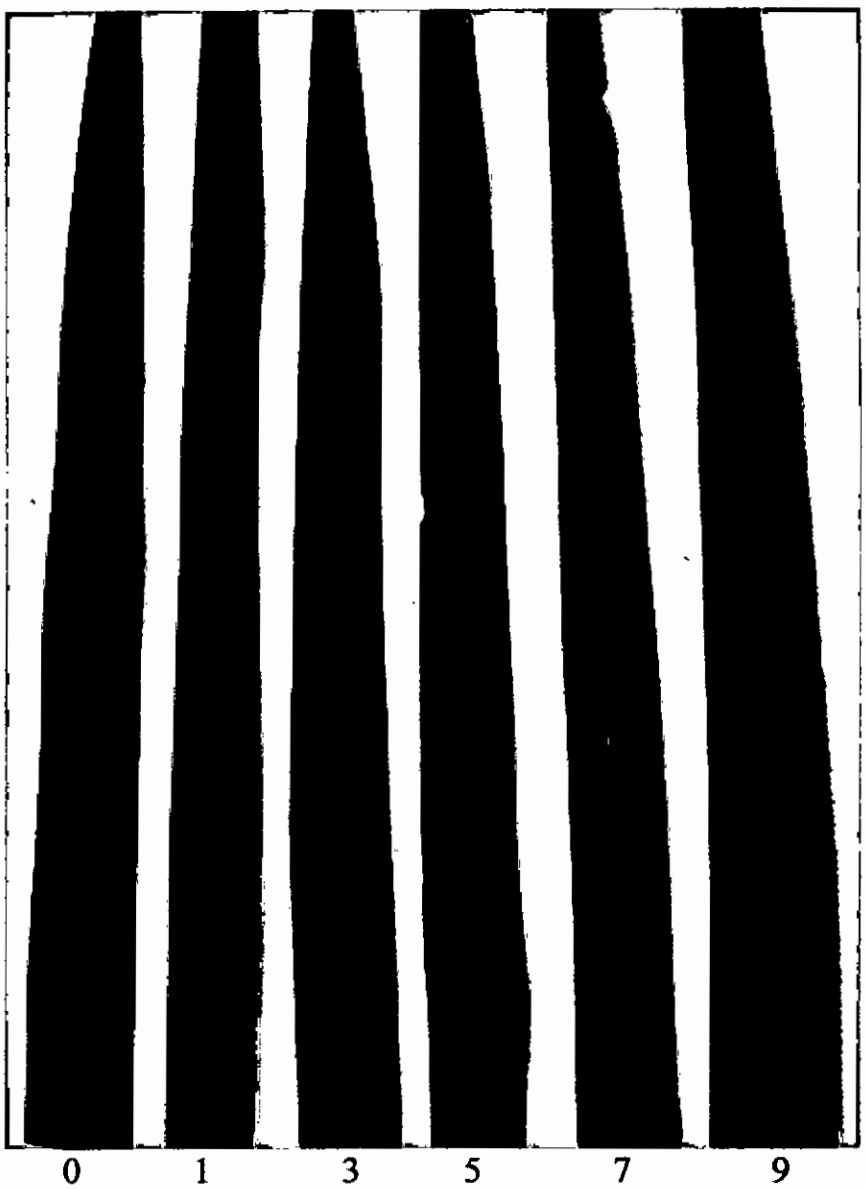


Figure 4. Leaves showing 0-9 ratting scale of narrow brown leaf spot severity

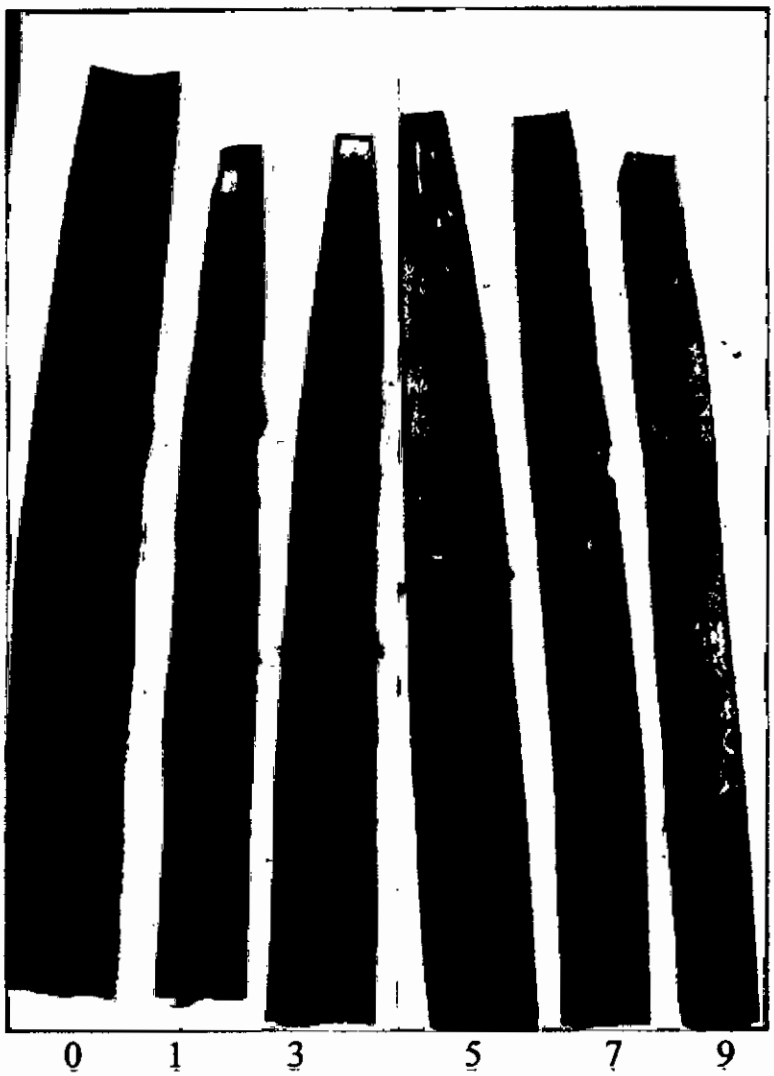


Figure 5. Leaves showing 0-9 ratting scale of leaf blast severity

Alternaria leaf spot: Disease severity of Alternaria leaf spot (*Alternaria sp.)* of rice was measured followed by 0-9 scale of brown spot of rice of Standard Evaluation System for Rice (Annon. 1996). The scale is

0 = no incidence

1 = less than 1% leaf areas affected

2 = 1-3% leaf areas affected

3 = 4-5% leaf areas affected

4 = 6-10% leaf areas affected

5 = 11-15% leaf area affected

6 = 16-25% leaf areas affected

7 = 26-50 leaf areas affected

8 = 51-75 % leaf areas affected,

9 = 76-100% leaf areas affected

Sheath blight: The assessment of rice sheath blight (*Rhizoctonia solani*) was done using the Standard Evaluation System for Rice on a 0-9 scale (Annon. 1996) The scale is

0 = no infection observed,

1= lesion limited to lower 20%

3 = 20-30%

5 = 31-45%

7 = 46-65%

9 = more than 65% (based on the lesion height).

Figure 6. Leaves showing 0-9 ratting scale of alternaria leaf spot severity

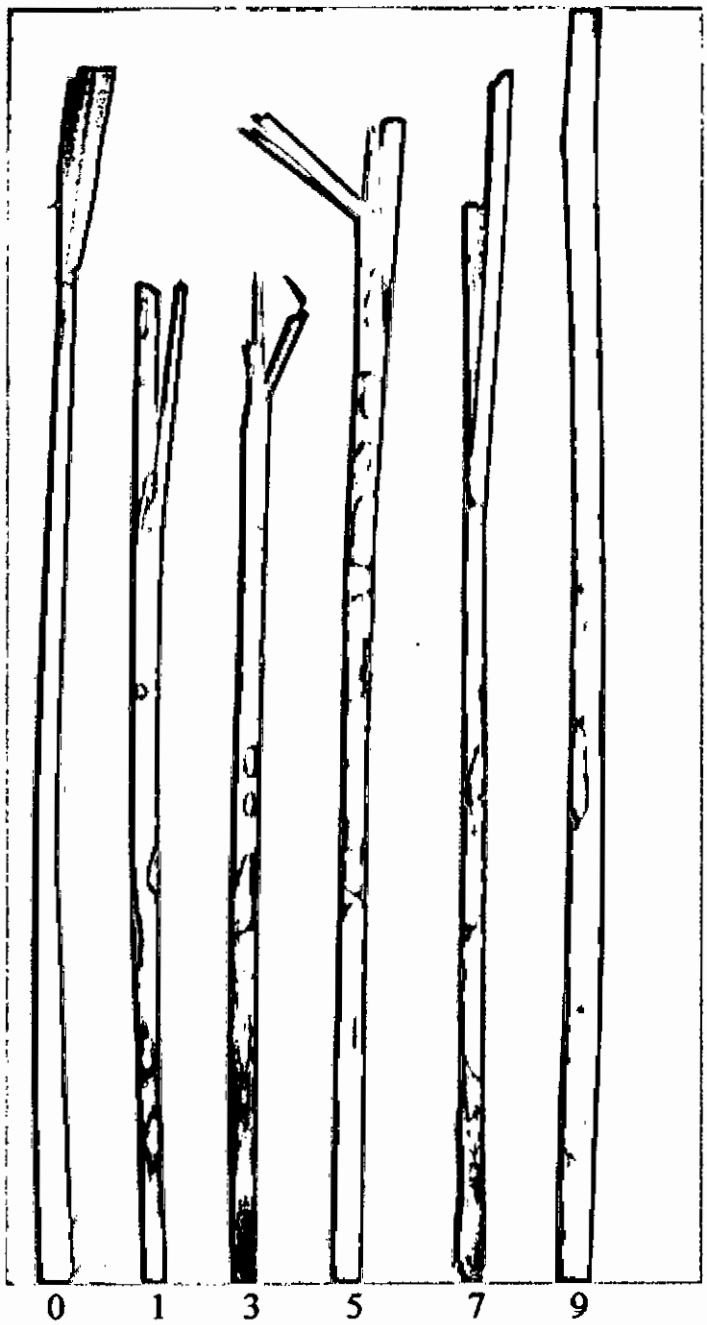


Figure 7. Leaves showing 0-9 ratting scale of sheath blight severity

Bacterial leaf blight (BLB): Bacterial leaf blight of rice (*Xanthomonas campestris* pv. *oryzae*) was measured for field test on a 0-9 scale by Standard Evaluation System for Rice (Annon. 1996).

0 = no lesion

1 = 1-5% lesion area

3 = 6-12% lesion area

5 = 13-25% lesion area

7 = 26-50% lesion area

9 = 51-100% lesion area

3.18. Harvesting and collection of data on yield and yield contributing parameters

The crop was harvested on 15 April 2009 at full ripening stage. Moreover 16 tagged plants of each plot were harvested separately. The data on the following yield contributing parameters were recorded:

- Plant height (cm)
- Panicle length (cm)
- No. of effective panicles/hill
- No. of ineffective panicles/hill
- No. of filled grains/ panicle
- No. of unfilled grains /panicle
- No. of rachis /panicle
- Weight of grains /panicle (g)
- Weight of grains /hill (g)
- Weight of straw/hill (g)
- Grain yield /plot (kg)
- Straw yield /plot (kg)
- Weight of thousand seeds (g)
- Grain yield (t/ha)

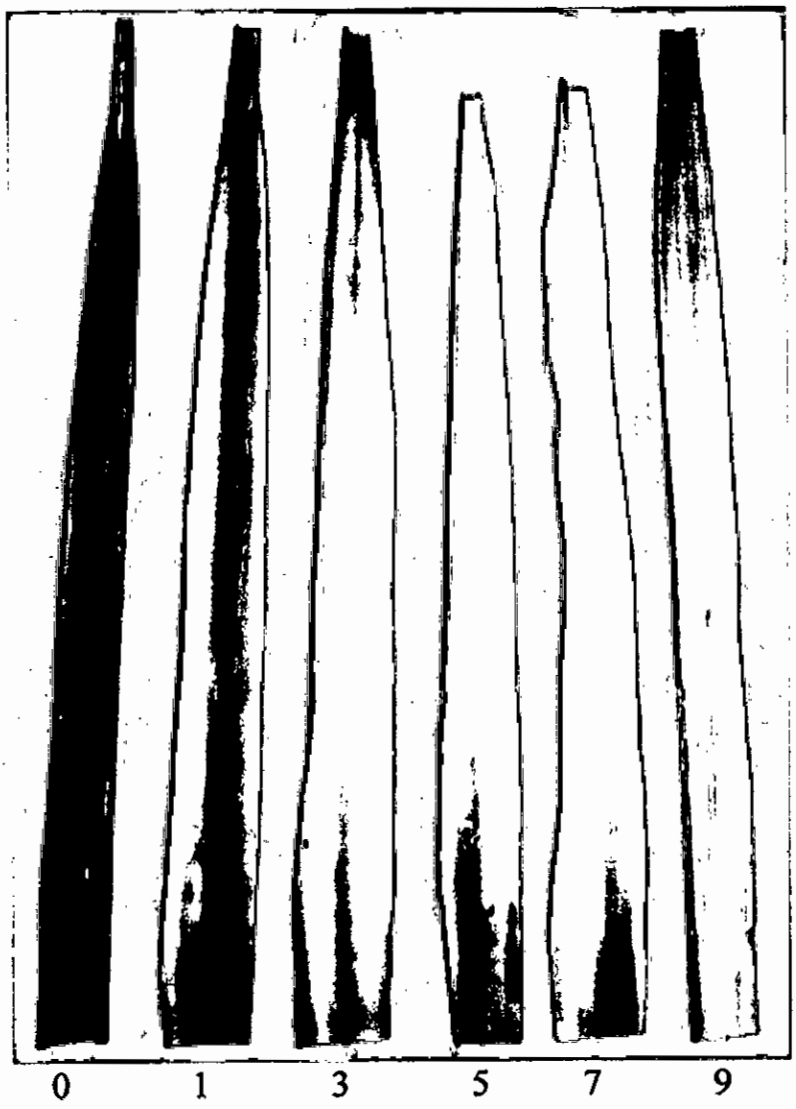


Figure 8. Leaves showing 0-9 ratting scale of bacterial leaf blight severity

3.19. Analysis of data

The data on different characters were subjected to statistical analysis using analysis of variance to find out the variation resulting from experimental treatments. The analysis was done using MSTAT computer software. Mean differences among the treatments were compared by Duncan's Multiple Range Test (DMRT).

3.20. Preparation of culture media

3.20.1. Potato dextrose agar medium (PDA)

200g clean and healthy potato slice were taken in saucepan in 500ml water and boiled. The extract was filtered throw a fine cloth and potato extract was then transferred in a clean beaker. 17g agar was melted in 500 ml of water in another beaker and the extract of potato was added to melt agar and was stirred with a glass rod. 20g of dextrose was dissolved and the volume was raised to 1000ml with distilled water. The mixture was agitated and heated with frequent stirring with a glass rod to dissolve and melted agar. The medium was poured to flask or tubes and was plugged with cotton and autoclaved for 15 minutes at 121°c under 15 PSI in an autoclave. After autoclaving, the liquid medium was poured in the petridishes and solidified.

3.20.2. Nutrient agar medium (NA)

Agar (15g) was taken in the Erlenmeyer flask containing 1000 ml distilled water. Peptone (5g) and beef extract (3g) were added to flask. For mixing properly the nutrient agar was shacked thoroughly for few minutes. Flask was then plugged with cotton and wrapped with a piece of brown paper and tied with thread. It was then autoclaved at 121°c under 15 lbs pressure for 15 minutes. After autoclaving, the liquid medium was poured in the petridishes and solidified.

3.21. Isolation and identification of different pathogenic fungi

Diseased rice leaves and sheath were collected from the field and brought to the laboratory. Diseased leaves and sheath were cut into small pieces along with healthy portion. Cut pieces were sterilized by the surface disinfectants e.g. 0.1% mercuric chloride for 30 seconds. After sterilization the cut pieces were washed three times with sterile water. The cut pieces were than placed on sterile blotter paper to remove excess water. The cut pieces were than placed on the PDA plate. The plate were labeled and placed in the incubation chamber for 7 days at 25^{0}c. After 7 days of incubation, the fungi grown on culture media. A portion of culture was taken on slide and observed under microscope and identified the pathogenic fungi i.e. *Bipolaris oryzae, Cercospora oryzae, Pyricularia grisea, Alternaria tenuissima, Rhizoctonia solani* with the help of relevant literature. A portion of culture was taken by inoculating needle on another PDA plate. A small portion from the subculture was inoculated to another PDA plate for pure culture. The fungus, thus purified, was kept in refrigerator for future use. All these operations were done aseptically in the laminar air flow chamber.

Figure 9. Symptoms of brown leaf spot in the field

Figure 10. Typical symptoms of brown leaf spot

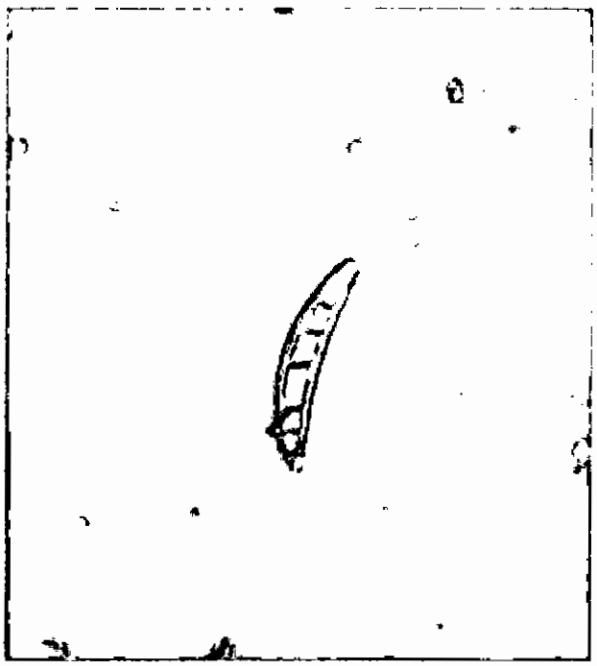


Figure 11. Conidium of *Bipolaris oryzae* observed under compound microscope (x400)

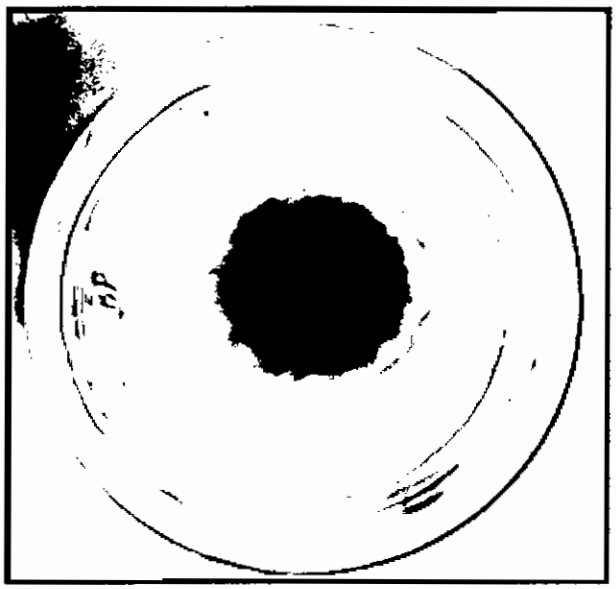
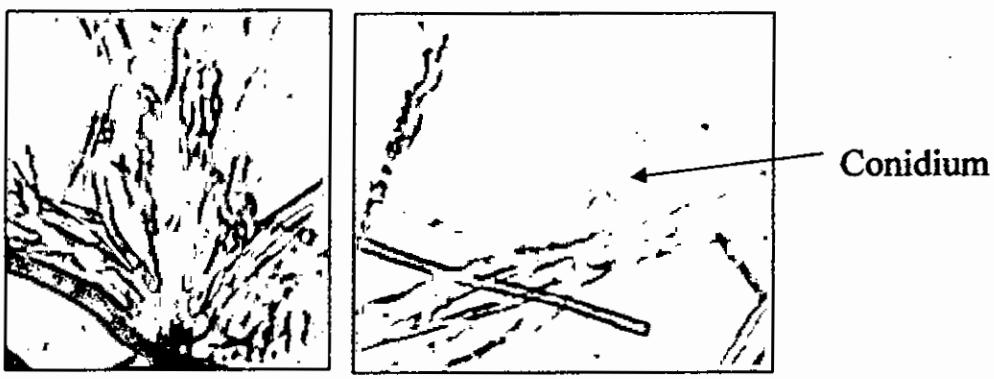


Figure 12. Pure culture of *Bipolaris oryzae*

Figure 13. Symptoms of narrow brown leaf spot observed in the field



A B

Figure 14. Compact mycelia [A(x400)] and conidium [B(x400)] of *Cercospora oryzae* observed under compound microscope

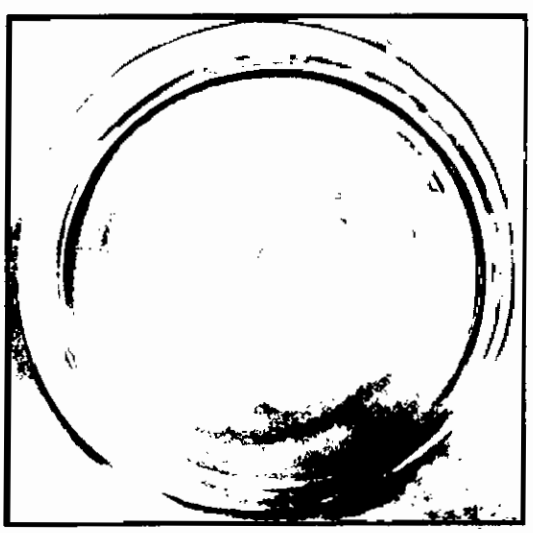


Figure 15. Pure culture of *Cercospora oryzae*

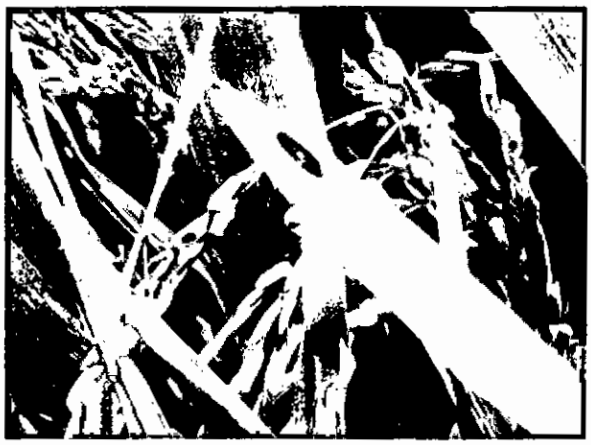


Figure 16. Symptom of leaf blast observed in the field

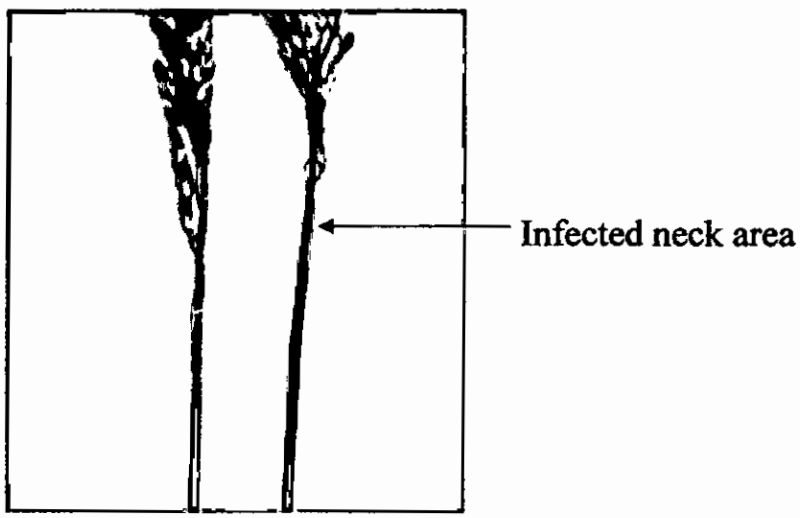


Figure 17. Symptom of neck blast

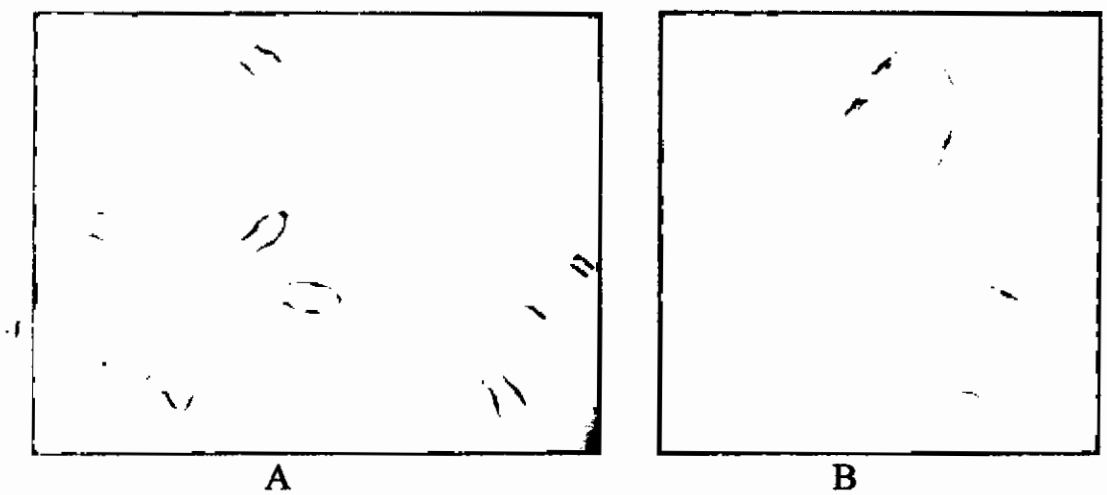


Figure 18. Conidia of *Pyricularia grisea* observed under compound microscope [A (x100) and B (x400)]

Figure 19. Symptoms of alternaria leaf spot observed in the field

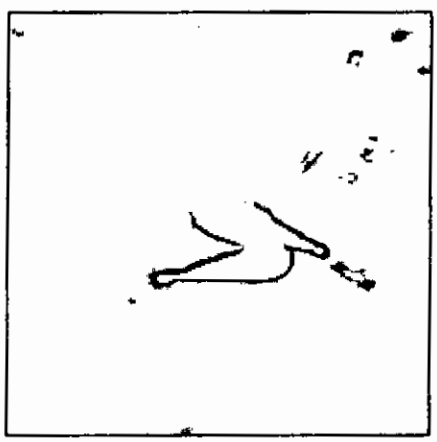


Figure 20. Conidia of *Alternaria tenuissima* observed under compound microscope (x400)

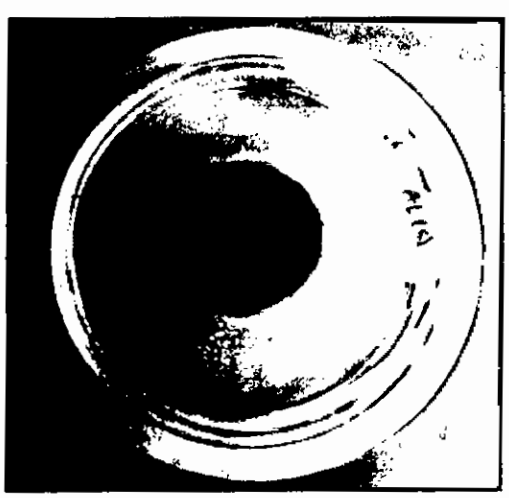


Figure 21. Pure culture of *Alternaria tenuissima*

Figure 22. Symptoms of sheath blight observed in the field

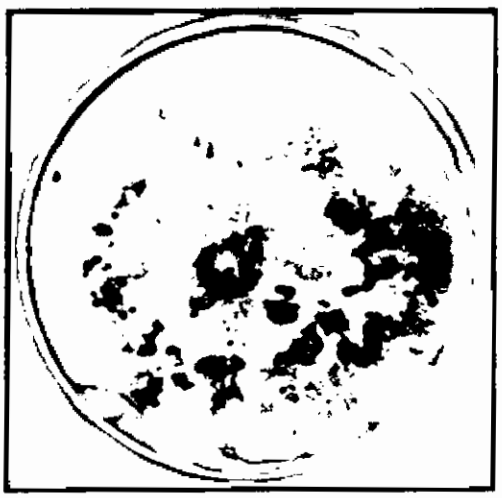


Figure 23. Pure culture of *Rhizoctonia solani*

3.22. Isolation and identification of bacteria

Blighted leaves were collected from the experimental plots. The leaves were washed by water and surface sterilized by 75% ethyl alcohol. The inocula were prepared by cutting into several small pieces from the affected leaves by a sterilized scalpel. Then the cut pieces were kept into a sterilized petridish. The sterilized inocula were placed into the culture plates. Three or four inocula were used in each petridish. Then the inoculated plates were allowed to incubate into an incubator of a temperature (37^0C). The inoculated plates were kept under daily observation to note bacterial growth around the pieces of inocula. After some days, bacterial ooze was found. Bacterial colony, light yellow colour was seen in media and *Xanthomonas campestris pv. oryzae* was identified by physiological study.

The procedure of Gram staining (Hucker's modification) -A drop of diluted inocula suspension taken by sterilized needle was placed on the slide and was fixed with the least amount of heat. Then the slide was immersed in iodine solution for one minute and washed in tap water. The water was shaken off from the slide but was not allowed to dry. The slide was decolorized for 25 seconds with 95% ethyl alcohol and then washed thoroughly in tap water and shake off excess water. Finally the slide was counterstained with safranine for 15-20 seconds and washed in tap water. The slide was dried by blotting paper or air dry and observed under the compound microscope.

Gram negative bacteria appear red colour after decolourization with 95% ethyl alcohol and gram positive ones violet colour.

3.22. Isolation and identification of bacteria

Blighted leaves were collected from the experimental plots. The leaves were washed by water and surface sterilized by 75% ethyl alcohol. The inocula were prepared by cutting into several small pieces from the affected leaves by a sterilized scalpel. Then the cut pieces were kept into a sterilized petridish. The sterilized inocula were placed into the culture plates. Three or four inocula were used in each petridish. Then the inoculated plates were allowed to incubate into an incubator of a temperature (37^{0}C). The inoculated plates were kept under daily observation to note bacterial growth around the pieces of inocula. After some days, bacterial ooze was found. Bacterial colony, light yellow colour was seen in media and *Xanthomonas campestris pv. oryzae* was identified by physiological study.

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Gram negative bacteria appear red colour after decolourization with 95% ethyl alcohol and gram positive ones violet colour.

Figure 24. Symptoms of Bacterial leaf blight observed in the field

Figure 25. Cells of bacteria of *Xanthomonas campestris pv. oryzae* observed under compound microscope(X400)

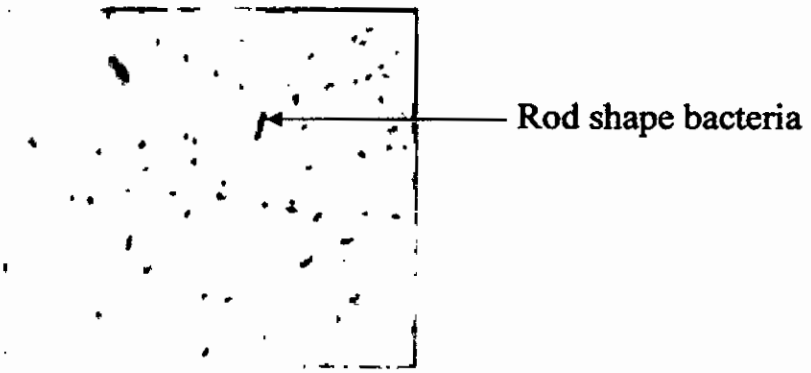
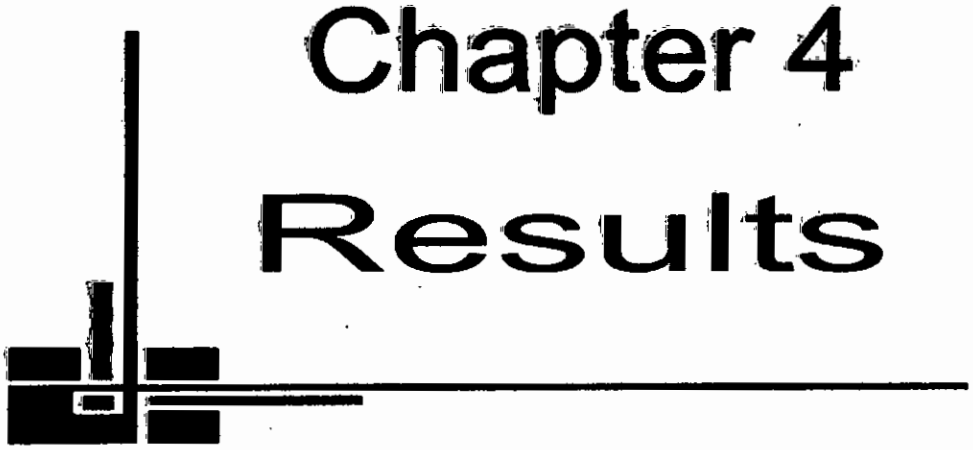


Figure 26. Rod shape of bacteria of *Xanthomonas campestris pv. oryzae* observed under compound microscope (x400)



Chapter 4
Results

CHAPTER 4

RESULTS

4.1. Disease incidence and severity of brown spot caused by *Bipolaris oryzae* of different hybrids and check varieties of boro rice

The incidence and severity of brown spot caused by *Bipolaris oryzae* in natural epiphytic condition of different hybrids and HYV varieties of rice presented in Table 2. The incidence and severity of brown spot of different hybrids and HYV varieties of rice were significantly different from one another. The incidence of brown spot at flowering stage ranged from 1.52% to 6.27%. The highest incidence of brown spot was observed in Aloron (6.27%) closely followed by Modhumoti-2 (5.08%) and BRRI dhan-29 (4.52%). The lowest incidence of brown spot was observed in Hira-2 (1.52%) which was statistically identical with ACI-1(1.63%) and Hira-1 (1.67%). The rest of the hybrids / varieties showed medium incidence.

The incidence of brown spot at milking stage ranged from 8.27% to 17.21%. The highest incidence of brown spot was observed in Aloron (17.21%) which was statistically identical with BRRI dhan-29 (17.02%) and closely followed by Modhumoti-2 and BRRI dhan-28. The lowest incidence of brown spot was observed on Hira-2 (8.27%) preceded by ACI-1 (8.92%) , Hira-1 (9.12%), BRRI hybrid dhan-1(10.21%) and Surma-1 (11.82%). The rest of the hybrids showed medium incidence.

The incidence of brown spot at maturity stage ranged from 15.51% to 25.85%. The highest incidence of brown spot was observed in Aloron (25.85%) closely followed by Modhumoti-2 (24.41%), BRRI dhan-29 (23.82%) and BRRI dhan-28 (20.45%) which was statistically identical with

Tinpata (20.42%). The lowest incidence of brown spot was observed in Hira-2 (15.51%) preceded by Moyna (16.21%), Hira-1(16.28%) and ACI-1 (17.23%). The rest of the hybrids showed medium incidence.

The severity of brown spot at flowering stage ranged from 0.08 to 1.27 (0-9 scales). The highest severity of brown spot was observed in Aloron (1.27) closely followed by Modhumoti-2 (1.12%) and Surma-1 (0.82%) which was statistically similar with BRRI dhan-28, BRRI dhan-29 and BRRI hybrid dhan-2. The lowest severity of brown spot was observed on Hira-2 (0.08) which was statistically identical with ACI-1 (0.12), Richer-101 (0.21), Taj-1 (0.24) and Sonar Bangla-6 (0.25). The rest of the hybrids showed medium severity.

The severity of brown spot at milking stage ranged from 0.32 to 2.89 (0-9 scales). The highest severity of brown spot was observed on Aloron (2.89) closely followed by Modhumoti-2 (2.59), BRRI dhan-29 (2.01), BRRI dhan-28 (1.92) and BRRI hybrid dhan-2 (1.87).The lowest severity of brown spot was observed on Hira-2 (0.32) which was statistically similar with the rest of the hybrids and HYV varieties.

The severity of brown spot at maturity stage ranged from 0.64 to 4.15 (0-9 scales). The highest incidence of brown spot was observed on Aloron (4.15) which was statistically identical with BRRI dhan-29 and Modhumoti-2 closely followed by BRRI dhan-28 (3.12) which was also statistically identical with Surma-1 (3.10) and BRRI hybrid dhan-2 (3.02).The lowest severity of brown spot was observed on Hira-2 (0.64) closely preceded by ACI-1 (0.92) and krishan-2 (1.09). The rest of the hybrids / HYV varieties showed medium severity.

Table 2. Disease incidence and severity of brown spot caused by *Bipolaris oryzae* in different hybrids and check varieties of boro rice (2008-2009)

Name of the varieties	Disease Incidence (%)			Disease severity grade (0-9 scales)		
	Flowering stage	Milking stage	Maturity stage	Flowering stage	Milking stage	Maturity stage
Hira-1	1.67 i	9.12 i	16.28 j	0.52 d	1.07 d	1.32 fg
Hira-2	**1.52 i**	**8.27 j**	**15.51 k**	**0.08 g**	**0.32 d**	**0.64 j**
ACI-1	1.63 i	8.92 i	17.23 i	0.12 g	0.34 d	0.92 i
Surma-1	3.21 g	11.82 g	19.21 g	0.82 c	0.92 d	3.10 c
Taj-1	4.21 d	13.21 e	20.23 e	0.24 e-g	0.57 d	1.81 d
Modhumoti-2	5.08 b	16.28 b	24.41 b	1.12 b	2.59 b	3.82 b
Krishan-2	2.15 h	12.45 f	19.23 g	0.25 e-g	0.54 d	1.09 hi
Sonar bangla-6	3.12 g	12.23 f	18.25 h	0.21 e-g	0.62 d	1.22 gh
Richer-101	3.28 g	12.28 f	19.39 f	0.17 fg	0.72 d	1.32 fg
Moyna	3.92 e	12.23 f	16.21 j	0.37 e	0.62 d	1.85 d
Tia	4.21 d	14.21 d	19.37 f	0.22 e-g	0.71 d	1.52 ef
Tinpata	3.87 ef	13.25 e	20.42 d	0.32 ef	0.58 d	1.72 de
Aloron	**6.27 a**	**17.21 a**	**25.85 a**	**1.27 a**	**2.89 a**	**4.15 a**
BRRI hybrid dhan-1	3.67 f	10.21 h	18.25 h	0.19 fg	0.61 d	1.39 fg
BRRI hybrid dhan-2	4.25 d	14.19 d	20.21 e	0.74 c	1.87 c	3.02 c
BRRI dhan-28	4.26 d	15.12 c	20.45 d	0.71 c	1.92 bc	3.12 c
BRRI dhan-29	4.52 c	17.02 a	23.82 c	0.79 c	2.01 bc	4.01 ab
LSD(P=0.05)	0.2104	0.3756	0.1052	0.1488	0.6398	0.1968

4.2. Disease incidence and severity of narrow brown leaf spot caused by *Cercospora oryzae* of different hybrids and check varieties of boro rice

The incidence and severity of narrow brown leaf spot caused by *Cercospora oryzae* in natural epiphytic condition of different hybrids and HYV varieties of rice shown in Table 3. The incidence and severity of narrow brown spot of different hybrids and varieties were significantly different from one to another. The incidence of narrow brown spot at flowering stage ranged from 0.00% to 3.52%. The highest incidence of narrow brown leaf spot was observed on Modhumoti-2 (3.52%) closely followed by the Surma-1 (2.02%), BRRI dhan-28 (1.96%) and Richer-101 (1.92%). The lowest incidence of narrow brown spot was observed on ACI-1 (0.00%) preceded by BRRI hybrid dhan-2 (0.68%), Hira-1 (0.92%) and Hira-2. The rest of the hybrids / varieties showed medium incidence.

The incidence of narrow brown spot at milking stage ranged from 2.17% to 5.27%. The highest incidence of narrow brown spot was observed on Modhumoti-2 (5.27%) closely followed by Surma-1 (4.92%), BRRI dhan-28 (4.47%), Krishan-2 (4.21%) which was statistically identical with Richer-101(4.21%) and BRRI dhan-29 (4.21%). The lowest incidence of narrow brown spot was observed on ACI-1 (2.17%) closely preceded by Hira-1 (2.82%), Hira-2 (3.00%). The rest of the hybrids showed medium incidence.

The incidence of narrow brown spot at maturity stage ranged from 6.27% to 12.23%. The highest incidence of narrow brown spot was observed on Modhumoti-2 (12.23%) and Surma-1 (12.23%) closely followed by Sonar Bangla-6 (11.82%), BRRI dhan-28 (10.82%) and Richer-101(10.21%) which was statistically identical with Krishan-2.The lowest incidence of narrow brown spot was observed on ACI-1 (6.27%) closely preceded by

BRRI hybrid dhan-2 (7.79%) which was statistically similar with Hira-2 (7.82%) which was preceded by BRRI hybrid dhan-1(8.20%) and Hira-1 (8.21%). The rest of the hybrids / varieties showed medium incidence.

The severity of narrow brown spot at flowering stage ranged from 0.09 to 0.92 (0-9 scales).The highest severity of narrow brown spot was observed on Modhumoti-2 (0.92) closely followed by Surma-1 (0.85), Sonar Bangla-6 (0.74), BRRI dhan-28 (0.67) and Krishan-2 (0.62).The lowest severity of narrow brown spot was observed on ACI-1 (0.09) which was statistically similar with Hira-1 (0.12), BRRI hybrid dhan-2 (0.13) and Hira-2(0.15). The rest of the hybrids / varieties showed medium severity.

The severity of narrow brown spot at milking stage ranged from 0.32 to 1.94 (0-9 scales). The highest severity of narrow brown spot was observed on Modhumoti-2 (1.94) closely followed by Surma-1 (1.82), Taj-1 (1.74) which was statistically identical with BRRI dhan-29 (1.74) and BRRI dhan-28 (1.62).The lowest severity of narrow brown spot was observed on ACI-1 (0.32) which was statistically similar with Hira-2 (0.34), BRRI hybrid dhan-2 (0.35) and Hira-1(0.42). The rest of the hybrids showed medium severity.

The severity of narrow brown spot at maturity stage ranged from 1.10 to 5.84 (0-9 scales). The highest severity of narrow brown spot was observed on Modhumoti-2 (5.84) closely followed by Surma-1 (5.32), BRRI dhan-28 (4.82) and Krishan-2 (4.32) which was statistically identical with Aloron (4.29).The lowest severity of narrow brown spot was observed on ACI-1 (1.10) which was statistically similar with Hira-1 (1.17) and Hira-2 (1.32). The rest of the hybrids / varieties showed medium severity.

Table 3. Disease incidence and severity of narrow brown leaf spot caused by *Cercospora oryzae* of different hybrids and check varieties of boro rice (2008-2009)

Name of the varieties	Disease Incidence (%)			Disease severity grade (0-9 scales)		
	Flowering stage	Milking stage	Maturity stage	Flowering stage	Milking stage	Maturity stage
Hira-1	0.92 j	2.82j	8.21 i	0.12 g	0.42 f	1.17 k
Hira-2	1.21 i	3.00 i	7.82 j	0.15 g	0.34 f	1.32 k
ACI-1	**0.00 l**	**2.17 k**	**6.27 k**	**0.09g**	**0.32 f**	**1.10 k**
Surma-1	2.02 b	4.92 b	12.23 a	0.85 ab	1.82 ab	5.32 b
Taj-1	1.57 g	3.72 f	9.87 e	0.33 f	1.74 b	3.82 e
Modhumoti-2	**3.52 a**	**5.27 a**	**12.23 a**	**0.92 a**	**1.94 a**	**5.84 a**
Krishan-2	1.87 de	4.21 d	10.92 d	0.62 cd	1.12 e	4.32 d
Sonar bangla-6	1.15 i	3.82 f	11.82 b	0.74 bc	1.32 d	2.09 j
Richer-101	1.92 cd	4.21 d	10.21 d	0.52 de	1.51 cd	3.72 ef
Moyna	1.68 f	3.96 e	8.29 i	0.37 f	1.61 bc	3.19 g
Tia	1.72 f	3.21h	8.56 h	0.41 ef	1.72 b	3.51 f
Tinpata	1.70 f	3.98 e	9.27 f	0.32 f	1.64 bc	2.52 i
Aloron	1.86 de	3.96 e	8.82 g	0.51 de	1.35 d	4.29 d
BRRI hybrid dhan-1	1.49 h	3.22 h	8.20 i	0.34 f	1.65 bc	2.64 hi
BRRI hybrid dhan-2	0.68 k	3.52 g	7.79 j	0.13 g	0.35 f	1.92 j
BRRI dhan-28	1.96 bc	4.47 c	10.82 c	0.67 c	1.62 bc	4.82 c
BRRI dhan-29	1.82 e	4.21 d	10.17 d	0.51 de	1.74 b	2.87 h
LSD(P=0.05)	0.07438	0.1176	0.2231	0.1288	0.1822	0.2630

4.3. Disease incidence and severity of leaf blast caused by *Pyricularia oryzae* of different hybrids and check varieties of boro rice

The incidence and severity of leaf blast caused by *Pyricularia grisea* in natural epiphytic condition of different hybrids and HYV varieties of rice shown in Table 4. The incidence and severity of leaf blast of different hybrids and varieties were significantly different from one to another. The incidence of leaf blast at flowering stage ranged from 1.21% to 5.29%. The highest incidence of leaf blast was observed on Richer-101 (5.29%) closely followed by Taj-1 (5.01%), Krishan-2 (4.57%) and Moyna (4.42%)which was statistically identical with Modhumoti-2 (4.28).The lowest incidence of leaf blast was observed on Hira-2 (1.21%) closely preceded by ACI-1 (1.42%), Hira-1 (1.57%), Tinpata (2.52%) and Aloron (2.82). The rest of the hybrids / varieties showed medium incidence.

The incidence of leaf blast at milking stage ranged from 6.28% to 13.28%. The highest incidence of leaf blast was observed on Richer-101 (13.28%) closely followed by Taj-1 (12.12%) which was statistically identical with Modhumoti-2 (12.11%) followed by krishan-2 (11.82%). The lowest incidence of leaf blast was observed on Hira-2 (6.28%) closely preceded by ACI-1 (7.12%) which was statistically identical with BRRI hybrid dhan-1 (7.12%) and which also preceded by Hira-1 (7.82%). The rest of the hybrids / varieties showed medium incidence.

The incidence of leaf blast at maturity stage ranged from 8.82% to 21.28%. The highest incidence of leaf blast was observed on Richer-101 (21.28%) closely followed by Taj-1 (20.82%), Krishan-2 (19.25%), Moyna (18.21%), and Tia (17.25%). The lowest incidence of leaf blast was observed on Hira-2

(8.82%) closely preceded by ACI-1 (9.02%), Hira-1 (9.27%), Surma-1 (9.82%) and Aloron (10.12%). The rest of the hybrids / varieties showed medium incidence.

The severity of leaf blast at flowering stage ranged from 0.04 to 0.86 (0-9 scales). The highest severity of leaf blast was observed on Richer-101 (0.86) which was statistically identical with Taj-1 (0.84) closely followed by Aloron (0.72) and Tinpata (0.71).The lowest severity of leaf blast was observed on Hira-2 (0.04) which was statistically similar with the ACI-1 and Hira-1. The rest of the hybrids / varieties showed medium severity.

The severity of leaf blast at milking stage ranged from 0.72 to 5.17 (0-9 scales). The highest severity of leaf blast was observed on Richer-101 (5.17) closely followed by Taj-1 (4.32), Krishan-2 (4.02) which was statistically similar with Tia (3.87). The lowest severity of leaf blast was observed on Hira-2 (0.72) which was statistically similar with the ACI-1 (0.82), and Hira-1 (0.91). The rest of the hybrids / varieties showed medium severity.

The severity of leaf blast at maturity stage ranged from 1.01 to 6.21 (0-9 scales). The highest severity of leaf blast was observed on Richer-101 (6.21) closely followed by Taj-1 (6.02), Krishan-2 (5.82) and Modhumoti-2 (5.76). The lowest severity of leaf blast was observed on Hira-2 (1.01) which was statistically similar with the ACI-1 (1.03), Hira-1 (1.09) and BRRI hybrid dhan-2 (3.83). The rest of the hybrids / varieties showed medium severity.

Table 4. Disease incidence and severity of leaf blast caused by *Pyricularia grisea* of different hybrids and check varieties of boro rice (2008-2009)

Name of the varieties	Disease Incidence (%)			Disease severity grade (0-9 scales)		
	Flowering stage	Milking stage	Maturity stage	Flowering stage	Milking stage	Maturity stage
Hira-1	1.57 l	7.82 h	9.27 o	0.12 f	0.91 i	1.09 j
Hira-2	**1.21 n**	**6.28 j**	**8.82 q**	**0.04 f**	**0.72 i**	**1.01 j**
ACI-1	1.42 m	7.12 i	9.02 p	0.09 f	0.82 i	1.03 j
Surma-1	3.02 i	9.92 f	9.82 n	0.42 de	2.92 f	4.82 d
Taj-1	5.01 b	12.12 b	20.82 b	0.84 a	4.32 b	6.02 ab
Modhumoti-2	4.28 d	12.11 b	11.21 k	0.48 de	3.52 d	5.76 c
Krishan-2	4.57 c	11.82 c	19.25 c	0.67 bc	4.02 c	5.82 bc
Sonar bangla-6	3.92 e	8.81 g	14.82 g	0.32 e	3.52 d	4.52 e
Richer-101	**5.29 a**	**13.28 a**	**21.28 a**	**0.86 a**	**5.17 a**	**6.21 a**
Moyna	4.42 d	10.21 e	18.21 d	0.46 de	3.38 de	4.72 de
Tia	3.37 h	7.82 h	17.25 e	0.54 cd	3.87 c	4.62 de
Tinpata	2.52 k	10.92 d	10.42 l	0.71 ab	2.87 f	4.21 f
Aloron	2.82 j	8.82 g	10.12 m	0.72 ab	2.21 g	3.92 g
BRRI hybrid dhan-1	3.72 f	7.12 i	13.25 i	0.32 e	1.28 h	1.21 j
BRRI hybrid dhan-2	4.02 e	7.81 h	12.21 j	0.39 de	3.01 f	3.83 g
BRRI dhan-28	3.65 f	9.92 f	13.82 h	0.52 cd	3.12 ef	3.19 i
BRRI dhan-29	3.52 g	10.02 ef	15.82 f	0.51 cd	3.02 f	3.42 h
LSD(P=0.05)	0.1488	0.2168	0.1744	0.1488	0.2783	0.2292

4.4. Disease incidence and severity of bacterial leaf blight (BLB) caused by *Xanthomonas campestris pv. oryzae* of different hybrids and check varieties of boro rice

The incidence and severity of BLB caused by *Xanthomonas campestris pv. oryzae* in natural epiphytic condition of different hybrids and HYV varieties of rice presented in Table 5. The incidence and severity of BLB of different hybrids and varieties were significantly different from one to another. The incidence of BLB at flowering stage ranged from 3.02% to 10.29%. The highest incidence of BLB was observed on Taj-1 (10.29%) which was statistically identical with Moyna (9.95%) closely followed by Krishan-2 (9.12%) which was statistically similar with Aloron (8.82%) closely followed by BRRI dhan-29 (8.21%). The lowest incidence of BLB was observed on BRRI hybrid dhan-1 (3.02%) closely preceded by Tinpata (3.10%) which was statistically identical with Hira-1 (3.12%) and ACI-1 (3.52%). The rest of the hybrids / varieties showed medium incidence.

The incidence of BLB at milking stage ranged from 7.82% to 16.25%. The highest incidence of BLB was observed on Taj-1 (16.25%) closely followed by Krishan-2 (15.21%) which was statistically similar with Aloron (14.85%) closely followed by BRRI dhan-29 (14.25%).The lowest incidence of BLB was observed on BRRI hybrid dhan-1 (7.82%) which was statistically identical with Hira-1 (8.21%) preceded by Hira-2 (8.85%). The rest of the hybrids / varieties showed medium incidence.

The incidence of BLB at maturity stage ranged from 13.28% to 28.92%. The highest incidence of BLB was observed on Taj-1 (28.92%) closely followed by Krishan-2 (27.28%) which was statistically similar with Aloron (27.26%)

Table 5. Disease incidence and severity of bacterial leaf blight caused by *Xanthomonas campestris pv. oryzae* of different hybrids and check varieties of boro rice (2008-2009)

Name of the varieties	Disease Incidence (%)			Disease severity grade (0-9 scales)		
	Flowering stage	Milking stage	Maturity stage	Flowering stage	Milking stage	Maturity stage
Hira-1	3.12 gh	8.21 j	16.29 k	0.63 j	1.12 h	1.29 j
Hira-2	7.12 de	8.85 i	18.21 i	1.92 c-f	2.55 de	6.02 de
ACI-1	3.52 g	14.15 cd	15.25 l	0.42 j	0.94 h	4.19 i
Surma-1	5.12 f	10.28 h	16.28 k	1.82 d-g	2.13 fg	4.98 f-h
Taj-1	**10.29 a**	**16.25 a**	**28.92 a**	**2.54 a**	**4.25 a**	**8.72 a**
Modhumoti-2	7.28 de	12.81 ef	19.25 h	1.62 f-h	1.87 g	4.67 h
Krishan-2	9.12 b	15.21 b	27.28 b	2.42 ab	4.12 ab	7.73 b
Sonar bangla-6	7.30 de	11.28 g	17.82 j	1.87 c-f	2.51 de	5.63 e
Richer-101	5.13 f	12.65 f	20.92 f	1.92 c-f	2.51 de	6.85 d
Moyna	9.95 a	15.82 a	27.12 b	2.01 c-e	3.92 bc	7.54 bc
Tia	7.47 d	13.72 d	25.71 d	2.13 b-d	2.72 d	6.82 d
Tinpata	3.10 gh	10.25 h	21.25 e	1.72 e-h	2.04 fg	4.96 f-h
Aloron	8.82 b	14.85 b	27.26 b	2.18 bc	3.94 bc	7.71 b
BRRI hybrid dhan-1	**3.02 h**	**7.82 j**	**13.28 m**	**0.52 j**	**0.94 h**	**1.21 j**
BRRI hybrid dhan-2	7.25 de	13.21 e	19.45 h	1.53 gh	2.27 ef	5.27 f
BRRI dhan-28	6.87 e	12.82 ef	20.32 g	1.47 h	2.15 f	4.89 gh
BRRI dhan-29	8.21 c	14.25 c	26.82 c	2.17 bc	3.82 c	7.29 c
LSD(P=0.05)	0.4174	0.5017	0.2292	0.2783	0.2522	0.3021

and Moyna (27.12%) closely followed by BRRI dhan-29 (26.82%). The lowest incidence of BLB was observed on BRRI hybrid dhan-1 (13.28%) closely preceded by ACI-1 and Hira-1 which was statistically similar with Surma-1. The rest of the hybrids / varieties showed medium incidence.

The severity of BLB at flowering stage ranged from 0.42 to 2.54 (0-9 scales). The highest severity of BLB was observed on Taj-1 (2.54) closely followed by Krishan-2 (2.42) and Aloron (2.18) which was statistically identical with BRRI dhan-29 (2.17). The lowest severity of BLB was observed on ACI-1 (0.42) which was statistically similar with BRRI hybrid dhan-1 (0.52) and Hira-1 (0.63). The rest of the hybrids / varieties showed medium severity.

The severity of BLB at milking stage ranged from 0.94 to 4.25 (0-9 scales). The highest severity of BLB was observed on Taj-1 (4.25) closely followed by Krishan-2 (4.12) which was statistically identical with Aloron (3.94) and BRRI dhan-29 (3.82). The lowest severity of BLB was observed on BRRI hybrid dhan-1 (0.94) which was statistically similar with ACI-1 (0.94) and Hira-1 (1.12). The rest of the hybrids / varieties showed medium severity.

The severity of BLB at maturity stage ranged from 1.21 to 8.72 (0-9 scales). The highest severity of BLB was observed on Taj-1 (8.72) closely followed by Krishan-2 (7.73) which was statistically identical with Aloron (7.71) and Moyna (7.54) closely followed BRRI dhan-29. The lowest severity of BLB was observed on BRRI hybrid dhan-1 (1.21) which was statistically similar with Hira-1 (1.29) preceded by ACI-1 (4.19). The rest of the hybrids / varieties showed medium severity.

4.5. Disease incidence and severity of alternaria leaf spot caused by *Alternaria tenuissima* of different hybrids and check varieties of boro rice

Results of the incidence and severity of alternaria leaf spot caused by *Alernaria tenuissima* in natural epiphytic condition of different hybrids and HYV varieties of rice is presented in Table 6. The incidence and severity of alternaria leaf spot of different hybrids and varieties were significantly different from one to another. The incidence of alternaria leaf spot at flowering stage ranged from 2.12% to 5.12%. The highest incidence of alternaria leaf spot was observed on Sonar Bangla-6 (5.12%) closely followed by Tia, Modhumoti-2 (4.95%) and Tinpata (4.02%). The lowest incidence of alternaria leaf spot was observed on Hira-1 (2.12%) which was statistically similar with ACI-1 (2.12%) closely preceded by Hira-2 (2.45%) and BRRI hybrid dhan-2 (2.82%). The rest of the hybrids / varieties showed medium incidence.

The incidence of alternaria leaf spot at milking stage ranged from 9.92% to 22.82%. The highest incidence of alternaria leaf spot was observed on Sonar Bangla-6 (22.82%) closely followed by Tia (21.29%), Modhumoti-2 (20.92%), Surma-1 (20.12%) and BRRI dhan-28 (19.38%).The lowest incidence of alternaria leaf spot was observed on Hira-1 (9.92%) closely preceded by Hira-2 (10.29%), Taj-1 (11.82%), ACI-1 (12.57%) and BRRI hybrid dhan-1 (14.28%).The rest of the hybrids / varieties showed medium incidence.

The incidence of alternaria leaf spot at maturity stage ranged from 13.27% to 32.12%. The highest incidence of alternaria leaf spot was observed on Sonar Bangla-6 (32.12%) closely followed by Tia (31.28%) which was statistically similar with Richer-101 (30.92%) which followed by Modhumoti-2

(26.98%), Surma-1 (25.53%) and Tinpata (24.11%). The lowest incidence of alternaria leaf spot was observed on Hira-1 (13.27%) closely preceded by ACI-1 (14.28%), Hira-2 (15.21%), BRRI dhan-29 (18.57%) and BRRI dhan-28 (19.81%). The rest of the varieties showed medium incidence.

The severity of alternaria leaf spot at flowering stage ranged from 0.12 to 0.98 (0-9 scales). The highest severity of alternaria leaf spot was observed on Sonar Bangla-6 (0.98) closely followed by Tia, Modhumoti-2 (0.78) and Richer-101 (0.78).The lowest severity of alternaria leaf spot was observed on Hira-1 (0.12) closely preceded by ACI-1 (0.14), BRRI hybrid dhan-1(0.21) and BRRI hybrid dhan-2 (0.32). The rest of the hybrids \ varieties showed medium severity.

The severity of alternaria leaf spot at milking stage ranged from 0.92 to 2.55 (0-9 scales). The highest severity of alternaria leaf spot was observed on Sonar Bangla-6 (2.55) which was statistically identical with Tia (2.48) closely followed by Modhumoti-2 (1.90), and Krishan-2 (1.63).The lowest severity of alternaria leaf spot was observed on Hira-1 (0.92) closely preceded by Hira-2 (1.02) which was statistically similar with ACI-1 (1.05), BRRI hybrid dhan-1 (1.08) and BRRI hybrid dhan-2 (1.10).The rest of the hybrids \ varieties showed medium severity.

The severity of alternaria leaf spot at maturity stage ranged from 1.42 to 3.00 (0-9 scales). The highest severity of alternaria leaf spot was observed on Sonar Bangla-6 (3.00) which was statistically identical with Tia (2.98) closely followed by Modhumoti-2 (2.30), Krishan-2, (2.12) and Aloron (2.05). The lowest severity of alternaria leaf spot was observed on Hira-1 (1.42) closely preceded by Hira-2 (1.62).The rest of the hybrids \ varieties showed medium severity.

Table 6. Disease incidence and severity of alternaria leaf spot caused by *Alternaria tenuissima* of different hybrids and check varieties of boro rice (2008-2009)

Name of the varieties	Disease Incidence (%)			Disease severity grade (0-9 scales)		
	Flowering stage	Milking stage	Maturity stage	Flowering stage	Milking stage	Maturity stage
Hira-1	**2.12 j**	**9.92 p**	**13.27 m**	**0.12 k**	**0.92 h**	**1.42 g**
Hira-2	2.45 i	10.29 o	15.21 k	0.38 g-i	1.02 gh	1.62 fg
ACI-1	2.12 j	12.57 m	14.28 l	0.14 jk	1.05 gh	2.01 cd
Surma-1	3.95 d	20.12 d	25.53 d	0.64 d-f	1.31 de	2.07 bc
Taj-1	3.32 f	11.82 n	21.95 f	0.72 c-e	1.12 fg	1.87 c-f
Modhumoti-2	4.95 bc	20.92 c	26.98 c	0.78 b-d	1.90 b	2.30 b
Krishan-2	3.57 e	13.21 l	21.29 g	0.74 c-e	1.63 c	2.12 bc
Sonar bangla-6	**5.12 a**	**22.82 a**	**32.12 a**	**0.98 a**	**2.55 a**	**3.00 a**
Richer-101	3.13 g	18.25 g	30.92 b	0.78 b-d	1.32 de	2.00 c-e
Moyna	3.12 g	18.57 f	20.95 g	0.58 e-g	1.35 d	2.08 bc
Tia	5.01 ab	21.29 b	31.28 b	0.92 ab	2.48 a	2.98 a
Tinpata	4.02 d	15.92 j	24.11 e	0.42 gh	1.30 d-f	1.72 ef
Aloron	3.12 g	16.95 i	22.18 f	0.39 g-i	1.20 d-g	2.05 bc
BRRI hybrid dhan-1	3.28 f	14.28 k	21.92 f	0.21 i-k	1.08 gh	1.85 c-f
BRRI hybrid dhan-2	2.82 h	17.82 h	20.51 h	0.32 h-j	1.10 gh	1.95 c-e
BRRI dhan-28	3.47 e	19.38 e	19.81 i	0.39 g-i	1.15 e-g	1.75 d-f
BRRI dhan-29	3.46 e	18.57 f	18.57 j	0.49 f-h	1.18 d-g	1.85 c-f
LSD(P=0.05)	0.1488	0.2522	0.3719	0.1744	0.1663	0.022

4.6. Disease incidence and severity of sheath blight caused by *Rhizoctonia solani* of different hybrids and check varieties of boro rice

The incidence and severity of sheath blight caused by *Rhizoctonia solani* in natural epiphytic condition of different hybrids and HYV varieties of rice shown in Table 7. The incidence and severity of sheath blight of different hybrids and varieties were significantly different from one to another. The incidence of sheath blight at flowering stage ranged from 2.21% to 5.87%. The highest incidence of sheath blight was observed on Krishan-2 (5.87%) closely followed by Taj-1 (5.28%) and Moyna (4.83%) which was statistically identical with Tinpata (4.82%). The lowest incidence of sheath blight was observed on Hira-1 (2.21%) which was statistically similar with Hira-2 (2.41%) and ACI-1 (2.34%) closely preceded by BRRI hybrid dhan-2 (3.02%).The rest of the hybrids / varieties showed medium incidence.

The incidence of sheath blight at milking stage ranged from 4.28% to 11.82%. The highest incidence of sheath blight was observed on Krishan-2 (11.82%) closely followed by Taj-1 (10.29%) which was statistically identical with Tia (10.21%) closely followed by Moyna (9.84%) and Tinpata (9.82). The lowest incidence of sheath blight was observed on Hira-1 (4.28%) closely preceded by ACI-1 (4.57%), Hira-2 (4.62%) and Surma-1 (6.29%).The rest of the hybrids / varieties showed medium incidence.

The incidence of sheath blight at maturity stage ranged from 9.27% to 25.82%. The highest incidence of sheath blight was observed on Krishan-2 (25.82%) closely followed by Taj-1 (24.21%) and Tia (24.02%). The lowest incidence of sheath blight was observed on Hira-1 (9.27%) closely preceded

by Hira-2 (10.21%) which was statistically similar with ACI-1 (10.51%) closely preceded by Sonar Bangla-6 (12.82%) and BRRI hybrid dhan-2 (15.27%).The rest of the hybrids / varieties showed medium incidence.

The severity of sheath blight at flowering stage ranged from 0.36 to 1.20 (0-9 scales). The highest severity of sheath blight was observed on Krishan-2 (1.20) closely followed by Taj-1 (0.98) and Tinpata (0.89). The lowest severity of sheath blight was observed on Hira-1 (0.36) closely preceded by BRRI hybrid dhan-1 (0.42) and Hira-2 (0.60).The rest of the hybrids / varieties showed medium severity.

The severity of sheath blight at milking stage ranged from 0.92 to 3.13 (0-9 scales). The highest severity of sheath blight was observed on Krishan-2 (3.13) closely followed by Taj-1 (2.92), Tinpata (2.45), Sonar Bangla-6 (2.11) and Richer-101 (2.01).The lowest severity of sheath blight was observed on Hira -1 (0.92) which was statistically similar with the hybrids Hira-2 (1.02) and ACI-1 (1.21).The rest of the hybrids / varieties showed medium severity.

The severity of sheath blight at maturity stage ranged from 1.52 to 8.74 (0-9 scales). The highest severity of sheath blight was observed on Krishan-2 (8.74) closely followed by Taj-1 (8.01), Tinpata (7.72) and Sonar Bangla-6 (7.52). The lowest severity of sheath blight was observed on Hira -1 (1.52) which was statistically similar with the hybrids Hira-2 (1.61) and ACI-1(1.92).The rest of the hybrids / varieties showed medium severity.

Table 7. Disease incidence and severity of sheath blight caused by *Rhizoctonia solani* of different hybrids and check varieties of boro rice (2008-2009)

Name of the varieties	Disease Incidence (%)			Disease severity grade (0-9 scales)		
	Flowering stage	Milking stage	Maturity stage	Flowering stage	Milking stage	Maturity stage
Hira-1	**2.21 i**	**4.28 k**	**9.27 l**	**0.36 g**	**0.92 h**	**1.52 g**
Hira-2	2.41 i	4.62 j	10.21 k	0.60 ef	1.02 h	1.61 g
ACI-1	2.34 i	4.57 jk	10.51 k	0.64 d-f	1.21 h	1.92 g
Surma-1	4.02 ef	6.29 i	18.81 f	0.87 b-d	1.80 d-f	5.82 e
Taj-1	5.28 b	10.29 b	24.21 b	0.98 b	2.92 ab	8.01 b
Modhumoti-2	3.38 g	7.85 g	16.32 h	0.71 c-e	1.95 c-e	7.23 cd
Krishan-2	**5.87 a**	**11.82 a**	**25.82 a**	**1.20 a**	**3.13 a**	**8.74 a**
Sonar bangla-6	4.10 ef	8.29 f	12.82 j	0.79 b-e	2.11 cd	7.52 bc
Richer-101	4.45 d	8.92 e	17.42 g	0.75 c-e	2.01 c-e	5.41 e
Moyna	4.83 c	9.84 c	23.85 c	0.68 c-e	1.92 c-e	7.20 cd
Tia	3.87 f	10.21 b	24.02 bc	0.76 b-e	1.82 d-g	7.14 cd
Tinpata	4.82 c	9.82 c	23.82 c	0.89 bc	2.45 bc	7.72 bc
Aloron	4.47 d	9.35 d	22.92 d	0.65 c-e	1.85 d-f	5.24 e
BRRI hybrid dhan-1	4.19 d-f	7.21 h	21.87 e	0.42 fg	1.34 f-h	3.37 f
BRRI hybrid dhan-2	3.02 h	8.86 e	15.27 i	0.72 c-e	1.49 e-h	5.41 e
BRRI dhan-28	4.32 de	8.84 e	23.85 c	0.71 c-e	1.90 c-e	5.49 e
BRRI dhan-29	4.46 d	9.37 d	23.01 d	0.78 b-e	1.19 h	6.65 d
LSD(P=0.05)	0.3021	0.3021	0.3284	0.2104	0.5180	0.5541

4.7. Effect of field diseases on plant growth and yield contributing characters of different hybrids and HYV varieties of boro rice

Results regarding the effect of field diseases like brown spot, narrow brown leaf spot, leaf blast, bacterial leaf blight, alternaria leaf spot and sheath blight on plant height, panicle length, number of effective panicle/hill, number of ineffective panicle/hill, number of filled grain/panicle, number of rachis/ panicle of different hybrids and HYV varieties of rice were shown in the Table 8.

Plant height

Plant height ranged from 87.47 cm to 100.6 cm. The highest plant height was recorded from the variety ACI-1 (100.6 cm) closely followed by Hira-2 (99.92 cm), Hira-1 (98.12 cm), BRRI hybrid dhan-1 (96.00 cm) and Richer-101 (95.42 cm). The lowest plant height was noted on BRRI dhan-28 (87.47 cm) which was statistically similar with Krishan-2 (88.47 cm) preceded by BRRI dhan-29 (88.91 cm). The rest of the hybrids had medium plant height.

Panicle length

Panicle length ranged from 17.50 cm to 26.02 cm. The highest panicle length was recorded from the variety ACI-1 (26.02 cm) which was statistically similar with Hira-2 (25.82 cm), Hira-1 (25.32 cm), BRRI hybrid dhan-2 (25.12 cm) and BRRI hybrid dhan-1 (24.13 cm). The lowest panicle length was recorded on BRRI dhan-29 (17.50 cm) closely preceded by BRRI dhan-28 (18.21 cm). The rest of the hybrids had medium plant height.

Number of effective panicles/hill

Number of effective panicles/hill ranged from 9.13 to 20. The maximum number of effective panicles/hill was recorded on Hira-1(20) closely followed by ACI-1 (19.21), Hira-2 (18.53), BRRI hybrid dhan-2 (17.82) and Tinpata (14.53). The minimum number of effective panicles/hill was noted

on Taj-1 (9.13) closely preceded by Modhumoti-2 (11.03), Krishan-2 (11.90), Richer-101 (12.13) and Sonar Bangla-6 (12.50) in which the last four hybrids were statistically similar. The rest of the hybrids / varieties had medium number of effective panicle/hill.

Number of ineffective panicles/hill

Number of ineffective panicles/hill ranged from 0.93 to 2.27. The maximum number of ineffective panicles/hill was recorded on Hira-2 (2.27) closely followed by ACI-1 (2.10) and BRRI hybrid dhan-2 (2.20) in which the last two hybrids were statistically identical. The minimum number of ineffective panicles/hill was noted on BRRI dhan-29 (0.93) closely preceded by BRRI dhan-28 (1.13), Tia (1.13), Surma-1 (1.17) and Taj-1 (1.21) in which the last two hybrids were statistically similar. The rest of the hybrids had medium number of effective panicles/hill.

Number of filled grains/panicle

Number of filled grains/panicle ranged from 88.87 to 128.7. The maximum number of filled grain/panicle was recorded on Hira-1 (128.7) closely followed by the hybrids ACI-1 (121.3) which was statistically similar with Sonar Bangla-6 (119.3), Hira-2 (118.1) and BRRI hybrid dhan-2 (117.7). The minimum number of filled grains/panicle was found on Taj-1 (88.87) which was statistically similar with Moyna (90.87), BRRI dhan-29 (90.87), Tia (92.93), BRRI dhan -28 (92.93) and Aloron (92.47). The rest of the hybrids had medium number of filled grains/panicle.

Number of unfilled grains/panicle

Number of unfilled grains/panicle ranged from 7.67 to 27.60. The maximum number of unfilled grains/panicle was recorded on Taj-1 (27.60) closely followed by the hybrids Sonar Bangla-6 (22.23) and ACI-1 (19.73). The minimum number of unfilled grains/panicle was recorded on BRRI dhan-28 (7.67) which was statistically similar with BRRI dhan-29 (8.20) and Hira-1 (8.20).The rest of the hybrids had medium number of unfilled grains/panicle.

Table 8. Effect of diseases on plant growth and yield contributing characters of different imported hybrids and check varieties boro rice (2008-2009)

Name of the Varieties	Plant height (cm)	Panicle length (cm)	No. of effective panicles/hill	No. of ineffective panicles/hill	No. of filled grains/panicle	No. of unfilled grains/panicle	No. of rachis/panicle
Hira-1	98.12 a-c	25.32 ab	20.00 a	1.93 bc	128.7 a	8.20 h	15.23 a
Hira-2	99.92 ab	25.82 a	18.53 bc	2.27 a	118.1 b	18.23 d	14.28 a
ACI-1	100.6 a	26.02 a	19.21 ab	2.10 ab	121.3 b	19.73 c	13.00 b
Surma-1	91.37 d-g	22.53 cd	11.53 hi	1.17 g-i	102.2 cd	12.33 f	12.26 b-d
Taj-1	91.87 d-g	20.13 ef	9.13 j	1.21 g-i	88.87 f	27.60 a	11.43 c-f
Modhumoti-2	92.83 d-f	22.43 cd	11.03 i	1.72 cd	102.1 cd	19.23 cd	11.17 d-f
Krishan-2	88.47 g	23.50 b-d	11.90 g-i	1.27 f-h	94.53 ef	12.67 f	9.77 g
Sonar bangla-6	91.63 d-g	23.40 b-d	12.50 f-h	1.53 d-f	119.3 b	22.23 b	12.53 bc
Richer-101	95.42 cd	23.30 b-d	12.13 g-i	1.73 cd	96.21 e	12.80 f	10.90 ef
Moyna	90.64 e-g	22.67 cd	11.97 g-i	1.60 de	90.87 ef	9.87 g	10.60 fg
Tia	93.67 c-e	20.33 e	13.00 e-g	1.13 hi	92.93 ef	15.80 e	11.87 c-e
Tinpata	89.87 e-g	21.40 de	14.53 d	1.47 d-g	96.56 de	12.33 f	11.33 d-f
Aloron	94.21 c-e	23.17 b-d	13.95 de	1.40 e-h	92.47 ef	11.47 f	11.20 d-f
BRRI hybrid dhan-1	96.00 b-d	24.13 a-c	13.97 de	1.78 cd	104.3 c	15.95 e	11.70 c-f
BRRI hybrid dhan-2	92.33 d-f	25.12 ab	17.82 c	2.20 ab	117.7 b	16.20 e	11.27 d-f
BRRI dhan-28	87.47 g	18.21 fg	13.67 d-f	1.13 hi	92.93 ef	7.67 h	11.53 c-f
BRRI dhan-29	88.91 fg	17.50 g	12.90 e-g	0.93 i	90.87 ef	8.20 h	10.73 e-g
LSD(P=0.05)	4.039	1.945	1.189	0.2881	5.488	1.206	0.9797

Number of rachis/ panicle

Number of rachis/ panicle ranged from 9.77 to 15.23. The maximum number of rachis/ panicle was recorded on Hira-1 (15.23) which was statistically similar with Hira-2 (14.28). The minimum number of rachis/ panicle was recorded on Krishan-2 (9.77) closely preceded by the hybrids / varieties Moyna (10.60) and BRRI dhan-29 (10.73).The rest of the hybrids / varieties had medium number of rachis/ panicle.

4.8. Effect of diseases on yield and yield contributing characters of different hybrids and check varieties of boro rice

Results regarding the effect of field diseases i.e. brown spot, narrow brown leaf spot, leaf blast, bacterial leaf blight, alternaria leaf spot and sheath blight on weight of grain/panicle, weight of grain/hill, weight of straw/hill, grain yield/plot, straw yield/plot 1000 seed weight and grain yield of different hybrids and varieties of boro rice were shown in the Table 9.

Weight of grains/panicle

Weight of grains/panicle ranged from 4.12 gm to 6.32 gm. The highest weight of grains/panicle was recorded on ACI-1 (6.32 gm) which was statistically similar with Hira-1 (6.06 gm), Hira-2 (6.02 gm), Moyna (5.41 gm), Tinpata (5.35 gm), Surma-1 (5.24 gm) and Tia (5.20 gm). The lowest weight of grains/panicle was found on BRRI dhan-29 (4.12 gm). The rest of the hybrids / varieties had medium weight of grains/panicle.

Weight of grains/hill

Weight of grains/hill ranged from 32.63 gm to 63.22 gm. The highest weight of grains/hill was recorded on Hira-1 (63.22 gm) which was statistically similar with ACI-1 (62.87 gm) and Hira-2 (62.31 gm). The lowest weight of grains/hill was noted on Krishan-2 (32.63 gm) closely preceded by the hybrids / varieties BRRI hybrid dhan-2 (39.55 gm), BRRI dhan-29 (41.19

gm), BRRI dhan-28 (44.49 gm) and Modhumoti-2 (45.81 gm) in which the last two were statistically identical. The rest of the hybrids had medium weight of grains/hill.

Weight of straw/hill

Weight of straw/hill ranged from 111.8 g o 130.3 gm. The highest weight of straw/hill was recorded on Hira-1 (130.3 gm) closely followed by the hybrids Moyna (128.2 gm) and Tinpata (127.8 gm). The lowest weight of straw/hill was recorded on BRRI dhan-28 (111.8) which was statistically identical with Surma-1 (115.3 gm), BRRI dhan-29 (115.8 gm) and Taj-1 (116.3 gm). The rest of the hybrids had medium weight of straw/hill.

Grain yield/plot

Grain yield/plot ranged from 1.69 kg to 4.05 kg. In case of hybrids, the highest grain yield/plot was recorded on Hira-1 (4.05 kg) which was closely followed by the hybrid Hira-2 (3.64 kg) which was statistically identical with ACI-1 (3.63 kg), Tia (3.60 kg) Sonar Bangla-6 (3.56 kg), Tinpata (3.45 kg) and Surma-1 (3.44 kg). The lowest grain yield/plot was found on Krishan-2 (2.96 kg) which was statistically similar with Richer-101 (2.97 kg). The rest of the hybrids had medium grain yield/plot. In case of local high yielding varieties (HYVs), the highest grain yield/plot was recorded on BRRI dhan-28 (1.84 kg) and the lowest grain yield/plot was noted on BRRI dhan-29 (1.69 kg).

Straw yield/plot

Straw yield/plot ranged from 8.20 kg to 13.05 kg. The highest straw yield/plot was recorded on BRRI dhan-28 (13.05 kg) closely followed by Krishan-2 (11.97 kg) and ACI-1 (11.70 kg). The lowest straw yield/plot was recorded on BRRI hybrid dhan-2 (8.20 kg). The rest of the hybrids / varieties had medium straw yield/plot.

Table 9. Effect of diseases on yield and yield contributing characters of different hybrids and check varieties of boro rice (2008-2009)

Name of the varieties	Wt. of grains/panicle (gm)	Wt. of grains/hill (gm)	Wt. of straw/hill (gm)	Grain yield/plot (kg)	straw yield/plot (kg)	1000 seed wt. (gm)	Grain yield (t/ha)
Hira-1	6.06 a	63.22 a	130.3 a	4.05 a	11.53 b-d	53.70 bc	10.77 a
Hira-2	6.02 a	62.31 a	124.7 de	3.64 b	10.57 d-f	54.40 abc	9.72 b
ACI-1	6.32 a	62.87 a	122.7 fg	3.63 b	11.70 bc	54.87 ab	9.70 b
Surma-1	5.24 a-c	55.47 de	115.3 k	3.44 b	11.30 b-e	47.95 g	9.17 b-d
Taj-1	4.24 bc	54.89 e	116.3 jk	3.19 bc	11.13 b-f	44..87 h	8.53 d-g
Modhumoti-2	4.43 bc	45.81 h	117.3 ij	3.37 bc	10.30 f	45.45 h	8.98 c-g
Krishan-2	4.22 bc	32.63 j	118.6 hi	2.96 c	11.97 b	47.76 g	7.90 g
Sonar bangla-6	4.23 bc	54.83 e	119.8 h	3.56 b	10.97 c-f	40.06 j	9.50 bc
Richer-101	4.28 bc	60.23 b	121.7 g	2.97 c	10.63 d-f	50.40 f	7.92 g
Moyna	5.41 ab	57.80 c	128.2 b	3.43 b	11.50 b-d	50.99 ef	9.15 b-f
Tia	5.20 a-c	50.84 f	126.3 cd	3.60 ab	10.77 c-f	53.78 bc	9.60 bc
Tinpata	5.35 ab	51.33 f	127.8 bc	3.48 b	10.40 ef	54.19 abc	9.30 bc
Aloron	4.37 bc	56.90 cd	125.6 de	3.17 bc	11.37 b-e	55.49 a	8.45 fg
BRRI hybrid dhan-1	5.21 a-c	48.29 g	124.3 ef	3.15 bc	11.27 b-f	53.00 cd	8.40 fg
BRRI hybrid dhan-2	4.45 bc	39.55 i	119.8 h	3.18 bc	8.20 g	51.90 de	8.48 e-g
BRRI dhan-28	4.32 bc	44.49 h	111.8 l	1.84 d	13.05 a	42.63 i	4.90 h
BRRI dhan-29	4.12 c	41.19 i	115.8 jk	1.69 d	10.63 d-f	41.04 j	4.50 h
LSD(P=0.05)	1.039	1.804	1.644	0.4369	0.8513	1.385	0.6178

Thousands (1000) Seed Weight

Thousands seed weight ranged from 40.06 gm to 55.49 gm. The highest 1000 seed weight was recorded on Aloron (55.49 gm) which was statistically identical with ACI-1 (54.87 gm), Hira-2 (54.40 gm) and Tinpata (54.19 gm)closely followed by Tia (53.78 gm) and Hira-1 (53.70 gm) in which Tia and Hira-1 were statistically similar. The lowest 1000 seed weight was recorded on Sonar Bangla-6 (40.06 gm) which was statistically identical BRRI dhan-29 (41.04 gm) closely preceded by BRRI dhan-28 (42.63 gm), Modhumoti-2 (45.45 gm) and Taj-1 (44.87 gm). Modhumoti-2 and Taj-1 were statistically identical. The rest of the hybrids had medium 1000 seed weight.

Grain yield

Grain yield ranged from 4.50 t/ha to 10.77 t/ha. In case of hybrids, the highest grain yield was recorded on Hira-1 (10.77 t/ha) which was closely followed by the hybrid Hira-2 (9.72 t/ha) which was statistically identical with ACI-1 (9.70 t/ha) closely followed by Tia (9.60 t/ha) which was statistically similar with Sonar Bangla-6 (9.50 t/ha) and Tinpata (9.30 t/ha). The lowest grain yield was found on Krishan-2 (7.90 t/ha) which was statistically identical with Richer-101 (7.92 t/ha) closely preceded by BRRI hybrid dhan-1 (8.40 t/ha), Aloron (8.45 t/ha), BRRI hybrid-2 (8.48 t/ha) and Taj-1 (8.98 t/ha). But Krishan-2, Richer-101, Taj-1, Aloron, BRRI hybrid dhan-1 and BRRI hybrid-2 were statistically identical. The rest of the hybrids had medium grain yield. In case of local high yielding varieties (HYVs), the highest grain yield was recorded on BRRI dhan-28 (4.90 t/ha) and the lowest grain yield was noted on BRRI dhan-29 (4.50 t/ha).

Chapter 5
Discussion

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The present investigation was carried out to evaluate imported hybrid rice varieties against major diseases under natural epiphytic conditions of Bangladesh during boro season of 2008-2009 at Sher-e-Bangla Agricultural University. The research work was aimed at recording the incidence and severity of field diseases viz. brown spot, narrow brown leaf spot, leaf blast, bacterial leaf blight, alternaria leaf spot and sheath blight on 15 rice hybrids (13 imported , 2 local) and 2 HYVs check varieties grown in boro season.

5.1. Disease incidence and severity of brown spot of rice

It was observed that under natural epiphytic conditions, the incidence and severity of brown spot was fairly significant. The incidence of brown spot caused by *Bipolaris oryzae* ranged 1.52% to 6.27%, 8.27% to 17.21% and 15.51% to 25.85% at flowering, milking and maturity stage, respectively. The severity of brown spot in grade (0-9 scales) ranged 0.08 to 1.27, 0.32 to 2.89 and 0.64 to 4.15, respectively at flowering, milking and maturity stage. In flowering stage, the highest incidence (6.27%) and severity (1.27) was recorded on Aloron. The lowest incidence (1.52%) and severity (0.08) was observed on Hira-2. In milking stage, the highest incidence (17.21%) and severity (2.89) was recorded on Aloron. The lowest incidence (8.27%) and severity (0.32) was observed on Hira-2. In maturity stage, the highest incidence (25.85%) and severity (4.15) was recorded on Aloron. The lowest incidence (15.51%) and severity (0.64) was observed on Hira-2. The present findings were supported by Rashed, 2001, who reported that the incidence and severity of brown spot were observed 30.75% to 62.75% and 25.25% to 47.50%, respectively at 50 days after transplanting on the hybrids line 321H.

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The incidence and severity were 40.50% to 80% and 45% to 77%, respectively at 70 days after transplanting on the hybrids line 321H. Saifulla (1994) reported that mean brown spot severity ranged 23.0% to 36.5% in IR9924-14 and IR9924-14.

5.2. Disease incidence and severity of narrow brown leaf spot of rice

The incidence of narrow brown leaf spot caused by *Cercospora oryzae* ranged 0.00% to 3.52%, 2.17% to 5.27% and 6.27% to 12.23% at flowering, milking and maturity stage, respectively. The severity in grade (0-9 scales) ranged 0.09 to 0.92, 0.32 to 1.94 and 1.10 to 5.84 at flowering, milking and maturity stage, respectively. In flowering stage the highest incidence (3.52%) and severity (0.92) was recorded on Modhumoti-2. The lowest incidence (0.00%) and severity (0.09) was recorded on ACI-1. In milking stage, the highest incidence (5.27%) and severity (1.94) was recorded on Modhumoti-2. The lowest incidence (2.17%) and severity (0.32) was recorded on ACI-1. In maturity stage, the highest incidence (12.23%) and severity (5.84) was recorded on Modhumoti-2. The lowest incidence (6.27%) and severity (1.10) was observed on ACI-1.The present findings were supported by Rai *et al.* (2003), who reported the increasing trend of disease severity of disease development at later stages of growth and the maximum disease severity 22.08% was recorded at dough stage. Jha (2004) reported that the average disease severity at the mature and dough stage were 23.8% and 26.2%, respectively.

5.3. Disease incidence and severity of leaf blast of rice

The incidence of leaf blast caused by *Pyricularia grisea* ranged 1.21% to 5.29%, 6.28% to 13.28% and 8.82% to 21.28% at flowering, milking and maturity stage respectively. The severity in grade (0-9 scales) ranged 0.04 to 0.86, 0.72 to 5.17and 1.01 to 6.21 at flowering, milking and maturity stage respectively. In flowering stage the highest incidence (5.29%) and severity (0.86) was recorded on Richer-101. The lowest incidence (1.21%) and severity (0.04) was recorded on Hira-2. In milking stage, the highest incidence (13.28%) and severity (5.17) was recorded on Richer-101. The lowest incidence (6.28%) and severity (0.72) was recorded on Hira-2. In maturity stage, the highest incidence (21.28%) and severity (6.21) was recorded on Richer-101. The lowest incidence (8.82%) and severity (1.01) was observed on Hira-2. These findings were supported by Kumar (2001), who reported that the severity ranged from 0% to 6.03% and the highest (6.03%) severity was recorded on the accession number 74R and lowest (0.0%) in 72R in boro season.

5.4. Disease incidence and severity of BLB of rice

The incidence of BLB caused by *Xanthomonas campestris pv. oryzae* ranged 3.02% to 10.29%, 7.82% to 16.25% and 13.28% to 28.92% at flowering, milking and maturity stage, respectively. The severity in grade (0-9 scales) ranged 0.42 to 2.54, 0.94 to 4.25 and 1.21 to 8.72 at flowering, milking and maturity stage, respectively. In flowering stage the highest incidence (10.29%) and severity (2.54) was recorded on Taj-1. The lowest incidence (3.02%) was found on BRRI hybrid dhan-1 and the lowest severity (0.42) was recorded on ACI-1. In milking stage, the highest incidence (16.25%) and severity (4.25) was recorded on Taj-1. The lowest incidence (7.82%) and severity (0.94) was recorded on BRRI hybrid dhan-1. In maturity stage, the highest incidence (28.92%) and severity (8.72) was recorded on Taj-1. The lowest incidence (13.28%) and severity (1.21) was observed on BRRI

5.3. Disease incidence and severity of leaf blast of rice

The incidence of leaf blast caused by *Pyricularia grisea* ranged 1.21% to 5.29%, 6.28% to 13.28% and 8.82% to 21.28% at flowering, milking and maturity stage respectively. The severity in grade (0-9 scales) ranged 0.04 to 0.86, 0.72 to 5.17and 1.01 to 6.21 at flowering, milking and maturity stage respectively. In flowering stage the highest incidence (5.29%) and severity (0.86) was recorded on Richer-101. The lowest incidence (1.21%) and severity (0.04) was recorded on Hira-2. In milking stage, the highest incidence (13.28%) and severity (5.17) was recorded on Richer-101. The lowest incidence (6.28%) and severity (0.72) was recorded on Hira-2. In maturity stage, the highest incidence (21.28%) and severity (6.21) was recorded on Richer-101. The lowest incidence (8.82%) and severity (1.01) was observed on Hira-2. These findings were supported by Kumar (2001), who reported that the severity ranged from 0% to 6.03% and the highest (6.03%) severity was recorded on the accession number 74R and lowest (0.0%) in 72R in boro season.

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hybrid dhan-1. The present findings were supported by Zakaria (2001), who reported that the maximum incidence and severity of BLB was recorded 33.08% and 33.87% respectively.

5.5. Disease incidence and severity of sheath blight of rice

The incidence of sheath blight caused by *Rhizoctonia solani* ranged 2.21% to 5.87 %, 4.28 % to 11.82% and 9.27% to 25.82% at flowering, milking and maturity stage, respectively. The severity in grade (0-9 scales) ranged 0.36 to 1.20, 0.92 to 2.11 and 1.52 to 8.74 at flowering, milking and maturity stage, respectively. In flowering stage the highest incidence (5.87%) and severity (1.20) was recorded on Krishan-2. The lowest incidence (2.21%) and severity (0.36) was recorded on Hira-1. In milking stage, the highest incidence (11.82%) and severity (2.11) was recorded on Krishan-2. The lowest incidence (4.28%) and severity (0.92) was recorded on Hira-1. In maturity stage, the highest incidence (25.82%) and severity (8.74) was recorded on Krishan-2. The lowest incidence (9.27%) and severity (1.52%) was observed on Hira-1. These findings were supported by Alam (2007), who reported that the maximum infection index (28.90 %) was recorded at soft dough stage and minimum (13.77%) infection index was found at maximum tillering stage.

From the results, it was observed that minimum incidence and severity results maximum yield. It was also observed that disease incidence and severity was gradually increased from flowering stage to milking stage and maturity stage. These findings were supported by Klomp (1977), who reported that the susceptibility of the disease increased with plant age.

5.6. Effect of major diseases in yield and yield contributing characters of boro rice

Plant height ranged from 87.47 cm to 100.6 cm. The highest plant height was recorded (100.6cm) in ACI-1 and the lowest (87.47 cm) in BRRI dhan-28. Panicle length ranged from 17.50 cm to 26.02 cm while the highest (26.02 cm) length was recorded in ACI-1 and the lowest (17.50 cm) in BRRI dhan-29. Number of effective panicle/hill ranged from 9.13 to 20. The highest (20) in Hira-1 and the lowest (9.13) in Taj-1. Numbers of ineffective panicle/hill ranged from 0.93 to 2.27 while the highest (2.27) in Hira-2 and the lowest (0.93) in BRRI dhan-29. Numbers of filled grain/panicle ranged from 88.87 to 128.7 while the highest (128.7) in Hira-1 and the lowest (88.87) in Taj-1. Number of unfilled grain/panicle ranged from 7.67 to 27.60 where the highest (27.60) in Taj-1 and the lowest (7.67) in BRRI dhan-28. Weight of grain/panicle ranged from 4.12 gm to 6.32 gm where the highest (6.32 gm) in ACI-1 and the lowest (4.12 gm) in BRRI dhan-29. Weight of grain/hill ranged from 32.63 gm to 62.31 gm. The highest (62.31gm) in Hira-1 and the lowest (32.63 gm) in Krishan-2. Grain yield/plot ranged from 1.69 kg to 4.05 kg. The highest grain yield (4.05 kg) in Hira-1 and the lowest (1.69 kg) in BRRI dhan-29. Straw yield/plot ranged from 8.20 kg to 13.05 kg. The highest straw yield (13.05 kg) in BRRI dhan-28 and the lowest (8.20 kg) in BRRI hybrid dhan-2. Thousands seed weight ranged from 40.06 gm to 55.49 gm. The highest 1000 seed weight (55.49 gm) was recorded in Aloron and the lowest (40.06 gm) in Sonar Bangla-6. Rashed (2001) studied on twenty hybrids/lines/ of boro rice who found that the incidence and severity of brown spot decrease considerable amount of yield and panicle length. Significantly higher number of healthy grains/panicle (138.50) was found in the line 312H and lower (73.50) in the line 321H. The highest number of spotted grains/panicle (20.47) was found in 321H and lower (4.30) in 312H. The

highest number of discolored grains/panicle (24.77) was found in 321H and lower (4.03) in 312H. The highest number of unfilled grains/panicle (56.33) was found in 321H and lower (15.70) in 312H. Incidence and severity of brown spot at 70 days after transplanting of hybrids/varieties of boro rice showed significantly and negatively correlated with yield.

The maximum incidence and severity of the diseases was found in Aloron, Richer-101, Taj-1, Krishan-2 and Modhumoti-2 and Sonar Bangla-6 but the panicle length of these hybrids was lower than other hybrids. The minimum incidence and severity of the diseases was found in Hira-2, Hira-1 and ACI-1 with maximum number of effective panicle/hill, number of filled grain/panicle, number of rachis/panicle. The minimum incidence and severity of the diseases was found in Hira-2, Hira-1 and ACI-1 with maximum weight of grain/panicle, weight of grain/hill, 1000 seed weight and grain yield/plot.

In case of brown spot disease, the highest incidence (25.85%) and severity (4.15) was recorded on Aloron in maturity stage with lower yield (8.45 t/ha). The lowest incidence (15.51%) and severity (0.64) was observed on Hira-2 with higher yield (9.72 t/ha).The present finding was supported by Rashed (2001) who studied on twenty hybrids/lines/ varieties. Among these the lowest incidence (40.50%) and severity (45.00%) at 70 days after transplanting with the highest yield (6.88 ton/ha) were recorded on the line 312H.

In case of BLB disease, the highest incidence (28.92%) and severity (8.72) was recorded on Taj-1 in maturity stage with lower yield (8.53 t/ha). The lowest incidence (13.28%) and severity (1.21) was observed on BRRI hybrid dhan-1with higher yield (8.40 t/ha). The second lowest incidence (16.29%) and severity (1.29) was observed on Hira-1 with highest yield (10.77 t/ha). Zakaria (2001) conducted an experiment on effect of BLB on yield and

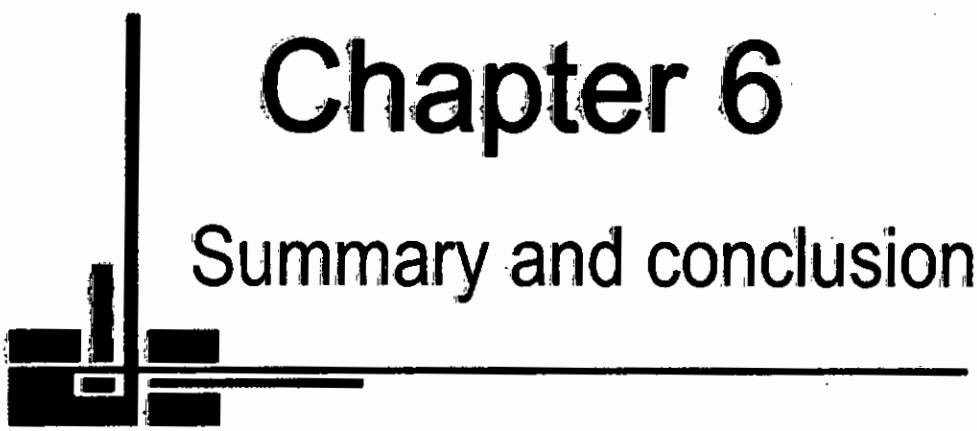
yield contributing characters of 20 rice hybrids/varieties reported that maximum incidence (33.08%) and severity (33.87%) of BLB were recorded in the hybrid 352H with lowest yield (2.99 ton/ha).

In case of leaf blast disease, the highest incidence (21.28%) and severity (6.21) was recorded on Richer-101 with second lowest yield (7.92 t/ha) at maturity stage. The lowest incidence (8.82%) and severity (1.01) was observed on Hira-2 with second highest yield (9.72 t/ha). Surek and Beser (1997) were studied the effect of blast disease on rice yield. Blast infection in conjunction with environmental factors accounted for the smaller yields.

In case of sheath blight disease, the highest incidence (25.82%) and severity (8.74) was recorded on Krishan-2 in maturity stage with lowest yield (7.90 t/ha). The lowest incidence (9.27%) and severity (1.52%) was observed on Hira-1 with highest yield (10.77 t/ha) which were supported by Sharma and Teng (1996) who reported that the disease development was higher at later growth stage and consequently the yield parameters declined.

In case of narrow brown leaf spot disease, the highest incidence (12.23%) and severity (5.84) was recorded on Modhumoti-2 at maturity stage with lower yield (8.98 t/ha). The lowest incidence (6.27%) and severity (1.10) was observed on ACI-1 with higher yield (9.70 t/ha).The present findings were supported by Rai *et al.* (2003) who reported that maximum diseases incidence and severity in maturity stage cause drastically yield loss.

In case of alternaria leaf spot (stackburn) disease, the highest incidence (32.12%) and severity (3.00) in maturity stage was recorded on Sonar Bangla-6 with medium yield (9.50 t/ha). The lowest incidence (13.27%) and severity (1.42) was observed on Hira-1 with highest yield (10.77 t/ha).



Chapter 6

Summary and conclusion

CHAPTER 6

SUMMARY AND CONCLUSION

The present study was conducted to find out the incidence and severity of some major field diseases on yield and yield contributing characters of hybrids and varieties of boro rice. The experiment was carried out in the Field of SAU (Sher-e-Bangla Agricultural University) farm allotted for the Department of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka-1207 during the period from November 2008 to April 2009. The experiment was carried out in RCBD with 15 hybrid rice varieties (13 imported and 2 local) and two high yielding varieties (HYVs). The hybrids and varieties were Hira-1, Hira-2, ACI-1, Surma-1, Taj-1, Modhumoti-2, Krishan-2, SonarBangla-6, Richer-101, Moyna, Tia, Tinpata, Aloron , BRRI hybrid dhan-1, BRRI hybrid dhan-2, BRRI dhan-28, and BRRI dhan-29. In Bangladesh 31 different diseases are known to occur on rice. In this experiment, six major field diseases were found and identified under natural epiphytic condition. These field diseases are brown spot (*Bipolaris oryzae*), narrow brown spot (*Cercospora oryzae*), leaf blast (*Pyricularia grisea)*, BLB (*Xanthomonas campestris pv. oryzae)*, sheath blight (*Rhizoctonia solani)* and alternaria leaf spot (*Alternaria tenuissima*).

From the result it was observed that seventeen hybrids and varieties were susceptible to the six field diseases. But some hybrids and varieties were highly susceptible to a specific disease and some hybrids and varieties were lowest susceptible to a specific field disease. Some hybrids and varieties were moderately susceptible to all the six field diseases.

In case of brown spot disease in maturity stage, the highest incidence (25.85%) and severity (4.15) was recorded on Aloron with lower yield (8.45

t/ha). The lowest incidence (15.51%) and severity (0.64) was observed on Hira-2 with higher yield (9.72 t/ha).

In case of narrow brown leaf spot disease in maturity stage, the highest incidence (12.23%) and severity (5.84) was recorded on Modhumoti-2 with lower yield (8.98 t/ha). The lowest incidence (6.27%) and severity (1.10) was observed on ACI-1 with higher yield (9.70 t/ha).

In case of leaf blast disease in maturity stage, the highest incidence (21.28%) and severity (6.21) was recorded on Richer-101 with second lowest yield (7.92 t/ha). The lowest incidence (8.82%) and severity (1.01) was observed on Hira-2 with second highest yield (9.72 t/ha).

In case of BLB disease in maturity stage, the highest incidence (28.92%) and severity (8.72) was recorded on Taj-1 with lower yield (8.53 t/ha). The lowest incidence (13.28%) and severity (1.21) was observed on BRRI hybrid dhan-1with higher yield (8.40 t/ha).The second lowest incidence (16.29%) and severity (1.29) was observed on Hira-1 with highest yield (10.77 t/ha).

In case of sheath blight disease in maturity stage, the highest incidence (25.82%) and severity (8.74) was recorded on Krishan-2 with lowest yield (7.90 t/ha). The lowest incidence (9.27%) and severity (1.52%) was observed on Hira-1 with highest yield (10.77 t/ha).

In case of alternaria leaf spot (stackburn) disease in maturity stage, the highest incidence (32.12%) and severity (3.00) was recorded on Sonar Bangla-6 with medium yield (9.50 t/ha). The lowest incidence (13.27%) and severity (1.42) was observed on Hira-1 with highest yield (10.77 t/ha).
From the results, it was revealed that Aloron, BRRI dhan-29, Modhumoti-2 and BRRI dhan-28 varieties were severely affected by brown spot disease where as Hira-2, ACI-1 and krishan-2 varieties give good performance

against the disease. Modhumoti-2, Surma-1, BRRI dhan-28 and Aloron varieties were severely affected by narrow brown leaf spot disease where as ACI-1, Hira-1 and Hira-2 show better result against narrow brown disease. At the same time, Richer-101, Taj-1, Krishan-2 and Modhumoti-2 varieties were severely affected by blast disease where as Hira-2, ACI-1, Hira-1 and BRRI hybrid dhan-2 give good performance against the disease. It was also found that Taj-1, Krishan-2, Aloron and Moyna varieties were severely affected by BLB disease where as BRRI hybrid dhan-1, Hira-1 and ACI-1 show better result against the disease. It was revealed that Sonar Bangla-6, Tia, Modhumoti-2 and Krishan-2 varieties were severely affected by alternaria leaf spot where as Hira-1 and Hira-2 give better result against the disease. The findings indicate that Krishan-2, Taj-1, Tinpata and Sonar Bangla-6 varieties were severely affected by sheath blight disease where as Hira -1, Hira-2 and ACI-1 varieties show good performance against the disease.

Plant height ranged from 87.47 cm to 100.6 cm. The highest plant height was recorded (100.6cm) in ACI-1 and the lowest (87.47 cm) in BRRI dhan-28. Panicle length ranged from 17.50 cm to 26.02 cm while the highest (26.02 cm) length was recorded in ACI-1 and the lowest (17.50 cm) in BRRI dhan-29. Number of effective panicle/hill ranged from 9.13 to 20. The highest (20) in Hira-1 and the lowest (9.13) in Taj-1. Numbers of ineffective panicle/hill ranged from 0.93 to 2.27 while the highest (2.27) in Hira-2 and the lowest (0.93) in BRRI dhan-29. Numbers of filled grain/panicle ranged from 88.87 to 128.7 while the highest (128.7) in Hira-1 and the lowest (88.87) in Taj-1. Number of unfilled grain/panicle ranged from 7.67 to 27.60 where the highest (27.60) in Taj-1 and the lowest (7.67) in BRRI dhan-28. Weight of grain/panicle ranged from 4.12 gm to 6.32 gm where the highest (6.32 gm) in ACI-1 and the lowest (4.12 gm) in BRRI dhan-29. Weight of

grain/hill ranged from 32.63 gm to 62.31 gm. The highest (62.31gm) in Hira-1 and the lowest (32.63 gm) in Krishan-2. Grain yield/plot ranged from 1.69 kg to 4.05 kg. The highest grain yield (4.05 kg) in Hira-1 and the lowest (1.69 kg) in BRRI dhan-29. Straw yield/plot ranged from 8.20 kg to 13.05 kg. The highest straw yield (13.05 kg) in BRRI dhan-28 and the lowest (8.20 kg) in BRRI hybrid dhan-2. Thousands seed weight ranged from 40.06 gm to 55.49 gm. The highest 1000 seed weight (55.49 gm) was recorded in Aloron and the lowest (40.06 gm) in Sonar Bangla-6.

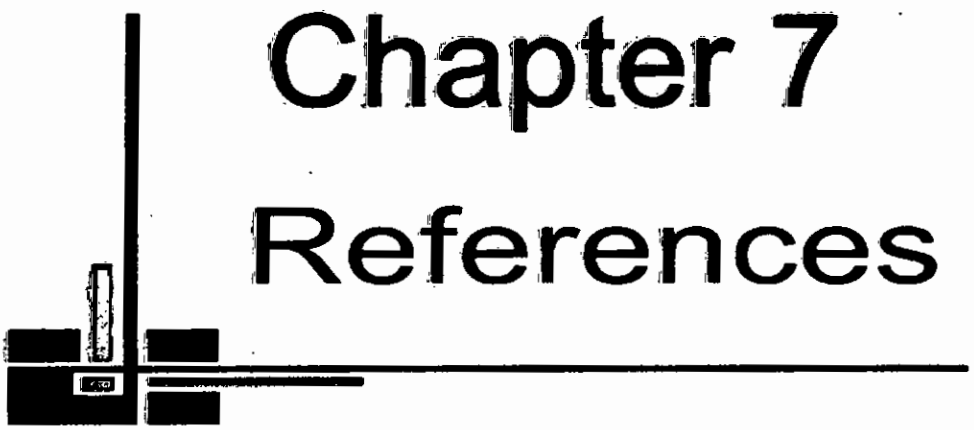
The maximum incidence and severity of the diseases was found in Aloron, Richer-101, Taj-1, Krishan-2 and Modhumoti-2 and Sonar Bangla-6 but the panicle length of these hybrids was lower than other hybrids. The minimum incidence and severity of the diseases was found in Hira-2, Hira-1 and ACI-1 with maximum number of effective panicles/hill, number of filled grains/panicle, number of rachis/panicle. The minimum incidence and severity of the diseases was found in Hira-2, Hira-1 and ACI-1 with maximum weight of grains/panicle (gm), weight of grains/hill (gm), 1000 seed weight (gm) and grain yield/plot (kg).

Grain yield ranged from 4.50 t/ha to 10.77 t/ha. In case of hybrids, the highest grain yield was recorded on Hira-1 (10.77 t/ha) which was closely followed by the hybrid Hira-2 (9.72 t/ha) which was statistically identical with ACI-1(9.70 t/ha), closely followed by Tia (9.60 t/ha) which was statistically similar with Sonar Bangla-6 (9.50 t/ha) and Tinpata (9.30 t/ha). The lowest grain yield was found on Krishan-2 (7.90 t/ha) which was statistically identical with Richer-101(7.92 t/ha) closely preceded by BRRI hybrid dhan-1(8.40 t/ha), Aloron (8.45 t/ha), BRRI hybrid-2(8.48 t/ha), Taj-1(8.53 t/ha) and Modhumoti-2(8.98 t/ha). But Krishan-2, Richer-101, Taj-1, Aloron, Modhumoti-2, BRRI hybrid dhan-1 and BRRI hybrid-2 were

statistically identical. The rest of the hybrids had medium grain yield. In case of local high yielding varieties (HYVs), the highest grain yield (4.90 t/ha) was recorded on BRRI dhan-28 and the lowest grain yield (4.50 t/ha) was noted on BRRI dhan-29.

From the results, it was observed that minimum incidence and severity results maximum yield. It was also observed that disease incidence and severity was gradually increased from flowering stage to maturity stage. From the result it was also observed that the incidence and severity increased with the age of the plant. Local hybrids varieties were moderately resistant to the selected diseases compared to the imported hybrid varieties of boro rice. High yielding varieties (HYVs) were also moderately resistant compared to the hybrid varieties of boro rice.

However, more studies need to be carried out to evaluate the performance of imported hybrid rice varieties against major disease under epiphytic condition for consecutive years in different Agro Ecological Zones (AEZs) of the country.



Chapter 7
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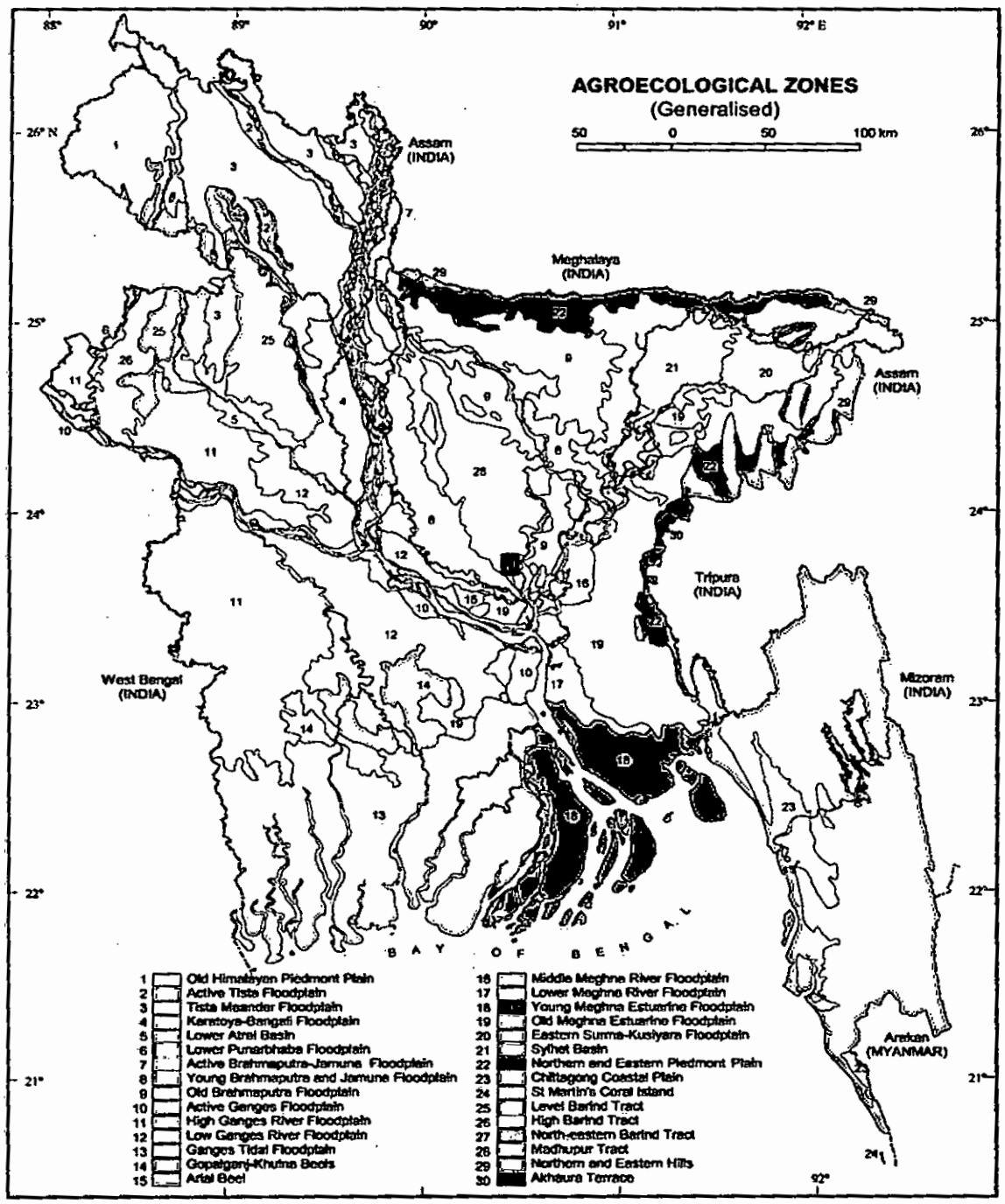
Appendices

APPENDICES

Appendix I. Map showing the location of experimental site



■ Indicate the experimental site

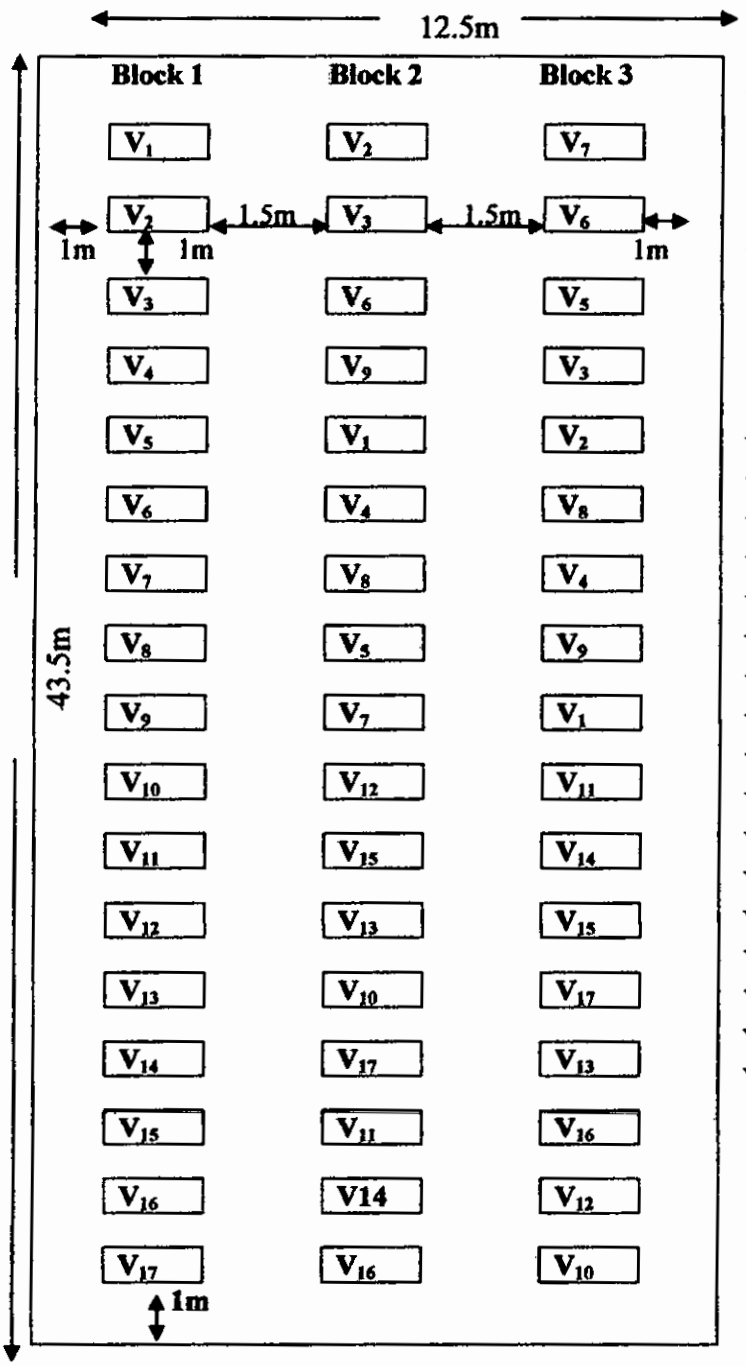
Source: www.fao.org.

Appendix II. Monthly average record of air temperature, rainfall, relative humidity, soil temperature and Sunshine of the experimental site during the period from November 2008 to April 2009

Months	Air temperature (°c)		Relative humidity (%)	Rainfall (mm) (total)	Sunshine (hr)
	Maximum	Minimum			
November, 2008	32.3	16.3	69	0	7.9
December, 2008	29.0	13.0	79	0	3.9
January, 2009	28.1	11.1	72	1	5.7
February, 2009	33.9	12.2	55	1	8.7
March, 2009	34.6	16.5	67	45	7.3
April, 2009	35.8	20.3	65	88	8.3

Source: Bangladesh Meteorological Department (Climate & Weather Division) Agargoan, Dhaka - 1212

Appendix III. Layout of the experiment



Block to Block distance = 1.5m
Plot to Plot distance = 1m
Unit Plot size =2.5m × 1.5m
Border length =1m
Total plot area = 43.5m × 12.5m

Varieties:

V_1=Hira-1
V_2= V Hira-2
V_3=ACI 1
V_4=Surma 1
V_5=Taj-1
V_6=Modumoti-2
V_7=Krishan-2
V_8=Sonar bangla-6
V_9=Richer-101
V_{10}=Moyna
V_{11}=Tia
V_{12}=Tinpata
V_{13}=Aloron
V_{14}=BRRI hybrid dhan-1
V_{15}= BRRI hybrid dhan-2
V_{16}= BR-28
V_{17}=BR-29