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RESEARCH PAPER

Field Evaluation of BRRI Boro Rice Varieties for Bacterial Blight Disease

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ABSTRACT

Bacterial blight (BB), caused by *Xanthomonas oryzae* pv. *oryzae*, is one of the most destructive diseases of rice in Bangladesh, causing significant yield losses in susceptible cultivars. The experiment was conducted in a Randomized Complete Block Design (RCBD) maintaining three replications of each treatment. BXO9, the isolate of *Xanthomonas oryzae* pv. *oryzae* in Bangladesh was used for inoculation at maximum tillering stage. Variations in the parameters related to BLB indicate the existence of genetic diversity among the tested varieties. The responses to BLB of the variety BR26, BRRI dhan27, BRRI dhan28 and BRRI dhan47 were highly susceptible (HS), while BR3, BR8 and BR15 are moderately resistant (MR). In case of BLB grain sterility (%) in healthy hill ranges from 10.7 to 58.1% and in diseased hill 12.1 to 65.4%. A positive relationship was observed between leaf damage area (LDA) and grain sterility (%) among the varieties. The grain yield (t/ha) in healthy hill ranges from 4.2 to 6.7 t/ha while in diseased hill it ranged from 2.8 to 6.3 t/ha. As the % LDA increased, grain yield (t/ha) decreased compared to healthy hills, and a positive relationship was observed.

Keywords: Rice, BLB, LDA, RLH, grain yield

Introduction

Bangladesh has fertile land for rice cultivation during Aus, Aman and Boro seasons. Rice is the most important cereal crop in Asia producing about 96% of the world's rice production (IRRI 2003). It is the staple food for about 140 million people in Bangladesh. It provides about 71% of the total calories and 51% of the total protein in a typical diet in Bangladesh (Anonymous 1998). The average world yield of rice is 4.44 t ha^{-1}, but the average yield in our country is around 2.75 t ha^{-1} in Bangladesh. The production of rice in Bangladesh is about 337.97 lakh metric tons, where the world production is about 467 million metric tons (BBS 2011). Low yield of rice is attributed to various factors. Among them, vulnerability of crop to pests and disease is an important one and sometimes leads to disastrous consequences (Hossain 2001). Thirty-six fungal, twenty-one viral, six bacterial and six nemic diseases have been recorded in rice (Ou 1985).

So far, in Bangladesh, 31 rice diseases have been identified, of which ten are considered as major (Miah and Shahjahan 1987; Anonymous 1995). Among them, five diseases, e.g. tungro, bacterial blight, sheath blight, blast and ufra have been considered as most important because of their widespread occurrence and significant damage potential. Among the major diseases, bacterial leaf blight (BLB) caused by *Xanthomonas oryzae* pv. *oryzae* has been recognized as one of the most damaging diseases of rice in Bangladesh (Anonymous 1975). Host resistance is an important component of an integrated disease management program for BLB; however, the pathogen population invariably changes and overcomes the deployed resistance. It is also a destructive disease in South and Southeast Asia. The disease may cause an average 20-30% yield loss (Du, 1973). In the tropics, depending on the severity of infection, the loss may be as high as 60-70% (Du, 1973). A comprehensive report on the effects of the diseases on rice yield is not available in Bangladesh. However, the disease may cause up to 32% yield loss (Anonymous 1988, Adhikari *et al*. 1999; Farooq and Ahmad 2007). The yield loss caused by BLB has been estimated as 6-60% in Bangladesh (Ashrafuzzaman, 1992). Breeding for

disease resistance is the most effective, economic and also eco-friendly method for controlling BLB elsewhere. Several germplasm donors carrying diverse genes for BLB resistance have been used to develop BLB-resistant varieties (Khush *et al.* 1989). An efficient and economic control strategy for sheath blight disease is extremely limited. The success of the use of expensive fungicides for controlling sheath blight has been reported (Akter *et al.* 2001, Hossain and Mia 2001). Moreover, resistant sources against the disease in Bangladesh are not available (Sharma *et al.* 1985, Jalaluddin *et al.* 2000).

Therefore, the study was undertaken to screen BRRI boro rice varieties against the existing races of bacterial leaf blight (BLB) pathogen and to assess preliminary yield loss due to BLB.

Materials and Method

The experiment was conducted in the experimental field of the Plant Pathology Division, Bangladesh Rice Research Institute (BRRI), Gazipur, during the Boro season (November–March) of 2011–2012 under field conditions. The experiment was conducted in a Randomized Complete Block Design (RCBD) maintaining three replications of each treatment maintaining spacing 20cm X 20cm and total 69-unit plots of 3m X 2m. The soil type of experimental fields belongs to the Shallow Red Brown Terrace type under Madhupur Tract of Agro Ecological Zone (AEZ) 28 which is characterized by silty clay with pH 6.5 (Brammer 1971). BRRI developed 23 boro rice varieties such as BR1, BR2, BR3, BR6, BR7, BR8, BR9, BR12, BR14, BR15, BR16, BR17, BR18, BR19, BR26, BRRI dhan27, BRRI dhan28, BRRI dhan29, BRRI dhan35, BRRI dhan36, BRRI dhan45, BRRI dhan47 and BRRI dhan50 were used as test materials. Seeds of the tested rice varieties were collected from the rice variety stability analysis experiment of the Statistics Division, BRRI, Gazipur. Bacterial blight isolate, BXO9 most virulent and reference isolate of the major race in Bangladesh, was used for artificial inoculation (Khan *et al.* 2009). BXO9 was obtained from the Plant Pathology Division, BRRI for inoculation. One week after transplanting, gap filling was done using the seedling from the same source. Irrigation was done, maintaining a constant level of up to 5cm in the field throughout the growing season. The water was finely drained out of the field before 15 days of harvesting to enhance maturity. The BLB isolate BXO9 was cultured on Peptone Sucrose Agar (PSA) slants for 72 hours at 30 ºC. Inoculum was prepared by mixing the cultured bacteria with 10 mL of sterile water in a slant. Before inoculation, the concentration of the bacterial suspension was adjusted to 10^8 to 10^{10} CFU/ml using sterile water. The leaf clipping inoculation method was adopted in this experiment, for mass inoculation, a special type of scissors was used for inoculation. In total, nine hills of each variety were inoculated with either the BLB pathogen during the maximum tillering stages. Data were recorded from only inoculated plants in both cases. *In case of Bacterial leaf blight (BLB)* diseased data of leaf damage area (LDA) and disease severity score were collected according to SES at 21 days after inoculation. Randomly 40 clipped leaves from each treatment were selected for data collection. Data on yield contributing characters, such as grain sterility and grain yield, were recorded during harvesting of the crop. The yield data was calculated by counting the hill number in a unit area for both healthy and diseased conditions. Collected data were analyzed statistically using Microsoft Excel and MSTAT- C.

Results and Discussion

Reaction of BRRI varieties against bacterial leaf blight (BLB)

Mean leaf damage area (%), disease severity scale (0-9), and response to BLB are shown in Table 1. Variations in the parameters related to BLB indicate the existence of genetic diversity among the tested varieties. The maximum leaf area damaged (65%) was recorded from BR26 and BRRI dhan47. The minimum (10%) leaf area damaged was observed on BR3, BR8 and BR15. Disease severity scale was highest (9) in BR26, BRRI dhan27, BRRI dhan28 and BRRI dhan47. The lowest (3) disease severity scale was in the variety of BR3, BR8 and BR15. The responses to BLB of the variety BR26, BRRI dhan27, BRRI dhan28 and BRRI dhan47 are highly susceptible (HS) and BR3, BR8 and BR15 showed moderately resistant (MR).

Table 1. Reaction of BRRI varieties against bacterial leaf blight (BLB) disease of rice under artificial inoculation in field conditions during the boro season of 2011-12

Sl. No.	Name of the varieties	Disease reaction to BLB		
		Leaf damage	Disease severity	Response to BLB[1]
1	BR1	28	7	S
2	BR2	35	7	S
3	BR3	10	3	MR
4	BR6	13	5	MS
5	BR7	18	5	MS
6	BR8	10	3	MR
7	BR9	18	5	MS
8	BR12	18	5	MS
9	BR14	28	7	S
10	BR15	10	3	MR
11	BR16	13	5	MS
12	BR17	40	7	S
13	BR18	20	5	MS
14	BR19	23	5	MS
15	BR26	65	9	HS
16	BRRI	55	9	HS
17	BRRI	60	9	HS
18	BRRI	45	7	S
19	BRRI	33	7	S
20	BRRI	23	5	MS
21	BRRI	40	7	S
22	BRRI	65	9	HS
23	BRRI	40	7	S

Disease response mentioned: R=resistant, MR=moderately resistant, MS=moderately susceptible, S=susceptible, HS=highly susceptible

Field performance of BRRI varieties in un-inoculated condition during boro season

The yield and yield components of 23 selected rice varieties, such as no. of filled grains/panicle, no. of unfilled grains/panicle and grain yield (t/ha) are presented in Table 2. No. of filled grains/panicle varied significantly among the tested rice varieties and ranged from 133.2 to 247.0. The highest no. of filled grains/panicle (247.0) was recorded on the rice variety BR1.The lowest no. of filled grain/panicle (133.2) was recorded for the rice varieties BRRI dhan47. Number of unfilled grain/panicles varied significantly among the tested rice varieties and ranged from 21.8 to 86.7. The highest no. of unfilled grain/panicle (86.7) was recorded in BR9. The lowest no. of unfilled grain/panicle (21.8) was recorded in BR19.

Mean grain yield varied significantly among the tested rice varieties and ranged from 4.17 to 6.70 t/ha. The highest grain yield (6.70 t/ha) was recorded in BR15, and the lowest grain yield (4.17) was recorded in BR17.

Table 2. Field performance of BRRI varieties in un-inoculated condition

Sl. No.	Name of the varieties	Yield contributing characters		
		No. of filled grains/panicle	No. of unfilled grains / panicle	Grain yield (t/ha)
1	BR1	247.0	76.3	5.20
2	BR2	219.0	78.3	4.55
3	BR3	181.8	56.9	5.55
4	BR6	175.6	61.5	5.41
5	BR7	168.5	83.7	4.75
6	BR8	176.7	56.0	4.61
7	BR9	149.1	86.7	5.34
8	BR12	166.6	56.9	4.36
9	BR14	159.4	51.4	5.11
10	BR15	212.6	63.3	6.70
11	BR16	151.3	42.7	5.95
12	BR17	212.6	63.2	4.17
13	BR18	151.3	42.7	4.66
14	BR19	203.4	21.8	4.72
15	BR26	201.0	49.9	4.92
16	BRRI	161.3	55.7	4.88
17	BRRI	156.4	40.2	5.64
18	BRRI	213.1	31.0	5.67
19	BRRI	207.8	57.7	5.06
20	BRRI	187.4	82.2	5.65
21	BRRI	164.1	61.6	5.31
22	BRRI	133.2	50.9	5.05
23	BRRI	149.4	37.9	5.13

Effect of bacterial leaf blight (BLB) of rice on yield contributing characters

Effect of bacterial leaf blight (BLB) of rice on yield contributing characters of 23 rice varieties under field conditions was shown in Table 3. Mean grain sterility (%) in healthy hills, diseased hills, and the corresponding percentage increased over healthy hills were assessed across the tested varieties. Grain sterility (%) in healthy hill ranged from 10.7 to 58.1%. The highest (58.1%) grain sterility in healthy hill was recorded in BR9, while the lowest (10.7%) was recorded in BR19.

Grain sterility (%) in diseased hill ranged from 12.1 to 65.4%. The highest (65.4%) grain sterility in diseased hill was recorded in BR9, and the lowest (12.9%) was recorded in BR19. Grain sterility % increase over healthy ranged from 4.8 to 43.4%. The highest (43.4%) grain sterility % increase over healthy was recorded in BR26, and the lowest (4.8%) was recorded in BR15.

Leaf damage area (LDA) due to BLB disease and grain sterility percentage of different boro rice varieties varied under field conditions. There was a positive relationship observed here among the varieties. Grain sterility (%) increases over healthy plant when % LDA increases (Fig 1).

Grain yield (t/ha) in healthy hill ranged from 4.2 to 6.7 t/ha. The highest (6.7 t/ha) grain yield in healthy hill was recorded in BR15 and the lowest (4.2) was recorded in BR17. Grain yield (t/ha) in diseased hill ranged from 2.8 to 6.3 t/ha. The highest (6.3 t/ha) grain yield in diseased hill was recorded in BR15 and the lowest (2.8 t/ha) was recorded in BRRI dhan47. Grain yield % decreased over healthy ranged from 5.5 to 45.3%. The highest (45.3%) grain yield % decrease over healthy was recorded in BRRI dhan47 and the lowest (5.5%) was recorded in BR15LDA due to BLB disease and grain yield (t/ha) of different boro rice varieties varied under field conditions. There was a positive relationship observed here among the variety. Grain yield (t/ha) decrease over healthy also increases when % LDA increases (Fig 2).

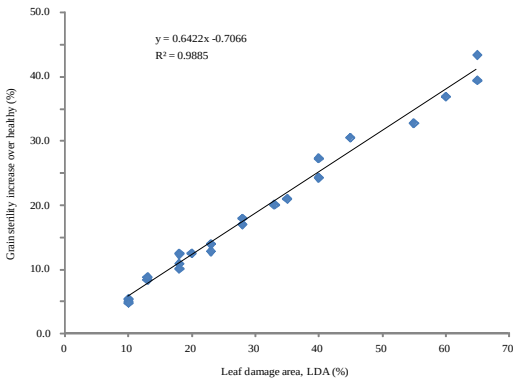

Fig 1. Relationship between leaf damage area (LDA) due to induced bacterial leaf blight (BLB) disease and grain sterility.

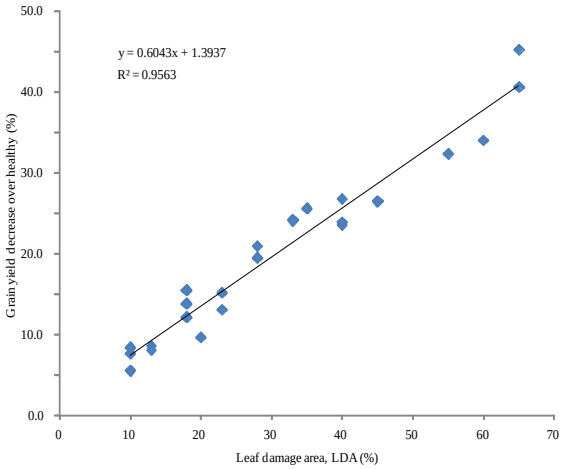

Fig 2. Relationship between leaf damage area (LDA) due to induced bacterial leaf blight (BLB) disease and grain yield of different boro rice varieties under field conditions

Bacterial leaf blight (BLB) caused by *Xanthomonus oryzae* pv *oryzae* has become a serious threat to rice yield and production in Bangladesh and other Asian countries. The diseases have been occurring commonly in all the modern rice cultivars throughout Bangladesh.

The present study was carried out to assess 23 BRRI rice varieties against bacterial leaf blight (BLB) in order to identify the resistant sources. For indexing, a BLB severity score (0-9) developed by IRRI, 1996 was followed. Among the 23 varieties, 3 varieties were moderately resistant and 4 varieties were highly susceptible in case of BLB (Table 1).

However, none of the test material showed resistant or highly resistant in this study. These results are in agreement with the results reported by Junaid *et al.* (2009) who tested 50 rice varieties for their resistance to BLB but none of the variety was identified to be resistant, only four entries/varieties were found moderately resistant and all other entries were moderately susceptible to highly susceptible.

The field performance of BRRI varieties in healthy condition during boro season were also studied. The yield and yield component of 23 selected rice varieties such as number of filled grain/panicle, number of unfilled grain/panicle and grain yield (t/ha) in healthy condition were recorded in (Table 2).

Table 3. Effect of bacterial leaf blight (BLB) of rice on yield contributing characters

Sl. No.	Name of the varieties	Grain sterility (%)			Grain yield (t/ha)		
		Healthy hill	Diseased hill	(%) increase over healthy	Healthy hill	Diseased hill	% decrease over healthy
1	BR1	30.9	36.1	17.0	5.2	4.2	19.5
2	BR2	35.8	43.3	21.0	4.6	3.4	25.6
3	BR3	31.3	33.0	5.4	5.6	5.1	7.7
4	BR6	35.0	37.9	8.4	5.4	4.9	8.6
5	BR7	49.7	55.1	10.9	4.8	4.2	12.2
6	BR8	31.7	33.3	5.0	4.6	4.2	8.4
7	BR9	58.1	65.4	12.4	5.3	4.6	13.8
8	BR12	34.2	37.6	10.1	5.4	3.7	15.5
9	BR14	32.2	38.0	17.9	5.1	4.0	21.0
10	BR15	29.8	31.2	4.8	6.7	6.3	5.5
11	BR16	28.2	30.7	8.8	5.9	5.5	8.1
12	BR17	29.7	37.8	27.3	4.2	3.2	23.6
13	BR18	28.2	31.7	12.5	4.7	4.2	9.6
14	BR19	10.7	12.1	12.8	4.7	4.0	15.2
15	BR26	24.8	35.6	43.4	4.9	2.9	40.6
16	BRRI	34.5	45.9	32.8	4.8	3.3	32.4
17	BRRI	25.7	35.2	36.9	5.6	3.7	34.1
18	BRRI	14.5	19.0	30.5	5.7	4.2	26.5
19	BRRI	27.8	33.3	20.0	5.1	3.8	24.2
20	BRRI	43.9	50.0	14.0	5.7	4.9	13.1
21	BRRI	37.5	46.7	24.3	5.3	3.9	26.8
22	BRRI	38.2	53.3	39.5	5.1	2.8	45.3
23	BRRI	25.4	31.5	24.3	5.1	3.9	23.9

The effect of BLB and ShB diseases of rice on yield contributing characters like grain sterility and grain yield were also studied. In case of BLB among the 23 varieties grain sterility (%) in healthy hill ranges from 10.7 to 58.1% and in diseased hill 12.1 to 65.4% (Table 3).

Leaf damage area (LDA) due to BLB disease and grain sterility percentage of different boro rice varieties varied under field conditions. There was a positive relationship observed among the varieties. When % LDA increases, grain sterility (%) increase over healthy also increase (Fig 1).

The grain yield (t/ha) in healthy hill ranges from 4.2 to 6.7 t/ha and in diseased hill 2.8 to 6.3 t/ha (Table 3). LDA due to BLB disease and grain yield (t/ha) of different boro rice varieties varied under field conditions. There was a positive relationship observed here among the variety.

When % LDA increases, grain yield (t/ha) decreases over healthy, also increases (Fig 2). The result of this investigation also supports the findings of Singh and Nanda (1975) who reported that in 15 hybrids, grain yield was negatively correlated with the incidence of BLB.

Conclusion

The findings of the present study clearly showed that, several resistant to moderately resistant source(s) present in our BRRI boro rice varieties against BLB. Except these tested materials, other BRRI boro rice varieties remain to be tested for further confirmation. The responses to BLB of the variety BR26, BRRI dhan27, BRRI dhan28 and BRRI dhan47 are highly susceptible (HS) and BR3, BR8 and BR15 are moderately resistant (MR). Therefore, it is necessary to screen more rice varieties which show resistance in field stage against *Xanthomonas oryzae* pv. *oryzae* for the selection of resistant source(s) and to assess preliminary yield loss due to BLB. Further research is necessary for confirmation of these materials as resistant sources.

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