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Screening of Rice Genotypes for Resistance to Bacteria Leaf Blight under Sodic Soil

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A B S T R A C T

The 60 F_{1s} (derived by line x tester analysis) along with their twenty three parents and two check varieties (Narendra Usar dhan 3 and IR 28) were tested against the Bacteria leaf blight, under sodic soil during *Kharif*, 2015 at the Research Farm of the Department of Genetics and Plant Breeding, Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj), Faizabad (U. P.). The experiment was conducted in sodic soil at pH =9.2, EC =2.21dSm^{-1} and ESP 45%. Resistance against Blast was assessed based on the damaged leaves following 0-9 scale as per the SES, IRRI, Manila, Philippines. Four crosses and one parent were found immune. Six parents, twenty two crosses and one check (Narendra Usar 3) were resistant and recorded damage score of '1' indicating resistance to BLB. Eighteen parents, twenty nine crosses and one check (IR 28) were moderately resistant and only three crosses (IR 13 T146 x Narendra 5026, A69-1 x Sarjoo52, NDRK 50036 x Sarjoo52,) were found to be moderately susceptible to BLB damage. The genotypes which were highly resistant may be used as donors in resistant breeding programmes against *Xanthomonas oryzae* pv. *oryzae*,

Keywords

BLB (*Xanthomonas oryzae* pv. *oryzae*), Yield loss, Line x tester, Sodic soil

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Introduction

Rice is one of the cereal crops of great significance in India and primary staple food for huge population in Asia, Africa and Latin America. In India rice covers about 23.3% of gross cropped area of the country and plays a vital role in the national food grain supply. It puts up 43% out of total food grain production and for total cereal production 46% of nation. India secures second position in production of rice among all rice producing countries, China leads the highest production. The world area, production and productivity in 2014-15 were 162.2 Mha, 483.3 million tones and 4.44 MT/ ha, respectively. In India, rice is being grown in 44.10 Mha area with production of 106.5 million tones and productivity of 3.52 MT/ha, respectively (USDA. 2016). The production of rice must be doubled to meet the requirement of the increasing population. This can be done only by enhancing the productivity and preventing losses caused by insect-pest and diseases of rice (Hossain 1996; Mishra *et al.*, 2003). Hybrid rice technology is one of the most important and practically feasible technologies to enhance the rice productivity in developing countries like India. Crop loss assessment studies have revealed that this disease reduces grain yield to varying levels, depending on the stage of the crop, degree of cultivar susceptibility and to a great extent, the conduciveness of the environment in which it occurs.

Bacterial blight (BB) caused by the *Xanthomonas oryzae* pv. *oryzae* (*Xoo*) pathogen is a chief factor limiting rice productivity worldwide because of its high epidemic potential (Sharma *et al.*, 2017). As a vascular disease that results in systemic infection, BB produces tannishgrey to white lesions along leaf veins (Mew 1987, Mew *et al.*, 1993, Nino-Liu *et al.*, 2006).

Most commonly, plants are affected at the maximum tillering stage. Yields are reduced by 20–30%. Infection at the tillering stage can engender total crop losses (Mew *et al.*, 1993; Busungu, 2017). Developing resistant cultivars is generally regarded as the most effective and economical means of controlling this disease (Guo *et al.*, 2005, Mew *et al.*, 1993, Khush, 2013). Grain yield of rice in salt affected soils is much lower because of its high sensitivity to salt stress. Rice is exceptionally sensitive to salinity and sodicity at early seedling stage and high yield losses have been observed because of high mortality and poor crop establishment. Modern high yielding varieties require considerable investment to ameliorate these soils to ensure reasonable yields, but this investment is beyond the capabilities of the resource-limited small holder farmers living off these salt affected areas. Increasing and sustaining yields in these areas will require a system that integrates salt tolerant varieties with effective and affordable crop and nutrient management practices. The present study was undertaken to evaluate selected rice genotypes for biotic and abiotic stresses on the basis of different morphological characters, yield and yield components under field conditions.

Materials and Methods

The experiment was laid out during wet season 2015 at the GPB farm of N.D. University of Agriculture and Technology, Faizabad. The experimental materials of rice for this investigation comprised of 20 genotypes as lines (females) and three testers (males) Narendra 5026, Jaya and Sarjoo 52. Each of three testers was crossed with 20 lines during kharif 2014. Thus, total number of 60 hybrids (F_1) was obtained. The total set of eighty five genotypes were grown during *kharif* in 2015 and evaluated along with their parents and two check varieties (Narendra Usar 3 and IR28) in Randomized complete block design with three replications crosses obtained through crossing in a “line × tester” mating design (Kempthorne 1957) [10]. Besides these, two checks *viz.*, Narendra Usar 3 and IR28 a rice hybrid were also included for standard heterosis. The experiment was conducted at pH = 9.2, EC =2.21 dSm-1 and ESP 45%. The fertilizers were applied @ 120 kg nitrogen, 60 kg phosphorus and 60 kg potash per hectare through urea, DAP and murate of potash, respectively. The full dose of phosphorus and potash and half dose of nitrogen were applied as basal and rest of nitrogen was applied in two split doses as top dressing at tillering and panicle initiation stage of crop growth. The observations *viz.*, plant height (cm), Flag leaf area (cm^2), panicle bearing tillers per plant, panicle length (cm), grains per panicle, grain yield per plant (g) leaf folder was recorded on the basis of five randomly selected competitive plants in each plot). Genotypes were also scored against the 0-9 damage score and were classified for varietal reaction as follows:

Results and Discussion

Use of resistant cultivars is the most effective and efficient methods to control this plant disease. Bacterial blight disease can be controlled in safe mode through cultivation of resistant varieties. Although cultural practice is one the important tool to control this, but primary and most efficient control is planting of resistant cultivars. Therefore, studies were planned to search out the resistant genotypes of rice under salt affected soil. In India, not much emphasis has been given to search on resistant genotypes of rice against BLB.

All together eighty five genotypes (twenty lines, three testers, sixty crosses, and two checks) were screened for their reaction to BLB (*Xanthomonas oryzae* pv. *oryzae*) in the field. Results (Table 1) revealed that one perent (Jaya) and four crosses, Narendra3112-1 x Jaya, NDRK 50057 x Jaya, CSR 36 x Jaya and Narendra 2064 x Narendra 5026 were found immune for BLB. Six parents (Jaya, Sarjoo 52, NDRK 50055, A69-1, CSR 28, Narendra 2064,), 22 crosses (IR 13 T143 x N5026, IR 13 T143 x Jaya, NDRK 50037 x Narendra 5026, NDRK 50037 x Sarjoo52, NDRK 50051 x Narendra 5026, NDRK 50051 x Jaya, NDRK 50051 x Sarjoo52, Narendra3112-1 x Sarjoo52, NDRK 50057 x Narendra 5026, NDRK 50057 x Sarjoo52, Narendra Usar 2009 x Narendra 5026, Narendra Usar 2009 x Jaya, NDRK 50063 x Narendra 5026, CSR 28 x Narendra 5026, NDRK 50045 x Jaya, NDRK 50045 x Sarjoo52, Pusa Basmati x Narendra 5026, Narendra 2064 x Jaya, Narendra 2064 x Sarjoo52, IRRI 123 x Jaya, IRRI 123 x Sarjoo52, NDRK 50033 x Narendra 5026, NDRK 50033 x Sarjoo52,) and one check (Narendra Usar 3) were noted for resistant while eighteen parents (Narendra 5026, IR13T143, NDRK 50046, IR13T146, NDRK 50037, A69-1, NDRK 50036, NDRK 50051, Narendra3112-1, NDRK 50057, Narendra Usar 2009, NDRK 50029, NDRK 50063, CSR 36, NDRK 50045, Pusa Basmati, IRRI 123, NDRK 50033,), 29 crosses (IR 13 T143 x Sarjoo52, NDRK 50055 x N5026, NDRK 50055 x Jaya, NDRK 50055 x Sarjoo52, NDRK 50046 x N5026, NDRK 50046 x Jaya, NDRK 50046 x Sarjoo52, IR 13 T 146 x Jaya, IR 13 T146 x Sarjoo52, NDRK 50037 x Jaya, A69-1 x Narendra 5026, A69-1 x Jaya, NDRK50036 x Narendra 5026, NDRK 50036 x Jaya, Narendra3112-1 x Narendra 5026, Narendra Usar 2009 x Sarjoo52, NDRK 50029 x Narendra 5026, NDRK 50029 x Jaya, NDRK 50029 x Sarjoo52, NDRK 50063 x Jaya, NDRK 50063 x Sarjoo52, CSR 36 x Sarjoo52, CSR 28 x Jaya, CSR 28 x Sarjoo52, NDRK 50045 x Narendra 5026, Pusa Basmati x Jaya, Pusa Basmati x Sarjoo52, IRRI 123 x Narendra 5026, NDRK 50033 x Jaya)and one check (IR 28) recorded moderate resistance against BLB. Three crosses (IR 13 T146 x Narendra 5026, A69-1 x Sarjoo52, NDRK 50036 x Sarjoo52,) was observed moderately susceptible. None of genotypes were found susceptible and highly susceptible for disease. Similar finding have also been reported earlier by Ashwarya *et al.*, (2016), Tyagi *et al.*, (2010) and Lussewa (2016). The most desirable genotypes were the cross, CSR 36 x Jaya had grain yield per plant (24.83g) and damage score of ‘0.33’ indicating immune for BLB. The high yielding check, Narendra Usar 3 (sodicity tolerant), produced grain yield 17.10 g and showed damaged rating 1.00 indicating resistant whereas the second check, IR 28 (sodicity susceptible) had lowest grain yield per plant 8.30g and moderately resistant (Score ‘3.00’) to BLB. The other cross, Narendra Usar 2009 x Sarjoo52 exhibited high mean (23.83g) performance and damaged leaf rating (3.00) observed moderately resistant followed by the cross, CSR 36 x Sarjoo 52 showed high mean performance (22.78g) among the crosses with BLB scoring (3.00) indicating moderately resistant to BLB under sodic soil.

Damage score

Damage score	Damaged leaves (%)	Varietal reaction	Damage score	Damaged leaves (%)	Varietal reaction
0	No damage	Immune	5	21-35%	Moderately susceptible
1	1-10%	Resistant	7	36-50%	Susceptible
3	11-20%	Moderately resistant	9	51-100%	Highly susceptible

Table.1 Reaction of rice genotypes against disease (BLB)

Rating	Reaction	No. of genotype	Name of genotype
0	**Immune**	**BLB (1P, 4 cross)**	Jaya, Narendra3112-1 x Jaya, NDRK 50057 x Jaya, CSR 36 x Jaya, Narendra 2064 x Narendra 5026
1	**Resistant**	**BLB (6P,22 cross, 1 check)**	Jaya, Sarjoo 52, NDRK 50055, A69-1, CSR 28, Narendra 2064, IR 13 T143 x N5026, IR 13 T143 x Jaya, NDRK 50037 x Narendra 5026, NDRK 50037 x Sarjoo52, NDRK 50051 x Narendra 5026, NDRK 50051 x Jaya, NDRK 50051 x Sarjoo52, Narendra3112-1 x Sarjoo52, NDRK 50057 x Narendra 5026, NDRK 50057 x Sarjoo52, Narendra Usar 2009 x Narendra 5026, Narendra Usar 2009 x Jaya, NDRK 50063 x Narendra 5026, CSR 28 x Narendra 5026, NDRK 50045 x Jaya, NDRK 50045 x Sarjoo52, Pusa Basmati x Narendra 5026, Narendra 2064 x Jaya, Narendra 2064 x Sarjoo52, IRRI 123 x Jaya, IRRI 123 x Sarjoo52, NDRK 50033 x Narendra 5026, NDRK 50033 x Sarjoo52, Narendra Usar 3,
3	**Moderately resistant**	**BLB (18 P, 29 cross, 1 check)**	Narendra 5026, IR13T143, NDRK 50046, IR13T146, NDRK 50037, A69-1, NDRK 50036, NDRK 50051, Narendra3112-1, NDRK 50057, Narendra Usar 2009, NDRK 50029, NDRK 50063, CSR 36, NDRK 50045, Pusa Basmati, IRRI 123, NDRK 50033, IR 13 T143 x Sarjoo52, NDRK 50055 x N5026, NDRK 50055 x Jaya, NDRK 50055 x Sarjoo52, NDRK 50046 x N5026, NDRK 50046 x Jaya, NDRK 50046 x Sarjoo52, IR 13 T 146 x Jaya, IR 13 T146 x Sarjoo52, NDRK 50037 x Jaya, A69-1 x Narendra 5026, A69-1 x Jaya, NDRK50036 x Narendra 5026, NDRK 50036 x Jaya, Narendra3112-1 x Narendra 5026, Narendra Usar 2009 x Sarjoo52, NDRK 50029 x Narendra 5026, NDRK 50029 x Jaya, NDRK 50029 x Sarjoo52, NDRK 50063 x Jaya, NDRK 50063 x Sarjoo52, CSR 36 x Sarjoo52, CSR 28 x Jaya, CSR 28 x Sarjoo52, NDRK 50045 x Narendra 5026, Pusa Basmati x Jaya, Pusa Basmati x Sarjoo52, IRRI 123 x Narendra 5026, NDRK 50033 x Jaya and IR28
5	**Moderately susceptible**	**BLB (3 cross)**	IR 13 T146 x Narendra 5026, A69-1 x Sarjoo52, NDRK 50036 x Sarjoo52,
7	**Susceptible**	**BLB**	Nil
9	**Highly susceptible**	**Disease**	Nil

Table.2 Most promising crosses, lines and checks based on mean performance for grain yield per plant under sodic soil

S. No.	Genotype	Grain yield per plant (g) *per se* Performance	scoring	Status
1.	CSR 36 x Jaya	24.83	0.33	I
2.	Narendra Usar 2009 x Sarjoo52	23.83	3.00	MR
3.	CSR 36 x Sarjoo52	22.78	3.00	MR
4.	NDRK 50057 x Sarjoo52	22.46	1.00	R
5.	NDRK 50057 x Jaya	22.27	0.66	I
6.	NDRK 50057 x Narendra 5026	22.16	**1.00**	R
7.	IRRI 123 x Jaya	21.46	1.00	R
8.	NDRK 50037 x Jaya	21.00	3.00	MR
9.	NDRK 50055 x Sarjoo52	20.53	3.00	MR
10.	NDRK 50037 x Narendra 5026	20.36	1.00	R
Check				
11.	**Narendra Usar 3**	17.10	1.00	R
12.	**IR 28**	8.30	3.00	MR
Testers				
13.	Narendra 5026	15.80	3.00	MR
14.	Jaya	15.70	1.00	R
15.	Sarjoo 52	16.30	1.00	R
Line				
16.	Narendra Usar 2009	17.46	3.00	MR
17.	NDRK 50037	16.10	3.00	MR
18.	IRRI 123	15.70	3.00	MR
19.	NDRK 50045	15.62	3.00	MR
20.	NDRK 50063	15.00	3.00	MR
21.	NDRK 50036	14.83	3.00	MR
22.	Narendra 2064	14.13	1.00	R
23.	IR13T143	14.03	3.00	MR
24.	NDRK 50055	13.93	1.00	R
25.	CSR 36	13.54	3.00	MR

The cross, NDRK 50057 x Sarjoo52 showed high mean performance (22.46g), scoring (1.00) for grain yield per plant. The fifth ranked cross, NDRK 50057 x Jaya showed high mean performance (22.27) with scoring (0.66) indicating immune for grain yield per plant under sodic soil. The cross, NDRK 50057 x Narendra 5026 showed high mean performance (22.16g) scoring rating (1.00), Seventh ranked cross, IRRI123 x Jaya exhibited high mean performance (21.46g) and rating scale (1.00) exhibited resistant.

The cross, NDRK 50037 x Jaya showed high mean performance (21.00g) and scoring (3.00) recorded moderately resistant. NDRK 50055 x Sarjoo 52 showed high mean performance (20.53g) and rating (3.00). The tenth ranked cross, NDRK 50037 x Narendra 5026 showed high mean performance (20.36g), and damaged leaf scoring (1.00) for grain yield per plant under sodic soil (Table 2). These crosses should be tested and evaluated in adaptive trial to find out their feasibility for recommendation for use as hybrid verities in respective groups for the target environments. The genotype, Narendra Usar 2009 produced highest grain yield per plant (17.46 g), second highest genotype NDRK 50037 (16.10g) the line, IRRI 123 (15.70 g) also showed superior mean performance for grain yield per plant which also showed moderately resistant(3.00) for BLB. Line, NDRK 50045 (15.62), NDRK 50063 (15.00), NDRK 50036 (14.83), Narendra 2064 (14.13) and IR13T143 (14.03) were found moderately resistant (3.00). NDRK 50055 (13.93 g) was placed under scale 1 of damage rating with resistant to BLB. The sodicity tolerant genotype, CSR 36 (13.54g) this variety was placed under score 3 with moderate level of resistant to BLB. The testers Narendra 5026 (15.80g) showed moderately resistant reaction with disease score (3) whereas Jaya (15.70g) and Sarjoo 52 (16.30g) recorded resistant (1). Resistance genitype of rice that can provide season-long protection from the infection of disease. similar result finding Mishra *et al.*, (2002), Nainu *et al.*, (2003), Pandya and Tripathi (2006), Satya *et al.*, (1999), Singh *et al.*, (2007) and Tyagi *et al.*, (2010). Thus, the high yielding parents discussed above having high mean performance for grain yield and for leaf folder may be recommended for use as parent for developing high yielding rice hybrids under sodic soil. The parents and crosses exhibiting immune, resistant or moderately resistant response to the pest studied in the present study may be considered for further exploitation for breeding purpose. Growing of these pest resistant genotypes do not appear to disturb the natural ecosystem and is environment friendly as well.

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