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Identifying superior genotypes in rice (*Oryza sativa* L.) against bacterial leaf blight (*Xanthomonas oryzae pv. oryzae*) to NEP zone

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Abstract
The seventy four genotype along with their four check varieties (Sarjoo-52, Pusa-44, NDU-3 and Kala Namak) were tested against the Bacteria leaf blight, under sodic soil during *Kharif*, 2020 at the main experiment Station Acharya Narendra deva University Of Agriculture and technology Kumarganj, Ayodhya (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. Two genotype found immune. Ten genotype were resistant and recorded damage score of "1" indicating resistance to BLB. Twenty five genotype and two check Pusa-44 & Kala-Namak were moderately resistant and eight genotype 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, sodic soil, screening genotype

Introduction
Rice (*Oryza sativa* L.) is the world's most important food crop, feeding over three billion people every day. It will feed roughly more than half of the world's population by 2020. India is the second largest rice producing country in the world next to China; as it is grown in almost all the state of India. The total cultivable area of India is 143 million ha out of which 43.79 million ha area is utilized for rice cultivation with total production of rice during 2020-21 is estimated at record 121.46 million tonne it is higher by 9.01 million tonnes than the five years average production of 112.44 million tonnes. Uttar Pradesh has largest area of rice *i.e.*, 5.87 million ha with production of 12.51 million tonnes. The productivity of rice in Uttar Pradesh is 2131 kg/ha. Though India ranks first in area under rice, its productivity is not even half of China. The bacterial blight of rice caused by *Xanthomonas oryzae pv. oryzae* (Xoo) (Ishiyama, 1922) Swings *et al.*, (1990) is an economically important (Mew, 1987) [13] and is one of most destructive disease of rice in both irrigated and rain fed environments in Asia (Mew, 1987) [13]. 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 rice among all rice producing countries, China leads the highest production. 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) [6]. 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) [20]. As a vascular disease that results in systemic infection, BLB produces tannish grey to white lesions along leaf veins (Mew 1987, Mew *et al.*, 1993, Nino-Liu *et al.*, 2006) [13, 12, 16]. 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) [12, 4]. Host Plant resistance is an important component of an integrated management program for this disease.

To minimize the risk of attack by bacterial blight, evolving resistant cultivars against the pathogen is the best non chemical method for management of the disease. 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) [5, 12, 10]. 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 2020 at the main experiment Station, Ayodhya. The experimental materials of rice for this investigation comprised of seventy four genotypes. All genotypes were grown during *kharif* in 2020 and evaluated selected rice genotypes for biotic stresses on the basis of different morphological characters, yield and yield components under field conditions in Randomized complete block design with three replications. 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), fertile spikelet 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

Seventy four rice genotypes were screened against *Xanthomonas oryzae* pv. *oryzae* under natural epiphytotic condition. Genotypes were classified into six classes based on degree of reaction and genotypes falling in particular class are presented in table 1. 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.

Table 1: All together seventy genotype and four checks were screened for their reaction to BLB (*Xanthomonas oryzae* pv. *oryzae*) in the field

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 2: Reaction of rice genotypes against disease BLB (*Xanthomonas oryzae* pv. *oryzae*) in the field

Rating	Reaction	G. no	Genotypes name
0	**Immune**	2	**NDU-3, NDR-2064,**
1	Resistant	10	Sambha Sub-1, Swarna Sub-1, NDRK19-5, NDR-359, Sonam, Sarjoo-52, Kala Dhan, Kala Namak(S), NDRK-5052, Kasturi- Chandauli.
3	Moderately Resistant	27	NDRK-2065, NDR-97, BRRI-75, CSR-30, Mahak-m51, Shreshtha Gold, Kala Namak, Bio Seed-799, Bio Seed-301, NDRK19-3, NDRK19-9, NDRK19-11, NDRK19-12, US-362, Pusa-1121, Nandi Super, Pusa Sugandha-5, Kala Namak(B), Kala Namak-03, NDRK-5007, NDRK-5083, Pusa-44, NDRK-5027, NDRK- 5036, Pioneer-28P67, NDRK19-2, Kala Namak(T)
5	Moderately susceptible	8	NDRK-5037, NDRK-5018, BRRI-78, Arize-6444, Moti-NP360, Moti-555, NDRK-3112, NDR-8002
7	Susceptible	27	Pant Basmati-1, Bina Dhan-11, PAU5564-18-1-2, CARI-Dhan6, Pusa Basmati-6, FL-478, UB-53, Karishma, PAC-8744, Kaveri-K108, HUR-1309, Pioneer-B9463, Ganga Kaveri, Pioneer-27P64, NDRK19-1, NDRK19-4, NDRK19-6, NDRK19-7, NDRK19-8, NDRK19-10, NDRK19-13, HUR-1304, Pusa Basmati-1, PNR-381, Sugandh-3, BPT-5204, US-305
9	Highly susceptible	0	Nil

Table 3: Most promising, lines and checks based on mean performance for grain yield per plant under sodic soil

S. No.	Genotype per se	Grain yield per plant (g)	Performance	Scoring Status
1	Sambha sub -1	18.78g	1	R
2	Swarna sub-1	18.42g	1	R
3	Kasturi Chandauli	18.18g	1	R
4	Soanam	17.41g	1	R
5	NDRK-5027	15.76g	3	MR
6	Kala Namak(C)	15.13g	3	MR
7	Kala Namak(s)	14.97g	1	R
8	NDRK19-5	14.69g	1	R
9	NDR-359	14.52g	1	R
10	Kala Namak(B)	14.27g	3	MR
11	Nandi Super	13.81g	3	MR
12	Shreshths Gold	12.85g	3	MR
13	Sarjoo-52(C)	12.61g	1	R
14	Kala Dhan	12.47g	1	R
15	NDRK19-12	12.38g	3	MR
16	CSR-30	12.34g	3	MR
17	Pusa Sugandha-5	12.32g	3	MR
18	NDR-2065	11.81g	3	MR
19	NDR-2064	11.64g	0.33	I
20	NDRK-5027	11.17g	3	MR
21	NDR-97	11.11g	3	MR
22	NDU-3(C)	10.97g	0.33	I
23	Pusa-1121	10.87g	3	MR
24	NDRK-5083	10.42g	3	MR
25	NDRK19-11	10.00g	3	MR
26	NDRK19-9	9.98g	3	MR
27	NDRK-5052	9.96g	1	R
28	BRRI-75	9.55g	3	MR
29	Mahak-m51	9.09g	3	MR
30	Pioneer28P67	9.07g	3	MR
31	NDRK19-2	9.06g	3	MR
32	Kala Namak(T)	8.80g	3	MR
33	US-362	8.78g	3	MR
34	NDRK-5036	8.66g	3	MR
35	NDRK19-3	8.45g	3	MR
36	Bio Seed-799	8.35g	3	MR
37	Bio Seed-301	7.87g	3	MR
38	Kala Namak-03	7.40g	3	MR
39	Pusa-44(C)	6.01g	3	MR

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 revealed that two genotype NDU-3 (check variety) and NDR-2064 were found immune for BLB. Similar finding have also been reported earlier by Rajpoot *et al.*, (2018) [18] and Acharya Basistha and KC Sujata (2021) [1]. Ten genotype Sambha-Sub-1, Swarna-Sub-1, NDRK19-5, NDR-359, Sonam, Sarjoo-52, Kala-Dhan, Kala-Namak(S), NDRK-5052, Kasturi-Chandaul were noted for resistant while twenty five genotype NDRK-2065, NDR-97, BRRI-75, CSR-30, Mahak-m51, Shreshtha-Gold, Bio-Seed-799, BioSeed-301, NDRK19-3, NDRK19-9, NDRK19-11, NDRK19-12, US-362, Pusa-1121, Nandi-Super, Pusa-Sugandha-5, Kala-Namak (S), Kala-Namak-03, NDRK-5007, NDRK-5083, NDRK-5027, NDRK-5036, Pioneer-28P67, NDRK19-2, Kala-Namak (B) and two check Pusa-44 and Kala-Namak, recorded moderate resistance against BLB. Similar finding have also been reported earlier by Rajpoot *et al.*, (2018) [18] and Acharya Basistha and KC Sujata (2021) [1]. Eight genotype NDRK-5037, NDRK-5018, BRRI-78, Arize-6444, Moti-NP360, Moti-555, NDRK-3112, NDRK-8002 was observed moderately susceptible. Twenty seven genotype *viz*., Pant Basmati-1, Bina Dhan-11, PAU5564-18-1-2, CARI-Dhan6, Pusa-Basmati-6, FL-478, UB-53, Karishma, PAC-8744, Kaveri-K108, HUR-1309, Pioneer-B9463, Ganga Kaveri, Pioneer-27P64, NDRK19-1, NDRK19-4, NDRK19-6, NDRK19-7, NDRK19-8, NDRK19-10, NDRK19-13, HUR-1304, Pusa Basmati-1, PNR-381, Sugandh-3, BPT-5204 and US-305, was observed susceptible and none genotype highly susceptible for disease. Similar finding have also been reported earlier by Ashwarya *et al*., (2016) [3], Tyagi *et al.*, (2010) [22] and Lussewa (2016) [11]. The most desirable genotypes were the NDR-2064 had grain yield per plant (11.68g) and damage score of "0.33" indicating immune for BLB. The high yielding check, Narendra Usar 3 (sodicity tolerant), produced grain yield 10.97g, and showed damaged rating 0.33 indicating immune whereas the second check, Pusa-44 (susceptible) had lowest grain yield per plant 6.01g and moderately resistant (Score "3.00") to BLB. The genotype exhibited high mean Sambha-Sub-1(18.78g) performance and damaged leaf rating (1) observed resistant followed by the Swarna-Sub-1(18.42g), Kasturi chandauli (18.18g), Soanam (17.41g), Kala-Namak (s)(14.97g), NDRK19-5 (14.69g), NDR-359(14.52g), Sarjoo-52(12.61g), Kala-Dhan(12.47g), NDRK-5052(9.96g) showed high mean performance among the genotype with BLB scoring (1) indicating resistant to BLB under sodic soil. The genotype exhibited mean performance NDRK-5027(15.76g) and damaged leaf rating (3) observed moderate resistant followed by the Kala-Namak (15.13g), Kala-Namak (15.13g), Kala-Namak (B)(14.27g), Nandi-Super (13.81g), Shreshths-Gold (12.85g), NDRK19-12 (12.38g), CSR-30 (12.34g), PusaSugandha-5 (12.32g), NDR-2065 (11.81), NDRK-5027 (11.17g), NDR-97 (11.11g), Pusa-1121(10.87), NDRK-5083 (10.42g), NDRK19-11 (10.00g), NDRK19-9 (9.98g), BRRI-75 (9.55g), Mahak-m51 (9.09g), Pioneer28P67 (9.07g), NDRK19-2 (9.06g), Kala Namak(T) (8.80g), US-362 (8.78g), NDRK-5036 (8.66g), NDRK19-3 (8.45g), Bio Seed-799 (8.35), Bio Seed-301 (7.87g), Kala Namak-03 (7.40g) and Pusa-44 (6.01g) showed mean performance among the genotype with BLB scoring (3) indicating moderate resistant to BLB under sodic soil.

Resistance genotype 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) [17], Satya *et al.*, (1999) [19], Singh *et al.*, (2007) [21] and Tyagi *et al.*, (2010) [22], Rajpoot *et al.*, (2018) [18] Thus, the high yielding parents discussed above having high mean performance for grain yield and for leaf folder may be recommended for use as genotype for developing high yielding rice hybrids under sodic soil. The genotype 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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