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Evaluation of *'Reference Panel'* of the Global Rice Array Exotic Rice Genotypes for BLB and False Smut Resistance under Field Condition

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ABSTRACT: The present investigation was conducted at the Norman E. Borlaug Crop Research Centre (NEBCRC), Govind Ballabh Pant University of Agriculture and Technology, Pantnagar during *Kharif* 2021, to investigate the genetic potential of 39 '*Reference Panel'* of the Global Rice Array exotic rice genotypes along with three checks *viz.*, Govind, Pant Dhan 4 and Pant Dhan 12 against bacterial leaf blight and false smut. Bacterial suspension from infected disease materials was prepared. Clip method of artificial inoculation was used. The genotypes were screened for false smut under open infection condition. All the genotypes along with 3 checks were scored for BLB and false smut by using SES for Rice (IRRI, 1996). Out of all the tested genotypes, 17 showed highly resistant, 16 were moderately resistant and 6 lines *viz.*, IR13V203, IR13V416, IR13V464, IR13V499, IR13V991 and IR13V1015 were susceptible. Among all the tested exotic genotypes, 6 genotypes namely IR13V203, IR13V224, IR13V617, IR13V624, IR13V112 and IR13V1119 showed highly resistance response to false smut. 16 were resistant, 8 showed moderately resistant, 6 were moderately susceptible whereas 3 genotypes *viz.*, IR13V325, IR13V400 and IR13V681 exhibited highly susceptible response to false smut. These exotic genotypes will be further studied in different location with MAS and can be used as source of resistant genes for BLB and false smut to transfer in cultivated varieties.

Keywords: *Xanthomonas oryza*, Reference Panel GRA, exotic lines, BLB, false smut, rice.

INTRODUCTION

Rice (*Oryza sativa* L.) is the world's second most important cereal crop which occupies an area of 165.25 million hectares with a production of 516 million tonnes (FAOSTAT, 2022). The average rice productivity in the global level is 4.25 metric tonnes/ha (FAOSTAT, 2022). India is the second largest producer of rice after China. India occupies 47 million hectares area under rice with 132 million tones production and an average productivity of 4.2 tons/ha (USDA, 2022). However, in recent era, global rice production has undergone an economic losses from bacterial leaf blight (BLB), a devasting bacterial disease caused by the Gram-negative proteobacterium *Xanthomonas oryzae pv. oryzae* (Qian *et al.*, 2013; Tian *et al.*, 2014). BLB attacks almost all the popular commercial rice strains (Duy *et al.*, 2021), and is one of the three main pests of rice, challenging both *Oryza sativa* (*Os*) subsp. *japonica* and *Oryza sativa* subsp. *indica* (Ji *et al.*, 2016). *Xanthomonas oryzae pv. oryzae* infection starts from tip of leaf with streaks that spreads to margins. These streaks become larger and eventually release a milky fluid that dries yellow. However, grayish white lesions on the leaves appear in late stage of infection which eventually causing the leaves drying out and dying. In seedlings, BLB causes the leaves to dry out and wilt, usually killing the seedling within two to three weeks. This bacterial disease less affects adult plant but the quality of rice has declined.

Controlling BLB has proven challenging, and consequently, BLB poses a threat to global food security. The symptoms of BLB and false smut are managed by using various chemical (Hegde *et al.*, 2000) and cultural management strategies (Brooks *et al*., 2009), but identification of resistant lines from diverse sources is more desirable. Chemical control, such as the use of antibiotics, has been restricted partly because of concerns over safety, practicality, and bacterial resistance. Biological control methods have also been limited. Although, false smut is a minor disease in our country, but in favourable condition the infection level crossed the ETL and caused severe yield loss in rice. However, more recently epidemics have been reported with increasing frequency in different parts of world because of the large scale expansion of high yielding cultivars, the use of chemical fertilizers, irrigation at high levels and climate change. In Punjab, 10 to 20% disease incidence was recorded in popular inbred rice varieties like PR 114, PR 116 and PAU 201 (Ladhalakshmi *et al.*, 2012). The disease causes reduction not only in quality and quantity of the produce, but also reduces the germaination vigour of the infected seedlings (Sanghera *et al.*, 2012). Therefore, the present study was conducted to screen 39 exotic Reference Panel genotypes of Global Rice Array (IV) for bacterial leaf blight and false smut resistance. The resistance genotypes will be used in crossing programme to transfer desirable genes to cultivated varieties.

MATERIALS AND METHODS

Collection of plant materials and experimental site. The experiment for present study consisted of exotic rice genotypes from *Antenna Panel* of the Global Rice Array flagship project of IRRI. The field experiment was done at the Norman E. Borlaug Crop Research Centre of Govind Ballabh Pant University of Agriculture and Technology, Pantnagar. Field evaluation and phenotyping were carried out during kharif 2021. The experimental material comprised of 39 genotypes of rice along with three checks (Govind, PD 4 and PD 12), all 39 genotypes from 'Reference *Panel'* of the Global Rice Array of IRRI (**Table 1**). All the three checks exhibited resistant reaction to BLB and FS. Each genotype was sown in a single of length 2m and plant-plant and row-row spacing was maintained by 20 cm and 40cm respectively.

Collection of diseased materials. Disease affected plants were identified by specific symptoms of yellow streaks on leaf margins. The diseased plants were collected from the sick field near Haldi, Pantnagar.

Isolation, purification of pathogen and inoculation. Infected rice leaves were cut into small pieces and were grinded in mortar and pestle. The bacterial suspension containing spores was prepared to inoculate the healthy plant by clip methods (Kauffman *et al.*, 1973). For this purpose, I used sterilized surgical scissors. The scissor was dipped in bacterial suspension and was used to cut top 1-3 inches leaves at seedling stage. The plant infected by such inoculums was confirmed by symptoms appearance i.e. yellow lesion on leaf surface.

Screening of rice genotypes in field. Seeds are sown in the nursery plot in the month of June in the single row of two meter. Seedlings were transplanted after 25 days of sowing. Seedling planted at a spacing of 20 cm plant to plant and row to row spacing maintained as 40cm. The experimental field was kept free from weeds by adopting manual weeding. The trial blocks were irrigated as and when needed. Other agronomic practices were followed as per recommendation. Disease scoring was done at 1-9 scale after three weeks of inoculation. On the basis of disease scoring value, genotypes were classified into different categories according to their resistance level using standard IRRI procedure (IRRI, 1996). Observations were recorded at the milky stage on the severity of bacterial leaf blight reaction on a 0-9 scale (Anon., 1996). All the genotypes along with were screened for false smut in open field condition by using SES for Rice (IRRI, 1996). The standard IRRI score chart for BLB and FS are presented in the Table 2 and 3, respectively.

Table 1: List of 39 genotypes from '*Reference Panel'* of the Global Rice Array *of* IRRI.

Sr. No.	Genotypes	Sr. No.	Genotypes
1.	IR13V203	21.	IR13V693
2.	IR13V205	22.	IR13V735
3.	IR13V224	23.	IR13V737
4.	IR13V252	24.	IR13V817
5.	IR13V259	25.	IR13V819
6.	IR13V279	26.	IR13V937
7.	IR13V325	27.	IR13V964
8.	IR13V366	28.	IR13V991
9.	IR13V377	29.	IR13V1015
10.	IR13V400	30.	IR13V1095
11.	IR13V407	31.	IR13V1102
12.	IR13V415	32.	IR13V1111
13.	IR13V416	33.	IR13V1113
14.	IR13V448	34.	IR13V1116
15.	IR13V464	35.	IR13V1119
16.	IR13V499	36.	IR13V1307
17.	IR13V566	37.	IR13V1331
18.	IR13V617	38.	IR13V1421
19.	IR13V624	39.	IR13V1444
20.	IR13V681		

Table 2: IRRI-SES Scale, 1996 for BLB.

Disease rating scale	Lesion area on leaf (%)	Category
1	1-5%	Resistant
3	6-12%	Moderately Resistant
5	13-25%	Moderately Susceptible
7	26-50%	Susceptible
9	51-100%	Highly Susceptible

Table 3: IRRI-SES Scale, 1996 for False Smut.

Category	Scale	Infected floret percentage
Highly Resistant	0	No disease
Resistant	1	<1
Moderately Resistant	3	1.0-5
Moderately Susceptible	5	5.1-25
Susceptible	7	25.1-50
Highly Susceptible	9	Above 50

RESULTS AND DISCUSION

Result for BLB screening. In the field condition, no genotypes were found for BLB resistant. 17 genotypes showed resistant to bacterial leaf blight *viz.,* IR13V205, IR13V259, IR13V279, IR13V325, IR13V377, IR13V448, IR13V617, IR13V693, IR13V735, IR13V737, IR13V937, IR13V1095, IR13V1102, IR13V1111, IR13V1116, IR13V1307 and IR13V1421. Out of 39 genotypes 16 genotypes were moderately resistant however six genotypes *viz*., IR13V203, IR13V416, IR13V464, IR13V499, IR13V991, IR13V1015 found to be susceptible to bacterial leaf blight. The genotypes which were exhibited moderately resistant to BLB are mentioned in Table 4. Genotypes were classified into three classes based on degree of reaction and genotypes falling in particular class are presented in Table 4.

Results for False Smut scoring. Six genotypes *viz.*, IR13V203, IR13V224, IR13V617, IR13V624, IR13V1102, IR13V1119 were found to be immune to false smut disease having score zero. 16 genotypes showed resistant to resistant false smut however eight genotypes exhibited moderately resistant to FS. Six genotypes and three genotypes were found to be moderately susceptible and susceptible, respectively. Genotypes which were grouped into 5 categories based on disease reaction are shown in Table 5.

Table 4: Genotypes response to disease reaction BLB.

Disease Reaction	Genotypes
Immune	**None**
Resistant	IR13V205, IR13V259, IR13V279, IR13V325, IR13V377, IR13V448, IR13V617, IR13V693, IR13V735, IR13V737, IR13V937, IR13V1095, IR13V1102, IR13V1111, IR13V1116, IR13V1307, IR13V1421
Moderately Resistant	IR13V224, IR13V252, IR13V366, IR13V400, IR13V407, IR13V415, IR13V566, IR13V624, IR13V681, IR13V817, IR13V819, IR13V964, IR13V1113, IR13V1119, IR13V1331, IR13V1444
Susceptible	IR13V203, IR13V416, IR13V464, IR13V499, IR13V991, IR13V1015

Table 5: Genotypes response to disease reaction False Smut.

Disease Reaction	Genotypes
Highly Resistant	IR13V203, IR13V224, IR13V617, IR13V624, IR13V1102, IR13V1119
Resistant	IR13V205, IR13V259, IR13V279, IR13V366, IR13V407, IR13V415, IR13V416, IR13V448, IR13V566, IR13V964, IR13V991, IR13V1015, IR13V1113, IR13V1116, IR13V1331, IR13V1444
Moderately Resistant	IR13V252, IR13V377, IR13V464, IR13V499, IR13V817, IR13V819, IR13V1095, IR13V1111
Moderately Susceptible	IR13V693, IR13V735, IR13V737, IR13V937, IR13V1307, IR13V1421
Susceptible	IR13V325, IR13V400, IR13V681

Rice genotypes showing different level of resistance to bacterial leaf blight and False Smut are shown in the bar graph in the Fig. 1. It obviously observed that approximately equal number of genotypes were exhibited resistant reaction to both BLB and FS. Only six genotypes showed immune reaction to FS where none genotypes are immune to BLB. Few exotic genotypes were susceptible to both BLB and FS. The similar result found by Acharya and Sujata (2021); Sarawgi *et al.* (2013).

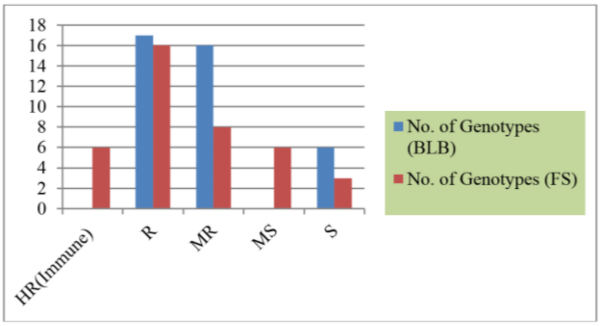

Fig. 1. Rice genotypes showing different level of resistance to bacterial leaf blight and False Smut.

CONCLUSIONS

Due to different genetic background the genotypes varied significantly for bacterial leaf blight disease and false smut disease. Rice genotypes found resistant could be used as a donor source for developing bacterial leaf blight resistant variety in India. The genotypes found moderately resistant could be used as the resistant source for developing bacterial leaf blight resistant and false smut resistant varieties for various domains of India. The Exotic Genotypes are further evaluated through genotyping by using BLB SSR markers. As the BLB is a devastating disease in many part of rice growing area of India, so these exotic IRRI genotypes will play a very good resistant source for transferring resistant gene to our high yielding cultivated variety.

FUTURE SCOPE

In India, rice is a staple food grain crop and more than 50% people depend on rice. India is also the largest exporter of rice in the world. Bacterial leaf blight is a major disease in many part of India *viz.,* Assam, West Bengal, Odisha, Andhra Pradesh, Telengana, KT and TM which affect yield reduction upto 80% in most favourable condition. After green revolution we are growing pure lines only which results loss of genetic variability of rice. Therefore, these exotic IRRI genotypes act as source of resistant genes non only for BLB and FS but also for any other deadly disease. Those exotic lines which have good yield plateau and grain quality along with resistant to various disease are directly used registered and cultivated as a variety.

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Conflict of Interest. None.

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