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PHENOTYPIC SCREENING FOR LEAF AND NECK BLAST IN VARIOUS *INDICA*, *JAPONICA* RICE AND THEIR CROSS HYBRIDS

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ABSTRACT

Leaf and neck blast are among the major disease of rice that causes huge yield loss. The development of resistant plant varieties is the cheapest, sustainable and eco-friendly approach to combat the blast disease in rice. The aim of present study was to identify the superior hybrids and their parents with blast resistance in natural field condition at RWRC, Malan during *kharif*- 2023. The experiment was carried out with 14 *indica* lines, three *japonica* testers and 42 crosses. The disease scoring was done by using 0-9 scale of Standard Evaluation System (SES) developed by IRRI, 2014. Based on the disease scoring by standard scales, the genotypes were categorized as resistant, moderately resistant/ susceptible and susceptible types. Out of total 59 entries (17 parents and 42 F_1) 18 entries (eight parents and 10 F_1) were found highly resistant for leaf as well as neck blast.
***Keywords* :** Rice, blast, disease, resistance, hybrids and susceptible.

Introduction

Blast is a serious fungal disease of rice that is threatening global food security. It has been extensively studied due to the importance of rice production and consumption, and because of its vast distribution and destructiveness across the world. Rice blast caused by *Magnaporthe oryzae* (anamorph stage: *Pyricularia grisea*) can infect aboveground tissues of rice plants at any growth stage and cause total crop failure or partial yield loss. The pathogen produces lesions on leaves (leaf blast), leaf collars (collar blast), culms, culm nodes, panicle neck nodes (neck blast), and panicles (panicle blast), which vary in colour and shape depending on varietal resistance and environmental conditions (Asibi *et al*., 2019). Understanding the rice blast reaction in interspecific hybrids of rice can provide critical insight into incidence of the disease in near future for the development of blast resistant rice varieties which is the most economic approach to reduce the loss due to leaf and neck blast and is fundamental strategy for the sustainable control of rice blast to improve rice production for global food security.

The pathogen causing blast disease is highly adaptable and mutates rapidly, making it challenging to control. To combat the disease, breeding resistant varieties and hybrids have proven to be the most effective and cost-efficient strategy. Unfortunately, most rice varieties grown in India lack resistance genes, so identifying resistant sources adapted to various environments is crucial. If rice blast is not controlled at the initial stage, it can result in up to 80 per cent loss of yield. Neck blast can prevent plants from producing any grains at all. Leaf blast can be lethal to young rice plants and can lead to significant yield losses in severe cases. The development of *indica-japonica* rice hybrids offers great scope to exploit the hidden genetic potential for controlling rice blast.

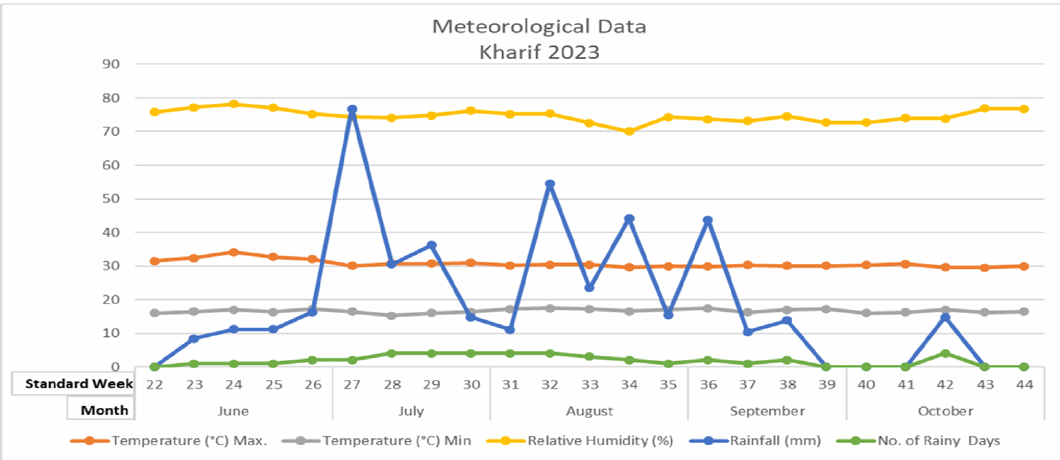
Material and Method

Material

The 42 interspecific hybrids were developed by using 14 *indica* lines, three *japonica* testers in line-tester mating design in *kharif*-2022. The entries were sown in three replication and screening data was not subjected to statistical analysis. Screening of cross hybrids along with 17 parents for leaf and neck blast was performed in the field conditions at Rice and Wheat Research Centre, Malan (CSKHPKV) during *kharif*, 2023 and their reaction to prevailing disease.

Meteorological Data

The agro-meteorological conditions prevailing during the research period were conducive to the development of both leaf and neck blast in rice. During the experimental season, the maximum temperature recorded was 34.11°C, while the minimum temperature dropped to 15.2°C, providing a favourable thermal regime for the infection and colonization processes of *Magnaporthe oryzae* (Khush and Jena, 2009). Relative humidity remained consistently high, with maximum and minimum values of 78.21% and 70.07%, respectively, which is known to enhance conidial germination, sporulation, and successful host penetration. The experimental site received a total rainfall of 436.78 mm, distributed over 42 rainy days, indicating frequent precipitation and prolonged periods of leaf and panicle wetness. Such conditions are particularly favourable for the initiation and progression of leaf blast during vegetative stages and neck blast during the reproductive phase. Consequently, the prevailing weather conditions ensured adequate natural disease pressure, enabling reliable assessment of genotypic responses to both leaf and neck blast under natural field conditions.



Method

Leaf blast evaluation

Materials were evaluated for leaf blast reaction using Standard Evaluation System (SES) for rice of IRRI on a 0-9 scale as given under:

Scale	Description/Symptoms
0	No lesions observed
1	Small brown specks of pinhead size without sporulating centre.
2	Small roundish to slightly elongated, necrotic grey spots, about 1-2 mm in diameter, with a distinct brown margin
3	Lesion type is the same as in scale 2, but a significant number of lesions are on the upper leaves
4	Typical susceptible blast lesions 3 mm or longer, infecting less than 4 per cent of the leaf area
5	Typical blast lesions infecting 4-10 per cent of the leaf area
6	Typical blast lesions infection 11-25 per cent of the leaf area
7	Blast lesions infecting 26-50 per cent leaf area
8	Typical blast lesions infection 51-75 per cent of leaf area and leaves are dead
9	More than 75 per cent leaf area affected

Neck blast evaluation

Materials were evaluated for neck blast reaction using Standard Evaluation System (SES) for rice of IRRI on a 0-9 scale during stage 8 (20-25 days after heading) as given under:

Score	Description
0	No incidence
1	Less than 5 per cent
3	5-10 per cent
5	11-25 per cent
7	26-50 per cent
9	More than 50 per cent

Disease reaction to blast

The parents/crosses were evaluated for leaf and neck blast under natural field conditions using Standard Evaluation System (SES) for rice of IRRI (2014). The reflected reactions are presented in Table 1.

Result

Leaf blast

Leaf blast is one of the most destructive diseases of rice. A leaf blast infection generally occurs at seedlings or the tillering stage. At later growth stages, a severe leaf blast infection reduces leaf area for grain fill, reducing grain yield. This disease can kill rice plants at seedling stage and cause yield losses in cases of severe infection.

For leaf blast, 30 parents/crosses were found to be highly resistant (SES score = 0), 19 genotypes showed resistant reaction (SES score =1, 2), eight genotypes were moderately resistant (SES score = 3, 4), two genotypes were found to be moderately susceptible (SES score = 5, 6, 7) *viz.,* HPR 1156 × Naggar Dhan and HPR 2904 × Bhrigu Dhan. None of the genotypes in the study were found to be susceptible to leaf blast.

Neck blast

Neck blast is also considered as one of the most destructive diseases of rice because neck and node blast affect the panicle directly, which eventually leads to the huge yield loss. For neck blast, 39 parents/crosses were found to be highly resistant (SES score = 0), three parents/crosses showed resistant reaction (SES score = 1), 14 parents/crosses were moderately resistant (SES score = 3), three parents/crosses *viz.,* HPR 2795 × Varun Dhan, HPR 2902 × Bhrigu Dhan and HPR 2905 × Bhrigu Dhan were found to be moderately susceptible (SES score = 5, 7). None of the parents/cross combinations in the study were found to be susceptible to neck blast.

Fig. 1: Leaf blast in field condition

Fig. 2: Neck blast in field condition

Discussion

The predominance of highly resistant and resistant reactions to both leaf and neck blast among the evaluated parents and cross combinations indicates the availability of effective resistance sources within the experimental material. The relatively lower frequency of moderately susceptible reactions, particularly for neck blast, further highlights the stability of resistance across vegetative and reproductive stages, which is a critical requirement for durable blast management. Similar trends of high resistance frequency under natural epiphytotic conditions have been reported earlier by Hossain and Hedge (2016); Vinayak *et al.* (2017); Saikiran *et al.* (2019); Zarbafi *et al.* (2019); Sidhu *et al.* (2021); Acharya *et al.* (2019); Jeevan *et al.* (2023); Raj *et al.* (2024); Shirisha *et al.* (2025) and Srujana *et al.* (2025) supporting the reliability of field-based screening for blast resistance. The identification of parents and cross combinations exhibiting consistent resistance to both leaf and neck blast underscores their potential utility in rice breeding programmes aimed at developing cultivars with durable and stage-independent blast resistance.

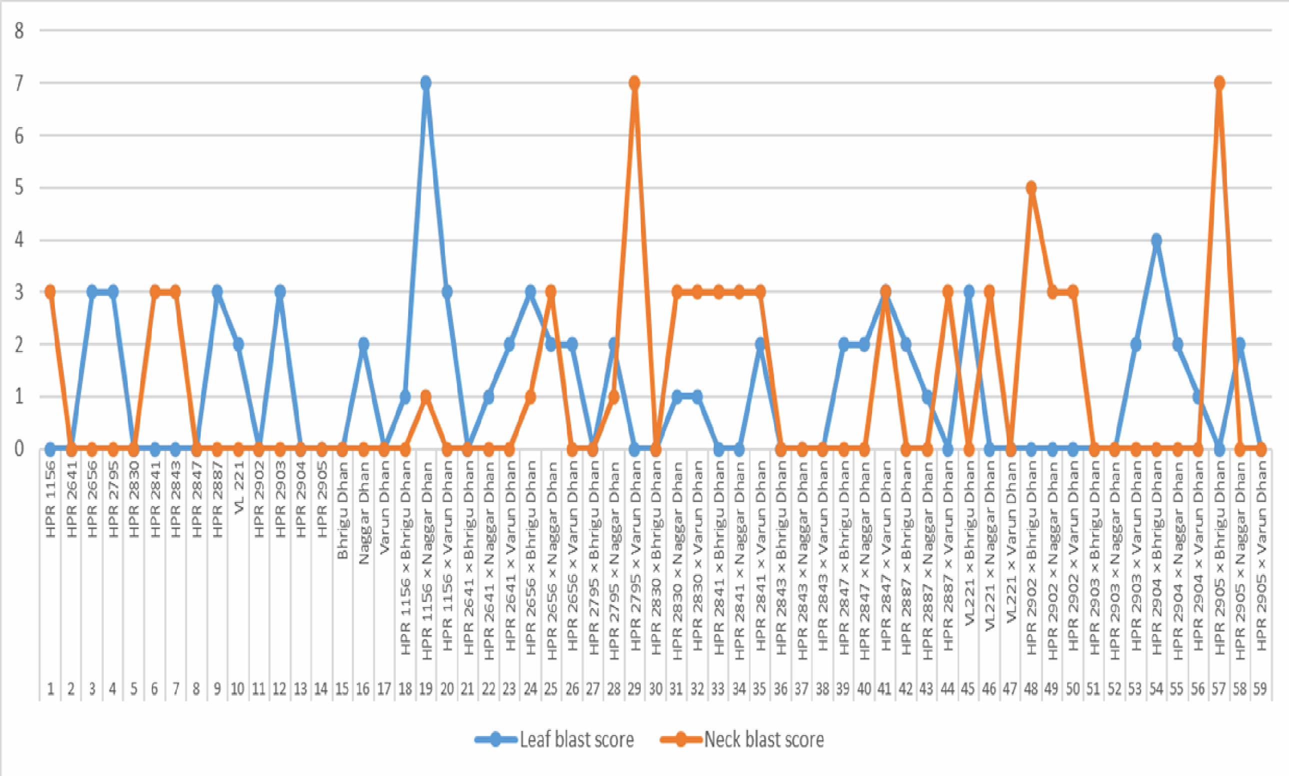


Fig. 3: Graph reflecting leaf and neck blast score in different genotypes

Table 1: Disease reaction of leaf and neck blast for various parents and interspecific crosses of rice

S. No.	Parents/crosses	Leaf blast score	Disease reaction	Neck blast score	Disease reaction
1.	HPR 1156	0	HR	3	MR
2.	HPR 2641	0	HR	0	HR
3.	HPR 2656	3	MR	0	HR
4.	HPR 2795	3	MR	0	HR
5.	HPR 2830	0	HR	0	HR
6.	HPR 2841	0	HR	3	MR
7.	HPR 2843	0	HR	3	MR
8.	HPR 2847	0	HR	0	HR
9.	HPR 2887	3	MR	0	HR
10.	VL 221	2	R	0	HR
11.	HPR 2902	0	HR	0	HR
12.	HPR 2903	3	MR	0	HR
13.	HPR 2904	0	HR	0	HR
14.	HPR 2905	0	HR	0	HR
15.	Bhrigu Dhan	0	HR	0	HR
16.	Naggar Dhan	2	R	0	HR
17.	Varun Dhan	0	HR	0	HR
18.	HPR 1156 × Bhrigu Dhan	1	R	0	HR
19.	HPR 1156 × Naggar Dhan	7	MS	1	R
20.	HPR 1156 × Varun Dhan	3	MR	0	HR
21.	HPR 2641 × Bhrigu Dhan	0	HR	0	HR
22.	HPR 2641 × Naggar Dhan	1	R	0	HR
23.	HPR 2641 × Varun Dhan	2	R	0	HR
24.	HPR 2656 × Bhrigu Dhan	3	MR	1	R
25.	HPR 2656 × Naggar Dhan	2	R	3	MR
26.	HPR 2656 × Varun Dhan	2	R	0	HR
27.	HPR 2795 × Bhrigu Dhan	0	HR	0	HR
28.	HPR 2795 × Naggar Dhan	2	R	1	R
29.	HPR 2795 × Varun Dhan	0	HR	7	MS
30.	HPR 2830 × Bhrigu Dhan	0	HR	0	HR
31.	HPR 2830 × Naggar Dhan	1	R	3	MR
32.	HPR 2830 × Varun Dhan	1	R	3	MR
33.	HPR 2841 × Bhrigu Dhan	0	HR	3	MR
34.	HPR 2841 × Naggar Dhan	0	HR	3	MR
35.	HPR 2841 × Varun Dhan	2	R	3	MR
36.	HPR 2843 × Bhrigu Dhan	0	HR	0	HR
37.	HPR 2843 × Naggar Dhan	0	HR	0	HR
38.	HPR 2843 × Varun Dhan	0	HR	0	HR
39.	HPR 2847 × Bhrigu Dhan	2	R	0	HR
40.	HPR 2847 × Naggar Dhan	2	R	0	HR
41.	HPR 2847 × Varun Dhan	3	MR	3	MR
42.	HPR 2887 × Bhrigu Dhan	2	R	0	HR
43.	HPR 2887 × Naggar Dhan	1	R	0	HR
44.	HPR 2887 × Varun Dhan	0	HR	3	MR
45.	VL221 × Bhrigu Dhan	3	MR	0	HR
46.	VL221 × Naggar Dhan	0	HR	3	MR
47.	VL221 × Varun Dhan	0	HR	0	HR
48.	HPR 2902 × Bhrigu Dhan	0	HR	5	MS
49.	HPR 2902 × Naggar Dhan	0	HR	3	MR
50.	HPR 2902 × Varun Dhan	0	HR	3	MR
51.	HPR 2903 × Bhrigu Dhan	0	HR	0	HR
52.	HPR 2903 × Naggar Dhan	0	HR	0	HR
53.	HPR 2903 × Varun Dhan	2	R	0	HR

54.	HPR 2904 × Bhrigu Dhan	4	MS	0	HR
55.	HPR 2904 × Naggar Dhan	2	R	0	HR
56.	HPR 2904 × Varun Dhan	1	R	0	HR
57.	HPR 2905 × Bhrigu Dhan	0	HR	7	MS
58.	HPR 2905 × Naggar Dhan	2	R	0	HR
59.	HPR 2905 × Varun Dhan	0	HR	0	HR

HR- Highly resistant, R-Resistant, MR- Moderately resistant, MS- Moderately susceptible and S-Susceptible

Table 2: Highly Resistant Parents for leaf as well as neck blast

S.No.	Lines	S.No.	Testers
1.	HPR 2641	1.	Bhrigu Dhan
2.	HPR 2830	2.	Varun Dhan
3.	HPR 2847		
4.	HPR 2902		
5.	HPR 2904		
6.	HPR 2905		

Table 3 : Highly Resistant Crosses for leaf as well as neck blast

S.No.	Cross
1.	HPR 2641 × Bhrigu Dhan
2.	HPR 2795 × Bhrigu Dhan
3.	HPR 2830 × Bhrigu Dhan
4.	HPR 2843 × Bhrigu Dhan
5.	HPR 2843 × Naggar Dhan
6.	HPR 2843 × Varun Dhan
7.	VL221 × Varun Dhan
8.	HPR 2903 × Bhrigu Dhan
9.	HPR 2903 × Naggar Dhan
10.	HPR 2905 × Varun Dhan

Conclusion

Blast disease remains one of the most destructive constraints to rice production, and the identification of reliable sources of resistance is therefore a key priority for rice improvement programs. In the present study, a wide range of responses to both leaf and neck blast was observed among the evaluated parental lines and their F_1 hybrids, clearly indicating the presence of exploitable genetic variability for blast resistance. Among the 59 entries (17 parents and 42 F_1) tested, 18 genotypes, including eight parents and ten F_1 hybrids, consistently exhibited a highly resistant reaction to both leaf and neck blast. In addition, 15 entries expressed resistance levels ranging from highly resistant to resistant against both diseases.

The simultaneous expression of resistance to leaf and neck blast is particularly represents a valuable outcome of this study. These resistant parents can serve as promising donor sources in future breeding programs aimed at pyramiding blast resistance genes and developing rice varieties with durable and broad-spectrum resistance and the hybrids conferring resistance can further be advanced and in future can be a promising variety reflecting resistance to blast disease in rice.

Overall, the results highlight the effectiveness of systematic screening under disease pressure for identifying robust resistance sources and reinforce the potential of integrating these genotypes into conventional and molecular breeding strategies. The utilization of such resistant material will contribute to the development of improved rice cultivars, ultimately sustain rice production in blast-endemic regions.

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