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Screening of Rice Germplasm Accessions for Resistance to Brown Plant Hopper (*Nilaparvata lugens* Stal.)

D Harshitha [a*], T. Srikanth [a], V. Ratnakar [b] and P. Madhukar [c]

[a] Department of Genetics and Plant Breeding, Agricultural College, Professor Jayashankar Telangana State Agricultural University, Polasa, Jagtial, Telangana, India.
[b] Department of Entomology, Agricultural College, Professor Jayashankar Telangana State Agricultural University, Polasa, Jagtial, Telangana, India.
[c] Department of Genetics and Plant Breeding, Professor Jayashankar Telangana State Agricultural University, RARS, Polasa, Jagtial, Telangana, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Short Research Article

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ABSTRACT

An investigation was executed with twenty-nine rice germplasm accessions to identify the source of resistance to Brown planthopper, *Nilaparvata lugens* (Stal.) during Rabi 2024 at RARS, Jagtial under glasshouse conditions. These rice germplasm accessions were screened following the Standard Seed box Screening Test, with one resistant check (PTB 33) and one susceptible check (TN1). Among 29 accessions, only five viz., IR 23352-7R, RP-4516-3-6, JMS 13 A × RP 4516-3-6,

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**Corresponding author: E-mail: daithalaharshitha22@gmail.com;*

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CMS 59A × RP 4516-3-6 and CMS 59A × KNM 7660 displayed damage score (DS) ranging from 1 to 3 are resistant (R). Eleven accessions viz., RMS 1A, IET 23993, JMS 24A × IR 23352-7R, JMS 24A × IR 10198-66-2R, JMS 24A × RP-4516-3-6, JMS 13 A × IR 23352-7R, JMS 13 A × IR 10198-66-2R, CMS 59A × IR 23352-7R, RMS 1 A × IR 10198-66-2R, RMS 1 A × RP 4516-3-6 and RMS 1 A × KNM 7660 exhibited scoring between 3.1-5.0 are moderately resistant. The remaining 13 were identified as moderately susceptible scoring between 5.1-7.0. Further studies on the resistant mechanisms such as antixenosis, antibiosis, and tolerance are required to determine the best genotypes that could be used for developing BPH-resistant / tolerant varieties/hybrids with preferable yield and quality traits.

Keywords: Rice, germplasm accessions, screening, Nilaparvata lugens, resistance.

1. INTRODUCTION

"Rice (*Oryza sativa* L.), one of the world's most important food crop is affected by serious pests which pose a major threat to production causing cumulative yield losses of about 25%" [1]. "Among these, the brown plant hopper (BPH), *Nilaparvata lugens* (Stal.) (Hemiptera: Delphacidae) is a serious pest causing significant yield losses under epidemic conditions. It is considered an important insect pest affecting rice cultivation with an annual yield loss of up to 80% which is $300 million in Asia" [2].

Nymphs and adults both cause direct damage by sucking the phloem sap and thereby resulting in 'hopper burn' [3]. "Also act as vector for the rice grassy stunt virus (GSV) and ragged stunt virus (RSV)" [4].

"The application of chemical pesticides like imidacloprid is the primary strategy used to control BPH attack in plants. However, this strategy is not only expensive but also dangerous for environment and human health. It also unintentionally eradicates natural predators and encourages the development of BPH biotypes resistance to pesticides" [5].

"Therefore, using a host-plant resistance approach to manage insects and increase yield is the most cost-effective, efficient and ecologically friendly" [6]. Given the significance of resistant and tolerant varieties of managing BPH, it has become essential to identify new sources of resistance with enhanced quality parameters to introduce these traits into high-yielding varieties.

2. MATERIALS AND METHODS

2.1 Mass Rearing of BPH

BPH was mass reared on the susceptible rice variety Taichung Native 1 (TN1) to produce enough nymphs for infestation. The population of nymphs was first gathered from the fields and pure culture was kept on 40-50 day-old potted plants of TN1 at a temperature of 30°C ± 5°C with a relative humidity of 60±5% in the glasshouse. Mass rearing was done in cages. First and second instars were collected and used for experiments.

2.2 Screening Procedure

"A total of 31 rice genotypes including a susceptible check (TN1) and a resistant check PTB33 were screened against BPH using the Standard Seed box Screening Test developed by the International Rice Research Institute [7]", [8]. Mass screening technique as described by Kalode et al., [9]. The method involves infestation of young seedlings (about 12 days old) of test entries grown in screening trays (50 cm × 40 cm × 8 cm) filled with fertilizer enriched puddled soil. Use of puddled soil helps in uniform growth of seedlings and avoids soil problems. Each screening tray includes the test lines, one row of PTB 33 in the middle and two rows of TN1 in the borders.

First and second instar nymphs will be released on test entries at 12-13 days after sowing by tapping heavily infested plants from oviposition cages on the screening trays, ensuring that each test seedling to be infested with at least 6-8 nymphs. The screening trays with BPH nymphs were covered with mylar cages to prevent escape of the nymphs. The infested trays will be monitored regularly for the plant damage. When TN1 plants on one side showed severe damage, the tray will be rotated by 180^0 for even reaction on both sides. When more than 90 percent plants of susceptible check, TN1 killed, the test entries will be scored for the damage reaction, based on 0-9 scale of

Table 1. Classification of level of resistance based on damage reaction

Plant State	Score	Resistance classification
No injury	0	Highly Resistant
Very slight injury	1	Resistant
The first and second leaves of most plants partially yellow	3	Moderately Resistant
Pronounced yellowing and stunting or about 10 to 25 % of the plants wilting or dead and remaining plants severely stunted or dying	5	Moderately Susceptible
More than half of the plants	7	Susceptible
All plants dead	9	Highly Susceptible

Table 2. Reaction and damage score of selected germ plasm accession

S. No.	Entry	Mean Damage Score (0-9 scale)	Reaction
		Lines	
1	JMS 24A	5.4	MS
2	JMS 13A	6.5	MS
3	CMS 59A	6.0	MS
4	RMS 1A	4.6	MR
		Testers	
5	IET 23993	3.7	MR
6	IR 23352-7R	3.0	R
7	IR-10198-66-2R	5.8	MS
8	RP-4516-3-6	2.8	R
9	KNM-7660	5.3	MS
		Hybrids	
10	JMS 24A × IET 23993	5.1	MS
11	JMS 24A × IR 23352-7R	3.1	MR
12	JMS 24A × IR 10198-66-2R	3.2	MR
13	JMS 24A × RP-4516-3-6	3.4	MR
14	JMS 24 A × KNM 7660	5.2	MS
15	JMS 13 A × IET 23993	5.1	MS
16	JMS 13 A × IR 23352-7R	3.5	MR
17	JMS 13 A × IR 10198-66-2R	3.2	MR
18	JMS 13 A × RP 4516-3-6	1.9	R
19	JMS 13 A × KNM 7660	5.8	MS
20	CMS 59A × IET 23993	6.0	MS
21	CMS 59A × IR 23352-7R	3.7	MR
22	CMS 59A × IR 10198-66-2R	4.5	MS
23	CMS 59A × RP 4516-3-6	2.8	R
24	CMS 59A × KNM 7660	3	R
25	RMS 1 A × IET 23993	5.1	MS
26	RMS 1 A × IR 23352-7R	6.1	MS
27	RMS 1 A × IR 10198-66-2R	3.3	MR
28	RMS 1 A × RP 4516-3-6	3.2	MR
29	RMS 1 A × KNM 7660	3.2	MR
		Checks	
30	TN-1 (Susceptible Check)	9	HS
31	PTB-33 (Resistant Check)	2	R

R - resistant, MR - moderately resistant, MS - moderately susceptible, S - susceptible, HS - highly susceptible

international standard evaluation system [7] as described in Table 1.

After scoring as per SES, means damage score of three replications was calculated. All the SSST entries were then categorized as resistant (R), moderately resistant (MR), moderately susceptible (MS), susceptible (S) and highly susceptible (HS) based on damage score shown in Table 2.

3. RESULTS AND DISCUSSION

Results regarding screening of 29 rice germplasm accessions, only five *viz*., IR 23352-7R, RP-4516-3-6, JMS 13 A × RP 4516-3-6, CMS 59A × RP 4516-3-6 and CMS 59A × KNM 7660 exhibited damage score (DS) ranging from 1 to 3 and were designated as resistant (R). Eleven accessions *viz*., RMS 1A, IET 23993, JMS 24A × IR 23352-7R, JMS 24A × IR 10198-

66-2R, JMS 24A × RP-4516-3-6, JMS 13 A × IR 23352-7R, JMS 13 A × IR 10198-66-2R, CMS 59A × IR 23352-7R, RMS 1 A × IR 10198-66-2R, RMS 1 A × RP 4516-3-6 and RMS 1 A × KNM 7660 exhibited damage score between 3.1-5.0 were designated as moderately resistance. The remaining 13 accessions were identified as moderately susceptible with damage score between 5.1-7.0.

"From the investigation, the five resistant rice accessions showed resistance characteristics on par with that of PTB33 can serve as donors of resistance for breeding BPH resistance lines. It was observed that only, IR 62 and IR 64 were resistant and IR 34, IR 36 and IR 56 showed moderately resistant reaction against BPH at Raipur" [10]. Five of the 38 elite rice lines were discovered to be BPH-resistant [11]. "Using an internationally accepted screening technique, 121 promising rice genotypes of IGAU were assessed against brown plant hopper in glasshouse. Among 121 genotypes, resistant genotypes were three, moderately resistant genotypes were 20 and susceptible were 98 genotypes" [12]. "Similarly to the present studies, the studies carried out among 400 germplasm accessions three accessions were found to be resistant and thirteen accessions were moderately resistant" [13]. "Of the seeds of 1989 wild rice accessions, 159 accessions are resistant during 2012. Among these accessions, 31 accessions were again screened during 2013. Seven O. *nivara* accessions and O. *longistaminata* accession IRGC81967 were resistant over the two years, while one accession and IRGC81967 were moderately resistant during 2013. The remaining 22 accessions showed resistant reaction during both the two years" [14].

Among the tested 121 potential rice cultivars in a glasshouse for brown planthopper (BPH) resistance, three genotypes were found to be resistant and their damaged scores ranged from 0.6 to 2.90. Twenty were found to be moderately resistant, whereas 98 genotypes were found vulnerable to BPH infestation [15]. "BILs of CBMAS14065 with different combinations of BPH resistant genes were evaluated for their resistance against brown plant hopper (BPH) along with CBMAS14065 (recipient parent), IR71033-15B (donor parent), PTB33 (resistant check) and susceptible check (TN1). CBMAS14065 was moderately susceptible, IR71033-15B and BILs were moderately resistant" [16].

4. CONCLUSION

The screening test revealed that out of 29 rice germplasm accessions, only five viz., IR 23352-7R, RP-4516-3-6, JMS 13 A × RP 4516-3-6, CMS 59A × RP 4516-3-6 and CMS 59A × KNM 7660 exhibited resistance (R). Eleven accessions exhibited moderate resistance (MR) to BPH and remaining accessions were moderately susceptible, along with one resistant check (PTB 33) and one susceptible check (TN1).

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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