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Screening and identification of brown planthopper resistance in F₁ progenies of selected rice accessions

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Abstract

Seven rice entries *Viz.* IR 36892-163-1-2-2-1, IR 43449-4-3-43-3, IR 5947-247-2-1, IR 59552-63-3-2-3, Aruna (MO.8), IR 71033-62-15, REMYA (MO.10) which showed resistant reaction to BPH in previous glasshouse & field screening tests were used in the study. For crossing purpose one susceptible Basmati variety Pusa-1 was also selected as one of the parent. All the resistant entries were taken as mother or female parent, while Pusa-1 served as father or male parent in the present breeding programme. The seed bed screening method was adopted for the evaluation of F₁ progenies for brown planthopper resistance under glass house conditions. F₁ progenies of all the seven crosses of rice entries were *at par* in their resistance reaction against BPH with their resistant female parents under glass house conditions, while F₁ progenies of REMYA (MO. 10) × Pusa Basmati 1 and IR 59552-63-2-3 × Pusa Basmati 1 were superior over other progenies in their resistance to brown planthopper.

Keywords: Brown planthopper, rice entries, resistance, F₁ progenies, screening test

Introduction

Rice (*Oryza sativa* L.) is the most important staple food crop in all the Asian countries. The world's population is estimated to increase from 7.9 billion in 2021 to 9.6 billion by 2050. To meet the demand for food grain, 40% more rice needs to be grown by 2030, and 70% by 2050 (Khush, 2001, 2005, 2013) [9, 7, 8]. Among different biotic factors influencing rice productivity, brown planthopper (BPH), *Nilaparvata lugens* (Stål), is one of the most damaging pest of rice causing significant loss every year in all rice growing countries (Kumar *et al.*, 2018; Liu *et al.*, 2015) [10, 12].

To develop a sustainable pest management system, it is important to find the right balance between breeding and management strategies to reduce the ecological fitness of BPH and to keep the pest under economic threshold levels (Bosque-Perez and Buddenhagen 1992) [2]. Host—plant resistance is an effective environmentally friendly approach to control BPH and maintain yield potential of cultivars (Jena and Kim, 2010) [5].

Biotype development has made breeding for resistance to BPH more complicated. Resistant cultivars in one region may be susceptible in another (Yan-yuan & Chuan-xi, 2019, Heinrichs, 1988) [18, 3].

To date, more than 37 brown planthopper (BPH) resistance genes have been reported from cultivated rice and wild *Oryza* species (Li, *et al.*, 2019; Wang *et al.*, 2018; Yang *et al.*, 2019) [11, 16, 17].

Twenty nine BPH resistance genes have been identified from *ssp. indica* and wild relatives (Ali and Chowdhury, 2014; Wang *et al.*, 2015) [1, 15]. All BPH resistance genes identified to date are from *indica* varieties and wild relatives. Bph1-Bph9, Bph19, Bph25-Bph28 are from *indica* accessions, whereas Bph10-Bph18, Bph20, Bph21, Bph27 and bph29 are from wild rice species (Jie *et al.*, 2016) [6].

Suresh *et al.* (2000) [14] evaluated the resistance of several rice hybrids to *N. lugens* and found five hybrids *viz.* Co 33 × ARC 10550, ADT 36 × ARC 6650, ADT 36 × ARC 10550, CO 33 × W 1263 and Co 33 × ARC 10550 resistant to BPH. Similarly study results of Reddy and Pasalu (2004) [13] obtained from F-1 and F-2 progenies indicated that bph resistance in rice successions Rathu Heenati, PTB 33, ARC 10550 and CR 57-MR-1523 is governed by a single dominant gene.

The final objective is to develop new varieties that contain the best genotypic combinations to confer durable resistance for brown planthopper in rice.

Materials and Methods

Seven rice entries which showed resistant reaction to BPH in glasshouse screening tests were used in the study. For crossing purpose one susceptible Basmati variety Pusa-1 was also selected as one of the parent. All the resistant entries were taken as mother or female parent, while Pusa-1 served as father or male parent in the present breeding programme (Table.2). After selection of the parents, crossing was started in *khariif* season at appropriate stage of rice crop. Five plants of each cross were grown in separate pots filled with well manured and puddled soil.

After maturity seed of each progeny were kept in separate envelopes for further studies. Fifty seeds from the F₁ plants were used to study the reaction of progenies against BPH. The remaining seeds from the F₁ plants were used for growing F₂ population in the next *khariif* season.

The seed bed screening method was adopted for the evaluation of F₁ progenies for brown plant hopper resistance under glass house conditions. For each F₁ progeny 20 pre-germinated seeds per row were sown along with one row each of the male and female parent and susceptible check TN-1. Experiment was replicated two times. The seedlings were uniformly infested at 12 days age with second and third instar nymphs of brown plant hopper. The dead and alive plants were counted when susceptible check TN-1 was completely killed. The rating for BPH was based on the scoring system as described by Heinrichs *et al.* (1985) [5]

(table.1).

Table 1: Rating scale to facilitate the rating of rice entries based on per cent seedling mortality due to BPH damage (Heinrichs *et al.* (1985) [4].

Scale	Per cent dead seedlings	Level of resistance
0	0	Immune (I)
1	1-5	Highly resistant (HR)
3	6-9	Resistant (R)
5	10-25	Moderately resistant (MR)
7	26-60	Moderately susceptible (MS)
9	61-100	Susceptible (S)

Results

Evaluation of F₁ progenies and their parents against BPH infestation was done in glasshouse conditions. The per cent seedling mortality in F₁ population and parents (Table.2) indicate that all the female parents were found moderately resistant to resistant, while male parent (Pusa basmati 1) was rated as susceptible against BPH under glasshouse conditions. In the F₁ population of IR 36892-163-1-2-1 × Pusa Basmati 1 and IR 43449-4-3-43-3 × Pusa Basmati 1, moderate level of resistance was observed with 25.0 and 24.3 per cent seedling mortality which was similar with their female parents *viz.* IR 36892-163-1-2-2-1 and IR 43449-4-3-43-3, which also showed moderately resistant reaction against BPH.

Table 2: Reaction of F₁ progenies and their parents to BPH under glasshouse conditions

Cross/Parent	Per cent seedling mortality	Score	Resistance grade
IR 36892-163-1-2-2-1 × Pusa Basmati 1	25.0	5	MR
IR 36892-163-1-2-2-1(Female)	24.5	5	MR
IR 43449-4-3-43-3 × Pusa Basmati 1	24.3	5	MR
IR 43449-4-3-43-3(Female)	12.5	5	MR
IR 5947-247-2-1 × Pusa Basmati 1	10.0	5	MR
IR 5947-247-2-1(Female)	6.7	3	R
IR 59552-63-3-2-3 × Pusa Basmati 1	7.2	3	R
IR 59552-63-3-2-3(Female)	10.0	5	MR
Aruna (MO.8) × Pusa Basmati 1	11.8	5	MR
Aruna (MO.8) (Female)	6.8	3	R
IR 71033-62-15 × Pusa Basmati 1	20.0	5	MR
IR 71033-62-15(Female)	0.0	0	I
REMYA (MO. 10) × Pusa Basmati 1	0.0	0	I
REMYA (MO. 10) (Female)	7.7	3	R
Pusa Basmati 1 (Male)	100.0	9	S
TN 1 (S. check)	100.0	9	S

Moderate resistance was recorded in cross IR 59547-247-2-1 × Pusa basmati 1 with 10.0 per cent dead seedlings, while the female parent IR 59547-247-2-1 was resistant to BPH attack with 6.7 per cent seedling mortality. In the F₁ population of IR 59552-63-3-2-3 × Pusa Basmati 1 resistance reaction was observed but the female parent was rated as moderately resistant. The reaction against BPH infestation was moderately resistant in ARUNA (MO.8) × Pusa Basmati 1 and IR 71033-62-15 × Pusa Basmati 1 with 11.8 and 20.0 per cent dead seedlings, while their female parents *viz.* ARUNA (MO 8) and IR 71033-62-15 were resistant. The F₁ seedlings of REMYA (MO.10) × Pusa Basmati 1 were immune to BPH, but their female parent REMYA (MO.10) was found resistant against BPH under glasshouse conditions.

Discussion

In our field and glasshouse screening tests we tried to follow such breeding and selection strategies that can help to

develop effective brown planthopper resistant varieties. It is evident from the results that F₁ population of crosses REMYA (MO.10) × Pusa Basmati 1 and IR 59552-63-3-2-3 × Pusa Basmati 1 was superior in resistance reaction against BPH over their male and female parents and other progenies. The F₁ progenies of IR 36892-163-1-2-2-1 × Pusa Basmati 1 and IR 43449-4-3-43-3 × Pusa Basmati 1 were found *at par* in their resistance to BPH with their female parent but superior over male parent (Pusa Basmati 1). Other three F₁ progenies of crosses IR 59547-247-2-1 × Pusa Basmati 1, Aruna (MO 8) × Pusa Basmati 1 and IR 71033-62-15 × Pusa Basmati 1 were inferior in their resistance reaction against BPH as compared to the female parents. Since every year new rice entries have been introduced for screening trials at different locations for identification of new sources of resistance, so we cannot match bph resistant rice accession numbers exactly with previous studies. Although study results of Suresh *et al.* (2000) [14] as well as Reddy and Pasalu (2004) [13] have

supported our findings and confirmed the fact that bph resistance in rice successions identified in our testing is also governed by a single dominant gene and all the F₁ progenies performed better than male parent.

Conclusion

F₁- progenies of crosses REMYA (MO.10) × Pusa Basmati 1 and IR 59552-63-3-2-3 × Pusa Basmati 1 were superior in resistance reaction against BPH as compared to both the parents and rest of the progenies tested. F₁ progenies of crosses IR 36892-163-1-2-1 × Pusa Basmati 1, IR 43449-4-3-43-3 × Pusa Basmati 1, IR 59547-247-2-1 × Pusa Basmati 1, ARUNA (MO. 8) × Pusa Basmati 1 and IR 71033-62-15 × Pusa Basmati 1 were at par in level of resistance with their female parent but found significantly superior than male parent Pusa Basmati 1.

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