Acta
Entomology and Zoology

E-ISSN: 2708-0021
P-ISSN: 2708-0013
www.actajournal.com
AEZ 2021; 2(2): 48-50
Received: 15-05-2021
Accepted: 20-06-2021

Hitendra Kumar
Associate Professor (Entomology), School of Agricultural Sciences, SGRR University, Dehradun, Uttarakhand, India

SN Tiwari
Professor & Head (Entomology), College of Agriculture, Govind Bhalabh Pant University of Agri Science & Technology, Pantnagar, Uttarakhand, India

Corresponding Author:
Hitendra Kumar
Associate Professor (Entomology), School of Agricultural Sciences, SGRR University, Dehradun, Uttarakhand, India

Screening and identification of brown planthopper resistance in F_1 progenies of selected rice accessions

Hitendra Kumar and SN Tiwari

DOI: https://doi.org/10.33545/27080013.2021.v2.i2a.43

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 F_1 progenies for brown plant hopper resistance under glass house conditions. F_1 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 F_1 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 plant hopper (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, C0 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 plant hopper 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 *kharif* 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 envelops for further studies. Fifty seeds from the F_1 plants were used to study the reaction of progenies against BPH. The remaining seeds from the F_1 plants were used for growing F_2 population in the next *kharif* season.

The seed bed screening method was adopted for the evaluation of F_1 progenies for brown plant hopper resistance under glass house conditions. For each F_1 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 F_1 progenies and their parents against BPH infestation was done in glasshouse conditions. The per cent seedling mortality in F_1 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 F_1 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 seeding 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 F_1 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 F_1 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 F_1 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 F_1 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 F_1 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 F_1 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 F_1 progenies performed better than male parent.

Conclusion

F_1- 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. F_1 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.

References

1. Ali MP, Chowdhury TR. Tagging and mapping of genes and QTLs of Nilaparvata lugens resistance in rice. Euphytica 2014;195:1-30.
2. Bosque-Perez NA, Buddenhagen IW. The development of host-plant resistance to insect pests: outlook for the tropics. In: Menken SBJ, Visser JH, Harrewijn P, editors. Proc 8th Int Symp insect–plant relationships. Dordrecht: Kluwer 1992;235:49.
3. Heinrichs EA. Variable resistance to homopterans in rice cultivars. Plants and Animals 1988;1:213-220.
4. Heinrichs EA, Medrano FG, Rapusas HR. Genetic evaluation for insect resistance in rice. IRRI, Los Banos, Philippines 1985, 356.
5. Jena KK, Kim SM. Current status of brown planthopper (BPH) resistance and genetics. Rice 2010;3:161-171.
6. Jie Hu, Cong Xiao, Yuqing He. Recent progress on the genetics and molecular breeding of brown planthopper resistance. Rice 2016;9:30.
7. Khush GS. What it will take to Feed 5.0 Billion Rice consumers in 2030. Plant Molecular Biology 2005;59:1-6.
8. Khush GS. Strategies for increasing the yield potential of cereals: Case of rice as an example. Plant Breeding 2013;436:433-436.
9. Khush GS. Green revolution: The way forward. Nature Reviews Genetics 2001;2(10):815-822.
10. Kumar GR, Sakthivel K, Sundaram RM, Neeraja CN, Balachandran SM, Rani NS, *et al*. Allele mining in crops: Prospects and potentials. Biotechnology Advances 2018;28(4):451-461.
11. Li WT, Chen MS, Yin JJ, Wang J, Chen XW. Recent advances in broad-spectrum resistance to the rice blast disease. Current Opinion in Plant Biology 2019;50:114-120.
12. Liu Y, Wu H, Chen H, Liu Y, He J, Kang H, *et al*. A gene cluster encoding lectin receptor kinase confers broad-spectrum and durable insect resistance in rice. Nature Biotechnology 2015;33(3):301-305.
13. Reddy K, Pasalu IC. Inheritance of resistance in rice to brown plant hopper, *Nilaparvata lugens* (Stal.). J Appl. Zool. Res 2004;15(1):51-53.
14. Suresh S, Paramasivan KS, Muppidathi N. Screening of F_1 rice hybrids against brown plant hopper (*Nilaparvata lugens*). Madras Agriculture J 2000;86(7-9):481-483.
15. Wang Y, Cao LM, Zhang YX, *et al*. Map-based cloning and characterization of BPH29, a B3 domain-containing recessive gene conferring brown planthopper resistance in rice. J Exp Bot 2015;66:6035-6045.
16. Wang H, Shi S, Guo Q, Nie L, Du B, Chen R, *et al*. High resolution mapping of a gene conferring strong antibiosis to brown planthopper and developing resistant near-isogenic lines in 9311 background. Molecular Breeding 2018;38:107.
17. Yang M, Cheng L, Yan L, Shu W, Wang X, Qiu Y. Mapping and characterization of a quantitative trait locus resistance to the brown planthopper in the rice variety IR64. Hereditas 2019;156:22.
18. Yan-yuan BAO, Chuan-xi ZHANG. Recent advances in molecular biology research of a rice pest, the brown planthopper, Journal of Integrative Agriculture 2019;18(4):716-728.