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Screening of germplasm for brown plant hopper [(*Nilaparvata lugens* (Stal)] resistance in rice (*Oryza sativa* L.)

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Abstract
A total of six hundred and thirty (630) rice genotypes were evaluated against brown planthopper (BPH) under field screening during *kharif* 2022 at RARS, Maruteru, West Godavari district, A. P., India with an objective to identify new sources of resistance against brown planthopper in rice. The results of field screening conducted during *kharif* 2022 revealed that sixty five (65) rice genotypes were found resistant with damage score (DS) of "1". Among these 65 rice genotypes, 13 genotypes *viz*., AM845, ADW262, BDW206, BDW207, BDW208, BDW209, BDW210, BE797, BM552, BM573, CL460, CM455 and CM456 possessed *Bph32* gene. Further, 94 genotypes were moderately resistant (DS-3), while the rest (470) were susceptible to brown planthopper with damage score of ≥5.

Keywords: Brown planthopper, screening, resistance, susceptible, rice and *Bph*32

Introduction
Rice (*Oryza sativa* L.) is an important staple food crop for more than half of the world population (Seni and Nayak, 2017) [8]. It alone provides 20% of the global dietary energy supply. Insect pests and diseases remain as the key biotic stresses limiting the rice production significantly. Among the insect pests infesting rice, brown planthopper (BPH), *Nilaparvata lugens* (Stal) belonging to the order, Homoptera and the family Delphacidae is considered as the major yield limiting factor in all rice growing countries both in tropics and temperate regions (Krishnaiah, 2014) [4]. Both nymphs and adults of the BPH suck plant sap from phloem cells resulting in "hopper burn" symptoms and cause almost 10 to 90 per cent yield losses in rice (Seni and Naik, 2017) [8]. In addition to direct damage, it also transmits rice grassy stunt virus (RGSV) and rice ragged stunt virus (RRSV).

Farmers rely solely on insecticides for the management of brown planthopper leading to adverse impact on environment, in addition to destruction of natural enemies, resurgence of the target pest and outbreak of secondary pests. Therefore, use of resistant varieties is considered as one of the most important management option against insect pests and diseases and several resistant varieties were developed against brown planthopper. However, BPH has shown its ability to develop resistance quickly against resistant varieties and insecticides (Sarupa *et al*., 1998; Jhansilakshmi *et al*., 2010) [7, 2]. Hence**,** Screening of rice germplasm for identifying the resistant sources and resistant QTLs/genes is a continuous process for development of resistant varieties. Molecular markers also play a significant role in the confirmation of resistance for BPH. As of now, 38 BPH resistance genes or QTLs have been identified from cultivated and wild species of rice. Of 38 resistant genes, eight genes (*Bph14, Bph3, Bph26, bph29, Bph18, Bph6, Bph32 and Bph9*) were position ally cloned (Kumar *et al*., 2020) [5]. The present study is an attempt in this direction to identify the promising donors against BPH.

Materials and Methods
The present study was carried out at the experimental fields of Dept. of Entomology, Regional Agricultural Research Station, Maruteru (16.38^{0}N, 81.44^{0}E), West Godavari district, Andhra Pradesh, India during *kharif* 2022.

Plant material: The experimental material consists of 630 rice genotypes including one resistant check (PTB 33) and one susceptible check (TN1).

Mass rearing of Brown planthoppers

The BPH population was maintained at the insectary of Dept. of Entomology by rearing them on 30 days old TN1 plants in FRP insect rearing cages (26''x 30''x 34''). Pre mated gravid females were allowed to oviposit on TN1 plants for two days. Nymph and adults of brown planthopper reared in insectary were utilized for field release.

Field Screening

Experimental material comprising of 630 rice genotypes are evaluated for resistance to BPH under field screening using the polythene barrier technique (Kalode *et al*., 1982) [3] during *kharif* 2022. Each genotype was transplanted at a spacing of 10 × 10 cm in two rows of 10 hills (Onemeter length). For every five entries, five rows of TN1 are planted on all the sides. All around the test entries, 10 rows of TN1 was transplanted as infestor rows to serve as bombardment rows for uniform infestation of seedlings with BPH.

Erection of polythene sheet barrier of 2.5 feet height all around the planting area within 15-20 days after planting, application of higher doses of N fertilizer i.e., Urea in the screening fields and spraying of deltamethrin (0.002%) on infestor rows for 3 to 4 times at 10 days interval starting from 35 days after transplanting is practiced to ensure buildup of the population of BPH. Further, Nymph as well as adults of brown plant hopper mass reared in the insectary was also released uniformly in polythene confined area to augment the population of brown plant hopper.

Number of dead and surviving plants per entry was recorded first at the time of hopper burn in susceptible check, TN1 followed by another observation prior to harvest. Each entry was rated on 0-9 scale of Standard Evaluation System for Rice (SES) (IRRI, 2013) [1] to categorize the genotypes in to different categories of resistance in response to BPH (Table 1).

Phenotypically confirmed (Damage score-1 under field condition), sixty five rice genotypes are subjected to High-throughput SNP genotyping using 20 SNP's panel consisting of *Bph32* gene to confirm the presence or absence of *Bph32* gene genotypically.

Results and Discussion

Field screening

The results on screening of 630 rice genotypes against brown plant hopper under field conditions during *kharif* 2022 are presented in Table 2 revealed that highly resistant reaction was observed for PTB 33, the resistant check ("0"damage score). Sixty five (65) rice genotypes *viz*., AL 1039, AL 1074, AL 1075, AL 1076, BDW 206, BDW 207, BDW 208, BDW 209, BDW 210, CDW 177,S 76, S 77, S 78, S 79, S 95, S 97, S 100, AM 844, AM 845, AM 926, AM 936, AM 938, AM 942, BM 552, BM 553, BM 569, BM 573, BM 574, CM 454, CM 455, CM 456, L 693, L 696, L 697, OHRT 361, OHRT 362, OHRT 363, OHRT 365, OHRT 366, OHRT 368, OHRT 376, RTCNP 25, RTCNP 27, RTCNP 28, RTCNP 29,RTCNP 30, RTCNP 31, RTCNP 35, RTCNP 36, RTCNP 57, RTCNP 58, RTCNP 59, RTCNP 61, RTCNP 64, AE 1187, AE 1219, AE 1232,BE 797, BE 798, ADW 261, ADW 262, ADW 263, NICRA 3, CL 459 and CL 460were showed resistant reaction with damage score of 1, while Ninety four (94) rice genotypes *viz*., ADW 260, ADW 297,AL 1026, AL 1036, AL 1068, AL 1071, AL 1072, AL 1073,CL 450,BDW 203, BDW 204, BDW 205, BDW 212, BDW 219, BL 500, BL 508, CDW 174, CL 479, S 89, S 90, S 91, S 98, S 99,AM 880, AM 881, AM 906, AM 920, AM 921, AM 925, AM 931, AM 932, AM 933, AM 934, AM 937,BM 514, BM 518, BM 560, BM 571, BM 572, BM 576, BM 578, BM 580, BM 582, BM 583, BM 584, BM 585, CM 438, CM 439, CM 446, CM 453, CM 457, CM 458, CM 461, L 692, L 695, M 651, OHRT 369, OHRT 377, OHRT 378, OHRT 382, OHRT 384, RTCNP 26, RTCNP 32, RTCNP 33, RTCNP 34, RTCNP 37, RTCNP 50, RTCNP 51, RTCNP 56, RTCNP 60, RTCNP 62, RTCNP 63, RTCNP 65, RTCNP 83, MCM 125, PYT 79, PYT 93, PYT 94, PYT 98,AE 1178, AE 1216, AE 1233, AE 1234, AE 1261, AE 1284, AE 1285, AE 1294,BE 764, BE 766,CE 661, CE 662, L 671, MST 96 and S 75 and were recorded moderately resistant reaction with damage score of 3. Rest of the rice genotypes were rated as moderately susceptible to highly susceptible (470) with damage score ranged from 5 to 9 (Table 2).

Among sixty five (65) rice genotypes, 13 genotypes *viz*., AM845, ADW262, BDW206, BDW207, BDW208, BDW209, BDW210, BE797, BM552, BM573, CL460, CM455 and CM456 possessed *Bph32* gene, that encodes for a short consensus repeat (SCR) domain containing protein that confers an antibiosis resistance to BPH and it is highly expressed in the leaf sheaths, where BPH first settles and feeds, inhibiting feeding in BPH (Ren *et al*., 2016) [6] (Table 3).

Further, 13 rice genotypes need to be screened at seedling stage under greenhouse conditions for confirmation of resistance and also study mechanisms of resistance against BPH before utilizing them as donors in resistance breeding programme against this pest.

Table 1: Standard evaluation system for rating damage by brown planthopper

Damage	Scale	Reaction
No injury	0	Highly resistant
Slight yellowing of few plants	1	Resistant
Leaves partially yellow but with no hopper burn	3	Moderately resistant
Leaves with pronounced yellowing and stunting or wilting and 10-25% of plants with hopper burn, remaining plants severely stunted	5	Moderately susceptible
More than half of the plant wilting or with hopper burn, remaining plants severely stunted	7	Susceptible
All plants dead	9	Highly susceptible

Table 2: Reaction of rice genotypes to brown planthopper under field screening during *kharif* 2022

S. No.	Damage score	Reaction	No. of genotypes	Name of the genotypes
1	0	Highly resistant	1	PTB 33 (Resistant Check)
2	1	Resistant	65	AL 1039, AL 1074, AL 1075, AL 1076, BDW 206, BDW 207, BDW 208, BDW 209, BDW 210, CDW 177, S 76, S 77, S 78, S 79, S 95, S 97, S 100, AM 844, AM 845, AM 926, AM 936, AM 938, AM 942, BM 552, BM 553, BM 569, BM 573, BM 574, CM 454, CM 455, CM 456, L 693, L 696, L 697, OHRT 361, OHRT 362, OHRT 363, OHRT 365, OHRT 366, OHRT 368, OHRT 376, RTCNP 25, RTCNP 27, RTCNP 28, RTCNP 29,RTCNP 30, RTCNP 31, RTCNP 35, RTCNP 36, RTCNP 57, RTCNP 58, RTCNP 59, RTCNP 61, RTCNP 64, AE 1187, AE 1219, AE 1232, BE 797, BE 798, ADW 261, ADW 262, ADW 263, NICRA 3, CL 459 and CL 460
3	3	Moderately resistant	94	ADW 260, ADW 297, AL 1026, AL 1036, AL 1068, AL 1071, AL 1072, AL 1073, CL 450, BDW 203, BDW 204, BDW 205, BDW 212, BDW 219, BL 500, BL 508, CDW 174, CL 479, S 89, S 90, S 91, S 98, S 99, AM 880, AM 881, AM 906, AM 920, AM 921, AM 925, AM 931, AM 932, AM 933, AM 934, AM 937, BM 514, BM 518, BM 560, BM 571, BM 572, BM 576, BM 578, BM 580, BM 582, BM 583, BM 584, BM 585, CM 438, CM 439, CM 446, CM 453, CM 457, CM 458, CM 461, L 692, L 695, M 651, OHRT 369, OHRT 377, OHRT 378, OHRT 382, OHRT 384, RTCNP 26, RTCNP 32, RTCNP 33, RTCNP 34, RTCNP 37, RTCNP 50, RTCNP 51, RTCNP 56, RTCNP 60, RTCNP 62, RTCNP 63, RTCNP 65, RTCNP 83, MCM 125, PYT 79, PYT 93, PYT 94, PYT 98, AE 1178, AE 1216, AE 1233, AE 1234, AE 1261, AE 1284, AE 1285, AE 1294, BE 764, BE 766, CE 661, CE 662, L 671, MST 96 and S 75
4	≥ 5	Susceptible	470	Other rice genotypes including TN 1(Susceptible Check)

Table 3: Genotypes showing positive reaction for *Bph32* using High-throughput SNP genotyping during *kharif*, 2022

S. No	Code	Designation	*Bph32*
1	AM 845	MTU 2856-85-1-1-1	[+]
2	ADW 262	PLA 100	[+]
3	BDW 206	MTU 2716-28-2-1-2	[+]
4	BDW 207	MTU 2716-28-2-2-2	[+]
5	BDW 208	MTU 2720-28-2-1-1	[+]
6	BDW 209	MTU 2721-7-1-2-1	[+]
7	BDW 210	MTU 2721-7-1-2-2	[+]
8	BE 797	MTU 2869-12-1-2	[+]
9	BM 552	MTU 2854-9-1-1-1-1	[+]
10	BM 573	MTU 2853-18-1-2-1	[+]
11	CL 460	MTU 278-6-1-2	[+]
12	CM 455	MTU 2853-20-1-1	[+]
13	CM 456	MTU 2853-19-1-1	[+]

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