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Identification of new sources for brown planthopper resistance from rice germplasm and introgression lines derived from *O. nivara*

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ABSTRACT

Brown planthopper (BPH) Nilaparvata lugens (Stål) causes considerable yield losses worldwide. As many of the donors, genes identified, and resistant varieties developed have become ineffective against the Indian biotype (biotype 4), identification of new resistant sources and genes is important. Nine hundred and twenty rice germplasm accessions along with five introgression lines derived from O.nivara in the background of Swarna and 18 gene donors were screened for reaction to brown planthopper using Standard Seedbox Screening Test and damage was scored by following SES (SES 2002). Some of the resistant introgression lines and gene donors along with checks were screened in field at maximum tillering stage to understand the reaction of BPH at adult plant growth stage. Twelve rice germplasm accessions and five introgression lines showed resistance reaction at seedling stage with damage score of 1-3.0 in 0-9 scale. While 23 accessions showed moderate resistance with damage score of 3.1-5.0. Among the donors with different genes/gene combinations, Bph3+Bph17, Bph6, Bph20+Bph21, Bph22, Bph23 and bph24 showed resistance reaction. RP Bio 4918 (230S), OM4498, RP2068-18-3-5 and PTB33 were resistant in adult stage and rest were susceptible. These lines can be used in breeding resistant varieties as well as in identification of genes for BPH resistance.

Key words: *Genes/gene combinations, germplasm accessions, Nilaparvata lugens, resistance, rice, wild rice introgression lines*

INTRODUCTION

Among the various biotic factors limiting rice production, insect pests are of prime importance (Heong and Hardy, 2009). The brown planthopper (BPH), *Nilaparvata lugens* (Stål), is a typical phloem sap feeder that has emerged as the menace to rice production in Asia (Normile, 2008; Heong and Hardy, 2009). Both nymphs and adults of BPH suck phloem sap from the lower portion of the plant, which results in extensive plant mortality known as 'hopper burn' (Liu et al., 2009; Horgan, 2009; Vanitha et al., 2011). The genetics of BPH resistance is well studied and more than 30 genes and QTLs have been identified from cultivated and wild species introgression lines (Fujita et al., 2013). But many of them are ineffective against biotype 4 which is most destructive and is distributed over the Indian sub continent (Heinrichs, 1986; Ram et al., 2010).

Most of the genes identified are based on the reaction at seedling stage but the maximum crop damage occurs at tillering and booting stage in farmer's field. Hence, it is necessary to know the effectiveness of donors/genes against BPH at later plant growth stages. Therefore, the present attempt was made to identify donors for BPH resistance from germplasm as well as introgression lines derived from *O.nivara* at seedling stage and also at maximum tillering stage.

MATERIALS AND METHODS

The experimental material consists of nine hundred twenty germplasm accessions and five introgression lines derived from *O.nivara* which were showing resistance reaction in preliminary screening and 18 different gene donors along with TN1, PTB33 as susceptible and resistant checks, respectively. The experiment was carried out at the ICAR-Indian Institute of Rice Research, Rajendranagar, Hyderabad, India.

Table 1. List of BPH resistant germplasm accessions and introgression lines

S.No.	Germplasm IC no.	Damage Score	Reaction	S. No.	Germplasm IC no.	Damage Score	Reaction
1	450492	1.3	R	21	449971	3.4	MR
2	17065	1.7	R	22	449548	3.6	MR
3	86004	1.8	R	23	449579	3.7	MR
4	450029	2.5	R	24	450007	3.8	MR
5	449575	2.7	R	25	544968	4.0	MR
6	449858	2.7	R	26	450025	4.0	MR
7	449833	2.7	R	27	450543	4.3	MR
8	449957	2.8	R	28	461205	4.4	MR
9	449784	2.9	R	29	459358	4.5	MR
10	461809	2.9	R	30	450052	4.5	MR
11	450011	2.9	R	31	17069	4.6	MR
12	413645	3.0	R	32	450587	4.6	MR
13	RPBIO-4918(212S)	2.1	R	33	461785	4.7	MR
14	RPBIO-4918(215S)	2.0	R	34	449557	4.7	MR
15	RPBIO-4918(224S)	1.8	R	35	450376	4.8	MR
16	RPBIO-4918(228S)	1.4	R	36	544979	4.9	MR
17	RPBIO-4918(230S)	1.0	R	37	450586	5.0	MR
18	449555	3.3	MR	38	449907	5.0	MR
19	449587	3.3	MR	39	344676	5.0	MR
20	449837	3.3	MR	40	545010	5.0	MR

R-Resistant, MR-Moderately Resistant

The BPH population was maintained in the glasshouse by rearing them on 30 days old TN1 plants in 70 cm x75cm wooden cages. Pre mated gravid females were allowed to oviposit on TN1 plants for two days and freshly hatched nymph were utilized for infestation in the experiment. Screening was done following standard seedbox screening technique (SSST) developed at IRRI (Heinrichs et al., 1985). Experiments were conducted in the greenhouse at 30 ± 5^0C with 60 ± 10% relative humidity (RH) under natural light/dark conditions. The seeds were pre-soaked and sown in the rows in 60 × 45 × 10 cm seedboxes along with resistant and susceptible checks. Each row was sown with one test entry having 20 seedlings. Twelve days old seedlings were infested with first instar nymphs at the rate of 6 to 8 per seedling. When 100% of plants die in the susceptible check, the damage scores were recorded in 0-9 scale following the standard evaluation system (SES) of rice (SES 2002) by scoring all plants in each row. The mean score of the plants in a row was used as the damage score of that test entry.

The experiment was repeated thrice and the resistant entries were retested to confirm the reaction. The resistant introgression lines along with all the gene donors, differentials, PTB33 and TN1 were tested in field for adult plant screening under hopper-burn conditions. After 40 days of planting, the plants were infested with second instar nymphs to create hopper burn. After 25 days of infestation, when susceptible check and many of the gene donors were completely burnt, then the damage score was recorded.

RESULTS AND DISCUSSION

Of the nine hundred twenty germplasm accessions, 12 accessions showed resistance reaction with damage score ranging from 1.3 to 3.0, while 23 accessions showed moderate resistance with damage score 3.1-5.0 and the rest were susceptible. The resistant accessions were IC NOs 450492, 17065, 86004, 450029, 449575, 449858, 449833, 449957, 449784, 461809, 450011, and 413645. In the repeated screening, the introgression lines *viz.*, RPBio-4918 (212 S), RPBio-4918 (215 S), RPBio-4918 (224S), RPBio-4918 (228S) and RPBio-4918 (230S) showed resistance against BPH (Table 1).

Among the gene donors, Rathuheenati (*Bph3+Bph17*), Swarnalatha (*Bph6*), IR 71033-121-15 (*Bph20+Bph21*), IR 71033-121-15 (*Bph23*), IR 73678-6-9-B (*bph24*) and ADR52 (*Bph25* + *Bph26*) showed resistant reaction, whereas IR 54751-2-44-15-24-3 (*Bph11*) and IR 65482-7-216-2 (*Bph18*) showed moderate resistance and others were susceptible (Table

Table 2. Reaction of gene donors at seedling stage against BPH biotype 4

Donors/Introgression lines	Parentage/Acc. number	Gene present	Reaction
Mudgo	Acc 6663	Bph1	S
ASD 7	Acc 6303	bph2	S
IR56		Bph3	S
Rathuheenathi	Acc 11730	Bph3,17	R
Babawee	Acc 8978	bph4	MR
ARC10550	Acc 12507	bph5	MR
T12	Acc 56989	bph7	S
Chinsaba	Acc 33016	Bph8	S
IR 54751-2-44-15-24-3	*O.officinalis*	bph11	MR
IR 54751-2-34-10-6-2	*O.officinalis*	bph12	S
Swarnalata	Acc 99634	Bph6	S
Pokkali		Bph9	S
IR 65482-4-136-2-2	*O.australiensis*	Bph10	S
IR 65482-7-216-2	*O. australiensis*	Bph18	MR
IR 71033-121-15	*O.minuta*	Bph20,21	R
IR 75870-5-8-5-B-1-B	*O.glaberrima*	Bph22	R
IR 71033-62-15	*O.minuta*	Bph23	R
IR 73678-6-9-B	*O.rufipogon*	bph24	R

S- Susceptible, MR-Moderately resisatant, R-Resistant

Table 3. Reaction of gene donors and introgression lines to BPH biotype 4 screened at maximum tillering stage

Donor/ Introgression line	Gene	Reaction
IR64	*Bph1*	MR
ASD7	*bph2*	S
IR62	*Bph3*	S
ARC10050	*bph5*	S
T12	*Bph7*	S
CHINSABA	*Bph8*	S
IR 65482-7-216-2	*Bph18*	S
IR 71033-121-15	*Bph20&21*	S
ADR52	*Bph25*&26	S
RP BIO 4918-230S (introgression line)	-	HR
OM4498	-	MR
RP 2068-18-3-5	-	HR
SINASIVAPPU	-	S
MUDGO	*Bph1*	S
IR36	*bph2*	S
IR40	*bph2*	S
1R70	*Bph3*	S
IR74	*Bph3*	S
POKKALI	*bph9*	S
PTB33	-	HR

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

2). The gene donors and the introgression lines screened for adult plant stage in field under hopper-burn conditions indicated that RPBio4918-230S, OM4498, RP2068-18-3-5 and PTB 33 were resistant and others were susceptible (Table 3).

Fig. 1. Gene donors and introgression lines screened in tillering stage against BPH biotype4

Most of the genes for BPH resistance identified so far are against biotypes 1, 2 and 3 and only few are resistant against biotype 4, which could be one of the reason for their ineffectiveness against BPH biotype available in Indian sub continent. Many of the donors which showed stable resistance across the biotypes have one or two major genes along with QTLs associated with resistance. Hence, it is important to identify new donors, novel genes/major QTLs effective against BPH biotype 4 to pyramid them for stable resistance. The genes from wild rices are reported to be robust and stable (Ram et al., 2010), hence, attempts were made to identify BPH resistant introgression lines at seedling stage and at maximum tillering and reproductive stage tolerance derived from *O. nivara* into Swarna. We are in the process of identifying the new genes for BPH resistance against biotype 4 associated with seedling and adult plant growth stage resistance introgressed from *O.nivara*.

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