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Donor validation studies on rice differential varieties against rice brown planthopper, *Nilaparvata lugens* (Stal.)

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ABSTRACT

Six differential varieties along with standard checks were evaluated for donor validation against rice brown plant hopper at glasshouse, Department of Entomology, IGKV, Raipur during 2013-14. All the differentials were resistant to Raipur BPH population. Among the differential tested, ARC 10550 exhibited list plant damage score (0.64) followed by Sinna Sivappu (0.75). Honeydew excretion values were minimum in Sinna Sivappu (15.3 mm^2) followed by Rathu Heenati (15.8 mm^2). The average probing marks were maximum in Sinna Sivappu (38.3) followed by Rathu Heenati (30.7) which were significantly higher than TN1, while nymphal survival value was minimum in variety INRC 3021 (29.21%). All the differentials showed resistant reaction in all the tests performed against Raipur population. These differentials were designated as the potential donors for BPH resistance.

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INTRODUCTION

Several insect pests feed on phloem sap of rice. Among these, brown planthopper *Nilaparvata lugens* (stal.) (Homoptera : Delphacidae) is the most common and turned up as a major pest in the last two decades. Recent severe outbreak of this pest was noticed during 2007 in parts of cauvery command area in Karnataka and during 2008 in Haryana, Punjab and Delhi. Four BPH biotypes have been reported so far. Biotypes 1 and 2 are widely distributed in southeast Asia, biotype 3 is laboratory biotype produced in Philippines while biotype 4 occurs in the Indian subcontinent. south Asian biotypes of *N.lugens* are more virulent than southeast Asian biotypes (Saxena and Barrion, 1983). These biotypes of BPH can be identified by their ability to feed and infest rice varieties with different resistance genes (IRRI, 1976).

Host plant resistance has played an important role in the management of pests successfully during past two decades. Several resistant varieties have been developed and grown in different areas of India (Mathur *et al*., 1999; Krishnaiah *et al*., 1999). After varieties with different resistant genes have been grown by farmers in an area, the local BPH population usually consists of a mixture of insects with different degrees of adaptation to different resistant genes. In such a situation, it is not possible to describe the population as being a particular biotype. However, it is possible to determine which resistant genes are still effective against the local BPH population.

For development of resistant varieties identification of strong resistant donors is the key step. Due to lack of precise studies under controlled conditions, information on performance of identified sources of BPH resistance carrying specific genes for resistance is lacking. Performance of these genes against various BPH populations across the country is

not known. Hence, the studies are being carried out at different locations like Maruteru, Mandya, Coimbtore, IARI, Ludhiana and DRR. Present study was formulated to assess the performance of different resistant sources against Raipur, Chhattisgarh BPH population.

MATERIAL AND METHODS

The experiment was carried out in glasshouse, Department of Entomology, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) during 2013-2014. The experimental material consisted of six rice differentials as BPH resistant donors *viz.*, ARC 10550 (bph5), Sinna Sivappu, INRC 3021, MR 1523, Rathu Heenati (Bph3) and MO1 along with TN1 and Ptb33 (Bph2+Bph3) as standard susceptible and resistant checks, respectively. Validation of donors achieved through various tests like standard seedbox screening test, honeydew excretion test, probing mark test, nymphal survival and days to wilt test.

Mass rearing :

Brown planthopper was mass reared at 30°±5°C on potted TN1 (Taichung native) variety (Heinrichs *et al.*, 1985). The newly emerged first and second instar nymphs of BPH were utilized for screening of differentials. Likewise, adults were used for probing mark test, honeydew excretion, nymphal survival and days to wilt test.

Screening of differentials against *Nilaparvata lugens* (Stal.) :

Screening was carried out as per methodology suggested by Kalode *et al.* (1979). The test and check genotypes were pre-germinated in petridishes and these germinated seeds were sown in rows 5 cm apart in 50×40×7 cm wooden trays, containing well puddled homogenous soil along with checks. When the seedling attain about 7 to 10 days old age, sufficient number of first and second instar nymphs were uniformly released on these seedlings, so that each seedling must be get infested with at least 8 to 10 nymphs. The observations were recorded on the basis of 0-9 scale (Table A), when more than 90 per cent TN1 seedling were killed by the brown planthopper insect.

Honeydew excretion test :

The honeydew excretion test conducted as per the method suggested by Sogawa and Pathak (1970). For this white Whatman number 1 filter papers were dipped in a solution of bromocresol green indicator and allowed to dry in sunlight thereby filter paper turned to yellowish orange colour. The treated filter papers were placed on an inverted petridish at the base of each plant through a slit made in centre. Thereafter, each plant was covered with inverted glass funnel along with two days old female. The adult female allowed to feed on leaf sheath for 24 hours. The feeding was assessed by quantifying the area of honeydew excreted by the insect on filter paper. Six replications were maintained for each entry. Each replication contained one 30 days old plant. Honeydew excretion by planthoppers reflects feeding activity (Park and Song, 1988). The amount of feeding by the insect was expressed in terms of honeydew excretion per two female in mm^2 unit.

Probing mark test :

Probing mark test was carried out according to methodology suggested by Natio (1964). For this purpose, seeds rice genotypes and check varieties *i.e.* TN1 and Ptb33 were germinated separately in petridishes. Germinated seeds were sown in wooden trays containing well puddled soil. After seven days, the seedling of each variety was removed from trays and washed thoroughly with water and then transferred individually into 15 cm long test tubes containing a few drops of water. One female was introduced individually into each test tube and test tubes were plugged with sterilized cotton swab. The female was allowed to make punctures on the seedling for 12 hrs. Thereafter, the seedlings were taken for staining in another tube containing 1 per cent erythrosine dye aqueous solution. Insect probing marks stained thereby counted visually after 30 minutes of staining. Ten replicates were maintained for each differential and each replication contains one seedling.

Nymphal survival of brown planthopper :

Survival test was carried out on 30 days old plants of differentials confined with Mylar tube. Then 10 nymphs (first and second instar) were released in such tubes then the open end of the tube covered by the muslin cloth and tied with rubber band. For each variety, six replications were maintained.

Table A : Visual plant damage score (0-9 scale) for evaluating rice against BPH

Score*	Rating	Symptoms
0.	Highly resistant	No visible damage
1.	Resistant	Partial yellowing at first leaf
3.	Moderately resistant	Partial yellowing first and second leaves
5.	Moderately susceptible	Pronounced yellowing and some wilting
7.	Susceptible	More than halves of the plants wilted or dead and remaining plants severely stunted
9.	Highly susceptible	All plants dead

*Mean score of plant damage was calculated. (Anonymous, 1996)

The plants were observed for the emergence of the adults. These emerged adults were removed from the tubes and per cent nymphal survival was calculated by using the following formula (Heinrichs *et al.,* 1985) :

$$\text{Per cent nymphal survival} = \frac{\text{Number of adult emerged}}{\text{Number of nymphs released}} \times 100$$

Developmental period was studied by counting the days taken by the nymphs to reach the adult stage (Pongprasert and Weerapat, 1979). Growth index (GI) of BPH on each genotype was computed from the data obtained from the experiments on nymphal survival and developmental period as below (Panda and Heinrichs, 1983).

$$\text{Growth indes (GI)} = \frac{\text{per cent of nymphs survived}}{\text{Mean developmental period}}$$

Days to wilting after infestation of brown planthopper *Nilaparvata lugens* (stal.) :

Days to wilt test was carried out as per method adopted by Soundararajan *et al.* (2004). For this experiment, well germinated seeds of test genotypes were sown in 500 ml earthen pots filled with fertilizers enriched puddle soil. After thirty days plants were covered by Mylar tubes with ventilating windows. On such covered plants, twenty five (first and second instar) nymphs were released and the open end of the tubes was covered by muslin cloth with the help of rubber band. At the wilt stage (all leaves dried) of the plant the days required to attain it was noted. This observation was recorded upto 40 days after release of the test insect on rice genotypes.

The final observations were statistically analyzed in Complete Randomized Design (CRD).

RESULTS AND DISCUSSION

Six differentials were evaluated for resistance against Raipur, Chhattisgarh BPH population. All the differentials showed resistant reaction against BPH infestation. The average plant damage score of differentials ranged from 0.64 to 1.00. Among the differentials tested ARC 10550 exhibited least plant damage score (0.64) followed by Sinna Sivappu (0.75) whereas, in resistant check Ptb33, it was 1.31(Table 2).

All the differentials exhibited average honeydew excretion values varying from 15.3 to 27.6 mm^2 per two female in 24 hrs, which was significantly lower than the susceptible check TN1. In TN1 susceptible check, the honeydew excretion value was maximum (119.6 mm^2/two female). Resistant check Ptb33 showed honeydew excretion value of 12.9 mm^2 which was lower than all differentials tested and also than the susceptible check TN1. The differential Sinna Sivappu had the lowest honeydew excretion value of (15.3 mm^2) followed by Rathu Heenati (15.8 mm^2) and INRC 3021 (17.5 mm^2). Among all ARC 10550 had the highest average honeydew excretion value of 27.6 mm^2 followed by MO1 (24.9 mm^2) but it was significantly lower than susceptible check TN1 (Table 1).

In all the differential varieties, the average probing marks values per seedling ranged from 25.3 to 38.3. Although, in resistant check Ptb33, the probe marks was 32.3 per seedling per female (Table 1). The variety Sinna Sivappu had the highest (38.3) average probing marks, followed by Rathu Heenati (30.7) and MR 1523 (30.5). Among all resistant varieties tested, ARC 10550 had the lowest (25.3) average probing marks per seedling followed by MO1 (27.2). However, the lowest average probing marks per seedling (14.2) was observed in susceptible check TN1.

All these resistant genotypes exhibited average nymphal survival values varying from 29.21 to 55.33 per cent which was significantly lower than the susceptible check TN1. In TN1 susceptible check, variety nymphal survival value was maximum (89.75 %), while resistant check Ptb33 supported 53.64 per cent nymphal survival (Table 1). The variety INRC 3021 had the lowest nymphal survival (29.21%) followed by ARC 10550 (41.5 %) and Sinna Sivappu (41.63), which was significantly lower than the susceptible check TN1. Among the tested material MR 1523 had the highest nymphal survival

Table 1 : Performance of differentials in different tests against Raipur BPH population

Sr. No.	Differential	Average plant damage score	Honeydew excretion (mm^2/2f)	Average probing marks	Nymphal survival (%)	Developmental period	Growth index	Days to Wilt	Remark
1.	ARC 10550 (bph5)	0.64	27.6	25.3	41.5	17.5	2.37	15.27	R
2.	Sinna sivappu	0.75	15.3	38.3	41.63	19.3	2.15	16.5	R
3.	INRC 3021	0.81	17.5	29.3	29.21	16.7	1.75	17.05	R
4.	MR 1523	0.94	21.3	30.5	55.33	16.2	3.42	15.55	R
5.	Rathu heenati (Bph3)	1.00	15.8	30.7	48.34	16.8	2.87	15.61	R
6.	MO1	1.00	24.9	27.2	52.32	14.7	3.57	14.16	R
	PTB 33 (Bph2+Bph3)	1.31	12.9	32.3	53.64	19.2	2.80	19.39	Check
	TN 1	9.00	119.6	14.2	89.75	11.8	7.58	8.9	Check
		S.E. ±	1.29	0.40	1.44	0.58		0.50	
		C.D. (P=0.05)	3.89	1.14	4.31	1.67		1.50	

value (55.33 %) followed by genotype MO1 (52.32 %), but it was significantly lower than the susceptible check variety TN1. Among all the resistant genotypes the developmental period ranges from 14.7 to 19.3 days. Highest developmental period was found on Sinna Sivappu (19.3 days) with growth index 2.15 followed by ARC 10550 (17.5 days) with growth index value 2.37. Among all the resistant genotypes INRC 3021 had lowest growth index value (1.75) which indicates the presence of antibiosis factors. In Ptb33 the development period value was 19.2 while in TN1 it was 11.8 days. All the differentials exhibited significantly higher values of developmental period than TN1.

All resistant varieties exhibited average days to wilting value varying from 14.16 to 17.05 days, which was significantly higher than the susceptible check TN1 (Table 1). In TN1 susceptible check variety days required to wilt was minimum (8.9 days) which was significantly lower than all varieties tested while, in resistant check variety Ptb33, the days required to wilt was 19.39 days. The genotypes INRC 3021 had the maximum number of days required to wilt (17.05 days) followed by the genotype Sinna Sivappu (16.5 days) which was significantly higher than the susceptible check TN1.

Norris and Kogan (1980) reported wide array of chemical substances including inorganic chemicals, primary and intermediary metabolites and secondary plant substances are known to impart biochemical resistance in a host plant to a wide variety of insect pests. Only small proportion of BPH nymphs develop as an adult when subjected to stay and feed on resistant variety. Results on the development of nymphs on the resistant genotypes suggested that the insect surviving on resistant genotypes had to face the problem of inadequate or unsuitable nutrition. Low nymphal survival on resistant genotypes/variety was also reported by Soundararajan *et al*. (2004), Reddy *et al*. (2005) and Alagar *et al*. (2007). The differentials showed resistant reaction to local population of Raipur. These varieties are the promising donors and being utilized in breeding programmes. The amalgamated data over all the locations can prove the importance of these donors all over the country.

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