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Screening of Rice Genotypes for their Resistance against Brown Plant Hopper, *Nilaparvata lugens* (Stal) under Field and Glasshouse conditions

R. Prathima Kumari[1*], Ch. Anusha[2], R. Shravan Kumar[3], K. Rajendra Prasad[4] and Y. Hari[5]

[1]M.Sc.(Agriculture), Department of Entomology, College of Agriculture, Rajendranagar, PJTSAU, Hyderabad (Telangana), India.
[2]Assistant Professor, Department of Entomology, Agricultural College, Warangal, PJTSAU, Hyderabad (Telangana), India.
[3]Scientist, Rice Section, Regional Agricultural Research Station (RARS), Warangal, PJTSAU, Hyderabad (Telangana), India.
[4]Assistant Professor, Department of Genetics and Plant breeding, Agricultural College, Warangal, PJTSAU, Hyderabad (Telangana), India.
[5]Scientist, Biotechnology Department, Regional Agricultural Research Station (RARS), Warangal, PJTSAU, Hyderabad (Telangana), India.

(Corresponding author: R. Prathima Kumari)*
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ABSTRACT: The present study was carried out to screen 45 rice genotypes along with resistant and susceptible checks to identify the sources of resistance against Brown Plant Hopper (BPH), *Nilaparvata lugens* (Stal) in rice by screening under field and glasshouse conditions (standard seed box technique) during *Kharif,* 2021 at Regional Agricultural Research Station(RARS), Warangal. Among 45 rice genotypes screened, 3 genotypes (Siddhi-BC_2F_6 BPH BL-43, Siddhi-BC_2F_6 BPH BL-30 and Siddhi-BC_2F_6 BPH BL-64) were found resistant; 9 genotypes (Siddhi-BC_2F_6 BPH BL-11, Siddhi-BC_2F_6 BPH BL-12, Siddhi-BC_2F_6 BPH BL-19, Siddhi-BC_2F_6 BPH BL-24, Siddhi-BC_2F_6 BPH BL-52, Siddhi-BC_2F_6 BPH BL-56, Siddhi-BC_2F_6 BPH BL-57, Siddhi-BC_2F_6 BPH BL-60 and Siddhi-BC_2F_6 BPH BL-61) were found moderately resistant under both the conditions.

Keywords: Brown Plant Hopper, Genotypes, Screening, Resistance.

INTRODUCTION

Rice (*Oryza sativa* L.) is the primary food source for nearly half of the world's population and is being cultivated extensively in the most diverse ecosystems of tropical and sub-tropical regions of the world. It is the staple food for people in 39 countries and source of calories for one third of the world population which include 2.70 billion people in Asia alone. Globally, rice is being cultivated in an area of 167.2 million hectares with an annual production of 769.6 million tonnes and productivity of 4,600 Kg/ha. In India, during 2019-20 rice crop was cultivated in an area of 43.66 million ha with an annual production of 118.87 million tonnes and productivity of 2,722 kg/ha (FAO, 2021). The world will need about 25% more rice by the year 2030 to meet the estimated demand for an increasing global population (Yarasi *et al*., 2008).

On the other hand, the limiting factor to rice production is an aggregation of both abiotic and biotic constraints which causes a total loss of 0.8 tons per hectare. Among various biotic constraints of rice production, the insect pests are of prime importance and warm humid environment of the crop is more favourable for their survival and proliferation. More than 100 insect species attacks rice, of these 20 are major pests (Atwal and Dhaliwal 2002).

Among them brown plant hopper, *Nilaparvata lugens* (Homoptera; Delphacidae), is a typical phloem sap feeder and one of the most serious and destructive pests of rice throughout Asia (Normile, 2008; Heong and Hardy 2009). It causes yield loss amounting to as high as 60% under epidemic conditions (Srivastava *et al*., 2009, Kumar *et al*., 2012). Both nymphs and adults suck sap from the leaves and leaf sheaths, which results in yellowing of leaves and severe attack of BPH causes 'hopper burn' symptoms (Liu *et al*., 2008; Horgan, 2009; Vanitha *et al*., 2011).

Over the years, the insect has attained the key pest status which is a consequence of the injudicious and indiscriminate insecticide application for its management. Though many chemicals were recommended for the control of this pest (Sarao, 2016), due to its feeding behaviour at the base of the plant, the farmers are unable to control this pest effectively. As a result, farmers resort to application of insecticides which often disrupts the ecological balance of rice ecosystem due to which this pest has already developed resistance against many insecticides in different Asian countries. (Gorman *et al*., 2008; Matsumura *et al*., 2009). Growing resistant variety can be one of the safer alternatives which can be helpful in increasing the rice production to satisfy the ever increasing population thereby minimizing the loss caused by insects in a sustainable approach. Identification of resistant varieties is very important as the biotypes of the pest is changing its behaviour from time to time and the earlier released resistant rice varieties showing susceptibility to the pest (Painter, 1958).

MATERIAL AND METHODS

The present investigation was carried out at Regional Agricultural Research Station (RARS), Warangal during *Kharif*, 2021. The investigation includes identification of resistant genotypes against BPH through phenotypic screening. The experimental material consisted of 45 rice genotypes, two resistant checks (BM 71 and PTB 33) and one susceptible check (TN1).

Screening under field conditions. Siddhi back cross derived genotypes (45) of F_6 generation were collected from Regional Agricultural Research Station (RARS), Warangal and screened to identify the resistant genotypes against BPH. Along with test entries, BM 71 and PTB 33 as resistant checks and TN1 as susceptible check were transplanted with a spacing of 20 × 10 cm. The screening was done with 0-9 Grade (Table 1). The extent of damage on each plant was examined by visual scoring and evaluated according to the criteria, standard evaluation system (SES) of rice (IRRI, 2014).

Table 1: Standard evaluation system for resistance against brown planthopper under field conditions.

Score	Damage level	Reaction
0	No damage	Highly Resistant
1	Slight yellowing of a few plants	Resistant
3	Leaves partially yellow	Moderately Resistant
5	Leaves with pronounced yellowing and some stunting or wilting and 10-25% plants with hopper burn, remaining plants severely stunted	Moderately Susceptible
7	More than half of the plants wilting or with hopper burn, remaining plants severely stunted	Susceptible
9	All Plants dead	Highly Susceptible

Screening under glass house conditions

Mass rearing of the BPH. Initial BPH population was collected from the rice fields in Warangal district. The BPH was mass reared on the susceptible rice variety Taichung Native I (TN1) to produce enough nymphs for infestation (Heinrichs, 1985). Using this technique, a continuous pure culture of the BPH was maintained. First and second in star insects were collected and used for experiments.

Standard seed box screening technique. The pre-germinated seeds were sown in seed boxes (plastic trays or wooden boxes) of size 50 × 40 × 7 cm filled with fertilizer enriched puddled soil along with susceptible check TN1 in the two border rows and seeds of resistant check PTB 33 and BM 71 were sown in the middle row. Each screening tray included 20 test genotypes with about 15 seedlings per line; one row of resistant check (PTB 33) in the middle and two rows of susceptible check TN1 in the borders. First and second in star hopper nymphs were released (6-8 nymphs per seedling) on to 8-10 days old seedlings in the screening trays. When 90% of the plants of the susceptible check line TN1 were killed, scoring of the entries for damage was taken based on standard evaluation system of rice (SES) (IRRI, 2014). Average of the individual score of all the plants in each test line was taken as the damage score (Table 2).

Table 2: Standard evaluation system for resistance against brown planthopper under glasshouse conditions.

Resistance	Plant state	Reaction
0	None of the leaves yellow or dried	Highly Resistant (0-1.0)
1	One bottom leaf yellow	Resistant (1.1-3.0)
3	One or two leaves yellow or one leaf dried	Moderately Resistant(3.1-5.0)
5	One or two leaves dried or one leaf healthy	Moderately Susceptible (5.1-7.0)
7	All leaves dried yellow but stem green	Susceptible (7.1-8.9)
9	Plant dead	Highly Susceptible (9)

RESULTS AND DISCUSSION

Screening under field conditions. Out of 45 rice genotypes evaluated for resistance to BPH under field conditions, three genotypes *viz*., Siddhi-BC_2F_6 BPH-BL-43, Siddhi-BC_2F_6 BPH-BL-30 and Siddhi-BC_2F_6 BPH-BL-64 were found to be resistant with a damage score of 1, nine genotypes were moderately resistant with a damage score of 3. Eight genotypes were moderately susceptible with damage score of 5, 19 genotypes were susceptible with a damage score of 7 and 6 genotypes were highly susceptible with a damage score of 9 (Table 3).

Table 3: Reaction of rice genotypes against brown plant hopper under field conditions.

Sr. No.	Genotypes	Field Screening	
		Damage score	Reaction
1	Siddhi-BC_2F_6 BPH-BL-1	7	S
2	Siddhi-BC_2F_6 BPH-BL-2	7	S
3	Siddhi-BC_2F_6 BPH-BL-3	7	S
4	Siddhi-BC_2F_6 BPH-BL-5	7	S
5	Siddhi-BC_2F_6 BPH-BL-6	9	HS
6	Siddhi-BC_2F_6 BPH-BL-7	7	S
7	Siddhi-BC_2F_6 BPH-BL-9	9	HS
8	Siddhi-BC_2F_6 BPH-BL-11	3	MR
9	Siddhi-BC_2F_6 BPH-BL-12	3	MR
10	Siddhi-BC_2F_6 BPH-BL-13	7	S
11	Siddhi-BC_2F_6 BPH-BL-14	7	S
12	Siddhi-BC_2F_6 BPH-BL-15	7	S
13	Siddhi-BC_2F_6 BPH-BL-16	7	S
14	Siddhi-BC_2F_6 BPH-BL-17	7	S
15	Siddhi-BC_2F_6 BPH-BL-18	9	HS
16	Siddhi-BC_2F_6 BPH-BL-19	3	MR
17	Siddhi-BC_2F_6 BPH-BL-20	7	S
18	Siddhi-BC_2F_6 BPH-BL-21	7	S
19	Siddhi-BC_2F_6 BPH-BL-22	7	S
20	Siddhi-BC_2F_6 BPH-BL-24	3	MR
21	Siddhi-BC_2F_6 BPH-BL-25	5	MS
22	Siddhi-BC_2F_6 BPH-BL-26	7	S
23	Siddhi-BC_2F_6 BPH-BL-27	5	MS
24	Siddhi-BC_2F_6 BPH-BL-28	5	MS
25	Siddhi-BC_2F_6 BPH-BL-29	5	MS
26	Siddhi-BC_2F_6 BPH-BL-30	1	R
27	Siddhi-BC_2F_6 BPH-BL-31	5	MS
28	Siddhi-BC_2F_6 BPH-BL-32	9	HS
29	Siddhi-BC_2F_6 BPH-BL-33	9	HS
30	Siddhi-BC_2F_6 BPH-BL-34	5	MS
31	Siddhi-BC_2F_6 BPH-BL-43	1	R
32	Siddhi-BC_2F_6 BPH-BL-44	5	MS
33	Siddhi-BC_2F_6 BPH-BL-45	7	S
34	Siddhi-BC_2F_6 BPH-BL-45	7	S
35	Siddhi-BC_2F_6 BPH-BL-49	5	MS
36	Siddhi-BC_2F_6 BPH-BL-51	7	S
37	Siddhi-BC_2F_6 BPH-BL-52	3	MR
38	Siddhi-BC_2F_6 BPH-BL-56	3	MR
39	Siddhi-BC_2F_6 BPH-BL-57	3	MR
40	Siddhi-BC_2F_6 BPH-BL-58	9	HS
41	Siddhi-BC_2F_6 BPH-BL-60	3	MR
42	Siddhi-BC_2F_6 BPH-BL-61	3	MR
43	Siddhi-BC_2F_6 BPH-BL-62	7	S
44	Siddhi-BC_2F_6 BPH-BL-64	1	R
45	Siddhi-BC_2F_6 BPH-BL-65	7	S
46	TN1(S)	9	HS
47	PTB 33(R)	1	R
48	BM 71(R)	2.5	R

R= Resistant; MR= Moderately resistant; S= Susceptible; MS= Moderately Susceptible; HS=Highly Susceptible

The similar results were reported by Meshram *et al.* (2022) who conducted an experiment comprised of 24 rice germplasm. Out of 24 rice germplasm lines, 13 germplasm lines showed the resistant reaction. The present results were similar with the findings of Tetarwal *et al.* (2014) who evaluated a total of 178 rice for resistance against brown planthopper (BPH) under natural infestation condition. The results revealed that only nine genotypes were resistant; 28 were found moderately resistant; 102 were moderately susceptible and the 46 were susceptible to brown planthopper.

Screening under glass house conditions. Among 45 genotypes tested in glass house conditions, three genotypes were categorized as resistant *viz*., Siddhi-BC_2F_6 BPH BL-43, Siddhi-BC_2F_6 BPH BL- 30, and Siddhi-BC_2F_6 BPH BL-64 with a damage score of 1.6, 2.7 and 3.0, respectively; nine genotypes were moderately resistant *viz*., Siddhi-BC_2F_6 BPH BL-11, Siddhi-BC_2F_6 BPH BL- 12, and Siddhi-BC_2F_6 BPH BL-19, Siddhi-BC_2F_6 BPH BL-24, Siddhi-BC_2F_6 BPH BL-52, Siddhi-BC_2F_6 BPH BL-56, Siddhi-BC_2F_6 BPH BL-57, Siddhi-BC_2F_6 BPH BL-60 and Siddhi-BC_2F_6 BPH BL-61 with a damage score of 3.1 to 5.0; eight genotypes were moderately susceptible with damage a score of 5.1 to 7.0, 19 genotypes were susceptible with damage a score of 7.1 to 8.9 and six genotypes were highly susceptible with damage a score of 9.0 (Table 4). The present results were similar with the findings of Soundararajan *et al.* (2019) who screened the advanced rice entries in standard seed box technique which indicated almost similar score of resistance for the rice genotypes.

Table 4: Reaction of genotypes against brown plant hopper under glasshouse conditions.

Sr. No.	Genotypes	Glass house	
		Damage score	Reaction
1	Siddhi-BC_2F_6 BPH-BL-1	8.8	S
2	Siddhi-BC_2F_6 BPH-BL-2	8.6	S
3	Siddhi-BC_2F_6 BPH-BL-3	8.4	S
4	Siddhi-BC_2F_6 BPH-BL-4	8.3	S
5	Siddhi-BC_2F_6 BPH-BL-5	8.6	S
6	Siddhi-BC_2F_6 BPH-BL-6	9	HS
7	Siddhi-BC_2F_6 BPH-BL-7	8.9	S
8	Siddhi-BC_2F_6 BPH-BL-9	9	HS
9	Siddhi-BC_2F_6 BPH-BL-11	3.9	MR
10	Siddhi-BC_2F_6 BPH-BL-12	4.9	MR
11	Siddhi-BC_2F_6 BPH-BL-13	8.3	S
12	Siddhi-BC_2F_6 BPH-BL-14	8.6	S
13	Siddhi-BC_2F_6 BPH-BL-15	8.1	S
14	Siddhi-BC_2F_6 BPH-BL-16	8.5	S
15	Siddhi-BC_2F_6 BPH-BL-17	8.3	S
16	Siddhi-BC_2F_6 BPH-BL-18	9	HS
17	Siddhi-BC_2F_6 BPH-BL-19	3.2	MR
18	Siddhi-BC_2F_6 BPH-BL-20	7.8	S
19	Siddhi-BC_2F_6 BPH-BL-21	7.3	S
20	Siddhi-BC_2F_6 BPH-BL-22	8.9	S
21	Siddhi-BC_2F_6 BPH-BL-24	4.7	MR
22	Siddhi-BC_2F_6 BPH-BL-25	5.7	MS
23	Siddhi-BC_2F_6 BPH-BL-26	8.8	S
24	Siddhi-BC_2F_6 BPH-BL-27	6.2	MS
25	Siddhi-BC_2F_6 BPH-BL-28	7	MS
26	Siddhi-BC_2F_6 BPH-BL-29	6.4	MS
27	Siddhi-BC_2F_6 BPH-BL-30	2.7	R
28	Siddhi-BC_2F_6 BPH-BL-31	6.2	MS
29	Siddhi-BC_2F_6 BPH-BL-32	9	HS
30	Siddhi-BC_2F_6 BPH-BL-33	9	HS
31	Siddhi-BC_2F_6 BPH-BL-34	5.8	MS
32	Siddhi-BC_2F_6 BPH-BL-43	1.6	R
33	Siddhi-BC_2F_6 BPH-BL-44	7	MS
34	Siddhi-BC_2F_6 BPH-BL-45	7.9	S
35	Siddhi-BC_2F_6 BPH-BL-49	5.2	MS
36	Siddhi-BC_2F_6 BPH-BL-51	8.9	S
37	Siddhi-BC_2F_6 BPH-BL-52	3.6	MR
38	Siddhi-BC_2F_6 BPH-BL-56	4.9	MR
39	Siddhi-BC_2F_6 BPH-BL-57	3.9	MR
40	Siddhi-BC_2F_6 BPH-BL-58	9	HS
41	Siddhi-BC_2F_6 BPH-BL-60	4.2	MR
42	Siddhi-BC_2F_6 BPH-BL-61	3.6	MR
43	Siddhi-BC_2F_6 BPH-BL-62	7.3	S
44	Siddhi-BC_2F_6 BPH-BL-64	3	R
45	Siddhi-BC_2F_6 BPH-BL-65	7.9	S
46	TN1(S)	9	HS
47	PTB33(R)	1.2	R
48	BM71(R)	2.8	R

R= Resistant; MR= Moderately resistant; S= Susceptible; MS= Moderately Susceptible; HS= Highly Susceptible

SUMMARY AND CONCLUSION

In the present study, out of 45 genotypes screened 12 genotypes had shown resistance reaction under both field and green house conditions. 3 genotypes *viz*., Siddhi-BC_2F_6 BPH BL-43, Siddhi-BC_2F_6 BPH BL- 30 andSiddhi-BC_2F_6 BPH BL-64 were resistant; 9 genotypes *viz*., Siddhi-BC_2F_6 BPH BL-11, Siddhi-BC_2F_6 BPH BL-12, Siddhi-BC_2F_6 BPH BL-19, Siddhi-BC_2F_6 BPH BL-24, Siddhi-BC_2F_6 BPH BL-52, Siddhi-BC_2F_6 BPH BL-56, Siddhi-BC_2F_6 BPH BL-57, Siddhi-BC_2F_6 BPH BL-60 andSiddhi-BC_2F_6 BPH BL-61were moderately resistant.

FUTURE SCOPE

There is necessity to identify suitable new donors resistant to brown plant hopper (BPH), *Nilaparvata lugens*, from different sources in order to combat the pest and develop material resistant to different biotypes. The BPH resistant lines may be used as donor parents in conventional breeding programmes or may be released as varieties which inturn reduces the cost of cultivation by avoiding chemical spray to control BPH.

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Conflict of Interest. None.

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