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## SCREENING TRADITIONAL RICE VARIETIES OF KERALA FOR RESISTANCE TO BROWN PLANTHOPPER *NILAPARVATA LUGENS* (STAL)

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### ABSTRACT

The present study investigated the differential responses of rice genotypes to artificial infestation by the brown planthopper (BPH), *Nilaparvata lugens* (Stål), under controlled conditions. A total of 83 rice accessions comprising 53 traditional Kerala varieties, 27 high yielding varieties and two check genotypes, PTB 33 (resistant) and TN 1 (susceptible) were evaluated for BPH resistance using the standard seedbox screening technique (SSST) in a polyhouse. Plant damage assessments were conducted 7–12 days after insect release using a visual damage scoring scale of 0–9. Significant variation was observed among the rice genotypes in their response to BPH infestation. MO 22 (Sreyas) exhibited a high level of resistance and this was the first report of resistance to BPH in Sreyas, whereas PTB 33 and MO 23 (Pournami) showed moderate resistance. Eleven genotypes were categorized as moderately resistant, while the remaining genotypes were susceptible. The identification of resistant and moderately resistant genotypes highlights the potential of exploiting promising genetic resources for breeding BPH resistant rice varieties. The findings emphasize the importance of host plant resistance as a sustainable and eco-friendly strategy for BPH management and for improving rice productivity in BPH prone agroecosystems.

**Keywords :** Resistance, *Nilaparvata lugens*, Rice genotypes, Screening.

### Introduction

Rice (*Oryza sativa* L.) is a crucial cereal crop globally and serves as a staple food for over 60% of the world's population. As the population rises, there is an increasing need to boost food grain production to maintain food security. Expanding the area devoted to rice cultivation is nearly unfeasible, so the focus must shift to enhancing productivity. This can be partly achieved by improving the control of major pests and diseases, which account for 24 to 41 per cent per cent loss in rice (Savary *et al.*, 2000). Over the last fifty years, the number of economically significant pests in rice has increased, resulting in a substantial reduction in both grain quality and production. The brown planthopper (BPH), a migratory and monophagous pest, causes yield losses ranging from 20 to 80 percent and incurs an estimated annual economic loss of

approximately \$300 million in Asia (Min *et al.*, 2014). Both adult and nymph forms of the pest feed on vascular tissues, extracting phloem sap from the rice leaf sheaths, leading to characteristic circular patches in the field, known as the hopper burn symptom (Rao *et al.*, 2003). Adult brown planthoppers exhibit two wing morphs: long winged and short winged forms. Short winged individuals are non-migratory but have a greater reproductive capacity, producing more eggs. On the other hand, long-winged planthoppers are capable of migration, enabling them to spread to new rice crops and endure through different growing seasons. This combination of high reproduction and migration has driven the swift population growth of the brown planthopper (Xu and Zhang, 2017). The indiscriminate and injudicious application of insecticides for the management of BPH has resulted in

its rise as a major pest. Despite the recommendation of several chemicals for pest control, farmers face difficulty in managing the pest effectively due to its feeding habit at the plant's base. (Sarao, 2015). This pest has developed resistance to several insecticides in various Asian countries (Wu *et al.*, 2018). Insect resurgence brought on by sublethal pesticide treatments necessitates further dose increments as well as more frequent insecticide applications to control the pest. Secondly, using insecticides causes disruption of the ecosystem in rice and a fall in natural enemies. Therefore, the quest for a more reliable BPH management option has become more difficult (Matsumura *et al.*, 2009). Use of resistant varieties is a practical, effective and environmentally responsible way for controlling insect pest populations, offers farmers economic pest control and is compatible with other control strategies in an integrated pest management programme.

### Materials and Methods

#### Mass rearing of brown planthopper (BPH)

Healthy seeds of susceptible rice variety, Taichung Native 1 (TN1) were soaked overnight and sown in plastic trays of 50cm x 40cm x 8cm size filled with fertilizer enriched puddled soil. Twenty days old seedlings were transplanted to pots of 3 L capacity filled with fertilizer enriched puddled soil, placed in glasshouse under ambient conditions. A water level of 2 cm was maintained. The potted plants were used for mass rearing of brown planthopper (Pathak and Khush, 1979) (Fig 1). Brown planthopper population, the pure cultures of which was maintained at ICAR-IIRR was used for mass rearing. Cages of dimension 70 cm x 62 cm x 75 cm with glass panel on one side and fine wire mesh on the other three sides were used for mass rearing. Twenty gravid female hoppers were collected with the help of an aspirator and were released in oviposition cages with pre-cleaned potted plants of TN1 (Plate 2). The hoppers were allowed four days for oviposition after which they were offered fresh batch of rice plants for further egg laying. Plants with eggs were taken out of the cages and placed in separate cages for the nymphs to hatch. Fresh plants were also placed in the cages with nymphs as and when required. The nymphs thus maintained were utilized for experiments as and when they attained the desired age. Necessary precautions were taken to keep the culture free from predators such as spiders, mirid bugs, other natural enemies and other hoppers like Green leafhopper (GLH). By this technique, a continuous pure culture of BPH was maintained during the entire period of study.

#### Mass screening of Traditional Rice Varieties for resistance to BPH under glasshouse conditions

In order to identify the sources of resistance to BPH, 57 Traditional Rice Varieties (TRV's) of Kerala and 23 High Yielding Varieties (HYV's) along with susceptible check (TN1) and resistant check (PTB 33) were procured from Department of Seed Science and Technology, College of Agriculture, Vellanikkara, Regional Agricultural Research Station, Pattambi and TNAU, Coimbatore. These genotypes were screened at ICAR-Indian Institute of Rice Research, Rajendranagar, Hyderabad during 2020-2022 (Fig 2). Screening was conducted using the SSST method under controlled greenhouse conditions, as outlined by Kalode *et al.* (1975). The process involved infesting 13 or 14 day old rice seedlings of the test entries with BPH nymphs. Seeds were pre-soaked and sown in seed boxes measuring 50cm x 40cm x 8cm, filled with well-fertilized, puddled soil and spaced 3.5 cm apart. Each box contained 20 test lines, with 20 seedlings per line, a row of the resistant check (PTB33) in the center, and two rows of the susceptible check (TN1) at each end. Each entry was screened in two replications. After sowing, the screening trays were placed in 60cm x 180cm x 8cm size fibre trays filled with water. Water in fibre trays served to maintain continuous supply of moisture for the growing seedlings in screening trays, to maintain adequate humidity and to avoid ants foraging for the honeydew excretion of BPH during the experiment. At the time of release of nymphs, the screening trays were covered with mylar cages on sides and nylon mesh on top to prevent the escape of the nymphs and entry of natural enemies. First and second instar nymphs of BPH were released onto the 13 or 14 day-old seedlings of the test entries by tapping heavily infested plants over the screening trays, ensuring that each seedling received at least 6-8 nymphs (Fig 3). Once over 90 per cent of the susceptible check plants (TN1) were killed, the test entries were evaluated for damage based on a 0-9 scale from the Standard Evaluation System (SES) (IRRI, 2014): 0 - No yellow or dead leaves (Highly resistant), 1 - One bottom leaf yellow (Resistant), 3 - One or two leaves yellow or dried (Moderately resistant), 5 - One or two leaves dried or one healthy leaf (Moderately susceptible), 7 - All leaves dried or yellow but stem green (Susceptible), 9 - Plant dead (Highly susceptible). After the scoring individual seedlings of an entry, the average score for all the seedlings of a given entry was calculated and used as a measure of the resistance reaction of the entry against the insect.



**Fig. 1 :** Mass rearing of BPH



**Fig. 2 :** Layout of screening tray



**Fig. 3 :** Screening tray with plants infested with nymphs

### Results and Discussion

One accession, MO 22 (Sreyas), with a mean damage score (DS) of 0.5 was found as highly resistant while PTB 33 and MO 23 (Pournami), with DS of 1.5 and 2.5, respectively. Eleven accessions with DS between 3.1 and 5.0 were identified as moderately resistant. Twenty-two entries that were identified as moderately susceptible. The damage score of the above category varied from 5.1 to 7.0. Damage scores of 39 entries clarified as susceptible, ranged between 7.1 to 8.9. Seven entries namely, Rakthasali,

Jeerakasala, Thottacheera, Kuruva, Nadankuruva, Biryanchiseera and TN1 had a DS of 9.0 and were highly susceptible.

Brown planthopper a sap feeding pest of rice, hampers the photosynthesis by inhibiting the movement of nutrients. Breeding resistant varieties require information about the potential sources of resistance to the pest. Indigenous varieties of rice are storehouse of resistance genes. MO 22 (Sreyas) is a high yielding variety released from Rice Research Station, Moncompu, KAU in 2015 for the Kuttanad

tract of Kerala. It was bred by crossing Pavitra X Triguna, both being reportedly resistant to gall midge *Orseolia oryzae* (Wood-Mason). However, Pavitra was evolved by crossing Surekha and MO 5 (Asha). While Surekha is resistant to BPH, MO 5 (Asha) is reportedly tolerant to BPH. The above lineage could have contributed to the resistance in Sreyas to BPH. The discovery of the highly resistant variety MO 22 (Sreyas) could give further impetus to the BPH resistance breeding programmes. The genotype can serve as a donor as well as the resistant check in the varietal screening trials against BPH. PTB 33 is a pureline selection of Arikkirai, a variety indigenous to Kerala. MO 23 (Pournami) is resistant to BPH. MO 23 was developed by crossing NHTA8 X MO 8 (Aruna), both of which have been reported as resistant to BPH. Aruna, in turn was developed by crossing Jaya X PTB 33. This would explain the expression of BPH resistance in MO 23. Majority of the moderately resistant genotypes (63.6%) *i.e.*, seven out of the 11 genotypes identified in the study were indigenous to Kerala. In concurrence with the study, Roy *et al.* (2021) examined the response of different rice landraces to BPH infestation and discovered that the entries Badshabog, Gamra, Haldichuri, Janglijata, Kalabhat, Khara, Adanshilpa, Chikonmashuri, Kerala Sundari and Lal Dudheshwar consistently displayed resistance to BPH alongside the standard resistant check PTB 33, under both the glasshouse and open-field situations. Plants with moderate to low level of resistance may be effective in a wide range of situations (Painter, 1951), since even a small disruption in the insect's ability to reproduce could tip the population's balance and cause it to gradually decline until it hits a critical minimum level. A total of 39 genotypes were identified as susceptible in the present study. This is along expected lines since primary breeding objective in most crops is yield and quality.

However, the inclusion of the elite cultivars of Kerala, PTB 39 (Jyothi) and Mo 16 (Uma) in the susceptible class is a cause for concern since these two varieties occupy over 80 per cent of the rice cropped area in the state. Hence, susceptibility of these varieties to BPH pose a severe threat to the rice farming in the state and therefore, there is an urgent need to improve their resistance to BPH. Marker assisted breeding approaches can be employed to hasten the development of varieties with desirable traits. According to Mishra *et al.* (2022), adoption of high-throughput genotyping and phenotyping platforms can deliver multiple target traits into desired genetic background. Cultivar TN1 was found to be highly susceptible, the same has been reported by several authors, including Raghavender *et al.* (2021) and Soundararajan *et al.* (2004). The above results confirm that the genotypes evaluated differed in their reaction to BPH infestation. Wide variability in the response of rice genotypes to BPH infestation was observed by Jena *et al.* (2015) who phenotyped 58 rice genotypes including 39 landraces of rice from the state of Odisha against the BPH population. Lakshmi *et al.* (2010) found that Pattambi rice genotypes (land races) which are known for resistance to major pest and diseases exhibited considerable variation in resistance reaction to BPH.

### Conclusions

This study underscores the significant genetic diversity present in rice accessions for resistance to brown planthopper (BPH), a major pest threatening rice production. The evaluation of rice accessions revealed promising candidates for BPH resistance. This study highlights the importance of traditional rice varieties, rich in resistance genes, as a vital resource for enhancing BPH resistance in rice breeding, ensuring improved crop protection and food security.

**Table 1 :** Reaction of genotypes to brown planthopper

Sl. No	Genotypes	TGC No.	Mean damage score (0-9 SES score)	Reaction
1	Chenkazhama	TGC 1	7.7	S
2	Kunjukunju	TGC 6	8.8	S
3	Kottampalarikayama	TGC 9	8.4	S
4	Chembavu	TGC 10	8.7	S
5	Aruvakari	TGC 12	8.6	S
6	Aryankayama	TGC 13	4.8	MR
7	Rakthasali	TGC 14	9.0	HS
8	Thavalakannan	TGC 15	7.7	S
9	Kalladiaryan	TGC 18	7.5	S
10	Hraswa	TGC 19	3.8	MR
11	Chenthondi	TGC 44	3.1	MR
12	Kurumbaali	TGC 58	5.6	MS

13	Adukkkan	TGC 59	4.6	MR
14	Karumbaayan	TGC 62	4.0	MR
15	Jeerakasala	TGC 66	9.0	HS
16	Kullan Palthondi	TGC 73	5.1	MS
17	Chuvanamodan	TGC 86	8.7	S
18	Karuthadukkan	TGC 87	8.6	S
19	Thottacheera	TGC 88	9.0	HS
20	Karuthamodan	TGC 89	8.7	S
21	Karanavara	TGC 90	8.9	S
22	Arimodan	TGC 94	7.7	S
23	African Goodday	TGC 96	8.9	S
24	PTB 51 (Athira)	TGC 97	7.8	S
25	PTB 34 (Annapurna)	TGC 98	7.8	S
26	PTB 52 (Aiswarya)	TGC 99	8.2	S
27	PTB 55 (Harsha)	TGC 101	8.7	S
28	PTB 56 (Varsha)	TGC 102	8.7	S
29	PTB 45 (Matta Triveni)	TGC 103	7.4	S
30	Improved Samba Mahsuri (ISM)	TGC 107	6.6	MS
31	MO 22 (Sreyas)	TGC 108	0.5	HR
32	PTB 60 (Vaisakh)	TGC 109	4.9	MR
33	PTB 50 (Kanchana)	TGC 110	5.3	MS
34	PTB 39 (Jyothi)	TGC 111	7.8	S
35	MO 16 (Uma)	TGC 112	7.9	S
36	Japan Violet	TGC 113	8.3	S
37	Aryan	TGC 132	8.4	S
38	Kuruva	TGC 135	9.0	HS
39	Veluthacheera	TGC 136	8.2	S
40	Njavara	TGC 165	6.1	MS
41	PTB 43 (Swarna Prabha)	TGC 208	6.8	MS
42	Vellathondi	TGC 233	5.3	MS
43	Ponnaryan	TGC 298	8.4	S
44	Kuttadan	TGC 299	5.7	MS
45	Krishnakamodh	TGC 300	8.4	S
46	Veluthanavara	TGC 303	7.6	S
47	Chuvanna Chitteni	TGC 306	7.2	S
48	Mattachamban	TGC 310	6.8	MS
49	Thonnuran	TGC 317	4.9	MR
50	Vellamunda	TGC 322	4.6	MR
51	Chitteni	TGC 323	5.1	MS
52	Chettadi	TGC 324	6.4	MS
53	Vellari	TGC 333	6.8	MS
54	Pattambi Thekkan	TGC 334	6.8	MS
55	Mundon	TGC 338	7.7	S
56	Odiyan	TGC 350	6.2	MS
57	Orkayama	TGC 355	4.4	MR
58	Ponmani <i>Sub-1</i>	TGC 358	8.2	S
59	Mallikuruva	TGC 361	8.8	S
60	Cheruvellari	TGC 377	7.1	S
61	Kavunginpoothala (Late)	TGC 378	7.8	S
62	Undachemban	TGC 395	7.6	S
63	Neycheera	TGC 400	8.2	S
64	Thovaan	TGC 407	7.1	S
65	KAU Manuratna	UN 17-22K	7.8	S
66	Karuthalikannan	TGC 410	8.2	S

67	Mullankuruva	TGC 412	7.3	S
68	Cherupunja	TGC 413	6.9	MS
69	Okanpuncha	TGC 452	6.8	MS
70	Chettiviruppu	TGC 422	6.9	MS
71	Nadankuruva	TGC 428	9.0	HS
72	Biryanchiseera	TGC 433	9.0	HS
73	Jaya	TGC 585	6.6	MS
74	PTB 62 (KAU Supriya)	UN 44	5.6	MS
75	PTB 61 (Akshaya)	UN 45	6.2	MS
76	MO 23 (Pournami)	UN 46-22K	2.5	R
77	PTB 47 (Neeraja)	UN 41	6.6	MS
78	PTB 57 (Swetha)	UN 42	5.1	MS
79	PTB 54 (Karuna)	UN 43	5.0	MS
80	KAU Manu Varna	UN 55-22K	4.8	MR
81	PTB33	-	1.5	R
82	TN1	-	9.0	HS

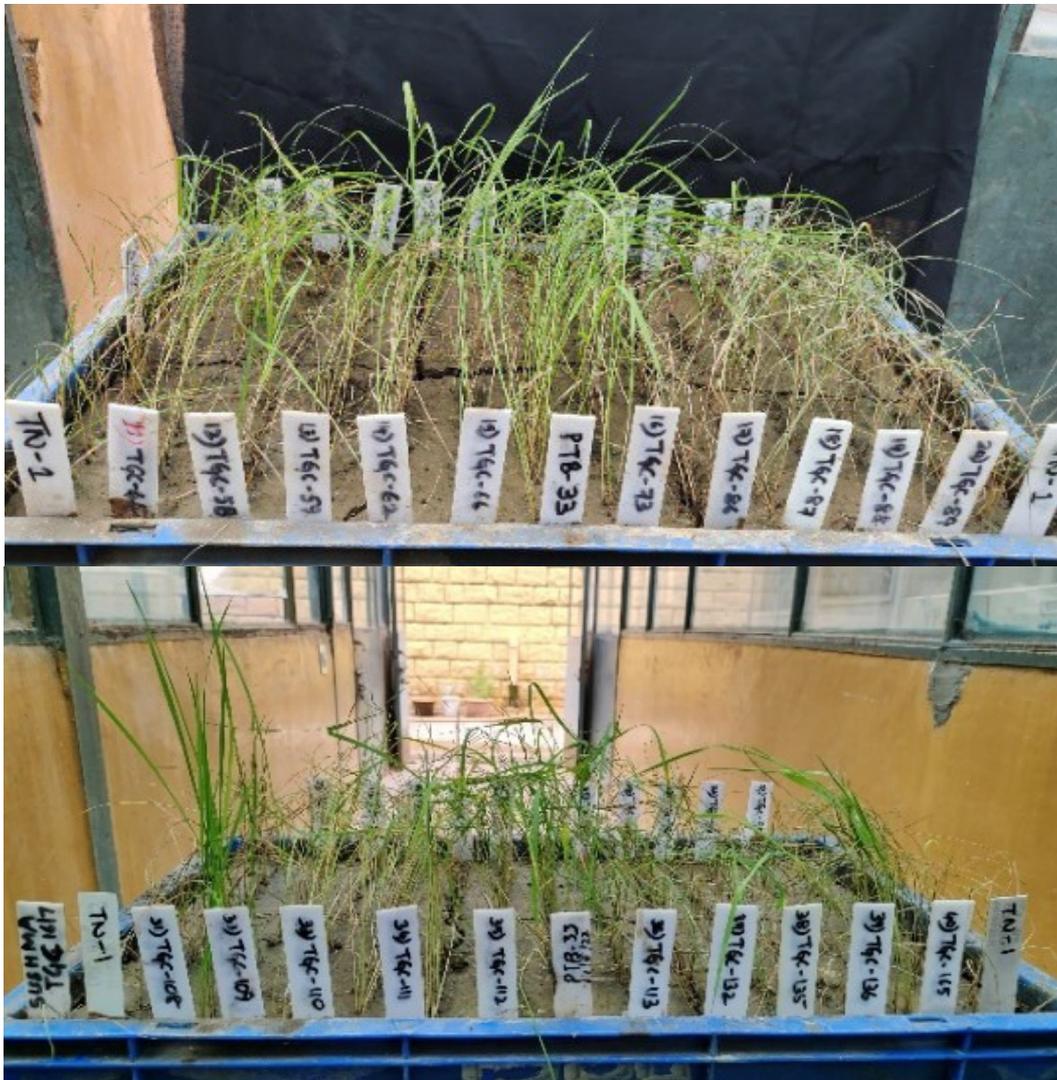
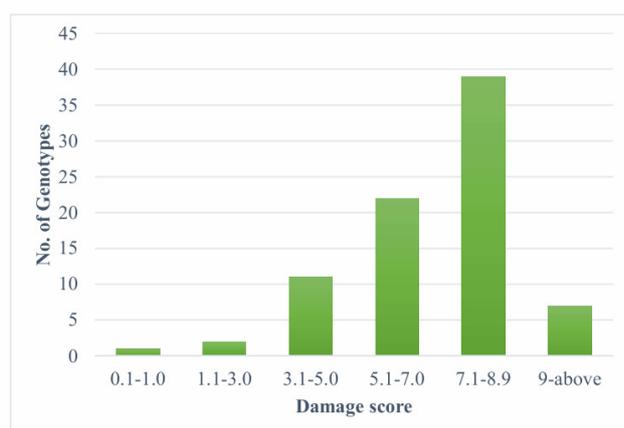


Fig. 4 : Reaction of genotypes for BPH infestation



**Fig. 5 :** Frequency distribution of genotypes according to their damage scores

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