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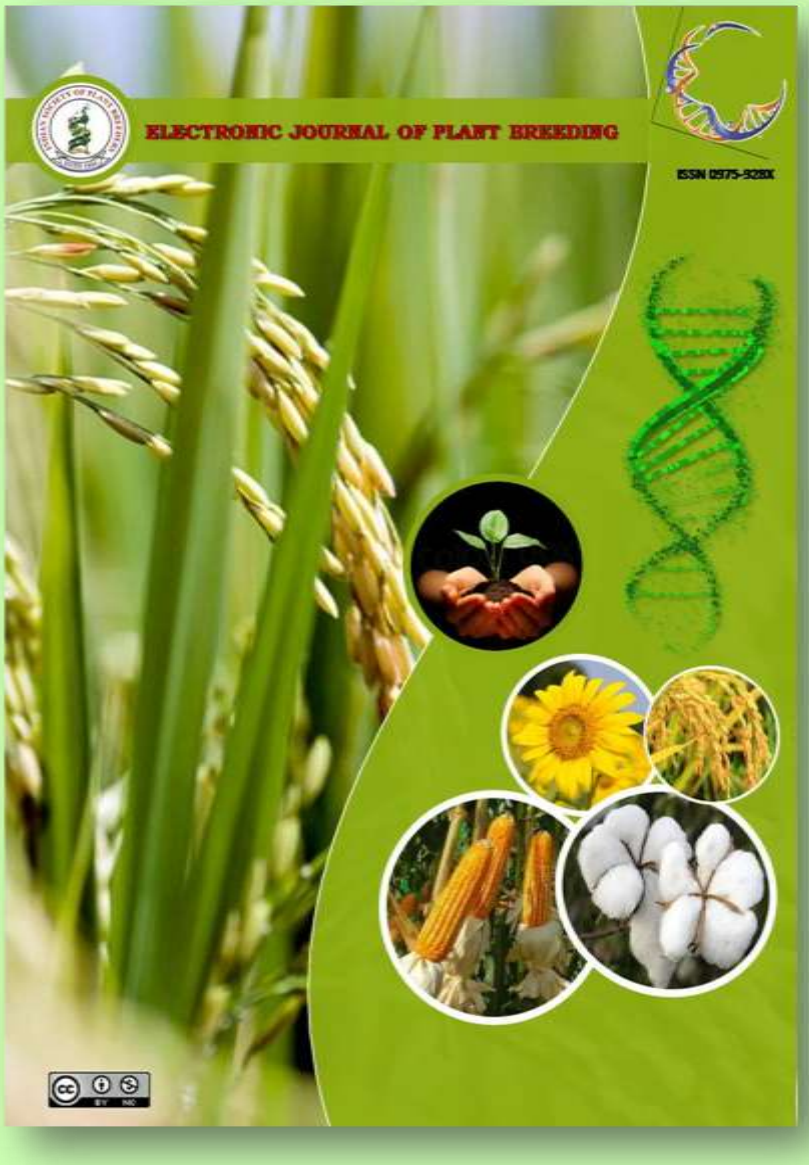

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Research Article

Evaluation of rice landraces for resistance to planthoppers and leafhoppers

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Abstract
Evaluation and identification of resistant entries for different hopper pests is a continuous process to develop new resistant varieties. Identification of novel resistant genotypes from landraces will provide valuable information, protect the local germplasm, using them in crossing programme. A total of seventy four rice landraces along with resistant and susceptible checks *viz*., Ptb-33, MO-1 and TN-1 were used for the present study. Standard seed box screening techniques were followed to evaluate resistance to BPH, WBPH and GLH under glass house condition. Among the landraces screened, none of the entries was observed as highly resistant. Ten entries were found resistant to BPH, eight each for WBPH and GLH with the damage score of 3. Among the resistant lines, Panamara Samba and Karthi Samba showed resistance to both BPH and WBPH. 25 landraces showed moderate resistance to BPH, 18 landraces showed resistance to WBPH and 27 landraces were found to be resistance to GLH with score 5.

Key words
Rice, resistance, landraces, screening, hoppers

Introduction

Rice (*Oryza sativa* L.) is the major food crop of the world, over 90 per cent of the rice is grown in Asia where more than 100 insect species attack the crop (Norton and Way, 1990). Planthoppers (Delphacidae) and leafhoppers (Cicindelidae) are economically important pests of rice, *Oryza sativa* (Denno and Perfect, 1994; Dupo and Barrion, 2009). Some of these species cause losses to rice production through feeding (often called mechanical damage), but others are problematic because they are vectors for damaging rice viruses including tungro and rice dwarf viruses (Hibino, 1996; Abo and Sy, 1997). The frequency and extent of outbreaks of these three species has increased throughout the Asian region since the early 2000s (Catindig *et al*., 2009). In India, From 1973 to 2000, the occurrence of planthoppers sporadically were noticed in Bihar, Jharkhand, Uttar Pradesh, Haryana and Punjab, Andhra Pradesh, Cauvery delta of Tamil Nadu, Tungabhadra delta of Karnataka, Mahanadi delta of Orissa and several areas in West Bengal (Krishnaiah, 2014). From 2006-07 onwards the severe incidences of planthoppers were noted in major rice growing regions of India. The annual yield losses estimated upto 30 per cent (DRR, 2010). The hoppers are serious pests of rice throughout Asia. Because of the economic importance of the hoppers, rearing and varietal resistance screening programs are well established in many countries. For over 50 years, host-plant resistance has been considered as an efficient method to reduce yield losses to rice caused by plant and leafhoppers. Already a number of resistant rice varieties have been developed and deployed throughout Asia. To date, over 70 hopper resistance genes have been identified in rice; however, less than 10 genes have been deliberately introduced to commercial rice varieties. Both nymphs and adults of planthoppers suck sap from lower portion of the rice plant, which causes extensive plant mortality referred as 'hopper burn' symptom (Liu *et al.*, 2008) and green leafhopper transmits 'rice tungro virus'. Screening rice germplasm at global level and breeding brown planthopper resistant rice varieties were initiated during 1970s, and several resistant varieties have been released for cultivation (Bentur *et al.*, 2011). The limitation to the success of resistance varieties is the potential threat of emergence of new biotypes of the insect (Glass, 1975). The resistant varieties released became susceptible in few years, due to adaptation of hoppers and outbreaks continue to occur. Most of the host plant resistance studies in rice against hoppers came out with the resistance confirmed at seedling stage screening test.

Screening at seedling stage will help to identify specific resistant genes in resistant varieties. Landraces are wonderful germplasm resources with different characteristic available in the local region. Many farmers still grow different landraces in their fields in small pocket for their own uses. Very little attempts have been earlier to use these landraces for resistance breeding programme particularly against insect pests. The basic data on their susceptible nature towards these three hoppers are lacking. The present investigation was carried out with 74 rice landraces available in Tamil Nadu and screened at seedling stage through standard seed box screening method to know their reaction to brown planthopper, *Nilaparvata lugens* (Stal), white backed planthopper, *Sogatella furcifera* (Horvath) and green leafhopper, *Nephotettix nigropictus* (Stal).

Materials and Methods

Mass culturing of brown planthopper (BPH), white backed planthopper (WBPH) and green leafhoppers (GLH) was carried out as per International Rice Research Institute (IRRI) standard protocol (Heinrichs *et al.,* 1985) at Entomology glass house, Paddy Breeding Station, Tamil Nadu Agricultural University (TNAU), Coimbatore. Initial insect populations were collected from unsprayed rice fields of Coimbatore, Tamil Nadu. The hoppers were separately mass cultured in the glass house on the susceptible rice variety Taichung Native 1 (TN-1). The landraces of rice entries were collected from germplasm resource at Paddy Breeding Station, Coimbatore and local farmers of Tamil Nadu. Totally seeds of seventy four rice landraces were collected and utilized along with resistant checks Ptb-33, MO-1 and susceptible check TN-1. The landraces were screened at seedling stage by following standard seed box screening technique along with resistant and susceptible check entries. In standard seed box screening technique, the test landraces were soaked in water for 24 h and then the water was drained off and the seeds were allowed to sprout for a day by keeping in darkness. The pre-germinated seeds of landraces were sown 3 cm apart in a plastic seed box filled with 5-10 cm depth of clay soil. In each seed box, 20 entries can be sown along with check. Each landrace was sown in a row across the width of the seed box in such a way so as to have at least 20 plants per row. Two rows of susceptible check, TN-1 at both the ends of seed box and one row of resistant check, Ptb-33 (for BPH, GLH) and MO-1 (for WBPH) near middle were sown in each seed box and the experiment was replicated thrice. The entries were screened for all three hoppers separately. The seed box was then transferred to a galvanized iron tray filled with water on third day. The hoppers population cultured on TN-1 plants were used to infest the seedlings. Seven days after sowing, the seedlings were infested with second and third instar nymphs. The plants with nymphs were gently tapped over the seedlings in such a way that approximately 8 to 10 nymphs on each seedling. Damage rating of the test landraces was done when 90 per cent of the seedlings in the susceptible check or in any test landraces started wilting by following Standard Evaluation System (SES) for rice, 0-9 scale (IRRI, 1980) (Table 1).

Results and Discussion

The results of the present investigation revealed that the rice landraces evaluated for their resistance against *N. lugens*, *S. furcifera* and *N. nigropictus* showed varied reaction (Table 2). None of the entry was observed as highly resistant in standard seed box method. The entries Shenmolagai, Sornavari, Karthi Samba, Matta Kuruvai, Panamara Samba, Thillainayagam, Thondi, Manvilayan, Varisuriyan and Kalavai were found to be resistant to brown planthopper with the damage score of 3. The landraces, Kudai Vazhai, Karthi Samba, Vadivel, Ponmani Samba, Kallimadayan, Panamara Samba, Kodaivilayan and Kalyani were found to be resistant to white backed planthopper (score 3). In green leafhopper screening, Kuruvai Kalanjiyan, Vellai Sithirai Kar, Palkachakka, Malayalathan Samba, Earapalli Samba, Kalar Kar, Aarkadu Kichii and Nootri Pathu were recorded as resistant with score 3. Twenty five landraces showed moderate resistance to brown planthopper, eighteen to white planthopper and twenty seven were found to be resistant to green leafhopper with damage score of 3 to 5. The resistant check, Ptb-33 showed resistant to brown planthopper and green leafhopper where as MO-1 recorded as resistant to white backed planthopper. The susceptible check, TN-1 had the score of 9 for all the three hopper insects.

Among the landraces screened, some of the entries showed resistant to two hopper species. The promising resistant landraces, Karthi Samba and Panamara Samba showing resistant to both planthopper species however moderately resistant to green leafhopper. Palkachaka showing resistance to green leafhopper but moderate resistance to both the planthoppers. Norungan and Maranellu showing moderate resistance to all three hoppers.

The entries *viz*., Kudai vazhai, Vadivel recorded resistant to white backed planthopper and moderately resistant to brown planthopper but susceptible and moderately susceptible respectively to green leafhopper. Interestingly the entries, Shenmolagai, Thillainayagam, Manvilayan, Kalavai were recorded as resistant to brown planthopper but susceptible or moderately susceptible to other planthopper species,

white backed planthopper. This shows there was variation in the level of resistant in the entries though both the species belong to same family as well as same feeding habit. The resistant check, MO-1 recorded as resistant to white backed planthopper and moderately resistant to brown planthopper where as Ptb-33 showed moderately resistant to white backed planthopper. The entries Kalar Kar and Nootri Pathu showed resistant to green leafhopper and moderately resistant to at least one planthopper species. Most of entries which were recorded as resistant to one hopper species were found moderately resistant any of the other species which showed there will be cross resistant at one or two hopper insects. This type of resistant mechanisms will be useful in the development of multiple insect pest resistant varieties.

Two landraces *viz*., Kal Valai, Thattan Samba were found to be susceptible to all three hoppers. The entries which were susceptible to brown planthopper in the present study were Aarkadu Kichii, Athira 1, Chinthamani, Earapalli Samba, Jeeraga Samba, Kalyani, Kal Vazhai, Kodavilayan, Kurukat, Red Sirumani, Senkar, Thooyamalli, Vadakathi Samba and Vellai Sithirai Kar. Twenty entries were found to be susceptible to white backed planthopper *viz*., Adukan, Athira 1, Athira 2, Kal Vazhai, Kaliyan Samba, Kattikar, Kattu Ponni, Kerala Kandagasala, Kothandam, Manvilayan, Mapillai Samba, Munda Maranellu, Rama Kuruvaikar, RPHP 59 (Taroari Basmati), Senkar, Taichung, Thattan Samba, Thillainayagam, Thondi and Thooyamalli. The popular landrace in Tamil Nadu, Mapillai Samba which is known for its high nutritive value shows its susceptibility to white backed planthopper and moderately susceptible to brown planthopper. The entries Athira 2, Kal Vazhai, Kattikar, Kayumma, Kudai Vazhai, Kurukat, Matta Kuruvai, Mikuruvai, Mullam Punchan, Raskadam, Sornavari, Thattan Samba, Varakkal, Varisuriyan and Vellai Kudaivazhai were susceptible to green leafhopper with score of 7 to 9.

Timmanagouda *et al.* (2017) also reported that Kerala Kandagasala and Aathira are susceptible to BPH through modified seedbox screening method. Same result was observed in the present study with the score of 9 in standard seedbox screening. Thamarai and Soundararajan (2017) screened few landraces and reported that Vellai Kudaivazhai and Kattu Ponni as moderately resistant whereas Mapillai Samba as moderately susceptible to Coimbatore population of brown planthopper. Similar results were obtained in the present study. Chandrasekar *et al.* (2017) reported that Njavara as a resistant landrace to white backed planthopper. However, in the present study it was found to be moderately susceptible to white backed planthopper and moderately resistant to brown planthopper. Vanaja *et al.*, (2010) mentioned that Uma as a resistant landrace to brown planthopper whereas it was recorded moderately susceptible to brown planthopper but moderately resistant to white backed planthopper and green leafhopper. The variation in the levels of resistance in cultivars may be due to the strain variation or biotype concept. The entries which were found resistant in Coimbatore region may not furnish same results in other regions due to geographical variation in population particularly planthoppers. Bhogadhi *et al.* (2015) screened 27 entries containing landraces and improved lines against BPH biotype 4. Among them entries BM71, ACC5098, ACC2398, MTU1001 and Rathuheenathi showed resistant to BPH biotype 4 with damage scoring 3 in both field and seedbox screening. Ganesh Ram *et al.* (2007) studied the genetic diversity among 35 rice accessions, which included 19 landraces using microsatellite (SSR) markers. They mentioned that Sadai Samba and Sirun Samba having BPH resistant traits and Pattambi 8 having GLH resistant traits. Ali *et al.* (2012) evaluated 1,767 varieties consisting of 1,210 domestic (mostly old indigenous cultivars) varieties. Among this, none of the landraces found to be resistant to brown planthopper. Jayalekshmy *et al.* (2015) screened 50 landraces to identify the resistant source using marker assisted selection. They found that Pallippurampokkali, Karurayima, Athikkiraya and Arikkirai having both *Bph 17* and *Bph 18* resistant genes.

In the present study, out of 74 landraces studied, Karthi Samba and Panamara Samba have shown its resistant to both planthopper species. However, it has moderate resistance to green leafhopper. Palkachaka showed resistance to green leafhopper but moderate resistance to both the planthoppers. Norungan and Maranellu showed moderate resistance to all the three hoppers. The promising entries can be further used for crossing and resistance breeding programmes in rice improvement.

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Table 1. Standard evaluation systems for BPH, WBPH and GLH resistance

Grade	Symptom	Rating
0	No visible damage	Immune
1	Very slight damage	Highly Resistant (HR)
3	First and second leaves of most plants partially yellowing	Resistant (R)
5	Pronounced yellowing and stunting or about half of the plants wilting or dead	Moderately Resistant (MR)
7	More than half the plants wilting or dead and remaining plants severely stunted	Moderately Susceptible (MS)
9	All plants dead	Susceptible (S)

Table 2. Screening of rice landraces for resistance to hopper insects

S. No	Name of landrace	BPH Rating*	Category	WBPH Rating*	Category	GLH Rating*	Category
1.	Aarkadu Kichii	8.33	S	6.33	MS	3	R
2.	Adukan	5	MR	8.33	S	7	MS
3.	Athira 1	8.33	S	9	S	7	MS
4.	Athira 2	5	MR	7.66	S	9	S
5.	Chinna Adukku Nel	7	MS	6.33	MS	7	MS
6.	Chinthamani	9	S	6.33	MS	5	MR
7.	Earapalli Samba	8.33	S	5	MR	3	R
8.	Haladichudi	5	MR	5	MR	7	MS
9.	IR 20 Red	4.33	MR	5	MR	5.66	MS
10.	Jaya	5	MR	6.33	MS	7	MS
11.	Jeeraga Samba	7.66	S	7	MS	7	MS
12.	Kal Vazhai	9	S	9	S	9	S
13.	Kalar Kar	6.33	MS	5	MR	3	R
14.	Kalavai	3	R	6.33	MS	5	MR
15.	Kaliyan Samba	5	MR	7.66	S	5	MR
16.	Kallimadayan	6.33	MS	3	R	5	MR
17.	Kalyani	8.33	S	3	R	7	MS
18.	Karthi Samba	3	R	3	R	6.33	MS
19.	Karungan	5	MR	7	MS	6.33	MS
20.	Karuthakar	7	MS	5	MR	5	MR
21.	Kattikar	5	MR	8.33	S	9	S
22.	Kattu Ponni	4.33	MR	9	S	5	MR
23.	Kayumma	7.66	S	5	MR	9	S
24.	Kerala Kandagasala	9	S	9	S	7	MS
25.	Kodai	5	MR	6.33	MS	7	MS
26.	Kodaikulathan	6.33	MS	5	MR	5	MR
27.	Kodavarai Samba	5.66	MS	5	MR	5	MR
28.	Kodavilayan	7.66	S	3	R	7	MS
29.	Kothandam	5	MR	7.66	S	7	MS
30.	Kudai Vazhai	5	MR	3	R	7.66	S
31.	Kurukat	9	S	5	MR	7.66	S
32.	Kuruvai Kalanjiyan	5.66	MS	6.33	MS	3	R
33.	Malayalathan Samba	7	MS	7	MS	3	R
34.	Mangam Samba	7	MS	6.33	MS	5	MR
35.	Manvilayan	3	R	7.66	S	5	MR
36.	Mapillai Samba	6.33	MS	8.33	S	5	MR
37.	Maranellu	5	MR	5	MR	5	MR
38.	Matta Kuruvai	3	R	5	MR	7.66	S

39.	Mattai Kar	7	MS	5	MR	5	MR
40.	Mikuruvai	5	MR	7	MS	7.66	S
41.	Mullam Punchan	7	MS	7	MS	9	S
42.	Munda Maranellu	6.33	MS	9	S	7	MS
43.	Murugan Kar	4.33	MR	6.33	MS	5	MR
44.	Nootri Pathu	5	MR	6.33	MS	3	R
45.	Norungan	5	MR	5	MR	5	MR
46.	Palkachakka	3.66	MR	5	MR	3	R
47.	Panamara Samba	3	R	3	R	5	MR
48.	Ponmani Samba	7	MS	3	R	4.33	MR
49.	Rama Kuruvaikar	7	MS	7.66	S	5	MR
50.	Raskadam	7	MS	6.33	MS	9	S
51.	Red Sirumani	7.66	S	7	MS	5	MR
52.	RPHP 134 (Njavara)	5	MR	6.33	MS	7	MS
53.	RPHP 59 (Taroari Basmati)	7	MS	8.33	S	7	MS
54.	RPHP 106 (Akut Phou)	4.33	MR	5.66	MS	5	MR
55.	Seevan Samba	7	MS	7	MS	5	MR
56.	Sembala	5.66	MS	5	MR	7	MS
57.	Senkar	8.33	S	9	S	4.33	MR
58.	Shenmolagai	3	R	6.33	MS	5	MR
59.	Sivappu Shithirai Kar	4.33	MR	7	MS	5	MR
60.	Soma Kuruvai	5	MR	4.33	MR	7	MS
61.	Sornavari	3	R	7	MS	7.66	S
62.	Taichung	5	MR	8.33	S	7	MS
63.	Thattan Samba	9	S	9	S	9	S
64.	Thillainayagam	3	R	8.33	S	5	MR
65.	Thogai Samba	5.66	MS	6.33	MS	5	MR
66.	Thondi	3	R	9	S	6.33	MS
67.	Thooyamalli	8.99	S	7.66	S	7	MS
68.	Uma	5.66	MS	5	MR	5	MR
69.	Vadakathi Samba	8.33	S	7	MS	7	MS
70.	Vadivel	5	MR	3	R	6.33	MS
71.	Varakkal	7	MS	5.66	MS	9	S
72.	Varisuriyan	3	R	7	MS	7.66	S
73.	Vellai Kudaivazhai	5	MR	5	MR	7.66	S
74.	Vellai Sithirai Kar	7.66	S	5.66	MS	3	R
	TN-1 (Susceptible check)	9	S	9	S	9	S
	Ptb-33 (Resistant check)	3	R	5	MR	3	R
	MO-1 (Resistant check)	5	MR	3	R	5	MR

* Mean of three replications, SES based scoring method
BPH – Brown planthopper, WBPH – White backed planthopper, GLH – Green leafhopper
R- Resistant; MR – Moderately Resistant; MS- Moderately Susceptible; S- Susceptible

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