Rapid screening of rice genotypes for resistance to brown planthopper, *Nilaparvata lugens* (Stal)

R. P. Soundararajan and P. Jeyaprakash

ISSN: 0975-928X

Volume: 10

Number:1

EJPB (2019) 10(1):76-82

DOI: 10.5958/0975-928X.2019.00009.7

https://ejplantbreeding.org

Electronic Journal of Plant Breeding, 10 (1): 76 – 82 (Mar 2019) DOI: 10.5958/0975-928X.2019.00009.7
ISSN 0975-928X

Research Article

Rapid screening of rice genotypes for resistance to brown planthopper, *Nilaparvata lugens* (Stal)

R. P. Soundararajan[1] and P. Jeyaprakash[2]
[1]Assistant Professor (Agrl. Entomology), Department of Rice, Tamil Nadu Agricultural University, Coimbatore – 641 003, India
[2]Professor and Head, Department of Rice, Tamil Nadu Agricultural University, Coimbatore – 641003, India
E-Mail: sound73insect@gmail.com

(Received: 21 Sep 2018; Revised: 11 Feb 2019; Accepted: 13 Feb 2019)

Abstract
The brown planthopper (BPH), *Nilaparvata lugens* (Stal) is still dominating and considered as an important insect in rice and causes considerable yield losses. Host plant resistance is an effective and environment friendly approach to manage the insect pest and screening is a continuous process to identify the resistant sources. With changing climatic conditions and development of biotypes or strains necessitate quicken the process of screening and identification resistant lines time to time. Standard seed box method has been followed for several years and identifying resistant at seedling stage is important process to initiate further identification of resistant factors and development of varieties. In the present study attempts were made to screen the advanced rice entries in protray and standard seed box methods. The reaction of rice entries to BPH in both methods are discussed. The advantage of protray screening and few limitations in the seed box method are described.

Key words
Rice, Brown planthopper, plant resistance, seed box screening, protray screening

Introduction

Brown planthopper, *N. lugens* (Stal) (BPH) is an important insect associated with rice in all tropical rice growing areas in Asia. It is recognized that BPH still continues a major pest in various rice growing regions of the country (Krishnaiah, 2014). Host plant resistance is an effective and environment friendly approach to manage the insect pest. Screening of rice germplasm at global level and breeding for BPH resistant were initiated during 1970s, and still it is continued (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 concept of natural existence of different strain or population of BPH was visualized. The resistant varieties released became susceptible in few years, due to adaptation of BPH and outbreaks continue to occur. Most of the host plant resistance studies in rice against planthopper came out with the resistance confirmed at seedling stage screening or mass screening methods. Hence, screening should be a continuous process and evaluation of genotypes for resistance to identify resistant source for further breeding programme is inevitable. Most of the mass screening experiment at seedling stage are carried out in the seed box method. In the present study attempts were made to screen the advanced rice entries in seed box as well as protrays. The variation in the reaction of resistant level to BPH in both method as well as few limitations in the seed box screening is discussed.

Materials and Methods

Mass culturing of BPH *Nilaparvata lugens* has been carried out at Entomology glass house, Paddy Breeding Station (PBS), Tamil Nadu Agricultural University (TNAU), Coimbatore. as per standard International Rice Research Institute (IRRI) protocol (Heinrichs *et al.*, 1985). The initial hopper populations were collected from unsprayed rice fields of Coimbatore, Tamil Nadu and maintained separately in susceptible rice variety Taichung Native-1 (TN-1). The nymphs emerged in the second generations were utilized for screening experiment. A set of 55 advanced rice entries were taken for the screening programme during 2017. The entries were subjected to two methods of screening, the regular standard seed box screening test and protray screening test along with resistant (Ptb-33) and susceptible check (TN-1). In standard seed box screening test the test entries 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 test genotypes were sown 3 cm apart in a plastic seed box filled with 5-10 cm depth of pulverized clay soil. Each genotype 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 (Fig.1). In protray screening test, the protrays of 51 x 28cm size were used. The protrays have 10 wells in lengthwise and 5 in widthwise and totally 50 wells with 5.5cm dia. of each well. The protrays are madeup of

polyethylene sheet commonly used for raising vegetable seedlings. Each well of protray is 5 cm in depth and was filled with pulverized clay soil as that of standard seed box method. Each well accommodates 20 seeds and soaked pre-germinated seeds are sown in each well (Fig.2&3). After establishment, it was thinned in to15 seedlings per well and maintained. The resistant and susceptible checks were also included. Seven days after sowing brown planthopper nymphs cultured on TN-1 plants were used to infest the seedlings. The seedlings of both methods were infested with second and third instar nymphs in such a way that approximately 8 to 10 nymphs on each seedling. Damage rating of the test genotypes was done when 90 per cent of the seedlings in the susceptible check or in any test entry started wilting by following standard evaluation system (SES) for rice, 0-9 scale (IRRI, 1980) (Table 1). In protray screening also the same SES scoring system has been followed.

Results and Discussion

The results on screening of different advanced entries showed a variation in resistance level to BPH among the rice genotypes. However, the scores obtained from SSST and PST screening methods indicated almost same score of resistance for the rice genotypes (Table 2). Among the 55 entries screened under SSST method, 25 entries recorded with damage score 9, 19 with score 7 and 11 entries with score 5. None of the entry was recorded under the score 3. The resistant check Ptb 33 only recorded with score 3 and the susceptible TN-1 had the damage score of 9. The entries which shows moderate resistance with score 5 *viz*., CB 14508, ACK 13010, AS 14023, CO 52, TR 13069, TR 13069, TR 13083, TR 09027 (R), PM 14042, CB 14756 and Anna (R) 4. In the protray screening also similar results were obtained for most of the entries. Some of the entries which recorded as score 7 in SSST were noticed with score 9.

In protray screening the entries were succumb to more susceptible to planthopper than the SSST method. However, most of the score 5 recorded rice entries were agreed with the same score in protray also *viz*., CB 14508, ACK 13010, CO 52, TR 09027, TRY (R) 2, PM 14042, CB 14756. The entries AS 14023, TR 13069, TR 13083, Anna (R) 4 which scored grade 5 in the SSST method recorded grade 7 in the protray screening. It reveals that the susceptible entries become easily wilted in the protray screening method. In SSST method, the seedlings are raised in rows and each row is having different entries. The insects have to spend time to select suitable susceptible plants. But in case of protray the seedlings of each entry is in group so the insect will quickly move from one susceptible plant to other plants within the genotypes and also disperse from resistant genotype to susceptible. Movement of BPH nymphs in circular passion is evident in field condition and hopper burn symptoms are always express in circular patches in the infected fields. Hence, the susceptible entries are wilted quickly in the protray screening method. Horgan (2009) revealed when cultivars have different levels of resistance the nymphs disperse between plants and the degree of movement (activity) being negatively correlated with feeding. Although movement between plants may appear to stimulate field responses, it is largely governed by push-pull dynamics in the experimental seed boxes. He further indicated key four behavioural options of BPH that determine levels of field infestation that are never considered when using SSST method. These behavioural characters are alight on host plant after host plant is located, the option to probe or disperse locally, option to disperse and option to disperse for oviposition following feeding. Hence, prescreening and cultivar selection using SSST method may cause overall bias towards feeding related mechanisms. Though portray screening method is not satisfied all the mentioned option, the dispersal and settling will be good as that field condition. Since, each genotype is sown in one group, the dispersed nymphs can settle in the susceptible plants quickly. In the present study, the entries AS 14023, TR 13069, TR 13083, Anna (R) 4 which scored grade 5 in the SSST method recorded grade 7 in the protray screening. In indicates that the entries are more towards susceptibility. This method can eliminate the entries which are having susceptible nature. Generally, in preliminary screening exclusion of susceptible materials is important to narrow down the diverse genetic stocks to probe further phenotypic and genotypic screening.

The long standing seed box method has few limitations in their practical utility when dealing with bulk of screening materials. It is comparatively more labourious with the use of conventional or plastic trays. Handling after filled with clay soil and transferring to zinc trays with water is difficult process. Individually each entry has to be sown after marking lines in the smoothened clay soil in seed box method. Whereas in protrays the pregerminated seeds can be sown in each well after filling moistened clay soil. It can be easily handled for transfer to zinc trays after 2-3 days to keep in water. In protray screening, at one time 50 entries can be screened. In SSST method usually around 15 cultivars can be tested in each time using 60x40x10cm seed box (Horgan, 2009). In conventional wooden seed boxes designated by IRRI (Heinrichs *et al.,* 1983), 36 entries can be

screened at one time, but the cost for fabrication of wooden boxes is high and intricate in handling.

The protray screening method can be used for screening of bulk of F2 - F5 segregating population in the breeding programme. After the first stage, the identified promising entries can be screened in advanced seedling stage screening as per Velusamy *et al.* (1986) by modified seed box screening test (MSST). The level of resistance may increases or decreases when the plant age increases. Differences in the reaction of genotypes in the two methods were demonstrated earlier. ADT-36 and Mapillai Samba showed moderately susceptible at SSST but observed as moderately resistant at MSST method (Thamarai and Soundararajan, 2017). After selection of resistant material at seedling stage they can subjected to adult plant screening like mechanisms of resistance (Heinrichs *et al.,* 1985; Soundararajan *et al.,* 2004), days to wilt (Kadirvel *et al.,* 2007) and tolerance parameters (Panda and Heinrichs, 1983; Soundararajan *et al.,* 2017) to identify individual component of resistance.

When comparing both the standard seed box and protray methods, there are few advantages in protray screening method. Protrays of 50 well can be used to screen 48 entries at one time along with one resistant and susceptible check. More over the seeds are arranged and sown in circular passion, the insect movement within susceptible plants becomes easy and hopper burn symptoms can be evident quickly as usually seen in field hopper burn symptoms develop in circular passion. The practical advantage for the protray method is ease of handling. In the standard seed box the trays are filled with clay soil and after watering it become still heavier, become difficult for shifting in to bigger trays for placing in submersible condition. In protrays the pulverized soil can be filled in the wells and it is lighter in weight compared to standard seed box for ease in shifting. While scoring the entries in protray method seedlings in each well has to be carefully observed for its drying of development of symptoms. In standard seed box, the scoring can be done on row basis whereas in protray method scoring can be done in well or individual pit basis. The present study indicates both the methods provide almost same results on scoring of entries. The study suggests a rapid and quick mass screening method by following the same standard evaluation system (SES) for identifying resistance in rice at seedling stage against brown planthopper.

Acknowledgement
The authors thankfully acknowledge the scientists Dr.M.Maheswaran and Dr.S.Robin Professors of Plant Breeding and Genetics, Tamil Nadu Agricultural University, Coimbatore for their encouragement to take up the study and providing base idea for developing an alternate method.

References

Bentur, J S, Padmakumari, A.S., Lakshmi, V.G., Padmavathi, Ch., Kondala, Y.R., Amudhan, S. and Pasalu, I.C. 2011. Insect Resistance in Rice. Technical Bulletin, Directorate of Rice Research, Hyderabad, India, 51p.

Glass, E.H. 1975. Integrated Pest Management: Rationale, Potential, needs and Important. E.S.A. Special publ., 75(2):141.

Heinrichs, E.A., Medrano, F.G. and Rapusas, H.R. 1985. Genetic Evaluation for Insect Resistance in Rice. International Rice Research Institute, Los Banos, Philippines, 356p.

Horgan, F. 2009. Mechanisms of Resistance: A Major gap in understanding planthopper-rice interactions. In: *Planthoppers: New Threats to the Sustainability of Intensive Rice Production Systems in Asia*. K.L.Heong and B. Hardy (Eds.), International Rice Research Institute, Los Banos, pp. 281-302.

IRRI 1980. Standard Evaluation system for rice. International Rice Research Institute. Los Banos, Philippines, 44p.

Panda, N and Heinrichs, E.A. 1983. Levels of tolerance and antibiosis in rice varieties having moderate resistance to the brown planthopper, *Nilaparvata lugens* (Stal) (Hemiptera: Delphacidae). *Environmental Entomology* **12**:1204-1214.

Krishnaiah, N.V. 2014. A Global Perspective of Rice Brown Planthopper Management, I- Crop-Climatic Requirement. *Int. J. Molecular Zoology*, **4(2):** 9-18.

Kadirvel, P., Maheswaran, M., Soundararajan, R.P. and Gunathilagaraj, K. 2007. A new phenotypic screen to map quantitative trait loci associated with rice tolerance for planthoppers. *International Rice Research Notes* **32.2:** 28-30

Soundararajan, R.P., Kadirvel, P., Gunathilagaraj, K. and Maheswaran, M. 2004. Mapping of quantitative trait loci associated with resistance to brown planthopper in rice by means of a double haploid population. *Crop Science* **44**: 2214-2220.

Soundararajan, R.P., Thamarai, M., Chandrasekar, K. and Jhansi Lakshmi, L. 2017. Tolerance mechanisms of resistance in selected rice genotypes against brown planthopper, *Nilaparvata lugens* (Stal.). *Journal of Rice Research* **10(2):** 66-69.

Thamarai, M. and Soundararajan, R.P. 2017. Reaction of rice genotypes against specific population of brown planthopper, *Nilaparvata lugens* (Stal). *Annals of Plants Protection sciences* **25(1):** 74-77.

Velusamy, R., Rajendran, R. and Sundarababu,P.C. 1986. Resistance of IR varieties to leafhoppers and planthoppers. *Int. Rice Res.Newsl.* **11**: 6.

Table 1. Standard evaluation systems for BPH resistance

Grade	Symptoms
0	No visible damage
1	Very slight damage
3	First and second leaves with yellow orange tips, slight stunting
5	More than half of the leaves with orange tips and pronounced stunting
7	More than half of the plants dead and remaining plants severely stunted and wilted
9	All plants dead

Table 2. Comparison of standard seed box and protray screening methods for BPH resistance

S.No.	Entries	Damage score*	
		SSST	PST
1	AD (Bio) 13060	9	9
2	CB 13529	9	9
3	AS 14017	7	7
4	TPS 5	7	7
5	ACK 14001	7	9
6	AD 14098	9	9
7	CB 14508	5	5
8	AD 13036	9	9
9	CO 51	7	7
10	CB 14536	9	9
11	AS 13355	7	7
12	ACK 14004	9	9
13	TNRH 285	9	9
14	AD (Bio) 13066	9	9
15	ADT 39	9	9
16	AD 12286	7	9
17	ACK 12021	9	9
18	AS 14032	9	9
19	TKM 13	9	9
20	CB 14811	7	9
21	ACK 13010	5	5
22	AS 14023	5	7
23	CB 14502	7	7
24	CO 52	5	5
25	CB 12132(R)	9	9
26	CB 13132	9	9
27	CORH 4	7	9
28	CB 13168		9
29	ADT 49	9	9
30	AD 12161	7	7
31	AD 13299	9	9
32	TNRH 273	9	9
33	CO (R) 50	9	9
34	AD 12184	9	9
35	AD 13121	7	9
36	ADT 50	7	9
37	AD 13125(R)	9	9
38	CR 1009Sub 1	7	9
39	AD 14175	7	7
40	AD 14142	7	9
41	TR 13069	5	7
42	TR 13083	5	7
43	TR 09027(R)	5	5
44	TRY (R) 2	5	5
45	PM 14042	5	5
46	CB 14756	5	5
47	Anna (R) 4	5	7
48	TM 13018	7	9
49	CB 14530	7	7
50	TM 12077(R)	7	9
51	IR 64 dt QTL	9	9
52	TM 12039	9	9
53	CB13084	9	9
54	TKM (R) 12	9	9
55	CB13805	7	7
	TN 1	9	9
	Ptb 33	3	3

* Standard Evaluation System of scoring the damage
SSST - Standard seed box screening test, PST - Protray screening test

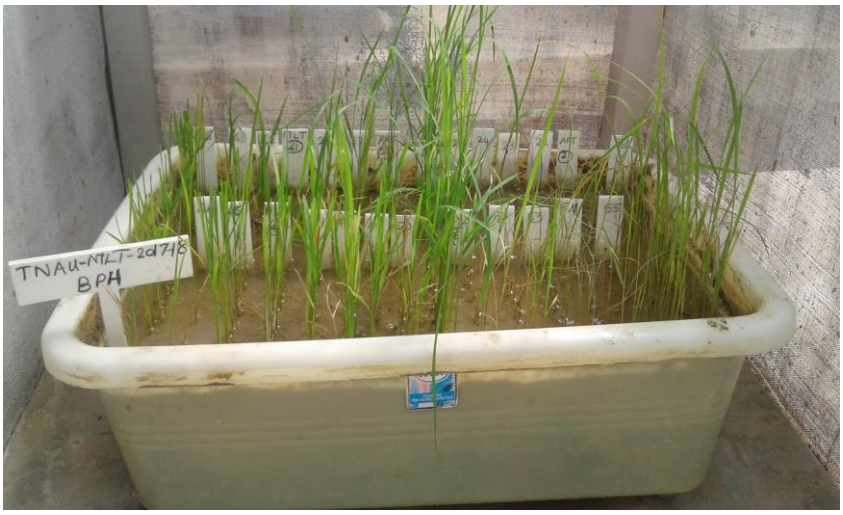
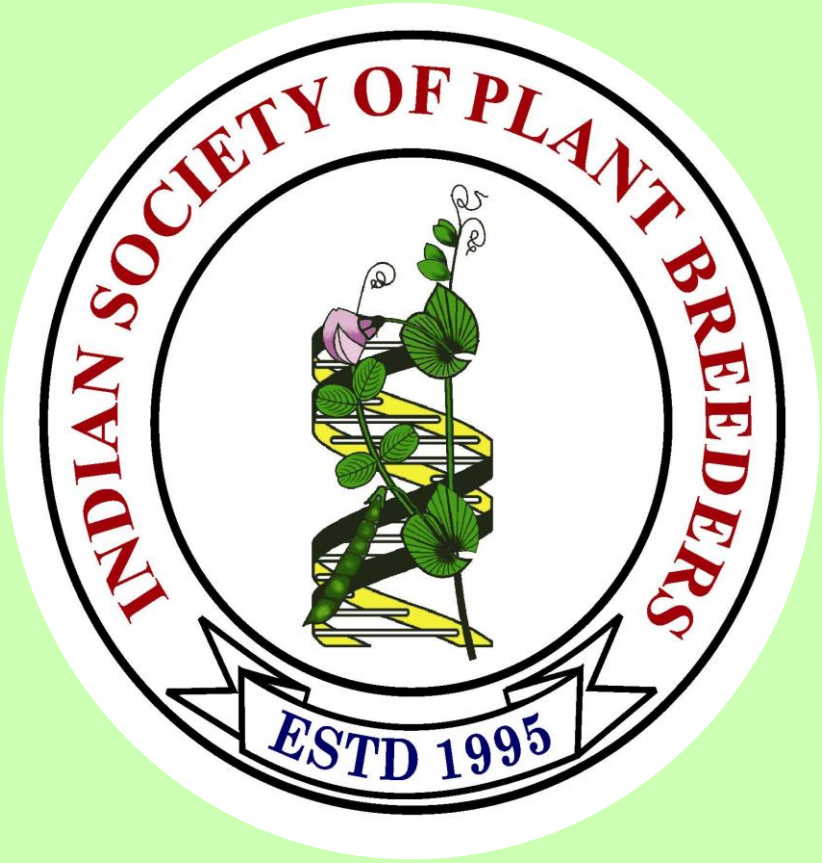


Fig. 1. Standard seed box screening

Fig. 2. Protray screening

Fig. 3. Damage symptom expression in protray screening



https://ejplantbreeding.org