

Phenotypic Screening of Rice cultures for resistance against Brown Plant Hopper, *Nilaparvatalugens* (Stal) at Warangal

Abstract

Brown planthopper (BPH), *Nilaparvatalugens* Stal (Homoptera: Delphacidae), is one of the most destructive insect pests causing significant yield losses in rice production. During Kharif, 2021, a set of 91 entries of rice cultures were screened against brown plant hopper (BPH) through the standard seed box technique in the screen house at the Regional Agricultural Research Station, Warangal. ~~Among these entries, 8 entries viz., RPGP-1066-36-12-1-2 (DS 0.20), WS-18-OYT-72/BPH (DS 0.82), RPGP-1386-3-1-1-1 (DS 2.08), BPT 3025 (DS 3.46), RPGP-1011-100-56-1-4-1 (DS 3.64), RPGP-2212-8-1-2-2 (DS 3.30), KNM 12505 (DS 4.92) and WS-18-AYT-10/BPH (DS 5) were found promising against brown plant hopper.~~ Results showed that the rResistant checks RP 2068-18-3-5 recorded Damage Score (DS) of <3, Mo-1 recorded DS of 3.67, PTB 33 recorded DS of 3.29. Mean damage score was 8.94 in the susceptible check, rice variety Taichung Native 1 (TN-1) against BPH. The two 2-entries viz., RPGP-1066-36-12-1-2 (DS) and WS-18-OYT-72/BPH (DS) were found to be highly resistant to BPH. RPGP-1386-3-1-1-1 (DS) was found to be resistant to BPH. Five 5 entries viz., BPT 3025, RPGP-1011-100-56-1-4-1, RPGP-2212-8-1-2-2, KNM 12505 and WS-18-AYT-10/BPH were found to be moderately resistant to BPH. Cultivation of resistant cultures will reduce the cost of plant protection against BPH in addition to protection of natural enemies and environment. The rice cultures exhibiting resistance against BPH may be helpful in crossing programmes to develop the BPH-resistant varieties which shall be used in IPM as a component.

Key words: BPH(write in full), Rice cultures, BPH (write in full, Screening, Seed box technique, Resistance

Introduction: (numbering of references in the text is abitconfusing, why begin reference with [9].. then [11].. [4] [21, [17].etc? kindly refer to the journal instructions

Rice (*Oryzasativa* L.) is a prominent staple food crop for more than 50% of the world population and it accounts for more than 50% of the daily calorie intake of the population [9]. Among the biotic limiting factors, insect pests and diseases are the key biotic stress factors ~~that and~~ limit rice production significantly. Among the serious insect pests of rice, brown planthopper (BPH), *Nilaparvatalugens* Stal (Homoptera: Delphacidae), is one of the most destructive insect pests causing significant yield losses [11]. These insects draw nutrients from the phloem of rice plants. High BPH populations can destroy a plant in a short period of time [4] [21]. BPH can consume more than 28% of the total dry matter of rice plants infested at reproductive stage [17]. Many chemical insecticides are registered to control rice BPH, but unscientific and injudicious use of these insecticides may break the natural pest-defender ratio in the field [15] [14]. Host-plant resistance is an important factor in developing an integrated pest management system in low-input farming conditions, especially in India [11]. Development of resistant rice cultivars through host plant resistance

is generally considered to be the most economic and effective way for controlling BPH damage. ~~Therefore Hence, this study was taken up with an the~~ objective of ~~this study was to~~ identify ~~yeation of~~ promising resistant rice cultures against rice BPH.

Materials and Methods:

This study was conducted in ~~the~~ screen house during *Kharif* 2021 at ~~the~~ Regional Agricultural Research Station (RARS), Warangal.

Mass rearing of BPH:

Initial BPH population was collected from the rice fields of farmers in Warangal district. The BPH was mass reared on the susceptible rice variety Taichung Native 1 (TN1) [3]. The gravid females were collected with an aspirator and left on pre-cleaned 35 days old potted plants of TN1, placed in oviposition cages (45 x 45 x 60 cm) having wooden frames, glass top, door and wire mesh side walls. Twenty females along with five males were released per plant. The ovipositing insects were removed three days later and plants with eggs were taken out of cages and placed in separated cages for the nymphs to emerge. The emerged nymphs were then transferred to 15 days old TN1 seedlings raised in the germination trays. The seedling trays were changed as and when necessary. Using this technique, a continuous pure culture of the BPH was maintained.

Standard Seed Box Technique:

~~Soaked Twenty (20) healthy seeds of each of the test entries-entries were soaked in~~ separate petridishes and ~~removed the~~ water ~~was removed~~ after one day. The seeds were sprouted within 2 days and ~~water was~~ sprinkled ~~water~~ on the germinated seeds to prevent drying. ~~Took S~~ seed boxes (plastic trays or wooden boxes ~~of your choice~~) of size 50 x 40 x 7 cm ~~were and filled the box~~ with fertilizer enriched puddled soil. ~~Drawn Thirteen (13) lines~~ ~~lines were drawn~~ at equal distance in the seed box width wise leaving 4 cm gap at both the margins. ~~Drawn Two (2) lines~~ ~~were drawn~~ with 5 cm space across these lines in the center of the box lengthwise cutting all the horizontally drawn lines. ~~Sown T~~ thirty sprouted seeds of susceptible check TN1 ~~were sown~~ in the two border rows/~~lines~~. In the middle row ~~sow~~ 30 sprouted seeds of resistant check PTB 33 ~~were sown~~. In the remaining 20 lines (each line only ½ the width of the box), ~~sow~~ the test ~~entries-entries were sown~~ with 15 sprouted seeds in each line. ~~Covered T~~ the boxes ~~were covered~~ so as to enhance seedling growth. When the seedlings were 8-10 days old with 2-3 leaves, ~~released~~ 1st or 2nd instar hopper nymphs ~~were released~~ in the screening trays so that each seedling had ~~s~~ 6-8 nymphs.

Comment [DN1]: Which type of boxes, were they plastic or wooden?, specify the exact type used

The infested seedlings were monitored until the susceptible check (TN1) seedlings showed 90 per cent mortality. When more than 90% of the plants of the susceptible check, TN1 were killed, scoring for the damage of the entries was done based on the 0-9 scale using Standard Evaluation System (SES) developed by the International Rice Research Institute (IRRI, 2014) [5] as detailed in Table 1. Scoring was done on individual plant basis. The scores of all the plants in a test line were averaged and then reported as the damage score.

Table 1: Criteria for BPH damage score

Damage Score	Plant state
0	None of the leaves yellow or dried
1	One bottom leaf yellow
3	One or two leaves yellow or one leaf dried
5	One or two leaves dried or one leaf healthy
7	All leaves dried/ yellow but stem green
9	Plant dead

After scoring as per the Standard Evaluation System (SES) the SSST entries were categorized as described in the Table 2 [6].

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Table 2: Categorization of levels of resistance based on damage score

S.No.	Reaction	Damage Score Range
0	Highly Resistant	0-<1.0
1	Resistant (R)	1.0-3.0
2	Moderately Resistant (MR)	3.1-5.0
3	Moderately Susceptible (MS)	5.1-7.0
4	Susceptible (S)	7.1-8.9
5	Highly Susceptible (HS)	9.0

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Results and Discussion:

During *Kharif*, 2021, a set of 91 entries were screened against brown plant hopper (BPH) through standard seed box technique in screen house. Among these 91 entries, 8 entries including viz., RPGP-1066-36-12-1-2 (DS 0.20), WS-18-OYT-72/BPH (DS 0.82), RPGP-1386-3-1-1-1 (DS 2.08), BPT 3025 (DS 3.46), RPGP-1011-100-56-1-4-1 (DS 3.64), RPGP-2212-8-1-2-2 (DS 3.30), KNM 12505 (DS 4.92) and WS-18-AYT-10/BPH (DS 5) were found promising against brown plant hopper (Table 3). Resistant checks RP 2068-18-3-5 recorded Damage Score (DS) of <3, Mo-1 recorded DS of 3.67, PTB 33 recorded DS of 3.29. Mean damage score was 8.94 in TN-1 against BPH. Two test entries namely viz., RPGP-1066-36-12-1-2 and WS-18-OYT-72/BPH were found to be highly resistant to BPH (Table 4). RPGP-1386-3-1-1-1 was found to be resistant to BPH. Five entries namely viz., BPT 3025, RPGP-1011-100-56-1-4-1, RPGP-2212-8-1-2-2, KNM 12505 and WS-18-AYT-10/BPH were found to be moderately resistant to BPH.

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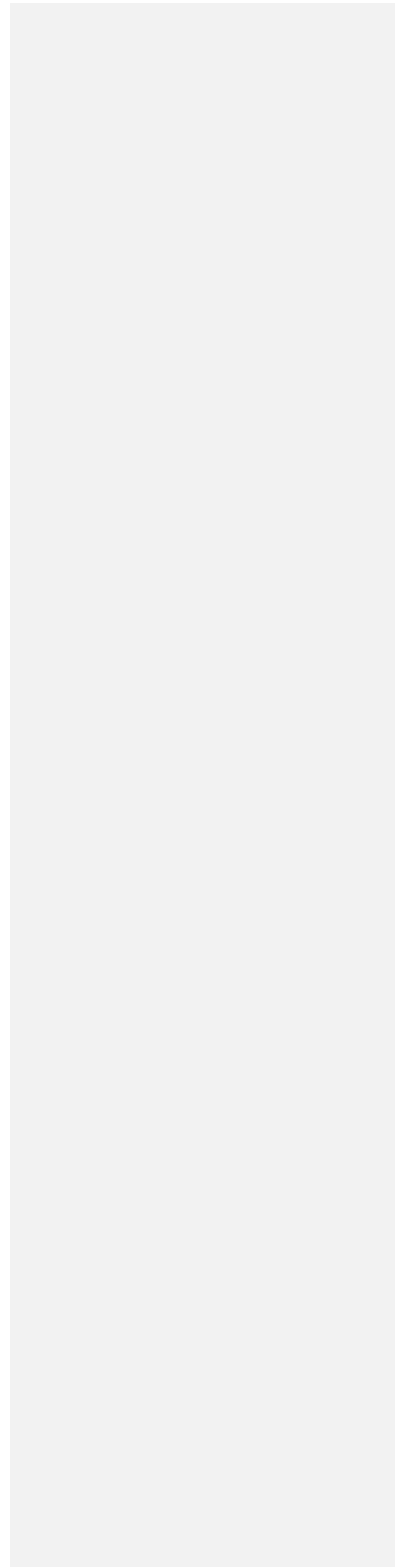


Table 3: Damage score of the 91 Screening of certain entries of the rice cultures due to againstBPHin Rice at the Regional Agricultural Research Station (RARS), Warangal (Standard Seed box Technique)

S.No.	Designation	Average Damage Score	S.No.	Designation	Average Damage Score
1	BPT 3025	3.46	47	KNM 7660	7.09
2	CB 18 156	5.15	48	KNM 10081	5.27
3	CB 17 135	8.67	49	KNM 12367	8.88
4	CB 18 107	8.23	50	KNM 12368	8.88
5	CB 16 217	8.27	51	KNM 12392	9.00
6	CB 16 660	6.50	52	KNM 12423	9.00
7	CB 16 618	8.67	53	KNM 12424	9.00
8	CB 16 580	5.54	54	KNM 12510	8.86
9	CB 16 566	9.00	55	KNM 12511	9.00
10	CB 16 605	8.60	56	KNM 11532	7.33
11	CB 16 656	9.00	57	KNM 11551	8.07
12	HWR-1-IR83784-5-28-B	9.00	58	KNM 11555	7.71
13	HWR-8-IR 54751-1-2-44-15-2-3-B	7.13	59	KNM 12504	8.54
14	HWR-15-IR 75870-5-8-5-B-5-B	9.00	60	KNM 12505	4.92
15	HWR-16-IR73382-80-9-3-13-2-2-1-3-B	8.33	61	KNM 12509	6.77
16	IBT-BPH 1	8.87	62	PTB 21	9.00
17	IBT-BPHM11	8.14	63	RDR-1199	9.00
18	IBT-BPHM12	9.00	64	RDR-1200	8.60
19	IBT-BPHM13	7.38	65	WGL 1533	8.18
20	IBT-BPHM15	9.00	66	RP 2068-18-3-5	0.16
21	IBT-BPHM16	9.00	67	WGL 1537	9.00
22	IBT-BPHM17	7.00	68	WGL 1543	9.00
23	IBT-BPHM19	8.60	69	WGL 1551	9.00
24	IBT-BPHM20	7.61	70	WGL 1557	9.00
25	IBT-BPHM23	8.23	71	WGL 1571	9.00
26	JGL 35076	9.00	72	WGL 1588	9.00
27	JGL 35085	6.08	73	WGL 1620	9.00
28	JGL 35158	2.60	74	WGL 1622	9.00
29	JGL 37180	6.27	75	WGL 1623	9.00
30	JGL 37216	7.73	76	WGL 1624	9.00
31	RP2068-18-3-5	0.43	77	WGL 1289	9.00
32	JGL 36175	9.00	78	WGL 1246	9.00
33	JGL 37088	8.54	79	RPGP-984-4-5-1-1-1-1	5.73
34	JGL 38021	9.00	80	RPGP-1066-36-12-1-2	0.20
35	JGL 38053	7.46	81	RPGP-1011-100-56-1-4-1	3.64
36	JGL 38067	8.20			
37	JGL 38071	9.00	82	RPGP-2022-412-21-3-2	5.40
38	JGL 38105	8.33	83	RPGP-2212-8-1-2-2	3.30
39	JGL 38125	8.00	84	RPGP-1386-3-1-1-1	2.08
40	JGL 38156	9.00	85	WS-18-AYT-10/BPH	5.00
41	JGL 38162	6.43	86	RMS-ISM-BpH33-24	9.00
42	JGL 38168	7.92	87	WS-18-OYT-72/BPH	0.82
43	JGL 38206	7.82	88	PTB33	3.29
44	JGL 38237	8.62	89	RP2068-18-3-5	2.10
45	JGL 38159	9.00	90	MO1	3.67
46	JGL 38190	7.10	91	ISM recurrent parent	9.00

#Average of damage score of 356 seedlings in standard seed box test

In the table show the resistant check, and the susceptible check to make it easy for a reader to see them.

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Table4: Reaction of Rice Cultures against BPH at RARS, Warangal in Standard Seed Box Technique (change table to the standard system of drawing table, as I have done in table 1.2, and 3)

S.No.	Designation	Reaction to BPH	S.No.	Designation	Reaction to BPH
1	BPT 3025	MR	47	KNM 7660	S
2	CB 18 156	MS	48	KNM 10081	MS
3	CB 17 135	S	49	KNM 12367	S
4	CB 18 107	S	50	KNM 12368	S
5	CB 16 217	S	51	KNM 12392	HS
6	CB 16 660	MS	52	KNM 12423	HS
7	CB 16 618	S	53	KNM 12424	HS
8	CB 16 580	MS	54	KNM 12510	S
9	CB 16 566	HS	55	KNM 12511	HS
10	CB 16 605	S	56	KNM 11532	S
11	CB 16 656	HS	57	KNM 11551	S
12	HWR-1-IR83784-5-28-B	HS	58	KNM 11555	S
13	HWR-8-IR 54751-1-2-44-15-2-3-B	S	59	KNM 12504	S
14	HWR-15-IR 75870-5-8-5-B-5-B	HS	60	KNM 12505	MR
15	HWR-16-IR73382-80-9-3-13-2-2-1-3-B	S	61	KNM 12509	MS
16	IBT-BPH 1	S	62	PTB 21	HS
17	IBT-BPHM11	S	63	RDR-1199	HS
18	IBT-BPHM12	HS	64	RDR-1200	S
19	IBT-BPHM13	S	65	WGL 1533	S
20	IBT-BPHM15	HS	66	RP 2068-18-3-5	HR
21	IBT-BPHM16	HS	67	WGL 1537	HS
22	IBT-BPHM17	MS	68	WGL 1543	HS
23	IBT-BPHM19	S	69	WGL 1551	HS
24	IBT-BPHM20	S	70	WGL 1557	HS
25	IBT-BPHM23	S	71	WGL 1571	HS
26	JGL 35076	HS	72	WGL 1588	HS
27	JGL 35085	MS	73	WGL 1620	HS
28	JGL 35158	R	74	WGL 1622	HS
29	JGL 37180	MS	75	WGL 1623	HS
30	JGL 37216	S	76	WGL 1624	HS
31	RP2068-18-3-5	HR	77	WGL 1289	HS
32	JGL 36175	HS	78	WGL 1246	HS
33	JGL 37088	S	79	RPGP-984-4-5-1-1-1-1	MS
34	JGL 38021	HS	80	RPGP-1066-36-12-1-2	HR
35	JGL 38053	S	81	RPGP-1011-100-56-1-4-1	MR

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36	JGL 38067	S	82	RPGP-2022-412-21-3-2	MS
37	JGL 38071	HS	83	RPGP-2212-8-1-2-2	MR
38	JGL 38105	S	84	RPGP-1386-3-1-1-1	R
39	JGL 38125	S	85	WS-18-AYT-10/BPH	MR
40	JGL 38156	HS	86	RMS-ISM-BpH33-24	HS
41	JGL 38162	MS	87	WS-18-OYT-72/BPH	HR
42	JGL 38168	S	88	PTB33	MR
43	JGL 38206	S	89	RP2068-18-3-5	R
44	JGL 38237	S	90	MO1	MR
45	JGL 38159	HS	91	ISM recurrent parent	HS
46	JGL 38190	S		TN-1	HS

HR- Highly Resistant, R- Resistant, MR- Moderately Resistant, MS- Moderately Susceptible, S- Susceptible, MS- Moderately Susceptible, HS- Highly Susceptible

Previously several scientists have reported PTB-33 as resistant to BPH which is being currently used as a resistant check in the screening studies [12] [6][7][1][16][19]. Udayasreeet *al.*, (2018) [20] reported that, of 39 promising rice genotypes screened, 17 genotypes were moderately resistant with damage score ranging between 3.6 -5.0 and among 17 genotypes, KNM 2305 and RNR 21571 recorded lowest damage score of 3.6.

Comment [DN3]: Citation should be as a number in brackets

Similar to our findings, Soundararajanet *al.*,(2004) [18] also recorded significantly low BPH population on PTB-33 followed by IR 64 and it was high in TN1. Jena et al. (2015)[8] reported that, of the 58 rice genotypes including 39 landraces from Odisha phenotyped against BPH population, 9 were highly resistant (HR), 9 as resistant (R) and 7 as moderately resistant (MR).

Comment [DN4]: This citation should be a number in the brackets, only

Comment [DN5]: This should be a reference number in brackets only

Deekshita et al. (2017)[2]evaluated 28 paddy advanced cultures for resistance against BPH and reported that 4 cultures viz., BPT 2789, BPT 2703, BPT 2787 and BPT 2688 were resistant with a damage score of 3.00 while remaining 24 genotypes viz., BPT2702, BPT 2717, BPT 2719, BPT 2741, BPT 2766, BPT 2768, BPT 2769, BPT 2678, BPT 2677, BPT 2680, BPT 2780, BPT 2781, BPT 2782, BPT 2783, BPT 2784, BPT 2786, BPT 2788, BPT 2790, BPT 2791, BPT 2793, BPT 2795, BPT 2796, BPT 2797 and BPT 2798 were found to be moderately resistant with a damage score of 5.00.

Comment [DN6]: In the test, citation should only be a number in brackets

Prathima et al., (2022) [12] reported that, out of 45 rice genotypes screened, 12 genotypes had shown resistance reaction under both field and green house conditions to BPH. 3 genotypes viz., Siddhi-BC2F6 BPH BL-43, Siddhi-BC2F6 BPH BL- 30 andSiddhi-BC2F6 BPH BL-64 were resistant; 9 genotypes viz., Siddhi-BC2F6 BPH BL -11, SiddhiBC2F6 BPH BL-12, Siddhi-BC2F6 BPH BL-19, SiddhiBC2F6 BPH BL-24, Siddhi-BC2F6 BPH BL-52, SiddhiBC2F6 BPH BL-56, Siddhi-BC2F6 BPH BL-57, SiddhiBC2F6 BPH BL-60 and Siddhi-BC2F6 BPH BL-61were moderately resistant.

Comment [DN7]: Citation should only be a number in brackets

Host plant resistance has an ability to reduce BPH and it is a good and best alternative method for use of chemical insecticides. In this study reaction of rice cultures against BPH is revealed to us and the resistant cultures may be grown in BPH endemic areas. Further the highly resistant and resistant genotypes can be utilized in the rice breeding programmes to develop resistant varieties with high yield and other suitable traits. Cultivation of resistant cultures will reduce the cost of plant protection against BPH in addition to protection of natural enemies and environment. Molecular confirmation or confirmation through biochemical analysis would further enable us for using these resistant cultures as donor parents in crossing programmes for development of resistant rice varieties.

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CONCLUSION:

Out of 91 entries screened against brown plant hopper (BPH) through standard seed box technique in screen house, Among these entries, 8 entries including viz., RPGP-1066-36-12-1-2 (DS 0.20), WS-18-OYT-72/BPH (DS 0.82), RPGP-1386-3-1-1-1 (DS 2.08), BPT 3025 (DS 3.46), RPGP-1011-100-56-1-4-1 (DS 3.64), RPGP-2212-8-1-2-2 (DS 3.30), KNM 12505 (DS 4.92) and WS-18-AYT-10/BPH (DS 5) were found promising against brown plant hopper. Resistant checks RP 2068-18-3-5 recorded Damage Score (DS) of <3, Mo-1 recorded DS of 3.67, PTB 33 recorded DS of 3.29. Mean damage score was 8.94 in TN-1 against BPH. Two he 2 entries namely viz., RPGP-1066-36-12-1-2 and WS-18-OYT-72/BPH were found to be highly resistant to BPH. RPGP-1386-3-1-1-1 was found to be resistant to BPH. Five 5 entries namely viz., BPT 3025, RPGP-1011-100-56-1-4-1, RPGP-2212-8-1-2-2, KNM 12505 and WS-18-AYT-10/BPH were found to be moderately resistant to BPH. Since most of the cultivated ing rice varieties are susceptible to BPH, identification of BPH resistant rice cultures will be very useful in development of BPH resistant rice varieties.

REFERENCES: (these references need to be presented in the order they appear in the text, going back to the text in the introduction, the first reference was shown as [9]. not as [11]. the next reference should be [2].. but the author showed [11].. then followed by [4] [21, [17

Author is advised to revisit the number ordering of reference starting in the introduction (refer to the Journal guidelines in writing references in the text and listing references, Pay attention to how the references should be written: For example author uses abbreviation for some journals (r.g Theor. Appl. Genet, Plant Mol. Biol.) and in others author write full form of the journal (e.e International Journal of Innovative and Applied Research). Author advised to be consistent , following the journal guidelines.

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