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Field Reaction of Certain Rice Cultures Against Brown Planthopper (BPH), *Nilaparvata lugens* Stal°

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ABSTRACT

Eighteen medium and ten long duration rice cultures along with resistant check, Ptb 33 and susceptible check, TN1 were mass screened both under greenhouse and field conditions for their reaction against brown planthopper (BPH), *Nilaparvata lugens* Stal° at Andhra Pradesh Rice Research Institute and Regional Agricultural Research Institute, Maruteru, West Godavari district, Andhra Pradesh during the period 2010 to 2011. The differential reaction of rice cultures to brown planthopper indicated that fourteen rice cultures from greenhouse and thirteen rice cultures from field studies were found to be resistant to BPH. Among the resistant rice cultures, BM 71 and the resistant check, Ptb 33 was highly resistant with a damage score of '1'. The rice cultures *viz.,* M 401 and L 406 with a damage score of '3' categorized as resistant and the rice cultures *viz.,* L 407 (damage score 3.3), M 406 (damage score 3.67), M 404 (damage score 4.0), M 391 (damage score 4.33), M damage score 405 (damage score 4.34), L 405 (damage score 4.34) M 392 (damage score 4.67), L 400 (damage score 4.67), and L 403 (damage score 5.0) with a damage score in between 3.0 to 5.0 have been designated as moderately resistant.

Key words : *Nilaparvata lugens* (BPH), Rice, Screening

Rice (*Oryza sativa* L.) is an important staple food crop for more than half of the world population and accounts for more than 50% of the daily calorie intake (Khush, 2005). Increasing production of rice is an important requirement to meet the needs of ever increasing population in India. Insect pests and diseases remain the key biotic stresses limiting rice production significantly. Among the serious insect pests of rice, brown planthopper (BPH), *Nilaparvata lugens* Stal° (Homoptera: Delphacidae), is one of the most destructive insect pests causing significant yield losses (Park *et al*., 2008). It is a rice specific herbivore damaging the plants by sucking assimilates from the phloem resulting in a condition called "hopper burn" and transmits virus diseases like grassy stunt, ragged stunt and wilted stunt (Sogawa, 1982). In recent years major out breaks of BPH were recorded in several rice growing countries like China, Korea, Japan, India, Indonesia, Malaysia, the Philippines, Thailand and Vietnam (Heong and Hardy, 2009). The most commonly used method for controlling BPH is the use of insecticides. However, the improper and consistent large scale use of these insecticides causes; first resurgence of the BPH and secondly insects developed resistance against insecticides (Tanaka *et al*., 2000; Lakshmi *et al*., 2010) and thus aggravating the BPH problem. One method to minimize insect damage is the use of resistant varieties. These resistant varieties can be either used as principal method of insect control or can be integrated with other methods to manage this pest in an integrated pest management programme (IPM). Several resistant varieties have been developed and grown in different parts of India (Pasalu *et al*., 2004). Continuous cultivation of resistant varieties particularly with vertical resistance results either in break down of resistance or development of biotypes. Therefore, there is recurring need to identify developed rice varieties with BPH resistance through proper screening against this pest. Hence, the present study was taken up with an objective to identify resistant rice cultures from the advanced rice cultures developed at different rice research stations of Acharya N. G. Ranga Agricultural University.

MATERIAL AND METHODS

The present investigations were carried out in the greenhouse and field conditions at Andhra Pradesh Rice Research Institute and Regional Agricultural Research Institute, Maruteru, West Godavari district, Andhra Pradesh during the period 2010 to 2011. The advanced rice cultures developed at different rice research stations of Acharya N. G. Ranga Agricultural University (Table 1) was screened initially in laboratory and later screened in field against BPH to identify resistant cultures as per the standard methods (Heinrichs *et al*., 1985).

Mass culturing of BPH

To obtain different instar nymphs and adults of BPH required for the various studies, the insect was mass reared in the greenhouse and iron framed rearing cages covered with fine mesh wire net. Four to six weeks old potted plants of susceptible rice variety, Taichung Native1 (TN1) were used for culturing the BPH. To start the culture of BPH, the potted TN1 plants were cleaned and the dried outer leaf sheaths were removed. They were then placed in an oviposition cage. Gravid females of BPH obtained from the maintenance cage were released on to the potted TN1 plants for oviposition and exposed for 3 days. Then the oviposited plants were placed in maintenance cage for hatching of the eggs. The host plants in culture maintenance cage were changed twice a week and replaced them with fresh potted plants (Heinrichs *et al*., 1985).

Standard Seed box screening technique

The pre germinated seeds of the test cultures were sown 3 cm apart in a galvanized iron tray filled with mud soil. Each test culture was sown in three replications in a row across the width of the seed box with at least 20 plants per row. At seven days after sowing, the seedlings were infested with second and third instar nymphs of BPH at the rate of eight to ten nymphs per seedling. After infestation each seed box was covered with a wire mesh cage to prevent any escape and to prevent entry of natural enemies. The test cultures were observed daily for the damage by the BPH. Damage rating of the test cultures was observed when 90 per cent of the seedlings in TN1 were killed. The test cultures were graded using standard evaluation system of rice on 0-9 (SES) scale as given below (IRRI, 1996).

Grade	Criteria	Reaction
0	No damage	Immune (I)
1	Slight yellowing of few plants	Highly resistant (HR)
3	First and 2nd leaves of most of plant partially yellowing	Resistant (R)
5	Pronounced yellowing and stunting or about 10 to 25 % of the plants wilting	Moderately resistant (MR)
7	More than half of the plants wilting or dead and remaining plants severely stunted or drying	Moderately susceptible (MS)
9	All plants dead	Susceptible

Field screening of rice cultures

Field screening was carried out for two successive cropping season's *viz*., *Rabi* 2010-11 and *Kharif* 2011. The rice cultures selected for screening were raised in nursery beds and were transplanted 21 days after sowing. Each culture was replicated three times and arranged in a randomized complete block design. Each replication consists of 20 hills each of test culture, a local resistant check (Vijetha) and a susceptible check (TN1) transplanted in two rows of 10 hills each. The spacing between rows and plants was 20 cm. Each replication was provided with seven rows of susceptible check (TN1) as border on all the sides. On each side of the test entry and the resistant check were transplanted with two rows of susceptible check (TN1). Foliar spray of methyl parathion 50 EC @ 500 g a.i. /ha was applied once at 20 days after transplanting and repeated twice at ten days interval to induce the BPH resurgence

Table 1. List of rice cultures selected for field screening.

S.No	Entry. No.	Designation	Cross combination
1	M-390	NLR 3084	BPT 5204/ MTU 1001
2	M-391	NLR 3090	RNR 19994/ MTU 7014
3	M-392	NLR 3093	MTU 1001/ RNR 19994
4	M-393	RDR 40	NA
5	M-394	RDR 23	NA
6	M-395	JGL 15230	MTU 4870/ JGL 420
7	M-396	JGL 11727	JGL 420/ MTU 1001
8	M-397	JGL 16259	JGL 1851/ IET 8585
9	M-398	JGL 17204	JGL 1791/ MTU 1010
10	M-399	RNR 2472	MTU 7029/ BPT 5204
11	M-400	RNR 2378	M 7/ RNR 19994
12	M-401	MTU 1075	NA
13	M-402	WGL 404	Erramallelu/ RNR 19994
14	M-403	WGL 482	WGL 14/ Sona
15	M-404	WGL 401	BPT 5204/ Badrakali
16	M-405	WGL II 218-5-1	MTU 1061/ MTU 1071
17	M-406	MTU PLA 99-1-3-1-2	PLA 1100/ NLR 145
18	M-407	MTU 1769-1-1	Erramallelu/ NLR 33358// BPT 5204
19	L-399	NLR 20136	BPT 5204/ CR 1009
20	L-400	NLR 20131	BPT 5204/ NLR 33359
21	L-401	NLR 20146	BPT 5204/ NLR 33359
22	L-402	BPT 2045	BPT 5204/NLR 33641
23	L-403	BPT 2409	BPT 5204/ IR 64/ MTU 4870/ MTU 1001
24	L-404	BPT 2411	BPT 5204/ BPT 4358
25	L-405	RDR 34	NA
26	L-406	RGL 7001	RGL 4107/ MTU 7029
27	L-407	RGL 7002	RGL 2232/ RGL 3250
28	BM 71	MTU IJ 206-7-4-1	(Vajram/W40//Vajram)/IR64
29	Ptb 33	Resistant Check	
30	TN1	Susceptible Check	

(Heinrichs *et al*., 1985). Data on number of planthopper population on 10 plants per each test rice culture at ten days interval from 60 to 80 days after transplanting was recorded for their antixenotic response. The rice cultures were scored when 90 per cent of the plants in the susceptible check were wilted as per the standard evaluation system (SES) on 0-9 scale as describedbelow (IRRI, 1996):

The data obtained from the experiments were subjected to ANOVA in simple RBD analysis after transforming the data into suitable transformations and the mean values were compared (Gomez and Gomez, 1984).

Grade	Criteria	Reaction
0	No damage	Immune (I)
1	Slight yellowing of few plants	Highly resistant (HR)
3	Leaves partially yellow	Resistant (R)
5	leaves with pronounced yellowing and some stunting or wilting and 10 to 25% plants severely stunted	Moderately resistant (MR)
7	More than half of the plants wilting or with hopperburn and remaining plants severely stunted	Moderately susceptible (MS)
9	All plants dead	Susceptible (S)

Table 2. Reaction of rice cultures to the brown planthopper under Standard seed box screening test.

Rice culture No.	Mean score (0-9 SES scale)*	Reaction S/MS/MR/R/ HR
M 390	5.80	MS
M 391	4.87	MR
M 392	3.67	MR
M 393	5.53	MS
M 394	8.47	HS
M 395	8.80	HS
M 396	9.00	HS
M 397	6.20	MS
M 398	5.67	MS
M 399	9.00	HS
M 400	7.67	S
M 401	4.80	MR
M 402	6.00	MS
M 403	3.67	MR
M 404	4.00	MR
M 405	3.07	MR
M 406	4.47	MR
M 407	7.00	S
L 399	7.93	HS
L 400	5.00	MR
L 401	6.07	MS
L 402	9.00	HS
L 403	3.40	R
L 404	6.37	MS
L 405	3.93	MR
L 406	3.87	MR
L 407	4.93	MR
BM 71	1.73	HR
Ptb 33	1.47	HR
TN 1	9.00	HS
F test	Sig	—-
CD (0.05)	0.95	—-
CV (%)	10.24	—-

*Mean of three replications

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

RESULTS AND DISCUSSION

Laboratory screening of rice cultures to BPH through standard seed box screening test

The rice cultures selected for screening against BPH were screened initially in the greenhouse under artificial infestation through standard seed box screening test. The results showed that there was significant variation between the cultures regarding damage scores. Out of the thirty entries screened against BPH, fourteen entries exhibited a damage score in between 1.0 to 5.0 and were categorized as resistant (Table 2). The remaining sixteen entries recorded more than '5' score were considered as susceptible. Among the fourteen resistant cultures, the rice culture BM 71 recorded a damage score of 1.73 and was on par with resistant check, Ptb 33 (1.47) and were categorized as highly resistant. The rice cultures *i.e.,* M 391, M 392, M 401, M 403, M 404, M 405, M 406, L 400, L 403, L 405, L 406 and L 407 with a damage score of 3.07 to 4.93 were considered as moderately resistant cultures to BPH.

Field screening of rice cultures against BPH *Rabi* 2010-11

Field screening of rice cultures during *rabi* 2010-11 showed that there was significant differences between the rice cultures (Table 3). Out of the thirty rice cultures screened against BPH, thirteen rice cultures exhibited a damage score in between 1.0 to 5.0 and were designated as resistant to the brown planthopper. Remaining cultures with a damage score of above '5' have been designated as susceptible to BPH. Among the thirteen rice cultures, the culture BM 71 recorded a damage score of '1' and was on par with resistant check, Ptb 33 with a damage score of '1' and were designated as highly resistant to BPH. The remaining cultures with a damage score between '1' and '5' were designated as resistant and moderately resistant cultures to BPH.

Kharif 2011

Field screening of rice cultures during the season *kharif* 2011 also showed that there was

Table 3. Field reaction of rice cultures to the brown planthopper.

Rice culture No.	Score (0-9 SES scale)*		Mean	ReactionS/ MS/MR/R/ HR
	Rabi 2010-11	*Kharif* 2011		
M 390	9.00	8.33	8.67	S
M 391	4.33	4.33	4.33	MR
M 392	4.33	5.00	4.67	MR
M 393	9.00	8.33	8.67	S
M 394	9.00	9.00	9.00	HS
M 395	7.00	6.33	6.67	MS
M 396	8.33	8.33	8.33	S
M 397	9.00	9.00	9.00	HS
M 398	8.33	8.33	8.33	S
M 399	9.00	7.00	8.00	S
M 400	9.00	9.00	9.00	HS
M 401	2.33	3.67	3.00	R
M 402	9.00	7.00	8.00	S
M 403	8.33	6.33	7.33	MS
M 404	3.00	5.00	4.00	MR
M 405	5.00	3.67	4.34	MR
M 406	3.67	3.67	3.67	MR
M 407	7.00	7.67	7.34	S
L 399	8.33	7.00	7.67	S
L 400	4.33	5.00	4.67	MR
L 401	7.67	7.67	7.67	S
L 402	7.00	7.00	7.00	S
L 403	5.00	5.00	5.00	MR
L 404	7.67	4.33	6.00	MS
L 405	5.00	3.67	4.34	MR
L 406	2.33	3.67	3.00	R
L 407	4.33	2.33	3.33	MR
BM 71	1.00	1.00	1.00	HR
Ptb 33	1.00	1.00	1.00	HR
TN 1	9.00	9.00	9.00	S
F test	Sig	Sig	—-	—-
CD (0.05)	1.20	1.74	—-	—-
CV (%)	11.78	18.08	—-	—-

*Mean of three replications

Table 4. Antixenotic response of Rice cultures to the Brown Planthopper population colonization during *rabi* 2010-11 and *kharif* 2011.

Rice culture No.	Mean population of BPH/10 hills*	
	rabi 2010-11	*kharif* 2011
M 390	1020.56 (24.64)	470.44 (20.03)
M 391	444.78 (15.81)	352.78 (17.55)
M 392	487.78 (16.57)	403.78 (18.95)
M 393	957.22 (24.70)	530.44 (20.71)
M 394	871.56 (23.28)	691.22 (23.33)
M 395	532.44 (17.24)	217.44 (14.15)
M 396	348.67 (14.59)	465.56 (19.71)
M 397	631.67 (19.12)	356.78 (17.44)
M 398	924.89 (23.03)	724.78 (23.54)
M 399	752.78 (20.16)	424.33 (18.84)
M 400	1196.33 (26.85)	432.78 (19.55)
M 401	570.78 (18.24)	350.44 (16.14)
M 402	910.33 (23.72)	439.67 (18.98)
M 403	743.44 (21.33)	563.56 (21.68)
M 404	431.00 (16.21)	407.44 (19.16)
M 405	446.67 (15.71)	249.00 (15.43)
M 406	466.22 (16.61)	213.44 (13.63)
M 407	751.56 (21.47)	630.89 (22.31)
L 399	555.78 (18.25)	542.00 (21.46)
L 400	579.67 (18.04)	377.56 (18.07)
L 401	556.56 (18.16)	408.44 (18.84)
L 402	656.22 (18.85)	495.89 (19.31)
L 403	211.78 (12.16)	299.89 (16.85)
L 404	412.44 (16.75)	309.67 (16.51)
L 405	437.00 (15.82)	369.44 (18.49)
L 406	170.67 (11.06)	300.22 (15.53)
L 407	300.56 (13.61)	506.22 (20.21)
BM 71	386.56 (14.65)	126.33 (10.66)
Ptb 33	148.22 (9.94)	152.89 (11.27)
TN 1	1003.67 (25.17)	1739.44 (36.58)
F test	Sig	Sig
CD (0.05)	7.68	8.04
CV (%)	25.56	26.15

*Mean of three replications; Figures in parenthesis are square root transformed values

significant differences between the cultures (Table 3). Out of thirty cultures screened against BPH, fourteen rice cultures exhibited a damage score in between 1.0 to 5.0 and were categorized as resistant and the remaining cultures which recorded a damage score of above 5' have been designated as susceptible to BPH. Among the fourteen resistant rice cultures, the rice culture BM 71 and resistant check, Ptb 33 recorded a damage score of '1' and were designated as highly resistant. The rice culture with a damage score of 1.0 to 3.0 (L 407) as resistant and the rice cultures with a damage score of 3.0 to 5.0 as moderately resistant (M 391, M 392, M 401, M 404, M 405, M 406, L 400, L 403, L 404, L 405, L 406 and L 407).

The overall mean of scores of rice cultures in both the seasons indicated that among the resistant rice cultures, BM 71 and the resistant check, Ptb 33 recorded a damage score of '1' and
were designated as highly resistant. The rice cultures *viz.,* M 401 and L 406 with a damage score of '3' categorized as resistant and the rice cultures *viz.,* L 407 (3.3), M 406 (3.67), M 404 (4.0), M 391 (4.33), M 405 (4.34), L 405 (4.34) M 392 (4.67), L 400 (4.67), and L 403 (5.0) with a damage score in between 3.0 to 5.0 have been designated as moderately resistant. The susceptible check, TN1 recorded '9' score in both the seasons and
categorized as highly susceptible.

Antixenosis response of rice cultures for population colonization of BPH in field conditions during *Rabi* 2010-11and *Kharif* 2011

The data on antixenotic response for population colonization of BPH among thirty rice cultures observed at 60, 70 and 80 DAT during both the seasons and their mean values were presented in tables 4. The overall mean of BPH populations on rice cultures during *rabi* 2010-11 indicated that there was significant difference in BPH numbers between the cultures. The resistant check, Ptb 33 recorded significantly lowest population colonization of BPH per ten hills (148.22 numbers) and was on par with L 406 (170.67 numbers), L 403 (211.78 numbers),

L 407 (300.56 numbers) and BM 71 (386.56 numbers) indicating their greater levels of antixenosis. Significantly highest population was recorded on M 400 (1196.33 numbers), M 390 (1020.56 numbers), TN1 (1003.67 numbers) and M 393 (957.22 numbers) indicated that they are highly preferable for BPH for feeding and oviposition.

The overall mean of BPH populations on rice cultures during *kharif* 2011 indicated that there was significant difference in BPH numbers between the cultures. The resistant culture BM 71 showed lowest population colonization of BPH per ten hills (126.33 numbers) and was on par with resistant check, Ptb 33 (152.89 numbers) suggesting greater levels of antixenosis in these cultures. The other cultures recorded least population colonization of BPH were M 406 (213.44 numbers), M 395 (217.44 numbers), L 406 (300.22 numbers), M 401 (350.44 numbers), L 405 (369.44 numbers) *etc.* Significantly highest population was recorded on TN1 (1739.44 numbers per ten hills).

Mostly, the damage to the rice crop by BPH was more at heading stage; although crop suffered some damage at all growth stages. Hence, it is necessary to look for resistance in the right stage of the crop growth rather than in seedling stage alone. Screening at seedling stage helps only to identify major gene resistance. By relying totally on this technique, there is loss of several promising field resistant sources (Chelliah *et al*., 1981). Velusamy and Heinrichs (1986) suggested that plants exposed to insect attack must be measured at proper stage of growth and opined that 'field resistance' was quantitative or polygenic in nature. Hence, in the present investigation, the selected rice cultures were screened both in greenhouse and field for assessing major and polygenic resistance.

According to Painter (1951), plants showing a low degree of resistance may be effective under varied conditions. So, the rice cultures designated as moderately resistant in the present investigation might be much important in the management of BPH as those cultures can tolerate higher populations with little damage or no yield loss at field level.

From the present investigation it was also evident that majority of the rice cultures which exhibited resistance to moderate resistance have BPH resistant varieties viz., MTU 1001 (Vijetha), MTU 7014, MTU 1010 (Cotton dorasannalu), MTU 1061 (Amara), MTU 4870 (Deepti), MTU 5294 (Vajram) and MTU 1071 as one of their parent (Suryanarayana, 1993; Pasalu *et al*., 2004). The resistant check, Ptb 33 and susceptible check, TN1 were long back reported as resistant and susceptible varieties and are routinely used as resistant and susceptible checks respectively in mass screening programme (Velusamy and Chelliah, 1984).

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