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Evaluation of $F_{5:6}$ RILS Derived from Cross MTU 3626 x BM 71 for Genetic Parameters and BPH Tolerance in Rice (*Oryza Sativa* L.)

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ABSTRACT

Evaluation of one hundred and forty two RILs in $F_{5:6}$ generation for genetic parameters of five yield attributing traits *viz.,* days to 50% flowering, plant height (cm), ear bearing tillers per plant, panicle length (cm) and grain yield per plant (g) and screening for brown plant hopper resistance was done during *kharif,* 2018 at Regional Agricultural Research Station, Maruteru, Andhra Pradesh. For grain yield per plant (g) higher estimates of both GCV and PCV were observed indicating greater variability. High heritability coupled with high genetic advance as percent of mean was also observed for grain yield per plant (g) indicating presence of additive gene action, hence improvement for grain yield per plant (g) can be done through simple selection. Phenotypic evaluation for brown plant hopper (*Nilaparvatha lugens stal)* tolerance in laboratory screening using standard seed box technique showed that forty four RILs were resistant, sixty two RILs were moderately resistant, thirty RILs were moderately susceptible and six RILs were susceptible, whereas in field screening sixty seven RILs were resistant, thirty four RILs were moderately resistant, twenty RILs were moderately susceptible, twenty one RILs were susceptible. Among the RILs evaluated ten RILs showed moderate brown plant hopper resistance with score less than 5.0 in both the screening methods and high yield than the checks.

Key words: *BPH, Genetic parameters, Rice, RILs, Tolerance.*

Rice crop is a host to large number of insects and plant hoppers are major among them. Of the six kinds of plant hoppers, Brown Plant Hopper (BPH) (*Nilaparvata lugens* Stal) is the most destructive monophagous insect pest of rice (Park *et al.,* 2008) in Asia. Out breaks of BPH in 1972, 1973 and 1974 in Asian countries and several parts of India had created unprecedented yield losses in rice (Kulshreshtha *et al.*, 1974).

Development and use of resistant varieties is an efficient and most economical method to control brown plant hopper, therefore it is essential to identify brown planthopper resistant genes and incorporate them into rice cultivars by using modern molecular tools (Alam *et al*., 1998 and Renganayaki *et al*., 2002). But, the resistant varieties are specific to a biotype and they are vulnerable to other types of biotypes (Gallagher *et al*., 1994). In Southeast Asia biotypes 1 and 2 were distributed widely, biotype 3 is laboratory specific and it was identified in Philippines, and biotype 4 is mostly seen in the Indian conditions (Khush and Brar., 1991). Many screening techniques were standardized at International Rice Research Institute (IRRI) for evaluation of brown plant hopper resistance. Hence, keeping in view of above aspects, the current study was taken to evaluate the RILs for brown plant hopper resistance.

MATERIAL AND METHODS

The experimental material consists of one hundred and forty two RILs derived from the cross MTU 3626 and BM 71 in $F_{5:6}$ generation, resistant check BM71, susceptible check TN 1, high yielding checks MTU 7029 and MTU 1075.

Variability, Heritability and Genetic advance as percent of mean

One hundred and forty two RILs and two checks MTU 7029 and MTU 1075 were planted in 12×12 simple lattice design for estimation of variability, heritability and genetic advance as percent of mean for five characters *viz.,* days to 50% flowering, plant height (cm), ear bearing tillers per plant, panicle length (cm) and grain yield per plant (g) during *kharif,* 2018 at Regional Agricultural Research Station, Maruteru, Andhra Pradesh.

Screening for brown plant hopper resistance

One hundred and forty two RILs were screened at Regional Agricultural Research Station, Maruteru, Andhra Pradesh, India, during *kharif,* 2018 in both field and lab conditions.

Seedling screening (Standard Seed box Screening Test)

The pre germinated seeds of the RILs were sown 3 cm apart in a galvanized iron tray and filled with

soil. Resistant check was sown in the middle column along the length of the seed box and each RIL was sown in a row across half the width of the seed box separated with susceptible check with at least 20 plants per row and a susceptible check was sown in four border rows. At nine days after sowing, the second and third instar nymphs of BPH were released on seedlings for infestation at the rate of 8-10 nymphs per each seedling. After release of nymphs, wired mesh cages were used to cover the box to prevent the escape of nymphs and prevent natural enemies entry into boxes. RILs sown in trays were exposed to BPH up to 90% of the seedlings of susceptible check (TN-1) showed specific symptom of BPH attack *i.e.* hopper burn. The RILs were categorized by using scale (0-9) of SES, IRRI (2014) in below Table 1.

Field screening

The RILs for screening were raised in nursery beds and were transplanted at 21 days after sowing along with resistant and susceptible checks. Twenty hills of each RIL were transplanted in two rows of 10 hills each. Five rows of test variety were transplanted alternating with one row of susceptible check (TN-1) and resistant check (BM 71). In addition TN-1 seedlings were transplanted as border rows of the field to serve as bombardment rows for infestation of test seedlings with BPH (Heinrichs *et al*., 1985). The RILs were scored when 90% of plants in the susceptible check (TN-1) were wilted as per the standard evaluation system (SES) on 0 to 9 scale as described in Table 1. (IRRI, 2014).

Table 1. Scoring criteria for both field and lab screening for BPH resistance

Score	Criteria	Reaction
0	No injury	Immune (I)
1	Very slight injury	Highly resistant (HR)
3	First and 2nd leaves of most plants partially yellowing	Resistant (R)
5	Pronounced yellowing and stunting or about 10-25% of the plants wilting or dead and remaining plants severely stunted or dying	Moderately resistant (MR)
7	More than half of the plants wilting or drying	Moderately susceptible (MS)
9	All plants dead	Susceptible (S)

RESULTS AND DISCUSSION

The ANOVA showed highly significant differences among the RILs for the five traits under study *viz*., days to fifty percent flowering, plant height (cm), number of ear bearing tillers per plant, panicle length (cm) and grain yield per plant (g). For grain yield per plant (g) higher estimates of both GCV and PCV were observed indicating greater variability (Table 2). High heritability coupled with high genetic advance as percent of mean was also observed for grain yield per plant (g) indicating presence of additive gene action, hence improvement for grain yield per plant (g) can be done through simple selection. Moderate heritability and genetic advance as percent of mean was recorded for plant height (cm) and ear bearing tillers per plant indicating presence of both additive and non additive gene actions. Moderate heritability with low genetic advance as percent of mean was observed for days to 50% flowering and panicle length (cm) indicating non additive gene action and selection may not be effective for the above traits (Figure 1). These results were similar with Longjam *et al*. (2019), Habiba *et al*. (2015), Girma *et al*. (2018), Anis *et al*. (2016) and Sumanth *et al*. (2017) for five traits respectively.

Screening for brown plant hopper tolerance

The results for seedling screening using Standard Seed box Screening Test in lab conditions showed forty four RILs were resistant to brown plant hopper with a score of 1-3, sixty two RILs were moderately resistant, showed a score of 3-5, thirty RILs were moderately susceptible with a score between 5-7 and six RILs were susceptible with a score of 7-9. Whereas in field conditions sixty seven RILs were resistant with 1-3 score, thirty four RILs were moderately resistant with a score of 3-5, twenty RILs were moderately susceptible with 5-7 score and twenty one RILs were susceptible to brown plant hopper with 7-9 score. Scores for BPH reaction in lab conditions was showed in Table 3 and scores for BPH reaction in field conditions was given in Table 4.

Both the screening methods were supported by Bhogadi *et al*. (2015) and Harini *et al*. (2013).

Table 2. Estimates of variability, heritability in broad sense and genetic advance as percent of mean

Character	Mean	Range		PCV	GCV	h² (bs)	GA	GA as % of mean
		Minimum	Maximum					
Days to 50% flowering	96.00	91.00	107.00	6.51	4.36	44.77	5.83	6.03
Plant height (cm)	133.05	100.60	172.00	15.27	10.18	44.42	18.62	14.00
Number ear bearing tillers per plant	8.70	7.00	14.30	19.36	11.44	34.90	1.22	13.94
Panicle length (cm)	28.49	12.00	32.15	11.47	6.49	31.93	2.16	7.56
Grain yield per plant (g)	13.13	4.05	20.36	26.63	25.21	89.68	6.47	49.25

Table 3. BPH scores of RILs under lab conditions at seedling stage

S.No.	RIL name	Score	S.No.	RIL name	Score
1	2711-1	9.00	38	2711-41	7.80
2	2711-2	2.90	39	2711-43	3.52
3	2711-3	5.85	40	2711-44	3.62
4	2711-4	5.00	41	2711-45	1.52
5	2711-5	3.50	42	2711-46	4.32
6	2711-6	7.20	43	2711-47	1.00
7	2711-7	7.00	44	2711-49	4.95
8	2711-8	3.42	45	2711-50	2.96
9	2711-9	5.22	46	2711-52	5.11
10	2711-11	3.35	47	2711-53	5.22
11	2711-13	3.50	48	2711-54	7.00
12	2711-14	5.00	49	2711-55	5.12
13	2711-15	5.23	50	2711-56	2.85
14	2711-16	3.45	51	2711-57	2.92
15	2711-17	6.52	52	2711-58	2.23
16	2711-18	5.30	53	2711-59	1.15
17	2711-19	3.60	54	2711-60	4.90
18	2711-20	8.23	55	2711-61	3.60
19	2711-22	4.90	56	2711-62	2.56
20	2711-23	5.00	57	2711-63	4.53
21	2711-24	3.65	58	2711-64	6.90
22	2711-25	1.52	59	2711-65	4.95
23	2711-26	3.60	60	2711-66	7.23
24	2711-27	3.21	61	2711-67	5.50
25	2711-28	2.56	62	2711-68	5.92
26	2711-29	5.60	63	2711-69	3.23
27	2711-30	4.67	64	2711-71	3.20
28	2711-31	3.52	65	2711-72	3.63
29	2711-32	2.92	66	2711-73	6.82
30	2711-33	5.00	67	2711-74	3.20
31	2711-34	4.56	68	2711-75	2.85
32	2711-35	3.45	69	2711-76	3.60
33	2711-36	5.65	70	2711-77	4.26
34	2711-37	4.20	71	2711-78	2.46
35	2711-38	3.56	72	2711-79	6.90
36	2711-39	5.65	73	2711-80	4.80
37	2711-40	5.23	74	2711-83	3.56
74	2711-83	1.5	110	2711-140	4.92
75	2711-84	1.9	111	2711-143	4.92
76	2711-86	2.7	112	2711-147	1.56
77	2711-87	2.7	113	2711-149	1.60
78	2711-88	2.65	114	2711-150	4.82
79	2711-89	2.95	115	2711-151	3.56
80	2711-92	5.63	116	2711-162	7.00
81	2711-93	4.95	117	2711-164	5.00
82	2711-94	4.12	118	2711-167	3.26
83	2711-100	2.50	119	2711-168	3.85
84	2711-101	1.90	120	2711-169	5.26
85	2711-102	3.76	121	2711-170	5.00
86	2711-103	4.20	122	2711-172	4.86
87	2711-104	1.29	123	2711-175	2.95
88	2711-105	2.96	124	2711-176	3.00
89	2711-106	1.92	125	2711-177	4.96
90	2711-107	4.28	126	2711-178	5.00
91	2711-108	2.56	127	2711-179	7.00
92	2711-110	4.75	128	2711-182	2.87
93	2711-111	3.00	129	2711-184	3.00
94	2711-112	2.95	130	2711-185	7.00
95	2711-113	1.86	131	2711-186	4.85
96	2711-115	6.53	132	2711-187	1.58
97	2711-116	6.93	133	2711-188	1.22
98	2711-117	6.40	134	2711-189	4.95
99	2711-119	5.13	135	2711-191	1.45
100	2711-120	2.96	136	2711-192	2.92
101	2711-122	2.85	137	2711-193	1.00
102	2711-123	1.00	138	2711-195	1.00
103	2711-125	4.95	139	2711-196	5.56
104	2711-127	3.27	140	2711-197	1.00
105	2711-129	1.00	141	2711-198	2.98
106	2711-130	5.00	142	2711-199	5.00
107	2711-131	6.95	143	BM71	3.00
108	2711-133	2.98	144	TN-1	9.00
109	2711-137	5.00			

Table 4. BPH scores of RILs under field conditions at crop maturity stage

S.No.	RIL name	Score	S.No.	RIL name	Score
1	2711-1	1.70	38	2711-41	9.00
2	2711-2	1.50	39	2711-43	4.90
3	2711-3	7.80	40	2711-44	6.10
4	2711-4	3.10	41	2711-45	4.15
5	2711-5	5.23	42	2711-46	2.50
6	2711-6	5.35	43	2711-47	4.20
7	2711-7	2.50	44	2711-49	3.65
8	2711-8	4.82	45	2711-50	2.75
9	2711-9	4.15	46	2711-52	2.30
10	2711-11	9.00	47	2711-53	1.50
11	2711-13	9.00	48	2711-54	1.70
12	2711-14	5.10	49	2711-55	1.24
13	2711-15	4.20	50	2711-56	1.33
14	2711-16	9.00	51	2711-57	1.80
15	2711-17	4.72	52	2711-58	1.08
16	2711-18	6.80	53	2711-59	2.30
17	2711-19	3.40	54	2711-60	2.90
18	2711-20	3.20	55	2711-61	7.30
19	2711-22	2.60	56	2711-62	2.02
20	2711-23	9.00	57	2711-63	1.50
21	2711-24	2.20	58	2711-64	5.80
22	2711-25	2.40	59	2711-65	3.40
23	2711-26	4.40	60	2711-66	8.82
24	2711-27	2.45	61	2711-67	9.00
25	2711-28	1.90	62	2711-68	8.30
26	2711-29	9.00	63	2711-69	4.95
27	2711-30	1.70	64	2711-71	8.40
28	2711-31	3.70	65	2711-72	7.90
29	2711-32	1.60	66	2711-73	3.25
30	2711-33	9.00	67	2711-74	2.95
31	2711-34	1.50	68	2711-75	1.10
32	2711-35	6.90	69	2711-76	7.10
33	2711-36	7.80	70	2711-77	1.23
34	2711-37	3.90	71	2711-78	1.14
35	2711-38	5.22	72	2711-79	1.20
36	2711-39	7.30	73	2711-80	4.20
37	2711-40	5.40	74	2711-83	1.50

S.No.	RIL name	Score	S.No.	RIL name	Score
75	2711-84	1.90	110	2711-140	2.70
76	2711-86	2.70	111	2711-143	1.70
77	2711-87	2.70	112	2711-147	5.90
78	2711-88	2.65	113	2711-149	6.40
79	2711-89	2.70	114	2711-150	1.30
80	2711-92	5.90	115	2711-151	4.05
81	2711-93	3.40	116	2711-162	3.90
82	2711-94	4.65	117	2711-164	3.60
83	2711-100	2.40	118	2711-167	5.10
84	2711-101	6.80	119	2711-168	3.20
85	2711-102	3.20	120	2711-169	5.60
86	2711-103	2.30	121	2711-170	4.90
87	2711-104	2.70	122	2711-172	1.09
88	2711-105	1.10	123	2711-175	1.70
89	2711-106	1.23	124	2711-176	2.70
90	2711-107	1.90	125	2711-177	4.00
91	2711-108	1.30	126	2711-178	3.70
92	2711-110	2.70	127	2711-179	1.00
93	2711-111	1.00	128	2711-182	1.27
94	2711-112	1.08	129	2711-184	9.00
95	2711-113	1.34	130	2711-185	1.02
96	2711-115	3.80	131	2711-186	1.50
97	2711-116	1.18	132	2711-187	2.70
98	2711-117	3.60	133	2711-188	1.06
99	2711-119	6.40	134	2711-189	3.22
100	2711-120	1.20	135	2711-191	2.40
101	2711-122	1.12	136	2711-192	1.23
102	2711-123	1.02	137	2711-193	8.02
103	2711-125	4.08	138	2711-195	5.32
104	2711-127	3.40	139	2711-196	8.20
105	2711-129	1.40	140	2711-197	6.30
106	2711-130	4.90	141	2711-198	1.40
107	2711-131	5.80	142	2711-199	9.00
108	2711-133	1.50	143	BM71	3.30
109	2711-137	1.32	144	TN-1	9.00

Table 5. Performance of RILs for yield and yield attributing traits

S. No.	RIL name	DFF	Plant height (cm)	Ear bearing tillers per plant	Panicle Length (cm)	Grain yield per plant (g)
1	2711-31	99.00	100.60	8.00	29.00	17.90
2	2711-37	93.00	119.00	8.00	28.10	20.36
3	2711-50	99.00	133.10	8.00	24.90	16.65
4	2711-69	97.00	142.80	7.00	29.50	16.05
5	2711-84	97.00	142.40	8.00	28.00	16.65
6	2711-88	98.00	138.10	8.00	29.90	19.85
7	2711-94	93.00	123.20	8.00	26.00	16.60
8	2711-100	96.00	147.90	8.00	29.95	17.65
9	2711-168	93.00	140.20	8.00	30.75	16.38
10	2711-191	99.00	112.00	8.00	32.10	16.15
11	MTU 7029	119.00	106.00	8.00	25.40	16.00
12	MTU 1075	113.00	114.70	9.00	26.70	17.80

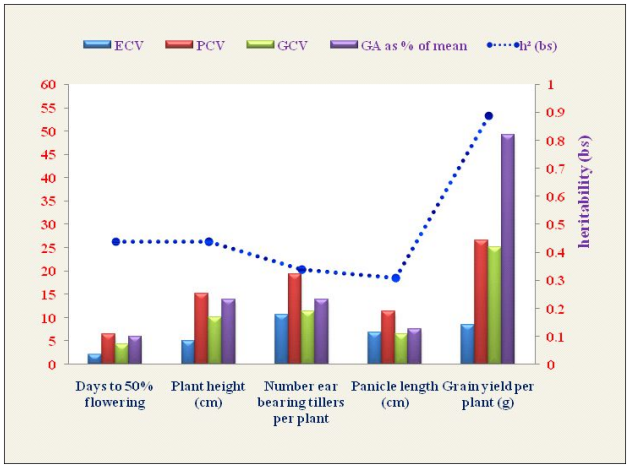

Figure 1. Variability parameters for five characters studied in 142 RILs and two checks

CONCLUSION

It can be conlude that, eighty three RILs showed less than 5.0 BPH score in both the field and seedling screening. Among them, nine RILs on par with high yielding checks *viz*., 2711 – 31(17.90g), 2711 – 50 (16.65g), 2711 – 69 (16.05g), 2711 – 84 (16.65g), 2711 – 88 (19.85g), 2711 – 94 (16.60g), 2711 – 100 (17.65g), 2711 – 168 (16.30g) and 2711 – 191 (16.15g) than two checks MTU 7029 (16.00g) and MTU 1075 (17.80g) and one RIL 2711 – 37 (20.36g) was statistically significant with best check MTU1075 (Table 5).

These ten RILs can be further tested for yield performance in station yield trials and if found promising with BPH tolerance can be further proposed for large scale testing in farmers fields and recommend for release and notification.

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