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Identification of Rice Genotypes for Resistance against Yellow Stem Borer in Irrigated Rice

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A B S T R A C T

The relative resistance or susceptibility of nearly 215 rice genotypes supplied by Indian Institute of Rice Research, Hyderabad was screened to identify the resistant genotype against rice yellow stem borer. The trial was conducted following augmented block design with two checks *i.e*., local check (BPT 5204) and susceptible check (TN1) for a period of two successive *kharif* seasons (2016 & 2017). The per cent incidence of stem borer was recorded at their peak infestation of dead hearts at tillering stage and white ears at reproductive stage. The status of the screened genotypes was determined by following the standard evaluation scale (SES) for stem borer as suggested by IRRI. The pooled results of screening trial for two seasons inferred that, among 215 genotypes screened, no entry exhibited resistance scale, 87 entries registered moderate resistant, 116 were found moderately susceptible and 22 lines recorded the susceptible scale with respect to per cent dead hearts infestation. Correspondingly, the pooled mean data relating to per cent white ears indicated that, only 14 entries were resistant, while 101 entries had registered moderate resistant, 82 entries were moderately susceptible, 17 entries recorded susceptible status and only 1 entry had exhibited susceptible status. The rice entries which had exhibited resistance at dead heart stage were found susceptible at white ears stage and *vice versa* as both the factors were independent. Hence, upon clean examination only seven rice entries with IC No. 381538, 450535, 463380, 464140, 464186, 574807 and 578388 were found to exhibit resistance or moderate resistance against yellow stem borer at both vegetative and reproductive stages of rice crop.

Introduction

In India rice crop is cultivated under wide range of altitude and climatic conditions. Rice cultivation extends from 8 to 35ºN latitude and from sea level to as high as 3000 meters in our country. In India, for the year 2018-19 rice was cultivated in an area of 43.79 million hectares with 115.63 millon tones of annual production accounting around 2.64 tonnes /ha productivity (Agricultural Statistics at a glance, 2018). The major production constraint in rice cultivation includes weeds infestation, pests and diseases attack. Even though, nearly 300 insect pests known to attack rice crop 23 insect species cause remarkable damage (Pasalu and Katti, 2006). Among various pests influencing the yield of rice crop, yellow stem borer, *Scirpophaga incertuals* was considered as major destructive pest resulting in average yield loss of 30 per cent (Krishnaiah and Varma, 2015).

In case of severe pest incidence of stem borer especially in susceptible varieties the usage of insecticides is inevitable. Many farmers are adopting combination chemicals in order to manage the stem borers and upon regular usage of chemicals with same mode of action and in compatible insecticidal combinations may lead to pest resistance, resurgence and residual effect. Hence, practicing integrated pest management (IPM) tools against rice stem borer plays a pivotal role. The prime and major component to be adopted in IPM strategies is host plant resistance as it is compatible with other components of IPM. It is noteworthy that at present no rice germplasm had exhibited resistance against both dead hearts at vegetative stage and white ears at reproductive stage. Keeping in view the ambiguity in resistance at dead hearts and white ears stage caused by yellow stem borer in rice, a screening trial was undertaken to identify the resistance source of rice genotypes against yellow stem borer for two consecutive *kharif* seasons.

Materials and Methods

Screening trial was conducted following augmented block design with 215 rice germplasm sourced by Indian Institute of Rice Research (IIRR), Rajendranagar, Hyderabad at Agricultural Research Station, Garikapadu for a period of two consecutive seasons *i.e.*, *kharif*, 2016 and *kharif*, 2017 to assess the resistance source against the rice yellow stem borer. The Augmented Block Design ABD was adopted for executing the trial in order to identify the resistant source of rice germplasm from 215 rice germplasm accessions along with susceptible check (TN1) and local check (BPT 5204) were transplanted after every fifteen entries.

Each entry was transplanted with two seedlings per hill in two rows of 20 hills with 5.0 m length was. The incidence of per cent dead hearts (% DH) and per cent white ears (%WE) were recorded on the rice entries and check varieties at the peak infestation during the vegetative stage and reproductive stage of the rice crop, respectively. The observations on % DH and % WE were recorded from ten randomly selected hills per entry and the per cent dead heart and white ear were calculated as per the formulae here under.

Per cent dead hearts =

$$\frac{\text{Total number of dead hearts in 10 hills}}{\text{Total number of tillers in 10 hills}} \text{ X } 100$$

Per cent White ears =

$$\frac{\text{Total number of white ears in 10 hills}}{\text{Total number of tillers in 10 hills}} \text{ X } 100$$

Based on the damage rating (per cent DH and per cent WE) and scale the reaction of rice genotypes towards resistance or susceptibility was determined by following the IRRI Standard Evaluation System (SES) for rice (IRRI, 2002) (Table 1 & 2).

Results and Discussion

During *kharif* 2016, the peak infestation of yellow stem borer in terms of per cent dead hearts (% DH) was recorded at 45 days after transplantation (DAT) whereas, during *kharif*, 2017 at 55 DAT peak infestation of DH were noticed. The maximum per cent white ear (%WE) damage by yellow stem borer during reproductive stage of the rice was recorded at 125 DAT during *kharif*, 2016 and at 130 DAT, during *kharif*, 2017.

Identification of rice genotypes against yellow stem borer with respect to per cent dead hearts during vegetative stage

kharif, 2016

For the season *kharif*, 2016 out of 215 rice entries screened for their reaction towards resistance or susceptibility against yellow stem borer, 81 entries exhibited the scale '3' with status of moderate resistance (MR) and the per cent DH in these entries ranged from 10.5 (C-858) to 20.4 (C-27) . A sum of 107 entries of rice had registered moderatel susceptible (MS) reaction with per cent DH damage ranged between 20.5 (C-692) and 30.1 (C-1180) and rated with scale '5'. A total of 27 rice entries exhibited susceptible (scale 7) reaction dead heart damage by stem borer infesting rice and the corresponding values ranged from 30.5 to 39.8. The per cent dead hearts in check varieties was recorded as 42.2 per cent in TN1 and 32.8 per cent in BPT 5204 with scale 7 representing the susceptible status (Table 3).

kharif 2017

Among 215 rice entries screened during *kharif*, 2017, only one entry (C-599) registered resistance (R) status with 10.3 per cent dead heart damage. A sum of 93 entries witnessed moderately resistant (10.6-20.4% DH) and 99 germplasm entries were found moderately susceptible (20.5-30.4% DH) to rice yellow stem borer. A total of 22 germplasm lines were determined as susceptible (S) entries with damage greater than 31 per cent DH representing scale 7. In check varieties the damage scale was found as '7' in TN1 (35.1 % DH) exhibiting susceptible (S) pest reaction and scale '5' was seen in BPT 5204 (26.9 % DH) check with moderately susceptible (MS) pest reaction.

The summative mean of both *kharif* seasons data in terms of per cent dead hearts indicated that among 215 rice entries identified for reaction towards resistance or susceptibility against rice yellow stem borer, 87 entries registered moderately resistant (11-20% DH), 106 were considered as moderately susceptible (21-30% DH) and 22 lines witnessed susceptible reaction with damage ranged from 31-40 per cent dead hearts DH. The lowest per cent dead hearts (11.0) were recorded in C-858 and C-1372 rice entries as against highest in C-358 and C-391 with 40.0 per cent DH, respectively (Table 3).

Identification of rice genotypes against yellow stem borer with respect to per cent white ears during reproductive stage

The rice entries (mostly) which expressed resistance (R) or moderate resistance (MR) against dead hearts during vegetative stage were found moderately susceptible (MS) susceptible (S) to white ears damage by yellow stem borer at reproductive stage and vice versa. The white ears damage due to rice yellow stem borer incidence had ranged from 2.4 to 31.5 per cent during *kharif*, 2016 and 2.3 to 29.3 per cent during *kharif*, 2017.

kharif, 2016

During *kharif*, 2016 215 rice entries were screened at field level to assess their reaction towards resistance or susceptibility against yellow stem borer and the results indicated that, 12 lines expressed resistance status with less than 5 per cent WE damage representing scale 1. The lowest per cent WE damage was noticed in rice entry C-1433 (2.4) followed by C-1464 (3.6) rice entry as against highest incidence recorded in C-490 (31.5 % WE with scale 9 the attaining the status of highly susceptible (HS). Whereas, 12 entries registered pest status of resistance (scale 1), 95 entries were regarded as moderately resistance (scale 3), 73 were identified as moderately susceptible (scale 5), 34 were categorized as susceptible with sacle7 and only one rice entry witnessed highly susceptible pest reaction with scale 9 (Table 4).

Kharif, 2017

The resultant resistance/ susceptible reactions of 215 rice accessions field screened against white ears damage caused by yellow stem borer during *kharif*, 2017 revealed that 29 entries were identified as resistant (R), 105 entries were categorized moderately resistant (MR), 58 entries were regarded as moderately susceptible (MS), 22 were witnessed as susceptible (S) and only one entry exhibited highly susceptible (HS) reaction with a damage range of 2.3-5.3, 5.6-10.4, 10.5-14.8, 15.6-21.8 and 29.3% white ears, respectively. The lowest and highest per cent white ears were recorded in C-1398 and C-490 with 2.3 and 29.3 per cent, respectively. The per cent WE damage recorded in check varieties TN1 (susceptible) and BPT 5204 (susceptible/ moderately susceptible) were 17.6 and 14.6, respectively (Table 4).

Table.1 Standard Evaluation System for rice yellow stem borer with respect to per cent dead hearts

Damage (%)	Scale	Reaction/Status
0	0	Highly Resistant (HR)
1-10	1	Resistant (R)
11-20	3	Moderately Resistant (MR)
21-30	5	Moderately Susceptible (MS)
31-60	7	Susceptible(S)
61 & above	9	Highly Susceptible(HS)

Table.2 Standard Evaluation System for rice yellow stem borer with respect to per cent white ears

Damage (%)	Scale	Reaction/ Status
0	0	Highly Resistant (HR)
1-5	1	Resistant (R)
6-10	3	Moderately Resistant (MR)
11-15	5	Moderately Susceptible (MS)
16-25	7	Susceptible(S)
26 & above	9	Highly Susceptible(HS)

Table.3 Field identification of rice genotypes against yellow stem borer, in terms of per cent dead hearts

S. No	Entry No.	*Kharif*, 2016	Scale	Status	*Kharif* 2017	Scale	Status	Mean	Status
1	C-08	21.3	5	MS	28.3	5	MS	25	MS
2	C-17	27.6	5	MS	21.4	5	MS	25	MS
3	C-27	20.4	3	MR	18.3	3	MR	19	MR
4	C-30	20.0	3	MR	23.8	5	MS	22	MS
5	C-37	26.9	5	MS	27	5	MS	27	MS
6	C-53	18.9	3	MR	16.3	3	MR	18	MR
7	C-55	20.5	5	MS	22.5	5	MS	22	MS
8	C-58	16.9	3	MR	14.6	3	MR	16	MR
9	C-64	18.5	3	MR	23.4	5	MS	21	MS
10	C-86	22.8	5	MS	29.8	5	MS	26	MS
11	C-115	21.5	5	MS	31.4	7	S	26	MS
12	C-124	26.8	5	MS	26.9	5	MS	27	MS
13	C-133	21.8	5	MS	19.6	3	MR	21	MS
14	C-140	14.6	3	MR	13.8	3	MR	14	MR
15	C-141	19.8	3	MR	20.8	5	MS	20	MR
16	C-144	26.8	5	MS	16.3	3	MR	22	MS
17	C-152	21.5	5	MS	20.4	3	MR	21	MS
18	C-170	22.8	5	MS	28.1	5	MS	25	MS
19	C-171	24.5	5	MS	16.3	3	MR	20	MR
20	C-178	19.6	3	MR	22.4	5	MS	21	MS
21	C-202	13.9	3	MR	18.3	3	MR	16	MR
22	C-207	20.8	5	MS	22.6	5	MS	22	MS
23	C-221	15.8	3	MR	18.4	3	MR	17	MR
24	C-228	13.8	3	MR	22.8	5	MS	18	MR
25	C-237	21.6	5	MS	21.0	5	MS	21	MS
26	C-240	20.5	5	MS	19.3	3	MR	20	MR
27	C-250	26.8	5	MS	16.8	3	MR	22	MS
28	C-269	14.9	3	MR	22.8	5	MS	19	MR
29	C-270	22.8	5	MS	16.9	3	MR	20	MR
30	C-273	20.0	3	MR	18.0	3	MR	19	MR
31	C-275	18.3	3	MR	22.0	5	MS	20	MR
32	C-280	16.8	3	MR	18.3	3	MR	18	MR
33	C-288	17.9	3	MR	14.3	3	MR	16	MR
34	C-306	18.5	3	MR	18.0	3	MR	18	MR
35	C-319	28.5	5	MS	20.0	3	MR	24	MS
36	C-321	18.8	3	MR	22.8	5	MS	21	MS
37	C-324	21.5	5	MS	16.5	3	MR	19	MR
38	C-328	26.5	5	MS	28.5	5	MS	28	MS
39	C-330	19.8	3	MR	16.5	3	MR	18	MR
40	C-342	22.8	5	MS	11.8	3	MR	17	MR

S. No	Entry No.	*Kharif*, 2016	Scale	Status	*Kharif*, 2017	Scale	Status	Mean	Status
41	C-343	19.0	3	MR	22.6	5	MS	21	MS
42	C-346	16.8	3	MR	18.3	3	MR	18	MR
43	C-349	22.4	5	MS	16.4	3	MR	19	MR
44	C-350	29.3	5	MS	22.0	5	MS	26	MS
45	C-352	26.1	5	MS	18.6	3	MR	22	MS
46	C-354	28.1	5	MS	29.6	5	MS	29	MS
47	C-358	39.3	7	S	40.1	7	S	40	S
48	C-361	22.5	5	MS	16.9	3	MR	20	MR
49	C-362	18.3	3	MR	33.4	7	S	26	MS
50	C-364	24.5	5	MS	40.8	7	S	33	S
51	C-365	20.9	5	MS	33.1	7	S	27	MS
52	C-368	23.8	5	MS	16.8	3	MR	20	MR
53	C-369	18.6	3	MR	13.2	3	MR	16	MR
54	C-372	13.8	3	MR	18.3	3	MR	16	MR
55	C-373	15.3	3	MR	14.6	3	MR	15	MR
56	C-374	18.3	3	MR	13.5	3	MR	16	MR
57	C-377	24.8	5	MS	18.4	3	MR	22	MS
58	C-378	23.1	5	MS	16.8	3	MR	20	MR
59	C-380	20.8	5	MS	13.8	3	MR	17	MR
60	C-384	16.8	3	MR	20.6	5	MS	19	MR
61	C-386	21.6	5	MS	19.8	3	MR	21	MS
62	C-388	20.8	5	MS	19.6	5	MR	20	MR
63	C-390	29.6	5	MS	34.6	7	S	32	S
64	C-391	38.5	7	S	40.6	7	S	40	S
65	C-393	20.8	5	MS	19.3	3	MR	20	MR
66	C-394	36.3	7	S	23.8	5	MS	30	MS
67	C-396	28.2	5	MS	10.8	3	MR	20	MR
68	C-400	16.5	3	MR	22.6	5	MS	20	MR
69	C-401	18.0	3	MR	16.8	3	MR	17	MR
70	C-404	14.6	3	MR	23.1	5	MS	19	MR
71	C-407	28.3	5	MS	31.4	7	S	30	MS
72	C-417	13.6	3	MR	18.6	3	MR	16	MR
73	C-437	20.8	5	MS	14.3	3	MR	18	MR
74	C-441	23.5	5	MS	18.6	3	MR	21	MS
75	C-448	19.6	3	MR	23.4	5	MS	22	MS
76	C-455	18.3	3	MR	20.8	5	MS	20	MR
77	C-464	28.0	5	MS	21.4	5	MS	25	MS
78	C-470	16.9	3	MR	15	3	MR	16	MR
79	C-473	22.5	5	MS	29.4	5	MS	26	MS
80	C-474	28.4	5	MS	20.6	5	MS	25	MS
81	C-475	26.5	5	MS	23.4	5	MS	25	MS
82	C-479	20.8	5	MS	21.5	5	MS	21	MS
83	C-481	16.8	3	MR	18.6	3	MR	18	MR

S. No	Entry No.	*Kharif*, 2016	Scale	Status	*Kharif*, 2017	Scale	Status	Mean	Status
84	C-490	22.1	5	MS	29.4	5	MS	26	MS
85	C-492	15.4	3	MR	16.3	3	MR	16	MR
86	C-497	11.6	3	MR	14.3	3	MR	13	MR
87	C-498	28.3	5	MS	21.5	5	MS	25	MS
88	C-499	16.4	3	MR	20.8	5	MS	19	MR
89	C-502	13.9	3	MR	22.5	5	MS	18	MR
90	C-504	14.2	3	MR	15.8	3	MR	15	MR
91	C-514	39.8	7	S	29.8	5	MS	35	S
92	C-515	22.6	5	MS	21.8	5	MS	22	MS
93	C-517	26.8	5	MS	24.3	5	MS	26	MS
94	C-518	17.6	3	MR	18.3	3	MR	18	MR
95	C-519	18.9	3	MR	21.8	5	MS	20	MR
96	C-536	23.6	5	MS	29.4	5	MS	27	MS
97	C-537	28.4	5	MS	22.5	5	MS	25	MS
98	C-538	31.6	7	S	38.4	7	S	35	S
99	C-540	18.5	3	MR	19.3	3	MR	19	MR
100	C-550	24.6	5	MS	28.6	5	MS	27	MS
101	C-551	20.6	5	MS	26.5	5	MS	24	MS
102	C-554	11.8	3	MR	16.3	3	MR	14	MR
103	C-556	10.8	3	MR	13.4	3	MR	12	MR
104	C-557	21.6	5	MS	28.6	5	MS	25	MS
105	C-559	21.6	5	MS	29.1	5	MS	25	MS
106	C-560	16.4	3	MR	14.2	3	MR	15	MR
107	C-561	38.1	7	S	29	5	MS	34	S
108	C-566	26.1	5	MS	20.5	5	MS	23	MS
109	C-575	28.3	5	MS	23.1	5	MS	26	MS
110	C-593	19.6	3	MR	16.8	3	MR	18	MR
111	C-597	12.5	3	MR	16.1	3	MR	14	MR
112	C-599	16.2	3	MR	10.3	1	R	13	MR
113	C-600	28.3	5	MS	29.1	5	MS	29	MS
114	C-602	31.8	7	S	30.4	5	MS	31	S
115	C-603	16.9	3	MR	18.5	3	MR	18	MR
116	C-608	28.3	5	MS	20.4	3	MR	24	MS
117	C-610	31.5	7	S	32.8	7	S	32	S
118	C-621	16.4	3	MR	18.2	3	MR	17	MR
119	C-637	18.6	3	MR	19.0	3	MR	19	MR
120	C-649	29.6	5	MS	30.1	5	MS	30	MS
121	C-651	31.8	7	S	32.0	7	S	32	S
122	C-682	19.5	3	MR	16.4	3	MR	18	MR
123	C-684	28.3	5	MS	23.5	5	MS	26	MS
124	C-685	16.9	3	MR	11.4	3	MR	14	MR
125	C-689	18.4	3	MR	13.5	3	MR	16	MR
126	C-692	20.5	5	MS	16.4	3	MR	18	MR

S. No	Entry No.	*Kharif*, 2016	Scale	Status	*Kharif*, 2017	Scale	Status	Mean	Status
127	C-693	28.1	5	MS	26.1	5	MS	27	MS
128	C-697	16.3	3	MR	18.4	3	MR	17	MR
129	C-702	26.1	5	MS	24.0	5	MS	25	MS
130	C-706	28.8	5	MS	20.5	5	MS	25	MS
131	C-713	31.4	7	S	26.3	5	MS	29	MS
132	C-714	31.6	7	S	38.2	7	S	35	S
133	C-715	30.8	7	S	26.4	5	MS	29	MS
134	C-727	21.8	5	MS	20.6	5	MS	21	MS
135	C-729	28.5	5	MS	31.0	7	S	30	MS
136	C-750	21.8	5	MS	22.6	5	MS	22	MS
137	C-750	23.8	5	MS	20.9	5	MS	22	MS
138	C-753	14.5	3	MR	16.3	3	MR	15	MR
139	C-754	28.6	5	MS	28.9	5	MS	29	MS
140	C-763	16.5	3	MR	10.6	3	MR	14	MR
141	C-766	38.4	7	S	19.8	3	MR	29	MS
142	C-767	21.8	5	MS	22.6	5	MS	22	MS
143	C-775	28.3	5	MS	21.6	5	MS	25	MS
144	C-780	25.5	5	MS	26.3	5	MS	26	MS
145	C-781	26.8	5	MS	19.8	3	MR	23	MS
146	C-782	22.1	5	MS	20.6	5	MS	21	MS
147	C-786	19.6	3	MR	23.5	5	MS	22	MS
148	C-787	31.8	7	S	30.5	7	S	31	S
149	C-788	26.8	5	MS	28.3	5	MS	28	MS
150	C-790	33.9	7	S	30.5	7	S	32	S
151	C-792	31.8	7	S	30.6	7	S	31	S
152	C-793	29.6	5	MS	21.8	5	MS	26	MS
153	C-794	31.2	7	S	29.6	5	MS	30	MS
154	C-795	22.8	5	MS	24.3	5	MS	24	MS
155	C-797	19.3	3	MR	22.8	5	MS	21	MS
156	C-798	20.8	5	MS	18.6	3	MR	20	MR
157	C-804	31.5	7	S	16.5	3	MR	24	MS
158	C-808	24.3	5	MS	20.8	5	MS	23	MS
159	C-810	28.5	5	MS	21.5	5	MS	25	MS
160	C-812	34.8	7	S	26.8	5	MS	31	S
161	C-828	18.6	3	MR	16.9	3	MR	18	MR
162	C-844	31.6	7	S	30.5	7	S	31	S
163	C-851	22.9	5	MS	26.5	5	MS	25	MS
164	C-858	10.5	3	MR	10.8	3	MR	11	MR
165	C-864	18.3	3	MR	26.4	5	MS	22	MS
166	C-870	26.8	5	MS	30.4	5	MS	29	MS
167	C-878	34.9	7	S	32.6	7	S	34	S
168	C-879	18.4	3	MR	18.2	3	MR	18	MR
169	C-884	14.9	3	MR	16.3	3	MR	16	MR

S. No	Entry No.	*Kharif*, 2016	Scale	Status	*Kharif* 2017	Scale	Status	Mean	Status
170	C-891	28.5	5	MS	29.0	5	MS	29	MS
171	C-901	16.9	3	MR	13.4	3	MR	15	MR
172	C-902	23.4	5	MS	19.3	3	MR	21	MS
173	C-903	16.8	3	MR	13.4	3	MR	15	MR
174	C-1165	21.8	5	MS	26.8	5	MS	24	MS
175	C-1167	18.6	3	MR	19.3	3	MR	19	MR
176	C-1170	11.4	3	MR	20.6	5	MS	16	MR
177	C-1172	18.3	3	MR	11.5	3	MR	15	MR
178	C-1175	29.3	5	MS	26.9	5	MS	28	MS
179	C-1176	16.4	3	MR	20.6	5	MS	19	MR
180	C-1179	19.8	3	MR	22.0	5	MS	21	MS
181	C-1180	30.1	5	MS	26.3	5	MS	28	MS
182	C-1181	38.3	7	S	21.8	5	MS	30	MS
183	C-1185	29.1	5	MS	30.5	7	S	30	MS
184	C-1199	19.8	3	MR	20.1	3	MR	20	MR
185	C-1205	23.5	5	MS	26.3	5	MS	25	MS
186	C-1226	26.5	5	MS	16.8	3	MR	22	MS
187	C-1237	19.8	3	MR	16.4	3	MR	18	MR
188	C-1241	20.8	5	MS	16.9	3	MR	19	MR
189	C-1247	16.3	3	MR	13.2	3	MR	15	MR
190	C-1248	21.5	5	MS	20.8	5	MS	21	MS
191	C-1249	22.9	5	MS	18.3	3	MR	21	MS
192	C-1257	28.3	5	MS	16.3	3	MR	22	MS
193	C-1259	19.6	3	MR	20.4	3	MR	20	MR
194	C-1289	21.3	5	MS	21.6	5	MS	21	MS
195	C-1320	23.5	5	MS	20.4	3	MR	22	MS
196	C-1328	26.3	5	MS	26.3	5	MS	26	MS
197	C-1372	11.9	3	MR	10.8	3	MR	11	MR
198	C-1378	21.8	5	MS	19.9	3	MR	21	MS
199	C-1391	30.5	7	S	41.5	7	S	36	S
200	C-1394	16.8	3	MR	21.8	5	MS	19	MR
201	C-1397	28.5	5	MS	16.9	3	MR	23	MS
202	C-1398	31.5	7	S	29.8	5	MS	31	S
203	C-1406	21.4	5	MS	25.8	5	MS	24	MS
204	C-1430	20.6	5	MS	30.0	5	MS	25	MS
205	C-1433	18.3	3	MR	16.9	3	MR	18	MR
206	C-1436	31.8	7	S	33.4	7	S	33	S
207	C-1439	29.6	5	MS	30.8	7	S	30	MS
208	C-1448	23.4	5	MS	24.6	5	MS	24	MS
209	C-1449	19.8	3	MR	20.5	5	MS	20	MR
210	C-1453	32.5	7	S	29.9	5	MS	31	S
211	C-1463	28.3	5	MS	21.9	5	MS	25	MS
212	C-1464	16.9	3	MR	16.4	3	MR	17	MR
213	C-1474	29.8	5	MS	20.3	3	MR	25	MS
214	C-1475	31.8	7	S	29.6	5	MS	31	S
215	C-1548	21.6	5	MS	20.0	3	MR	21	MS
Checks	TN1	42.2	7	S	35.1	7	S	39	S
	BPT 5204	32.8	7	S	26.9	5	MS	30	MS
Mean		22.94	-	-	22.39	-	-	22.67	-
Std. Dev.		8.28	-	-	9.61	-	-	8.95	-
Std. Error		0.56	-	-	0.65	-	-	0.61	-
CV (%)		36.07	-	-	42.88	-	-	57.51	-

Table.4 Field identification of rice genotypes against yellow stem borer, in terms of per cent white ears

S.No.	Entry No.	*Kharif*, 2016	Scale	Status	*Kharif*, 2017	Scale	Status	Mean	Status
1	C-08	11.3	5	MS	10.3	3	MR	11	MS
2	C-17	14.3	5	MS	13.5	5	MS	14	MS
3	C-27	8.6	3	MR	7.5	3	MR	8	MR
4	C-30	10.3	3	MR	8.9	3	MR	10	MR
5	C-37	6.8	3	MR	6.0	3	MR	6	MR
6	C-53	11.9	5	MS	12.0	5	MS	12	MS
7	C-55	15.2	5	MS	13.4	5	MS	14	MS
8	C-58	12.3	5	MS	10.3	3	MR	11	MS
9	C-64	14.0	5	MS	18.2	7	S	16	S
10	C-86	11.3	5	MS	6.8	3	MR	9	MR
11	C-115	8.6	3	MR	10.2	3	MR	9	MR
12	C-124	9.3	3	MR	8.6	3	MR	9	MR
13	C-133	10.4	3	MR	10.1	3	MR	10	MR
14	C-140	16.1	7	S	17.2	7	S	17	S
15	C-141	10.9	5	MS	16.1	7	S	14	MS
16	C-144	13.4	5	MS	11.5	5	MS	12	MS
17	C-152	18.0	7	S	12.5	5	MS	15	MS
18	C-170	16.4	7	S	18.5	7	S	17	S
19	C-171	8.9	3	MR	6.5	3	MR	8	MR
20	C-178	7.3	3	MR	7.0	3	MR	7	MR
21	C-202	15.4	5	MS	11.0	5	MS	13	MS
22	C-207	13.9	5	MS	19.5	7	S	17	S
23	C-221	10.8	5	MS	11.3	5	MS	11	MS
24	C-228	13.9	5	MS	14.0	5	MS	14	MS
25	C-237	16.4	7	S	13.8	5	MS	15	MS
26	C-240	13.2	5	MS	12.8	5	MS	13	MS
27	C-250	10.5	5	MS	11.5	5	MS	11	MS
28	C-269	12.6	5	MS	16.8	7	S	15	MS
29	C-270	25.0	7	S	10.3	3	MR	18	S
30	C-273	10.4	3	MR	11.0	5	MS	11	MS
31	C-275	10.4	3	MR	10.5	5	MS	10	MR
32	C-280	9.8	3	MR	10.4	3	MR	10	MR
33	C-288	6.9	3	MR	6.9	3	MR	7	MR
34	C-306	8.0	3	MR	5.3	1	R	7	MR
35	C-319	10.3	3	MR	7.1	3	MR	9	MR
36	C-321	14.2	5	MS	11.5	5	MS	13	MS
37	C-324	8.5	3	MR	6.8	3	MR	8	MR

S.No.	Entry No.	*Kharif*, 2016	Scale	Status	*Kharif*, 2017	Scale	Status	Mean	Status
38	C-328	11.8	5	MS	12	5	MS	12	MS
39	C-330	16.3	7	S	14.3	5	MS	15	MS
40	C-342	12.8	5	MS	10.9	5	MS	12	MS
41	C-343	16.4	7	S	10.8	5	MS	14	MS
42	C-346	10.4	3	MR	11.6	5	MS	11	MS
43	C-349	13.6	5	MS	14.8	5	MS	14	MS
44	C-350	10.3	3	MR	16.3	7	S	13	MS
45	C-352	6.9	3	MR	5.6	3	MR	6	MR
46	C-354	15.1	5	MS	14.3	5	MS	15	MS
47	C-358	18.3	7	S	12.6	5	MS	15	MS
48	C-361	10.3	3	MR	11.9	5	MS	11	MS
49	C-362	18.6	7	S	19.3	7	S	19	S
50	C-364	14.3	5	MS	16.2	7	S	15	MS
51	C-365	10.9	5	MS	9.8	3	MR	10	MR
52	C-368	21.6	7	S	16.3	7	S	19	S
53	C-369	6.4	3	MR	5.3	1	R	6	MR
54	C-372	10.2	3	MR	3.9	1	R	7	MR
55	C-373	7.3	3	MR	6.4	3	MR	7	MR
56	C-374	6.0	3	MR	5.1	1	R	6	MR
57	C-377	8.1	3	MR	6.1	3	MR	7	MR
58	C-378	8.4	3	MR	9.3	3	MR	9	MR
59	C-380	6.5	3	MR	6.0	3	MR	6	MR
60	C-384	7.9	3	MR	9.9	3	MR	9	MR
61	C-386	10.9	5	MS	9.3	3	MR	10	MR
62	C-388	15.3	5	MS	11.0	5	MS	13	MS
63	C-390	16.8	7	S	17.3	7	S	17	S
64	C-391	10.9	5	MS	16.2	7	S	14	MS
65	C-393	16.3	7	S	14.3	5	MS	15	MS
66	C-394	18.2	7	S	16.3	7	S	17	S
67	C-396	10.2	3	MR	10.8	5	MS	11	MS
68	C-400	9.4	3	MR	8.6	3	MR	9	MR
69	C-401	9.8	3	MR	9.0	3	MR	9	MR
70	C-404	15.1	5	MS	14.2	5	MS	15	MS
71	C-407	18.3	7	S	10.3	3	MR	14	MS
72	C-417	20.3	7	S	16.9	7	S	19	S
73	C-437	10.8	5	MS	9.8	3	MR	10	MR
74	C-441	10.3	3	MR	6.4	3	MR	8	MR
75	C-448	12.4	5	MS	8.4	3	MR	10	MR
76	C-455	11.4	5	MS	9.9	3	MR	11	MS
77	C-464	19.2	7	S	14.3	5	MS	17	S
78	C-470	6.4	3	MR	6	3	MR	6	MR
79	C-473	8.3	3	MR	9.2	3	MR	9	MR

S.No.	Entry No.	*Kharif*, 2016	Scale	Status	*Kharif*, 2017	Scale	Status	Mean	Status
80	C-474	10.9	5	MS	11.4	5	MS	11	MS
81	C-475	14.2	5	MS	12.1	5	MS	13	MS
82	C-479	16.3	7	S	14.3	5	MS	15	MS
83	C-481	10.4	3	MR	9.8	3	MR	10	MR
84	C-490	31.5	9	HS	29.3	9	HS	30	HS
85	C-492	7.3	3	MR	4.2	1	R	6	MR
86	C-497	10.8	5	MS	10.1	3	MR	10	MR
87	C-498	11.4	5	MS	12.8	5	MS	12	MS
88	C-499	8.0	3	MR	6.3	3	MR	7	MR
89	C-502	7.5	3	MR	6.0	3	MR	7	MR
90	C-504	10.4	3	MR	10.0	3	MR	10	MR
91	C-514	11.8	5	MS	12.0	5	MS	12	MS
92	C-515	10.3	3	MR	9.6	3	MR	10	MR
93	C-517	12.4	5	MS	6.8	3	MR	10	MR
94	C-518	7.8	3	MR	8.3	3	MR	8	MR
95	C-519	8.0	3	MR	8.5	3	MR	8	MR
96	C-536	10.4	3	MR	11.5	5	MS	11	MS
97	C-537	6.9	3	MR	6.8	3	MR	7	MR
98	C-538	12.2	5	MS	10.4	3	MR	11	MS
99	C-540	9.3	3	MR	13.5	5	MS	11	MS
100	C-550	10.8	5	MS	11.5	5	MS	11	MS
101	C-551	11.9	5	MS	10.9	5	MS	11	MS
102	C-554	10.5	5	MS	11.5	5	MS	11	MS
103	C-556	6.3	3	MR	4.8	1	R	6	MR
104	C-557	13.8	5	MS	10.3	3	MR	12	MS
105	C-559	15.3	5	MS	11.4	5	MS	13	MS
106	C-560	6.3	3	MR	8.4	3	MR	7	MR
107	C-561	18.0	7	S	16.8	7	S	17	S
108	C-566	11.5	5	MS	12.8	5	MS	12	MS
109	C-575	14.3	5	MS	9.6	3	MR	12	MS
110	C-593	4.2	1	R	9.0	3	MR	7	MR
111	C-597	10.3	3	MR	9.3	3	MR	10	MR
112	C-599	15.3	5	MS	11.8	5	MS	14	MS
113	C-600	12.6	5	MS	10.3	3	MR	11	MS
114	C-602	10.6	5	MS	9.8	3	MR	10	MR
115	C-603	7.5	3	MR	8.4	3	MR	8	MR
116	C-608	8.9	3	MR	9.3	3	MR	9	MR
117	C-610	10.3	3	MR	9.6	3	MR	10	MR
118	C-621	9.2	3	MR	8.9	3	MR	9	MR
119	C-637	8.6	3	MR	7.3	3	MR	8	MR
120	C-649	6.9	3	MR	4.9	1	R	6	MR
121	C-651	17.9	7	S	16.3	7	S	17	S

S.No.	Entry No.	*Kharif*, 2016	Scale	Status	*Kharif*, 2017	Scale	Status	Mean	Status
122	C-682	10.4	3	MR	5.6	3	MR	8	MR
123	C-684	13.8	5	MS	11.4	5	MS	13	MS
124	C-685	6.5	3	MR	3.5	1	R	5	R
125	C-689	10.3	3	MR	6.0	3	MR	8	MR
126	C-692	15.8	7	S	8.1	3	MR	12	MS
127	C-693	10.3	3	MR	9.3	3	MR	10	MR
128	C-697	6.4	3	MR	5.0	1	R	6	MR
129	C-702	5.0	1	R	6.3	3	MR	6	MR
130	C-706	16.4	7	S	10.4	3	MR	13	MS
131	C-713	19.3	7	S	11.6	5	MS	15	MS
132	C-714	18.6	7	S	14.2	5	MS	16	S
133	C-715	10.9	5	MS	9.9	3	MR	10	MR
134	C-727	18.3	7	S	21.8	7	S	20	S
135	C-729	10.4	3	MR	9.5	3	MR	10	MR
136	C-750	10.4	3	MR	9.3	3	MR	10	MR
137	C-750	13.4	5	MS	14.0	5	MS	14	MS
138	C-753	6.3	3	MR	6.9	3	MR	7	MR
139	C-754	10.8	5	MS	11.3	5	MS	11	MS
140	C-763	7.3	3	MR	8.0	3	MR	8	MR
141	C-766	8.9	3	MR	7.3	3	MR	8	MR
142	C-767	10.6	5	MS	11.8	5	MS	11	MS
143	C-775	10.3	3	MR	12.5	5	MS	11	MS
144	C-780	11.4	5	MS	10.8	5	MS	11	MS
145	C-781	10.1	3	MR	9.5	3	MR	10	MR
146	C-782	8.3	3	MR	6.9	3	MR	8	MR
147	C-786	9.3	3	MR	8.2	3	MR	9	MR
148	C-787	9.4	3	MR	15.6	7	S	13	MS
149	C-788	16.5	7	S	19.2	7	S	18	S
150	C-790	19.2	7	S	10.3	3	MR	15	MS
151	C-792	18.3	7	S	10.8	5	MS	15	MS
152	C-793	10.6	5	MS	8.8	3	MR	10	MR
153	C-794	9.8	3	MR	9.0	3	MR	9	MR
154	C-795	11.6	5	MS	12.4	5	MS	12	MS
155	C-797	13.8	5	MS	10.6	5	MS	12	MS
156	C-798	14.1	5	MS	6.8	3	MR	10	MR
157	C-804	10.8	5	MS	3.9	1	R	7	MR
158	C-808	11.5	5	MS	8.4	3	MR	10	MR
159	C-810	16.8	7	S	3.9	1	R	10	MR
160	C-812	18.3	7	S	6.4	3	MR	12	MS
161	C-828	9.8	3	MR	5.3	1	R	8	MR
162	C-844	11.9	5	MS	9.1	3	MR	11	MS
163	C-851	13.8	5	MS	16.2	7	S	15	MS

S.No.	Entry No.	*Kharif*, 2016	Scale	Status	*Kharif*, 2017	Scale	Status	Mean	Status
164	C-858	4.3	1	R	2.9	1	R	4	R
165	C-864	10.2	3	MR	3.3	1	R	7	MR
166	C-870	13.9	5	MS	10	3	MR	12	MS
167	C-878	16.3	7	S	9.8	3	MR	13	MS
168	C-879	10.9	5	MS	11.2	5	MS	11	MS
169	C-884	8.4	3	MR	8.0	3	MR	8	MR
170	C-891	9.8	3	MR	11.4	5	MS	11	MS
171	C-901	5.6	3	MR	5.0	1	R	5	R
172	C-902	6.8	3	MR	4.8	1	R	6	MR
173	C-903	4.3	1	R	4.0	1	R	4	R
174	C-1165	10.4	3	MR	6.8	3	MR	9	MR
175	C-1167	6.3	3	MR	6.3	3	MR	6	MR
176	C-1170	4.4	1	R	10.3	3	MR	7	MR
177	C-1172	6	3	MR	7.5	3	MR	7	MR
178	C-1175	10.4	3	MR	10.3	3	MR	10	MR
179	C-1176	4.3	1	R	4.3	1	R	4	R
180	C-1179	4.9	1	R	2.8	1	R	4	R
181	C-1180	10.8	5	MS	10.3	3	MR	11	MS
182	C-1181	13.9	5	MS	14.2	5	MS	14	MS
183	C-1185	10.4	3	MR	16.8	7	S	14	MS
184	C-1199	9.2	3	MR	10.2	3	MR	10	MR
185	C-1205	11.8	5	MS	10.9	5	MS	11	MS
186	C-1226	10.2	3	MR	6.4	3	MR	8	MR
187	C-1237	6.8	3	MR	2.8	1	R	5	R
188	C-1241	4.3	1	R	4.0	1	R	4	R
189	C-1247	6.1	3	MR	4.1	1	R	5	R
190	C-1248	10.4	3	MR	3.9	1	R	7	MR
191	C-1249	9.8	3	MR	6.8	3	MR	8	MR
192	C-1257	6.3	3	MR	9.4	3	MR	8	MR
193	C-1259	9	3	MR	9.3	3	MR	9	MR
194	C-1289	9.8	3	MR	6.9	3	MR	8	MR
195	C-1320	10.3	3	MR	11.2	5	MS	11	MS
196	C-1328	11.8	5	MS	10.0	3	MR	11	MS
197	C-1372	4	1	R	3.2	1	R	4	R
198	C-1378	6.9	3	MR	3.5	1	R	5	R
199	C-1391	18.2	7	S	4.8	1	R	12	MS
200	C-1394	10.5	5	MS	6.8	3	MR	9	MR
201	C-1397	6.2	3	MR	6.0	3	MR	6	MR
202	C-1398	4.9	1	R	2.3	1	R	4	R
203	C-1406	11.8	5	MS	6.9	3	MR	9	MR
204	C-1430	19.3	7	S	11.5	5	MS	15	MS
205	C-1433	2.4	1	R	3.5	1	R	3	R

206	C-1436	18.6	7	S	21.0	7	S	20	S
207	C-1439	7.4	3	MR	8.3	3	MR	8	MR
208	C-1448	10.6	5	MS	10.0	3	MR	10	MR
209	C-1449	10.5	5	MS	6.8	3	MR	9	MR
210	C-1453	10.3	3	MR	8.3	3	MR	9	MR
211	C-1463	10.9	5	MS	6.8	3	MR	9	MR
212	C-1464	3.6	1	R	2.5	1	R	3	R
213	C-1474	16.8	7	S	8.6	3	MR	13	MS
214	C-1475	10.4	3	MR	7.3	3	MR	9	MR
215	C-1548	11.0	5	MS	8.6	3	MR	10	MR
Checks	TN1	22.7	7	S	17.6	7	S	20	S
	Local	17.0	7	S	14.6	5	MS	16	S
Mean		11.47	-	-	9.98	-	-	10.73	-
Std. Dev.		7.26	-	-	7.58	-	-	7.42	-
Std. Error		0.49	-	-	0.51	-	-	0.50	-
CV(%)		63.30	-	-	75.86	-	-	69.58	-

Table.5 The promising rice genotypes identified against rice yellow stem borer

S.No	IC No.	Dead hearts						White ears					
		kharif 2016		*kharif* 2017		Mean		*kharif* 2016		*kharif* 2017		Mean	
		% DH	Status	% DH	Status	% DH	Status	% WE	Status	% WE	Status	% WE	Status
1	381538	11.6	MR	14.3	MR	13	MR	10.8	MS	10.1	MR	10	MR
2	450535	16.9	MR	11.4	MR	14	MR	6.5	MR	3.5	R	5	R
3	463380	10.5	MR	10.8	MR	11	MR	4.3	R	2.9	R	4	R
4	464140	16.9	MR	13.4	MR	15	MR	5.6	MR	5.0	R	5	R
5	464186	16.8	MR	13.4	MR	15	MR	4.3	R	4.0	R	4	R
6	574807	16.3	MR	13.2	MR	15	MR	6.1	MR	4.1	R	5	R
7	578388	11.9	MR	10.8	MR	11	MR	4.0	R	3.2	R	4	R

MR : Moderately Resistant; R : Resistant

Identification of resistant entries of rice genotypes against yellow stem borer (pooled mean of two seasons)

The cumulative mean of per cent white ear damage by yellow stem borer for two consecutive *kharif* seasons inferred that out of 215 rice genotypes screened at field level, 14 entries registered stem borer incidence less than 5.0 per cent and categorized as resistant entries (R). A sum of 101, 82 and 17 entries were rated as moderately resistant (MR), moderately susceptible (MS) and susceptible (S) with per cent white ears damage ranged from 6-10, 11-15 and 16-20 per cent, respectively. One entry (C-490) had exhibited highly susceptible (HS) status with 30 per cent WE as against the lowest in C-1433 and C-1464 entries with only 3.0 per cent white ears damage.

Considering the influence of damage by yellow stem borer at vegetative stage and reproductive stage in terms of dead hearts and white ears, respectively and their impact on yield only seven genotypes were identified as resistance/ moderately resistant entries out of 215 entries screened, that had exhibited lowest pest damage and considered as promising entries to be utilized for further biochemical analysis and breeding programmes. The selected seven promising genotypes of rice with indigenous collection number (IC no) were 381538, 450535, 463380, 464140, 464186, 574807 and 578388, respectively (Table 5).

From the present investigation trial, it was clearly witnessed that, most of the rice genotypes which were resistance/ moderately resistant to the dead hearts damage by yellow stem borer at vegetative stage had exhibited moderately susceptible or susceptible reaction to white ears damage at reproductive stage and vice versa. The result was in agreement with the findings of Pathak *et al.*, (1971) who inferred that the rice varieties exhibiting resistance at dead heart stage were found susceptible at white ear stage demonstrating the resistance at both stages as independent factors.

The screening studies by Pandey and Choubey (2011) also supported the present results stating that resistance reaction by rice varieties against yellow stem borer differed among the seasons. They have screened 60 rice germplasm against rice stem borer for two successive *kharif* seasons (2003 & 2004) and notified that among 60 rice entries 35, 29 and 6 entries were rated as resistant, moderately resistant and susceptible respectively. Whereas 31, 21 and 8 germplasm were rated as resistant, moderately resistant and susceptible entries, respectively during *kharif*, 2004.

The above reports indicated variation in performance of rice varieties among seasons and were further supported by findings of Justin and Preetha (2014) who screened 77 genotypes during *kharif*, 2011 & 2012 and 57 genotypes during *rabi* 2011 & 2012 for their reaction to rice YSB. During *kharif* 2011, the genotypes TP 08079, TP 10015, TP 10019, TP 10029 and TP 10031 were promising with meager incidence and rated as highly resistant. While, the genotypes TP 10006, TP 10007, TP 10008, TP 10009, TP 10010, TP10011 and TP 10012 were highly resistant with scale ‘0’ at both vegetative and reproductive stages of *kharif*, 2012. Out of 57 genotypes screened for the year, *rabi* 2011, TP 10007 recorded nil incidence and rated as highly resistant while at *rabi* 2012, 15 genotypes recorded nil incidence of stem borer. The genotype TP 10052 & TP 08033 and T P 09119 were rated as resistant during *kharif* and *rabi* seasons, respectively.

Similar screening trials in rice by Mohan *et al.*, (2003) stated that W1263 and TKM 6 had exhibited significantly low damage of YSB infesting rice at both vegetative (% DH) and reproductive stages (% WE) of crop growth. Prasad *et al.*, (2015) evaluated 55 promising rice genotypes against yellow stemborer along with susceptible check variety (TN1) and resistant check (variety Suraksha) and inferred that genotypes RP-Bio-Patho-02, BPT-5204 and R-DRR-02 were promising and highly resistant with 0.67, 0.78 and 1.22 per cent mean stem borer infestation in comparison to susceptible check and resistant check with 20.69 and 5.22 per cent mean YSB infestation, respectively. Field screening trails by Rishikesh *et al.*, (2018) for 73 rice genotypes during *kharif* 2016 and 2017 against rice yellow stem borer witnessed that lowest white ears damage was recorded in IR 36, R 1700-302-1-156-1, Shyamla and IR 64 with 0.0, 0.17, 0.17 & 0.1 per cent white ears per plant on each genotypes, respectively

In conclusions, field screening trials revealed seven promising rice genotypes (IC No. 381538, 450535, 463380, 464140, 464186, 574807 and 578388) exhibiting moderate resistance/ resistance to yellow stem borer both in terms of per cent dead hearts and white ears. The selected promising rice germplasm against yellow stem borer from the present investigations can be further studied for bio chemical analysis. The molecular characterization and identification of QTLs for resistance against stem borers through molecular markers may be utilized for introgression of resistant genes in the breeding programmes of rice cultures.

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