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Screening of certain rice entries against Asian rice gall midge, *Orseolia oryzae* (Wood-Mason) in Warangal, Telangana

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Abstract
173 rice entries were screened against gall midge [*Orseolia oryzae* (Wood-Mason)] for resistance at Professor Jayashankar Telangana State Agricultural University (PJTSAU), Regional Agricultural Research Station, Warangal, Telangana during wet season (*Kharif*) of 2019 under delayed planting situation ensuring sufficient pest load. Among 173 rice entries screened, three entries *viz*., IBT MRR 18, IBT MRR 23 and IBT MRR 24 were found highly resistant and six entries *viz*., IBT MRR 17, IBT MRR 19, IBT MRR 20, IBT MRR 21, IBT MRR 22 and IBT MRR 28 had shown resistant reaction against gall midge. These entries can be used in breeding programmes as a source of gall midge resistance or could be released as varieties, if found promising for yield traits.

Keywords: Gall midge, resistance, rice, screening

1. Introduction
Rice is the most important staple food crop of India, which provides instant energy with high carbohydrate content to millions of Indians. Many biotic and abiotic factors influence the productivity of rice. Among the biotic factors, insect pests play a vital role in reducing the yields of rice. Nearly 300 species of insect pests attack the rice crop at different stages, of which, only 23 species cause notable damage [9]. Among these, Asian rice gall midge, *Orseolia oryzae* (Wood-Mason) is an important pest which has been prevalent in almost all the rice growing states in India except Western Uttar Pradesh, Uttaranchal, Punjab, Haryana and Hill states of Himachal Pradesh and Jammu and Kashmir [2]. This is essentially a monsoon pest and causes damage wherever high humidity and moderate temperature prevail, even in dry seasons [6]. This pest attacks rice from the seedling to the end of the tillering stage. In India, it is rated as the third most important pest of rice in terms of spread and severity of damage and yield loss [1]. Warangal is an endemic region to rice gall midge especially when the transplantings are delayed due to late onset of monsoon or due to late release of water into canals.
Use of insecticides may not be effective against rice gall midge due to internal feeding habit of this pest. Among different management strategies that are employed to reduce the damage caused by this insect-pest, use of resistant rice varieties appears to offer the most effective component for incorporation into an integrated pest management strategy [13]. The present experiment was conducted to evaluate rice entries against gall midge in Warangal, Telangana, India.

2. Materials and Methods
The present experiment was conducted in Professor Jayashankar Telangana State Agricultural University (PJTSAU), Regional Agricultural Research Station, Warangal, Telangana during wet season (*Kharif*) of 2019. 173 different rice entries developed at different research stations of PJTSAU, were evaluated for field resistance against gall midge. Delayed sowing (by one month) was done for natural build up of gall midge in the experimental block.
Nursery of the test entries along with susceptible check TN-1 was grown on raised beds. Sowing was done on 21st July, 2019 and transplanted on 22nd August, 2019 at a spacing of 20 cm between the rows and 15 cm between the plants within the row. Each test entry had 20 plants transplanted in a single row. For every 9 test entries, infestor row of susceptible check TN-1 was grown. TN-1 was also grown as border rows around the block of test entries to facilitate sufficient pest buildup.

All the recommended agronomic practices were followed during the crop growth period except plant protection. Observations on gall midge incidence were recorded twice at 31-33 and 53-60 days after transplanting. Number of plants and number of plants with silver shoots were counted and per cent plant damage was arrived at using the formula:

$$\text{Per cent Plant Damage (PD\%)} = \frac{\text{Number of plants with silver shoots}}{\text{Total number of plants}} \times 100$$

Similarly, data were recorded on number of tillers and number of silver shoots in all the 20 plants. Mean was calculated and per cent silver shoot damage (tiller damage) was arrived at using the formula:

$$\text{Per cent Silver Shoots (SS \%)} = \frac{\text{Mean number of silver shoots per plant}}{\text{Mean number of tillers per plant}} \times 100$$

Then, the test entries were assessed for gall midge damage as per Standard Evaluation System (Table 1), International Rice Research Institute (IRRI) for gall midge [4].

Table 1: Standard Evaluation System scale for scoring the reaction against gall midge

Per cent damage	Score	Reaction
Based on Per cent silver shoots		
0	0	Highly Resistant
<1	1	Resistant
1-5	3	Moderately Resistant
6-10	5	Moderately Susceptible
11-25	7	Susceptible
>25	9	Highly Susceptible
Based on Per cent plant damage		
0-10		Resistant
>10		Susceptible

3. Results and Discussion

Perusal of the data recorded at 31-33 DAT (Table 2) indicated that, the susceptible check TN-1 had recorded plant damage in the range of 0-15 percent and tiller damage in the range of 0-1.89 percent silver shoots. At 53-60 DAT, 60-100 percent plant damage and 7.92 - 30.04 percent tiller damage (silver shoots) was recorded in TN-1, with mean of 80.45% plant damage and 13.23% silver shoots showing susceptible reaction with Score 7. Since the damage level was low during first observation, the test entries were assessed as per Standard Evaluation System of IRRI for gall midge based on the damage score recorded during second observation (*i.e.*, at 53-60 DAT). Gall midge incidence among the test entries was ranged from 0 – 100 percent plant damage and 0 – 37.96 percent silver shoots. It is observed that among 173 rice entries screened against gall midge, three entries *viz*., IBT MRR 18, IBT MRR 23 and IBT MRR 24 were found highly resistant with "nil" gall midge damage. Six entries *viz*., IBT MRR 17, IBT MRR 19, IBT MRR 20, IBT MRR 21, IBT MRR 22 and IBT MRR 28 had shown resistant reaction (<1% silver shoots). The entries *viz*., JGL 27356, JGL 33016, JGL 33138, JGL 33145, JGL 33310, JGL 33311, JGL 34594, JGLH 1, RNR 28359, RNR 28360, RNR 28361, IBT MRR 03, IBT MRR 25, IBT MRR 26 and IBT MRR 27 were found to be moderately resistant with 1-5% silver shoots. However, except IBT MRR 03, all the moderately resistant entries recorded more than 10% plant damage. All the other test entries recorded damage score of 5-9 and showed moderately susceptible to highly susceptible reaction against gall midge.

Table 2: Screening of rice entries against Gall midge during *Kharif*, 2019

S. No.	Entry	I Observation (31 -33 DAT)		II Observation (53-60 DAT)		Damage Score#	Reaction#
		% Plant Damage	% Silver shoots	% Plant Damage	% Silver shoots		
1	KNM 6854	5.00	0.27	90.00	7.87	5	MS
2	KNM 6856	10.00	0.52	95.00	8.20	5	MS
3	KNM 6869	0.00	0.00	80.00	11.22	7	S
4	KNM 6871	5.00	0.45	90.00	13.81	7	S
5	KNM 6873	0.00	0.00	30.00	12.64	7	S
6	KNM 7037	10.00	0.84	80.00	13.58	7	S
7	KNM 7048	0.00	0.00	60.00	12.38	7	S
8	KNM 7624	0.00	0.00	85.00	15.08	7	S
9	KNM 7632	5.00	0.50	90.00	14.17	7	S
10	KNM 7633	5.00	0.61	80.00	16.13	7	S
11	KNM 7635	0.00	0.00	95.00	19.05	7	S
12	KNM 7660	0.00	0.00	85.00	16.38	7	S
13	KNM 7703	5.00	0.35	95.00	14.95	7	S
14	KNM 7715	0.00	0.00	90.00	12.15	7	S
15	KNM 7759	0.00	0.00	100.00	16.81	7	S
16	KNM 7771	0.00	0.00	85.00	12.09	7	S
17	KNM 7777	0.00	0.00	60.00	11.43	7	S
18	KNM 7778	0.00	0.00	80.00	13.09	7	S
19	KNM 7786	0.00	0.00	95.00	11.55	7	S
20	KNM 7787	10.00	0.73	90.00	14.47	7	S
21	JGL 27356	0.00	0.00	45.00	5.20	3	MR
22	JGL 28454	0.00	0.00	65.00	7.66	5	MS
23	JGL 32429	0.00	0.00	95.00	14.61	7	S

24	JGL 33016	0.00	0.00	30.00	3.45	3	MR
25	JGL 33124	0.00	0.00	65.00	14.03	7	S
26	JGL 33126	0.00	0.00	95.00	17.53	7	S
27	JGL 33138	0.00	0.00	35.00	3.06	3	MR
28	JGL 33145	0.00	0.00	15.00	1.82	3	MR
29	JGL 33164	0.00	0.00	65.00	12.83	7	S
30	JGL 33310	0.00	0.00	55.00	3.93	3	MR
31	JGL 33311	0.00	0.00	15.00	1.62	3	MR
32	JGL 34450	5.00	0.53	35.00	6.85	5	MS
33	JGL 34452	5.00	0.56	65.00	9.64	5	MS
34	JGL 34505	0.00	0.00	70.00	17.61	7	S
35	JGL 34540	0.00	0.00	90.00	13.06	7	S
36	JGL 34594	0.00	0.00	35.00	4.40	3	MR
37	JGLH 1	0.00	0.00	60.00	4.86	3	MR
38	JGLH 130	15.00	1.42	95.00	16.51	7	S
39	WGL 697	5.00	0.43	95.00	16.86	7	S
40	WGL 962	0.00	0.00	90.00	19.61	7	S
41	WGL 1083	10.00	0.71	90.00	18.71	7	S
42	WGL 1181	5.00	0.45	95.00	14.89	7	S
43	WGL 1191	0.00	0.00	95.00	19.57	7	S
44	WGL 1242	0.00	0.00	95.00	21.86	7	S
45	WGL 1246	5.00	0.33	90.00	15.22	7	S
46	WGL 1250	0.00	0.00	70.00	12.73	7	S
47	WGL 1252	0.00	0.00	75.00	10.71	7	S
48	WGL 1261	0.00	0.00	75.00	11.84	7	S
49	WGL 1262	0.00	0.00	85.00	11.98	7	S
50	WGL 1272	0.00	0.00	65.00	5.71	5	MS
51	WGL 1283	0.00	0.00	85.00	17.17	7	S
52	WGL 1289	0.00	0.00	95.00	18.12	7	S
53	WGL 1316	0.00	0.00	50.00	6.63	5	MS
54	WGL 1320	10.00	0.78	100.00	23.19	7	S
55	WGL 1355	0.00	0.00	95.00	17.43	7	S
56	WGL 1362	0.00	0.00	80.00	17.86	7	S
57	WGL 1413	10.00	1.71	60.00	10.81	7	S
58	RNR 15453-2	0.00	0.00	70.00	9.60	5	MS
59	RNR 15459-6	5.00	0.23	75.00	9.83	5	MS
60	RNR 15460-1	5.00	0.23	75.00	8.56	5	MS
61	RNR 15462-4	0.00	0.00	60.00	8.33	5	MS
62	RNR 21240	5.00	0.79	50.00	12.75	7	S
63	RNR 25988	10.00	1.12	85.00	13.36	7	S
64	RNR 26068	10.00	0.97	70.00	12.12	7	S
65	RNR 26121	10.00	0.73	85.00	17.36	7	S
66	RNR 28343	5.00	0.51	95.00	20.92	7	S
67	RNR 28348	15.00	2.00	85.00	11.72	7	S
68	RNR 28359	0.00	0.00	25.00	4.40	3	MR
69	RNR 28360	10.00	0.79	30.00	2.95	3	MR
70	RNR 28361	10.00	1.12	40.00	5.10	3	MR
71	RNR 28362	0.00	0.00	75.00	14.14	7	S
72	RNR 28367-2	15.00	1.30	90.00	16.12	7	S
73	RNR 28371-1	5.00	0.51	100.00	21.10	7	S
74	RNR 28373-1	10.00	1.31	95.00	30.05	9	HS
75	RNR 28389-1	5.00	0.37	95.00	18.06	7	S
76	RNR 28390	5.00	0.37	90.00	19.57	7	S
77	RNR 28399	10.00	1.11	90.00	19.51	7	S
78	RNR 28403	10.00	0.91	80.00	17.87	7	S
79	RNR 28408	0.00	0.00	50.00	15.15	7	S
80	RNRH 2	10.00	0.81	75.00	18.34	7	S
81	RNRH 3	0.00	0.00	100.00	20.50	7	S
82	RNRH 10	10.00	0.56	80.00	10.48	7	S
83	RNRH 15	30.00	1.87	95.00	25.95	9	HS
84	RNRH 18	20.00	2.35	100.00	37.96	9	HS
85	RNRH 27	30.00	2.25	100.00	30.86	9	HS
86	RNRH 29	35.00	2.87	90.00	19.69	7	S
87	RNRH 38	20.00	1.97	80.00	15.93	7	S
88	RNRH 39	25.00	2.20	100.00	36.68	9	HS
89	RNRH 59	35.00	3.61	100.00	26.47	9	HS
90	RNRH 62	5.00	0.44	100.00	30.09	9	HS
91	RNRH 66	15.00	1.91	100.00	31.56	9	HS

92	RNRH 68	25.00	2.07	100.00	26.38	9	HS
93	RNRH 77	10.00	0.89	95.00	21.53	7	S
94	RNRH 78	5.00	0.33	100.00	32.30	9	HS
95	RNRH 83	10.00	0.95	85.00	19.92	7	S
96	RNRH 87	25.00	1.81	95.00	28.19	9	HS
97	RNRH 92	5.00	0.52	50.00	7.50	5	MS
98	RNRH 94	15.00	1.31	100.00	28.92	9	HS
99	RNRH 95	0.00	0.00	75.00	16.44	7	S
100	RNRH 96	5.00	0.35	85.00	17.01	7	S
101	RNRH 98	0.00	0.00	95.00	17.18	7	S
102	RNRH 99	0.00	0.00	75.00	15.22	7	S
103	RNRH 100	5.00	0.51	95.00	16.67	7	S
104	RNRH 102	10.00	1.03	90.00	17.56	7	S
105	RNRH 105	5.00	0.46	90.00	17.03	7	S
106	RNRH 106	10.00	0.75	100.00	17.83	7	S
107	IRUE 02	20.00	1.71	95.00	23.53	7	S
108	IRUE 06	20.00	2.24	95.00	31.53	9	HS
109	IRUE 13	10.00	0.82	100.00	30.60	9	HS
110	IRUE 17	15.00	1.40	100.00	29.34	9	HS
111	IRUE 19	15.00	1.46	95.00	30.38	9	HS
112	IRUE 21	20.00	1.47	100.00	30.30	9	HS
113	IRUE 28	0.00	0.00	75.00	19.83	7	S
114	IRUE 29	0.00	0.00	85.00	21.19	7	S
115	IRUE 30	0.00	0.00	85.00	23.36	7	S
116	IRUE 31	0.00	0.00	90.00	14.93	7	S
117	IRUE 33	0.00	0.00	95.00	18.15	7	S
118	IRUE 34	0.00	0.00	65.00	13.06	7	S
119	IRUE 36	20.00	2.25	100.00	17.31	7	S
120	IRUE 38	5.00	0.49	80.00	13.94	7	S
121	IRUE 40	5.00	0.58	85.00	20.62	7	S
122	IRUE 41	5.00	0.61	75.00	16.00	7	S
123	IRUE 43	0.00	0.00	55.00	13.07	7	S
124	IRUE 45	0.00	0.00	95.00	16.59	7	S
125	IRUE 46	0.00	0.00	85.00	13.45	7	S
126	IRUE 47	0.00	0.00	85.00	19.31	7	S
127	IRUE 50	0.00	0.00	85.00	16.58	7	S
128	IRUE 52	0.00	0.00	65.00	15.32	7	S
129	IRUE 53	0.00	0.00	95.00	18.06	7	S
130	IRUE 58	5.00	0.49	80.00	16.59	7	S
131	RDR 1199	0.00	0.00	40.00	6.77	5	MS
132	RDR 1210	0.00	0.00	85.00	17.10	7	S
133	RDR 1221	0.00	0.00	50.00	12.50	7	S
134	RDR 1232	10.00	1.16	50.00	10.06	5	MS
135	RDR 1295	0.00	0.00	55.00	9.84	5	MS
136	IBT MRR 01	0.00	0.00	90.00	19.31	7	S
137	IBT MRR 02	15.00	1.22	100.00	16.67	7	S
138	IBT MRR 03	0.00	0.00	10.00	1.12	3	MR
139	IBT MRR 04	5.00	0.50	60.00	10.96	7	S
140	IBT MRR 05	0.00	0.00	55.00	10.45	5	MS
141	IBT MRR 06	0.00	0.00	75.00	12.76	7	S
142	IBT MRR 07	5.00	0.54	45.00	6.60	5	MS
143	IBT MRR 08	0.00	0.00	80.00	13.33	7	S
144	IBT MRR 09	10.00	0.64	90.00	16.67	7	S
145	IBT MRR 10	0.00	0.00	85.00	15.45	7	S
146	IBT MRR 11	20.00	1.91	75.00	13.20	7	S
147	IBT MRR 12	0.00	0.00	75.00	10.12	5	MS
148	IBT MRR 13	5.00	0.81	85.00	18.55	7	S
149	IBT MRR 14	0.00	0.00	95.00	15.51	7	S
150	IBT MRR 15	0.00	0.00	95.00	18.80	7	S
151	IBT MRR 16	5.00	0.38	100.00	17.75	7	S
152	IBT MRR 17	0.00	0.00	5.00	0.39	1	R
153	IBT MRR 18	0.00	0.00	0.00	0.00	0	HR
154	IBT MRR 19	0.00	0.00	10.00	0.67	1	R
155	IBT MRR 20	0.00	0.00	10.00	0.85	1	R
156	IBT MRR 21	0.00	0.00	5.00	0.35	1	R
157	IBT MRR 22	0.00	0.00	5.00	0.35	1	R
158	IBT MRR 23	0.00	0.00	0.00	0.00	0	HR
159	IBT MRR 24	0.00	0.00	0.00	0.00	0	HR

160	IBT MRR 25	0.00	0.00	20.00	2.31	3	MR
161	IBT MRR 26	0.00	0.00	30.00	1.60	3	MR
162	IBT MRR 27	5.00	0.35	35.00	3.65	3	MR
163	IBT MRR 28	5.00	0.40	10.00	0.68	1	R
164	IBT MRR C1	0.00	0.00	70.00	12.93	7	S
165	IBT MRR C2	0.00	0.00	55.00	8.33	5	MS
166	RNR 28344	0.00	0.00	80.00	16.23	7	S
167	RNR 29250	0.00	0.00	55.00	7.46	5	MS
168	WGL 1062	0.00	0.00	65.00	9.92	5	MS
169	KNM 6915	0.00	0.00	85.00	13.50	7	S
170	JGL 28639	0.00	0.00	55.00	9.13	5	MS
171	RNR 11450	0.00	0.00	65.00	9.88	5	MS
172	RNR 17941	0.00	0.00	60.00	7.89	5	MS
173	DSN-23 (K18)/ CB12 132	0.00	0.00	30.00	5.65	5	MS
174	TN-1 * (S.Check)	2.50	0.27	80.45	13.23	7	S

***** Mean incidence of all the infestor rows of TN-1

[#] Based on per cent silver shoots at second observation

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

In a study conducted at Chiplima, Odisha during 2016 the genotypes W 1263, INRC 3021, Sudu Hondarawala, PTB 26, RP4686-48-1-937, RMSG-11, WGL 1147, WGL 1127, WGL 1121, WGL 1131, WGL 1141, JGL 27058 exhibited resistance against gall midge [10]. At the same location, screening of 137 entries revealed that the germplasm lines *viz*., WGL 1164, WGL 1127, RP 5925, RP 1, INRC 3021, IBT R4, IBT GM (1, 2, 3, 4, 7, 9, 11, 12, 13, 16, 17, 18, 19, 20, 21, 22, 23, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 46), KNM 6854, IBT GM (5, 6, 10, 14, 15, 24, 44), W 1263, WGL 1147 were promising against gall midge [11]. The entry KNM 6854 showed moderate susceptibility in the present study (Table 2). This could be due to spatial variation in the gall midge population.

So far, 11 gall midge resistance genes have been characterized from different rice varieties and seven biotypes of the pest have been identified based on their reaction to these genes. Warangal derived gall midge population were characterized as a distinct new gall midge biotype and designated tentatively as GMB4M, as it is similar to biotype 4 but with added virulence against CR-MR1523 differential [8]. Sumathi and Manickam [12] tested different rice accessions at Rice Research Station, Tirur, Tamil Nadu during 2009 and found that the cultures *viz.*, RP 4683-29-2-645, RP 4683-30-1-648, RP 4686-49-1- 943, RP 4687-52-2-1197, RP 4688-53-2-1258, RP 4688-53-2-1259, JGL 17025, JGL 17183, JGL 17187, JGL 17189, KAVYA, JGL 17190, JGL 17196, JGL 17198, JGL 17211 and JGL 17221 recorded 'nil' damage and were resistant against gall midge in field screening. In the present study, the JGL cultures *viz.*, JGL 27356, JGL 33016, JGL 33138, JGL 33145, JGL 33310, JGL 33311, JGL 34594, JGLH 1 showed moderate resistant reaction against Warangal gall midge biotype. Promising varieties resistant to the rice gall midge were established in India (Shakti, Ptb 18, Leuang 152, Warangal 1263), where some of resistant varieties are utilized in paddy fields for practical control [3,5]. Cultivation of gall midge-resistant varieties such as Surekha and Phalguna on 70% of the rice areas in gall midge-endemic districts in Telangana and north coastal districts in Andhra Pradesh, reduced pest incidence considerably, resulting almost 45% increase in yield [7]. This reiterates the importance of growing gall midge resistant varieties in endemic areas.

4. Conclusion

On the basis of present investigation, it can be concluded that among 173 rice entries screened against gall midge, three entries *viz*., IBT MRR 18, IBT MRR 23 and IBT MRR 24 were highly resistant and six entries *viz.*, IBT MRR 17, IBT MRR 19, IBT MRR 20, IBT MRR 21, IBT MRR 22 and IBT MRR 28 were resistant against rice gall midge. These entries can be used in breeding programmes as a source of gall midge resistance or could be released as varieties, if found promising for yield.

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