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Screening of rice genotypes for resistance against rice gall midge, *Orseolia oryzae* (Wood-Mason) under field conditions

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Abstract
The investigation was conducted at S. G. College of Agriculture and Research Station, Jagdalpur, Bastar (C.G.). during *Kharif* 2022. Total 110 rice genotypes were screened against rice gall midge (*Orseolia oryzae* W.) and the incidence was recorded as silver shoot (SS%) on 30, 50 and 75 days after transplanting and scoring was done. From the results, out of 110 genotypes, 53 genotypes *i.e.,* KNM 11575, KNM 11579, JGL 38071 etc. were free from gall midge with 0% percent silver shoot found to be highly resistant to gall midge while, 2 genotypes *i.e.,* APKS 83-20 and RP6290-22-57 (RMS-22-14) were resistant with 0.63% and 0.98% silver shoots, 18 genotypes were moderately resistant, 6 genotypes were moderately susceptible, 6 genotypes were susceptible and 25 genotypes exhibited highly susceptible reaction against silver shoot incidence respectively.

Keywords: *Orseolia oryzae* W., screening, genotypes, rice

Introduction
Rice (*Oryza sativa* L.) is the world's single most important crop, belonging to the family Poaceae. It is one of the most significant cereals and a staple food for more than 2 billion people. In India, rice was grown on about 43 million hectares, with a production of about 118.43 million tonnes and an average productivity of 2.75 tonnes ha^{-1} (Anonymous, 2020a) [2]. Chhattisgarh is known as the "rice bowl of India," and about 82% of the population of the state is dependent on agriculture for their livelihood. The total rice grown area was 3.6 million hectares, with a production of 6.5 million tonnes and a productivity of 1.77 tonnes ha^{-1} (Anonymous, 2020b) [3]. Total production of rice during 2021-22 was recorded at 127.93 million tonnes. It was higher by 11.49 million tonnes than the last five years average production of 116.44 million tonnes (Anonymous, 2022) [4]. Historically, the rice gall midge was first reported as an unidentified insect pest on rice in Monghyr district of Bihar, India, by Ridley (1881) [12], which was later identified as *Cecidomyia oryzae* by Wood-Mason (Cotes, 1889) [7]. Felt (1921) [8] renamed the insect as *Pachydiplosis oryzae* and then by Gagne (1973) as *Orseolia oryzae*. In India, the first authentic report of this insect was published by the American naturalist during 1881 (Ridley, 1881) [12]. The Asian rice gall midge *Orseolia oryzae* (Wood-Mason) (Diptera: Cecidomyiidae) is a serious pest of rice (*Oryza sativa* L.) in India, causing an average annual yield loss of about US $80 million (Bentur *et al.,* 2003) [6]. Yield loss projections for damage due to 1% gall midge induced silver shoot damage was 3.5% loss (Muralidharan and Pasalu, 2005) [6].

Materials and Methods
The experiment was conducted at Research cum Instructional farm of Shaheed Gundadhoor College of Agriculture and Research Station, Jagdalpur, Baster (C.G.) 494001. 110 rice genotypes were screened on *Kharif*-2022. The row to row and plant to plant spacing was 15 x 15 cm. The gall midge infestation was calculated by the percent of silver shoots or onion leaves. These genotypes were sown on 5th July and were transplanted into the main field after one month and regular crop practices were followed in the main field. Gall midge incidence as silver shoots were recorded on 30, 50 and 75 days after transplanting and then percentage of silver shoots was worked out. Observations were recorded by counting the total number of plants, damaged plants, total number of tillers and total number of silver shoots. Acc. to Singh and Singh, 2017, percent silver shoot calculated by the given formula:

$$\text{Percent silver shoot (\%)} = \frac{\text{Number of silver shoots}}{\text{Total number of tillers}} \times 100$$

The percent infestation was checked on a 0-9 scale using the standard evaluation score (SES) for rice by IRRI (table 1).

Table 1: Standard evaluation system for rice gall midge

Scale	Damage (%)	Reaction
0	0% (No damage)	HR
1	<1%	R
3	1-5%	MR
5	6-10%	MS
7	11-25%	S
9	>25%	HS

(**Source:** Standard evaluation system for rice, IRRI, 2013)
(HR-highly resistant, R-resistant, MR-moderately resistant, MS-moderately susceptible, S-susceptible, HS-highly susceptible)

Results and Discussion

The experiment was conducted in research cum instructional farm of Shaheed Gundadhur College of Agriculture and Research Station, Jagdalpur, Bastar (C.G.) 494001 during *Kharif* 2022. The genotypes, 110 entries of rice were sown in the lines for gall midge screening and every line had 20 hills for gall midge screening. During the crop growth period, all agronomic procedures were followed. On 30, 50, and 75 DAT, the incidence of gall midges was recorded as silver shoots (SS), randomly ten hills selected from every line and the percentage of SS was calculated. The analysis of the data revealed that healthy tillers and damaged tillers/hills were recorded for the percentage of gall midge infestation. The resistance to gall midge was confirmed by observing ten randomly chosen hills from the lines out of 110 transplanted cultures/lines. A genotypes resistance level and silver shoot infection level were determined. The following responses of various rice accessions were noted as promising genotypes for gall midge infestation at the maximum tillering stage.

The percentages of infested tillers were classified into different six groups under 0-9 scale (IRRI, 2013). The data presented on Table 3 showed that the incidence of gall midge. Total 53 entries *viz.*, KNM 11575, KNM 11579, JGL 38071, JGL 38206, KNM 12392, WGL 1614*, WGL 1624*, RP 6614-112-11-4-2-1-1-1(19102)*, RP 6614-112-11-4-2-1-1-1(FBL 19112), Karma Mahsuri*, Mahamaya*, GM 5 (IBT)*, IBTWGL 2*, Akshayadhan (Gm4+Gm8)*, IBTWGL 3, IBTWGL 21, IBT WGL 31, RP 5923, RP 5922*, RP 6290-20-6, PTB18, PTB21, RP6290-21-22 (RMS-22-1), Aganni, RP6290-22-41 (RMS-22-7), RP6290-22-42 (RMS-22-8), RP6290-22-43 (RMS-22-9), RP6290-22-53 (RMS-22-10), RP6290-22-54 (RMS-22-11), RP6290-22-55 (RMS-22-12), RP6290-22-58 (RMS-22-15), RP6290-22-59 (RMS-22-16), RP6290-22-60 (RMS-22-17), RP6290-22-61 (RMS-22-18), RP6290-22-70 (RMS-22-21), RP6290-22-71 (RMS-22-22), RP6290-22-72 (RMS-22-23), RP6290-22-4 (RMS-22-24), RP6290-22-5 (RMS-22-25), RP6290-22-11 (RMS-22-26), RP6290-22-12 (RMS-22-27), RP6290-22-23 (RMS-22-29), GP 91, KNM 14282, Kavya, RNR 35112, WGL-1119, Aganni, WGL 1767, WGL 1790, WGL 1798, WGL 1800, W1263 were ranked with "0" scale (0% SS) and found to be (HR) highly resistance to gall midge.

The 2 entries *viz.*, APKS 83-20, RP6290-22-57 (RMS-22-14) were found score "1" scale to be resistance to gall midge incidence. The 18 entries *viz.*, RP 6614-102-11-3-3-1-1-1 (FBL 19101)*, APKS 82-75, RP6290-21-23 (RMS-22-2), RP6290-22-25 (RMS-22-4), RP6290-22-26 (RMS-22-5), RP6290-22-69 (RMS-22-20), RP6290-22-24 (RMS-22-30), KNM 14283, KNM 14382, RNR 35123, WGL 1789, WGL 1792, RP6504-46, RP6505-30, RP6505-31, Abhaya, RP6505-32, RP6505-89 were recorded under scale "3" MR (moderately resistant) to gall midge incidence (Table 3).

The 6 entries *viz.*, RP 6614-64-12-3-1-1-1 (FBL 19064)*, IBT WGL 1*, Abhaya, RP6290-21-24 (RMS-22-3), RP2068-18-3-5, RP6505-29 were "5" scale to be MS (moderately susceptible) to gall midge. The 6 entries *viz.*, GM 4 (IBT)*, PTB 10, WGL 1511, WGL 1778, WGL 1782, APKS 84-47 were "7" scale to be S (susceptible) to gall midge. The 25 entries *viz.*, WGL 1620*, TN1, ISM, RP6290-22-40 (RMS-22-6), RP6290-22-56 (RMS-22-13), RP6290-22-68 (RMS-22-19), TN1, RP6290-22-21 (RMS-22-28), KNM 14445, WGL 1512, WGL 1573, WGL 1590*, RP6503-3, RP6503-11, RP6503-13, RP6503-17, RP6503-59, RP6503-75, RP6503-76, RP6503-81, RP6503-86, TN1, RP6504-99, APKS 84-50, TN1 were recorded under scale "9" HS (highly susceptible) to gall midge (Table 3).

Previous researchers, Singh (1990) [14] tested the 137-rice genotype in Manipur, India. The most resistant to that site were R320-300, R321-108, RP2436-79-22-2, WGL18011-15, WGL 20471-97, WGL 26358, BPT 3624, W1263, Aganni, T1477 and Banglei. Similarly, Setty *et al.* (1994) [13] identified the varieties IET 9691, IET 11475, IET 12351, IET 12797, IET 12811, IR 36, Abhaya, Surekha and Shakthi as resistant among the 50 promising genotypes. Archana *et al.* (2012) [5] screened the 49 hybrid rice genotypes against gall midge of which 42 hybrids found to be susceptible (11-25% SS), 2 hybrids were highly susceptible (> 25% SS) and 5 hybrids were highly resistant (0% SS). Sumathi and Manickam (2013) [16] tested the 17 entries in GMBT, the entries *viz.*, ARC 6605 and INRC 3021 were recorded nil gall midge damage and found to be resistant to gall midge. The entries *viz.*, INRC 202 and INRC 1997 were found to be moderately susceptible. The entries *viz.*, Phalguna, Madhuri L 9, RP 2068-18-3-5, Abhaya and Aganni were found to be highly susceptible and the remaining 7 entries were found to be susceptible to gall midge damage. The check variety TN 1 was found to be susceptible with 14.7% gall midge damage. Kumar *et al.* (2020) [10] screened 173 rice entries against gall midge (*Orseolia oryzae* Wood-Mason); 3 entries, *viz.*, IBT MRR 18, IBT MRR 23 and IBT MRR 24, were found highly resistant and 6 entries, *viz.*, IBT MRR 17, IBT MRR 19, IBT MRR 20, IBT MRR 21, IBT MRR 22 and IBT MRR 28, showed a resistant reaction against gall midge.

Table 2: Reaction of different rice entries against rice gall midge (*Orseolia oryzae* W.)

No. of entries		Silver Shoots %			Damage Score	Reaction
		(30 DAT)	(50 DAT)	(75 DAT)		
1	KNM 11575	0.00	0.00	0.00	0	HR
2	KNM 11579	0.00	0.00	0.00	0	HR
3	JGL 38071	0.00	0.00	0.00	0	HR
4	JGL 38206	0.00	0.00	0.00	0	HR
5	KNM 12392	0.00	0.00	0.00	0	HR
6	WGL 1614*	0.00	0.00	0.00	0	HR
7	WGL 1620*	0.00	24.74	25.44	9	HS
8	WGL 1624*	0.00	0.00	0.00	0	HR
9	RP 6614-64-12-3-1-1-1 (FBL 19064)*	0.00	3.37	5.52	5	MS
10	TN1	0.00	49.12	35.06	9	HS
11	RP 6614-102-11-3-3-1-1-1(FBL 19101)*	0.00	0.00	2.52	3	MR
12	RP 6614-112-11-4-2-1-1-1(19102)*	0.00	0.00	0.00	0	HR
13	RP 6614-112-11-4-2-1-1-1(FBL 19112)	0.00	0.00	0.00	0	HR
14	Karma Mahsuri*	0.00	0.00	0.00	0	HR
15	Mahamaya*	0.00	0.00	0.00	0	HR
16	GM 4 (IBT)*	0.00	12.00	7.02	7	S
17	GM 5 (IBT)*	0.00	0.00	0.00	0	HR
18	IBT WGL 1*	0.00	5.00	7.83	5	MS
19	IBTWGL 2*	0.00	0.00	0.00	0	HR
20	Akshayadhan (Gm4+Gm8)*	0.00	0.00	0.00	0	HR
21	IBTWGL 3	0.00	0.00	0.00	0	HR
22	IBTWGL 21	0.00	0.00	0.00	0	HR
23	IBT WGL 31	0.00	0.00	0.00	0	HR
24	RP 5923	0.00	0.00	0.00	0	HR
25	APKS 82-75	0.00	0.00	1.54	3	MR
26	APKS 83-20	0.00	0.00	0.63	1	R
27	RP 5922*	0.00	0.00	0.00	0	HR
28	RP 6290-20-6	0.00	0.00	0.00	0	HR
29	PTB 10	0.00	13.74	4.25	7	S
30	Abhaya	0.00	9.68	0.00	5	MS
31	PTB18	0.00	0.00	0.00	0	HR
32	PTB21	0.00	0.00	0.00	0	HR
33	ISM	0.00	30.11	31.37	9	HS
34	RP6290-21-22 (RMS-22-1)	0.00	0.00	0.00	0	HR
35	RP6290-21-23 (RMS-22-2)	0.00	4.39	2.36	3	MR
36	RP6290-21-24 (RMS-22-3)	0.00	5.38	3.36	5	MS
37	RP6290-22-25 (RMS-22-4)	0.00	1.39	0.00	3	MR
38	RP6290-22-26 (RMS-22-5)	0.00	5.00	0.00	3	MR
39	RP6290-22-40 (RMS-22-6)	0.00	38.94	58.65	9	HS
40	Aganni	0.00	0.00	0.00	0	HR
41	RP6290-22-41 (RMS-22-7)	0.00	0.00	0.00	0	HR
42	RP6290-22-42 (RMS-22-8)	0.00	0.00	0.00	0	HR
43	RP6290-22-43 (RMS-22-9)	0.00	0.00	0.00	0	HR
44	RP6290-22-53 (RMS-22-10)	0.00	0.00	0.00	0	HR
45	RP6290-22-54 (RMS-22-11)	0.00	0.00	0.00	0	HR
46	RP6290-22-55 (RMS-22-12)	0.00	0.00	0.00	0	HR
47	RP6290-22-56 (RMS-22-13)	3.23	26.32	12.90	9	HS
48	RP6290-22-57 (RMS-22-14)	0.00	0.98	0.00	1	R
49	RP6290-22-58 (RMS-22-15)	0.00	0.00	0.00	0	HR
50	RP2068-18-3-5	0.00	7.69	3.96	5	MS
51	RP6290-22-59 (RMS-22-16)	0.00	0.00	0.00	0	HR
52	RP6290-22-60 (RMS-22-17)	0.00	0.00	0.00	0	HR
53	RP6290-22-61 (RMS-22-18)	0.00	0.00	0.00	0	HR
54	RP6290-22-68 (RMS-22-19)	1.22	29.27	26.23	9	HS
55	RP6290-22-69 (RMS-22-20)	0.00	2.15	0.00	3	MR
56	RP6290-22-70 (RMS-22-21)	0.00	0.00	0.00	0	HR
57	RP6290-22-71 (RMS-22-22)	0.00	0.00	0.00	0	HR
58	RP6290-22-72 (RMS-22-23)	0.00	0.00	0.00	0	HR
59	RP6290-22-4 (RMS-22-24)	0.00	0.00	0.00	0	HR
60	TN1	0.00	29.75	45.53	9	HS
61	RP6290-22-5 (RMS-22-25)	0.00	0.00	0.00	0	HR
62	RP6290-22-11 (RMS-22-26)	0.00	0.00	0.00	0	HR
63	RP6290-22-12 (RMS-22-27)	0.00	0.00	0.00	0	HR

64	RP6290-22-21 (RMS-22-28)	0.00	40.32	56.86	9	HS
65	RP6290-22-23 (RMS-22-29)	0.00	0.00	0.00	0	HR
66	RP6290-22-24 (RMS-22-30)	0.00	3.00	1.15	3	MR
67	GP 91	0.00	0.00	0.00	0	HR
68	KNM 14282	0.00	0.00	0.00	0	HR
69	KNM 14283	0.00	0.00	2.82	3	MR
70	Kavya	0.00	0.00	0.00	0	HR
71	KNM 14382	0.00	3.45	4.94	3	MR
72	KNM 14445	4.55	26.52	24.44	9	HS
73	RNR 35112	0.00	0.00	0.00	0	HR
74	RNR 35123	0.00	0.00	2.88	3	MR
75	WGL-1119	0.00	0.00	0.00	0	HR
76	WGL 1511	1.33	11.11	5.19	7	S
77	WGL 1512	1.32	35.56	19.23	9	HS
78	WGL 1573	3.28	56.52	43.43	9	HS
79	WGL 1590*	3.45	33.33	40.54	9	HS
80	Aganni	0.00	0.00	0.00	0	HR
81	WGL 1767	0.00	0.00	0.00	0	HR
82	WGL 1778	1.33	13.73	3.90	7	S
83	WGL 1782	0.00	16.47	2.70	7	S
84	WGL 1789	0.00	4.84	3.74	3	MR
85	WGL 1790	0.00	0.00	0.00	0	HR
86	WGL 1792	0.00	1.11	1.49	3	MR
87	WGL 1798	0.00	0.00	0.00	0	HR
88	WGL 1800	0.00	0.00	0.00	0	HR
89	RP6503-3	3.17	57.40	57.93	9	HS
90	W1263	0.00	0.00	0.00	0	HR
91	RP6503-11	1.69	38.46	50.00	9	HS
92	RP6503-13	0.34	38.52	56.88	9	HS
93	RP6503-17	0.00	48.25	23.86	9	HS
94	RP6503-59	0.00	32.41	33.33	9	HS
95	RP6503-75	0.00	37.40	47.96	9	HS
96	RP6503-76	0.00	45.57	78.13	9	HS
97	RP6503-81	0.00	50.68	61.21	9	HS
98	RP6503-86	0.00	57.97	53.49	9	HS
99	RP6504-46	0.00	2.06	0.00	3	MR
100	TN1	0.00	53.85	56.84	9	HS
101	RP6504-99	1.12	43.33	34.86	9	HS
102	RP6505-29	2.67	9.52	1.10	5	MS
103	RP6505-30	0.00	2.91	1.23	3	MR
104	RP6505-31	0.00	2.04	0.00	3	MR
105	Abhaya	1.32	3.30	0.00	3	MR
106	RP6505-32	0.00	2.08	1.28	3	MR
107	RP6505-89	4.88	0.92	0.00	3	MR
108	APKS 84-47	3.00	19.82	21.62	7	S
109	APKS 84-50	0.00	21.90	42.70	9	HS
110	TN1	1.12	27.73	31.17	9	HS

Score = 0-Highly resistant (0% SS), 1-Resistant (<1% SS), 3-Moderately resistant (1-5% SS), 5-Moderately susceptible (6-10% SS), 7-Susceptible (11-25% SS), 9-Highly susceptible (>25% SS).

Table 3: Screening of rice genotypes against gall midge

Percent damage	Score	Reaction	No. of entries	Name of entries	Range of SS (%)
0%	0	HR	53	KNM 11575, KNM 11579, JGL 38071, JGL 38206, KNM 12392, WGL 1614*, WGL 1624*, RP 6614-112-11-4-2-1-1-1(19102)*, RP 6614-112-11-4-2-1-1-1(FBL 19112), Karma Mahsuri*, Mahamaya*, GM 5 (IBT)*, IBTWGL 2*, Akshayadhan (Gm4+Gm8)*, IBTWGL 3, IBTWGL 21, IBT WGL 31, RP 5923, RP 5922*, RP 6290-20-6, PTB18, PTB21, RP6290-21-22 (RMS-22-1), Aganni, RP6290-22-41 (RMS-22-7), RP6290-22-42 (RMS-22-8), RP6290-22-43 (RMS-22-9), RP6290-22-53 (RMS-22-10), RP6290-22-54 (RMS-22-11), RP6290-22-55 (RMS-22-12), RP6290-22-58 (RMS-22-15), RP6290-22-59 (RMS-22-16), RP6290-22-60 (RMS-22-17), RP6290-22-61 (RMS-22-18), RP6290-22-70 (RMS-22-21), RP6290-22-71 (RMS-22-22), RP6290-22-72 (RMS-22-23), RP6290-22-4 (RMS-22-24), RP6290-22-5 (RMS-22-25), RP6290-22-11 (RMS-22-26), RP6290-22-12 (RMS-22-27), RP6290-22-23 (RMS-22-29), GP 91, KNM 14282, Kavya, RNR 35112, WGL-1119, Aganni, WGL 1767, WGL 1790, WGL 1798, WGL 1800, W1263	0%
<1%	1	R	2	APKS 83-20, RP6290-22-57 (RMS-22-14)	0.63-0.98%
1-5%	3	MR	18	RP 6614-102-11-3-3-1-1-1(FBL 19101)*, APKS 82-75, RP6290-21-23 (RMS-22-2),	1.39-5.00%

				RP6290-22-25 (RMS-22-4), RP6290-22-26 (RMS-22-5), RP6290-22-69 (RMS-22-20), RP6290-22-24 (RMS-22-30), KNM 14283, KNM 14382, RNR 35123, WGL 1789, WGL 1792, RP6504-46, RP6505-30, RP6505-31, Abhaya, RP6505-32, RP6505-89	
6-10%	5	MS	6	RP 6614-64-12-3-1-1-1 (FBL 19064)*, IBT WGL 1*, Abhaya, RP6290-21-24 (RMS-22-3), RP2068-18-3-5, RP6505-29	5.38-9.68%
11-25%	7	S	6	GM 4 (IBT)*, PTB 10, WGL 1511, WGL 1778, WGL 1782, APKS 84-47	11.11-21.62%
>25%	9	HS	25	WGL 1620*, TN1, ISM, RP6290-22-40 (RMS-22-6), RP6290-22-56 (RMS-22-13), RP6290-22-68 (RMS-22-19), TN1, RP6290-22-21 (RMS-22-28), KNM 14445, WGL 1512, WGL 1573, WGL 1590*, RP6503-3, RP6503-11, RP6503-13, RP6503-17, RP6503-59, RP6503-75, RP6503-76, RP6503-81, RP6503-86, TN1, RP6504-99, APKS 84-50, TN1	25.44-78.13%
		Total	110		

* HR-highly resistant, R-resistant, MR-moderately resistant, MS-moderately susceptible, S-susceptible, HS-highly susceptible.

Conclusion

A total of 110 genotypes were examined for gall midge resistance, of which 53 genotypes *i.e.,* KNM 11575, KNM 11579, JGL 38071 etc. were determined to be highly resistant, 2 genotypes were resistant *i.e.,* APKS 83-20 and RP6290-22-57 (RMS-22-14), 18 were moderately resistant, 6 were moderately susceptible, 6 were susceptible and 25 were highly susceptible. In RP6503-76, the highest infection percentage of 78.13 percent was reported. The 55 genotypes were found to be promising genotypes, they can be developed as varieties or utilised as a source of gall midge resistance in breeding programmes.

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