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Atanu Seni
Orissa University of Agriculture and Technology, AICRIP, RRTTS, Chiplima, Sambalpur, Odisha, India

Bhima Sen Naik
Orissa University of Agriculture and Technology, AICRIP, RRTTS, Chiplima, Sambalpur, Odisha, India

Correspondence
Atanu Seni
Orissa University of Agriculture and Technology, AICRIP, RRTTS, Chiplima, Sambalpur, Odisha, India

Evaluation of rice germplasm against rice gall midge, *Orseolia oryzae* (Wood-Mason)

Atanu Seni and Bhima Sen Naik

Abstract
In order to develop rice cultivars for resistance to the gall midge, *Orseolia oryzae* (Wood-Mason), some rice entries were screened under natural field conditions at the Chiplima, OUAT, Odisha under All India Coordinated Rice Improvement Project during *kharif*, 2018. Gall midge incidence as silver shoot was recorded on 30 and 50 days after transplanting and scoring was done. ***H***ighest incidence of silver shoot was recorded in TN-1 (38.85% SS after 50 DAT) whereas 52 entries 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 found resistant to gall midge. So, they can be developed as varieties or can be used in breeding programme as a source of gall midge resistance.

Keywords: Gall midge, chiplima, rice cultivars, screening, field

Introduction

Rice is the most important cereal food crop of India covering about one-fourth of the total cropped area and providing food to about half of the Indian population. It grows well under different topographic and hydrologic conditions ranging from rain fed upland to rain fed lowland as well as in deep water condition. But, its production is hampers due to the infestation of various insect pests. Nearly 300 species of insect pests attack the rice crop at different stages and among them only 23 species cause notable damage [8]. Asian rice gall midge (ARGM), *Orseolia oryzae* (Wood-Mason) is one of the important insect which has been prevalent in almost all the rice growing states in India except the Western Uttar Pradesh, Uttaranchal, Punjab, Haryana and Hill states of Himachal Pradesh and Jammu and Kashmir [2]. Although occasional outbreaks of gall midge were reported prior to the 1960s [1], but the problem became extensive following the introduction and widespread cultivation of dwarf and high-yielding rice cultivars. The Asian rice gall midge has been reported as a pest in several Asian countries including Bangladesh, China, Cambodia, India, Indonesia, Lao PDR, Myanmar, Sri Lanka, Thailand, and Vietnam. The African rice gall midge (AfRGM) is reported in several African countries including Benin, Burkina Faso, Cameroon, Chad, Côte d'Ivoire, Gambia, Ghana, Guinea, Guinea Bissau, Malawi, Mali, Niger, Nigeria, Senegal, Sierra Leone, Sudan, Tanzania, Togo, Uganda, and Zambia [1]. It causes an annual yield loss of 0.8% of the total production, amounting to US$80 million [1]. It is also observed that in some areas in Odisha, hybrid rice recorded as much as 90% crop damage with a yield loss of about 70% [1]. This is essentially a monsoon pest and causes damage wherever high humidity and moderate temperature prevail, even in dry seasons [5]. The external symptom of damage caused by gall midge is the production of a silvery-white, tubular leaf sheath gall called a *silver shoot* or *onion shoot*. This is due to the feeding and salivary secretion by the larvae which turn the growing shoot meristem into a gall [2]. This renders the tiller sterile and do not bear panicle [11]. Chemical management is some extent effective against the pest but not desirable because only adults and eggs are exposed to the chemical, while the internal feeding stages escape as well as increases the cultivation cost [1]. Preventive control measures such as nursery treatment and seedling root dips are cost-effective, but have not been accepted by farmers because of the unpredictable nature of pest occurrence. The adoption of resistant cultivars is highly appreciated by farming community as this involves less cost and no requirement of insecticides and other cultural practices [7]. Beside this, as varietal resistance is a key component of integrated pest management [15] so, screening for host-plant resistance against

Gall midge is necessary at hot-spot locations. Sambalpur in Odisha is considered as one of the endemic pockets for gall midge in India [1] so, the present work was undertaken for screening the rice germplasm to find out the resistance sources against this pest.

2. Materials and Methods

Experimental site

The experiment was conducted in the experimental farm of Regional Research and Technology Transfer Station (OUAT), Chiplima, Sambalpur, Odisha, during *kharif,* 2016. The Station is situated at $20^{0}21'$ N latitude and $80^{0}55'$E longitude in Dhankauda block of Sambalpur district at an altitude of 178.8 m above MSL. The climate of the area is warm/sub humid.

Source of rice germplasm

Different rice germplasm were obtained from ICAR-IIRR, Hyderabad and were evaluated to find out the field resistance against rice gall midge.

Field experiment

Nurseries of different rice germplasm were sown in the July and transplanting was done after 25 days of sowing at 15 cm x 15 cm hill spacing. All the agronomic practices were followed during crop growth period.

Data collection and analysis

Gall midge incidence as silver shoot was recorded on 30 and 50 days after transplanting and then percentage of silver shoot (SS) was worked out by using the formula; SS (%) = Number of silver shoot/ Total number of tillers observed in 10 hills × 100. Then, the pest intensity was scored as per standard evaluation system, International Rice Research Institute (IRRI) [3] for gall midge.

Table 1: Standard evaluation system for rice gall midge

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

3. Results and Discussion

Rice gall midge is one of the major pests of rice in Hirakud command area, Sambalpur, Odisha [13]. From the table 2 it is observed that among 137 rice entries screened against gall midge, the entries 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) were found highly resistant. The entries viz., KNM 6854, IBT GM (5, 6, 10, 14, 15, 24, 44), W 1263, WGL 1147 were found resistant. Whereas, the entries viz., JGL (32485, 33100, 34450, 34594), KNM (6869, 6871, 6872), Aganni, KAVYA, ARC 5906, INRC 17470, PTB 32, SKL 07-13-316-8-31-65-44, SKL 07-08-720-63-147-182-276, SKL 06-02-27-13-54-239-34 were found to be moderately resistant and the remaining entries were found moderate susceptible to highly susceptible against gall midge.

Table 2: Reaction of different rice entries against rice gall midge

Entry No.	Name of entry	Silver shoot (SS)%		Reaction
		30 DAT	50 DAT	
1	JGL 24267	17.14	20.83	HS
2	JGL 28547	2.53	8.86	MS
3	JGL 32429	13.64	25.41	HS
4	JGL 32467	17.86	12.38	S
5	JGL 32485	2.82	3.57	MR
6	JGL 32979	12.86	16.05	S
7	JGL 33037	19.18	18.56	S
8	JGL 33049	16.44	20.83	S
9	JGL 33077	14.10	17.44	S
10	JGL 33080	15.79	22.22	S
11	JGL 33100	4.21	2.00	MR
12	JGL 33124	0.00	5.19	MS
13	JGL 33130	2.38	6.17	MS
14	JGL 33366	4.69	9.52	MS
15	JGL 33399	15.79	24.39	S
16	JGL 33430	3.41	7.59	MS
17	JGL 33440	2.67	4.94	MR
18	JGL 33508	25.00	33.33	HS
19	JGL 33510	16.95	32.76	HS
20	TN 1	26.36	38.85	HS
21	JGL 34450	1.20	2.33	MR
22	JGL 34505	2.78	5.71	MS
23	JGL 34508	7.14	6.41	MS
24	JGL 34540	8.64	14.86	S
25	JGL 34560	12.50	13.04	S
26	JGL 34564	25.00	27.50	HS
27	JGL 34569	24.56	24.53	S
28	JGL 34594	3.28	2.67	MR
29	KNM 6854	1.28	0.00	R
30	KNM 6868	0.00	0.00	HR

31	KNM 6869	1.85	3.16	MR
32	KNM 6871	0.00	4.00	MR
33	KNM6872	0.00	1.08	MR
34	KNM 6873	0.00	5.48	MS
35	KNM 6881	15.28	24.14	S
36	KNM 6905	12.12	21.13	S
37	KNM 6907	17.72	20.51	S
38	KNM 6915	20.31	19.23	S
39	KNM 6927	10.26	20.48	S
40	Aganni	1.16	0.00	MR
41	KNM 6928	10.48	20.59	S
42	KNM 6929	7.79	22.89	S
43	KNM 7037	19.05	25.00	S
44	KNM 7055	11.58	27.55	S
45	SKL 07-11-117-50-65-60-267	2.78	12.33	S
46	SKL 07-11-177-50-84-12-40	2.74	7.79	MS
47	SKL 07-13-316-8-31-65-44	3.30	2.33	MR
48	SKL 07-16-87-38-12-154-118	3.61	8.60	MS
49	SKL 07-08-720-63-147-182-276	1.37	0.00	MR
50	SKL 06-02-27-13-54-239-34	2.59	2.50	MR
51	WGL-1151	5.63	4.29	MS
52	WGL-1153	8.57	8.45	MS
53	WGL-1164	0.00	0.00	HR
54	WGL-1175	16.67	20.93	S
55	WGL-1176	15.73	27.08	HS
56	WGL-1178	5.41	23.26	S
57	WGL-1180	16.25	33.98	HS
58	WGL-1187	21.98	31.00	HS
59	WGL-1191	10.47	20.69	S
60	WGL-1196	2.60	18.92	S
61	ARC 6626	6.74	18.63	S
62	AMBEMOHAR	11.43	22.78	S
63	ARC 5906	2.20	5.13	MR
64	ARC 5913	6.90	15.00	S
65	ARC 6601	12.33	15.28	S
66	ARC 6625	11.27	13.33	S
67	KOLLIMALAISAMBA	13.92	9.46	S
68	GEB 24	9.32	20.00	S
69	Kavya	4.71	6.98	MS
70	INRC 17438	13.41	22.99	S
71	IC 330695	10.53	5.45	MS
72	INRC 17470	5.13	1.32	MR
73	RP 5923	11.86	31.15	HS
74	IC 462248	11.46	15.91	S
75	IC 576897	30.95	29.87	HS
76	CVL *(*CHINA*)*	16.18	18.18	S
77	PTB 32	2.25	1.28	MR
78	IC332045	15.38	13.04	S
79	W1263	0.00	0.87	R
80	IR 75870-5-8-5-B-2-B (HWR-17)	20.45	26.67	HS
81	IR 75870-5-8-5-B-1-B (HWR-20)	19.42	24.75	S
82	RP 5922	8.64	16.67	S
83	RP 5925	0.00	0.00	HR
84	IBT GM 1	0.00	0.00	HR
85	IBT GM 2	0.00	0.00	HR
86	IBT GM 3	0.00	0.00	HR
87	IBT GM 4	0.00	0.00	HR
88	IBT GM 5	0.78	0.76	R
89	IBT GM 6	1.01	0.00	R
90	IBT GM 7	0.00	0.00	HR
91	IBT GM 8	0.00	0.00	HR
92	IBT GM 9	0.00	0.00	HR
93	IBT GM 10	1.02	0.00	R
94	IBT GM 11	0.00	0.00	HR
95	IBT GM 12	0.00	0.00	HR
96	IBT GM 13	0.00	0.00	HR
97	IBT GM 14	0.00	1.10	R
98	IBT GM 15	1.19	0.00	R

99	IBT GM 16	0.00	0.00	HR
100	IBT GM 17	0.00	0.00	HR
101	IBT GM 18	2.27	0.00	MR
102	IBT GM 19	0.00	0.00	HR
103	IBT GM 20	0.00	0.00	HR
104	IBT GM 21	0.00	0.00	HR
105	IBT GM 22	0.00	0.00	HR
106	IBT GM 23	0.00	0.00	HR
107	IBT GM 24	0.95	0.00	R
108	IBT GM 25	0.00	0.00	HR
109	IBT GM 26	3.95	4.23	MR
110	IBT GM 27	0.00	0.00	HR
111	IBT GM 28	0.00	0.00	HR
112	IBT GM 29	0.00	0.00	HR
113	IBT GM 30	0.00	0.00	HR
114	IBT GM 31	0.00	0.00	HR
115	IBT GM 32	0.00	0.00	HR
116	Abhaya	17.09	13.91	S
117	IBT GM 33	0.00	0.00	HR
118	IBT GM 34	0.00	0.00	HR
119	IBT GM 35	0.00	0.00	HR
120	IBT GM 36	0.00	0.00	HR
121	IBT GM 37	0.00	0.00	HR
122	IBT GM 38	0.00	0.00	HR
123	IBT GM 39	0.00	0.00	HR
124	IBT GM 40	0.00	0.00	HR
125	IBT GM 41	7.50	11.49	HR
126	IBT GM 42	0.00	0.00	HR
127	IBT GM 43	2.27	4.63	MR
128	IBT GM 44	0.93	0.00	R
129	IBT GM 45	11.22	20.00	S
130	IBT GM 46	0.00	0.00	HR
131	WGL-1127	0.00	0.00	HR
132	WGL-1147	1.05	0.00	R
133	RP 1 (Parent)	0.00	0.00	HR
134	IBT R7	20.69	20.69	S
135	IBT R4	0.00	0.00	HR
136	INRC 3021	0.00	0.00	HR
137	KAVYA	3.66	3.41	MR

R–Resistant, MS–Moderately susceptible, S–Susceptible, HS–Highly susceptible

After extensive research of host-plant differentials it is found that biotype 1 is present in Sambalpur, Hyderabad, Warangal, Raipur and Maruteru; biotype 2 is present in Cuttack, Bhubaneswar, Mangalore, Goa and Sakoli; biotype 3 is present in Ranchi, Wangbal; biotype 4 is present in Srikakulam, Vizianagaram and Bhandara; biotype 5 is present in Moncompu and biotype 6 is present in Manipur beside, biotype 3 also present there [4, 1, 12]. Although gall midge biotype 1 is present at Chiplima, Sambalpur [1, 12]. But sometimes, it infested Kavya, W 1263 variety containing *Gm1* gene, so, there is possibility of another biotype present here.

After systematic evaluation of rice germplasm for gall midge resistance at hot spots such as Cuttack and Sambalpur in Odisha and at Warangal in Andhra Pradesh under field conditions helped to identify some gall midge resistance sources such as Eswarakora, PTB 18, PTB 21, Siam 29, and Leuang 152 [9]. Tan *et al.*, [14] noted that Daqiuqi cultivar was resistant to four biotypes of gall midge and it was used as donor for developing gall midge resistant varieties in Guangdong, China. Many resistant and moderately resistant varieties are being cultivated by the farming community in Odisha to reduce the gall midge incidence. These include, Heera, Kalinga-II, Neela, Tara, Khandagiri, Udaya, Daya, Gouri, Pratap, Shakti, Phalguna, Meher, Birupa, Bhanja, Pratiksha and Samanta for medium lands and Samalei, Manika and Urbashi for lowlands [1]. It is observed that 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 [6]. Gall midge resistant variety Ratnagiri was developed and released by the field station at Sakoli in Maharashtra, and varieties Panchami, Pavithra, and Uma were developed and released by the research station in Kerala [1]. Sumathi and Manickam, [13] tested different rice accession in field condition 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 were recorded nil gall midge damage and found to be resistant in field screening. Seni and Naik, [12] screened different rice entries in field condition at OUAT regional Research Station, Chiplima, Sambalpur during *Kharif*, 2016 and observed that the entries W 1263, INRC 3021, Sudu Hondarawala, PTB 26, RP 4686-48-1-937, RMSG-11, WGL 1147, WGL 1127, WGL 1121, WGL 1131, WGL 1141, JGL 27058 were found resistant to gall midge.

Conclusion
Emergence of many gall midge biotypes has limited the use of resistance genes for resistant varieties. But systematic search for new and effective sources of resistance that are effective against more biotypes are necessary in future breeding programs. Here, the germplasm 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 exhibited resistance against gall midge so, they can be developed as varieties or can be used in breeding programme as a source of gall midge resistance.

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