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Evaluation of long duration Promising Rice Genotypes for Resistance to Stem Borer, *Scirpophaga incertulas* (Walker) and gall Midge, *Orseolia oryzae* (Wood-Mason)

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ABSTRACT

Field evaluation of sixteen promising rice genotypes under natural infestation of stem borer and gall midge was carried out at Agricultural Research Station, Nellore, Andhra Pradesh over two consecutive years during kharif season. The results revealed that out of 16 genotypes screened, NLR 3763 during 2019-20 and NLR 3747 and NLR 3742 during 2020-21 recorded highly resistant reaction to stem borer with nil dead heart incidence at 30 DAT. Six rice genotypes viz., NLR 3745, NLR 3749, NLR 3750 NLR 3753, NLR 3762 and NLR 3765 consistently reported resistant reaction (Scale 1) to stem borer during two years of study and at 30 and 50 DAT with dead heart incidence less than 10 per cent. Regarding gall midge although five genotypes viz., NLR 3744, NLR 3747, NLR 3748, NLR 3749 and NLR 3753 at 30 DAT and one genotype NLR 3750 at 50 DAT found highly resistant (score 0) with nil gall midge incidence during 2019-20 their expression was not consistent. The genotypes NLR 3752, NLR 3753, NLR 3763, NLR 3762, NLR 3760 and NLR 3765 showed consistent results with moderately resistant reaction to gall midge during two years of study period at 30 DAT. More over NLR 3753 consistently reported highly resistance reaction at 30 DAT and became moderately resistant at 50 DAT during two years of study.

Key words: *Rice genotypes, Stem borer, Gall midge, Resistance*

Introduction

Rice (*Oryza sativa* L.) is the most important and staple food crop for more than two thirds of the population in India. It occupies largest area among all food crops in India and is cultivated in an area of 43.78 million hectares with 118.43 million tonnes of production and 2705 kg/ha of productivity (Department of Agriculture, Cooperation and Farmers' Welfare, GOI, 2019-20). Yield loss in rice due to insect pests is one among several factors that contributes for gap between potential and actual rice yields across the nation (Chatterjee *et al.*, 2016). Nearly 300 species of insect pests attack the rice crop at different stages and among them only 23 species cause notable damage (Pasalu and Katti, 2006). The yield losses caused by the insect pests in rice have been reported to the tune of 25 per cent Chaudari *et al.*, 2017). Insect pest like Stem borer, *Scirpophaga incertulas* (Walker) and Asian Rice Gall Midge, *Orseolia oryzae* (Wood-Mason) are the major constraints in achieving desirable levels of rice yield.

The Yellow Stem Borer (YSB), *S. Incertulas* is distributed widely, covering almost all the Asian countries. YSB usually comprised more than 90 % of the borer populations and damage the rice crop from seedling to maturity causing either dead hearts at tillering stage or produces white ears at harvest stage, which can lead to complete failure of the crop (Yadav *et al.,* 2019). The affected tillers are unproductive resulting a yield loss of about 10-60 % (Chatterjee *et al.,* 2017). To overcome this insect damage, farmers mostly rely on different insecticides which lead to various undesirable consequences.

Asian rice gall midge (ARGM), *O. oryzae* (Wood-Mason) is one of the important insect which has been prevalent in almost all the rice growing states in India (Bentur *et al.,* 1992). Gall midge problem became extensive after introduction and wide spread cultivation of high yielding rice varieties. It causes and annual yield loss of 0.8 % of the total production, accounting to US$80 million. In some areas of Odisha, hybrid rice recorded as much as 90 % crop damage with yield loss of about 70 % (Bennett *et al.,* 2004). The external symptom of damage caused by gall midge is the production of a silvery shoots, tubular leaf sheath gall called as 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 (Bentur *et al.,* 1992). This renders the tiller sterile and do not bear panicle (Seni and Naik, 2017). 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. 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 (Krishnaiah *et al.,* 1983). Besides this, as varietal resistance is key component of integrated pest management (Ukwungwu *et al.,* 1999). Though several rice varieties released against several insects most of them have lost their resistance in the present day scenario either due to continuous exposure to the pest or due to development of more virulent population. And the genotypes still remaining the resistance are not popular among farmers due to low yield or cooking quality. Hence identification of resistant genotypes to different rice pests among the promising advanced lines should be a continuous process to combat the pest situation in rice successfully.

Keeping in view of the emerging pest problems in rice and role of resistant genotypes in controlling these pests, the study was conducted to identify resistant lines among the promising ones against stem borer and gall midge in rice.

Materials and Methods

A total of 16 long duration promising advanced rice genotypes developed by Dept. of Plant breeding, Agricultural Research Station (ANGRAU), Nellore, Andhra Pradesh were evaluated for resistance against stem borer, *S. incertulas* and gall midge, *O. oryzae* on rice under natural field conditions during kharif 2019-20 and 2020-21. Taichung Native 1 (TN 1) was used as a susceptible check. Sixteen rice genotypes along with TN1 were sown in single row for each line on raised beds. Sowing was done during August, 2019 and 2020 and one month old seedlings were transplanted in a single row of 3.3 mt length with a spacing of 20 cm between rows and 15 cm between plants and single seedling was transplanted per hill. The crop was raised by adopting standard agronomic practices of irrigation and fertilizers except plant protection measured against pests throughout the study period.

Observations on the incidence of stem borer in terms of dead hearts were recorded at 30 and 50 days after transplantation (DAT). Observation on dead heart incidence was recorded by counting the total number of tillers and number of dead hearts on 20 hills per genotype at 30 DAT and 50 DAT and the per cent dead hearts incidence was calculated using the following formula.

$$\text{Per cent stem borer incidence} = \frac{\text{Mean number of dead hearts per hill}}{\text{Mean number of tillers per hill}} \times 100$$

Observations on gall midge incidence of in terms of silver shoots was recorded by counting the total number of tillers and number of silver shoots on 20 hills per genotype at 30 DAT and 50 DAT and the per cent silver shoot incidence was calculated using the following formula.

$$\text{Per cent stem borer incidence} = \frac{\text{Mean number of silver shoots per hill}}{\text{Mean number of tillers per hill}} \times 100$$

Based on the percentage of dead hearts and silver shoots the genotypes were ranked as highly resistant, resistant, moderately resistant, moderately susceptible, susceptible and highly susceptible as per the Standard Evaluation System of IRRI, 2013.

Results and Discussion

Stem borer

A total of 16 long duration rice genotypes were screened under natural field condition against stem borer and gall midge in rice during kharif, 2019-20 and 2020-21. Test genotypes were evaluated on the basis of standard evaluation scale of 0-9 (Table 1) for stem borer and gall midge (Table 1).

The results of screening rice genotypes against stem borer revealed that, dead heart incidence varied from 0.00 to 19.15 per cent and 0.00 to 12.50 per cent during kharif, 2019-20 and 2020-21, respectively.

At 30 DAT the rice genotype NLR 3763 was not at all preferred by stem borer with nil dead heart incidence (score 0) while 13 genotypes viz., NLR 3742, NLR 3743, NLR 3744, NLR 3745, NLR 3746, NLR 3747, NLR 3748, NLR 3749, NLR 3750, NLR 3753, NLR 3762, NLR 3760 and NLR 3765 were least preferred with dead heart incidence ranged from 1.23 to 8.7 per cent (Score 1). Among 16 genotypes, two were (NLR 3751 and NLR 3752) found moderately resistant with dead heart incidence ranged from 12.68 to 14.29 (Score 3). Preetha , 2017 also reported that the rice cultures viz., TP 10003, TP 10004, TP 10039 and TP 18095 were showed nil or minimal incidence of stem borer during the three years of study in the kharif season. Singh *et al.* (2006) also screened fifty three cultivars of rice against *S. incertulas* under natural infestation and the result revealed that eighteen rice varieties were totally free from stem borer damage in terms of DH and WE.

At 50 DAT genotype NLR 3746 was totally free from stem borer incidence interms of dead hearts (score 0) and genotypes viz., NLR 3742, NLR 3745,NLR 3747, NLR 3749, NLR 3750, NLR 3753, NLR 3763, NLR 3762 and NLR 3765 were found resistant to stem borer with dead heart incidence ranged from 1.16 to 9.86 per cent (score 1). Six rice genotypes viz., NLR 3743, NLR 3744, NLR 3748, NLR 3751, NLR 3752 and NLR 3760 were moderately resistant with 10.81 to 19.15 per cent dead heart incidence (Scale 3). Chatterjee *et al.* (2011) screened out 51 rice entries and recorded that dead heart tolerant promising rice entries were Anjali, Pusa RH 10, ADT 44, JKRH 10, Pant Dhan 19, Gorsa, CSR 27, IC 115737, LF 270.

In the present study out of 16 genotypes screened the genotype NLR 3763 recorded highly resistant reaction with nil dead heart incidence (Scale 0) at 30 DAT during 2019-20, same genotype recorded resistant reaction with less than 10 per cent dead heart incidence (Scale 1) at 50 DAT during 2019-20 and 30 & 50 DAT during 2020-21. The similar pattern was also observed with the other two rice genotypes, NLR 3747 and NLR 3742, expressed highly resistant reaction at 30 DAT during kharif 2020-21 and resistant reaction at 50 DAT during 2020-21 and 30 & 50 DAT during 2019-20. Visalakshmi *et al.,* 2014 in her study revealed that CR 3005-77-2 was moderately resistant during kharif 2011 and 2012 where as CR 3006-8-2 was moderately resistant in one year and moderately susceptible in another year.

The rice genotype NLR 3746 showed highly resistant reaction at 50 DAT and resistant reaction at 30 DAT during 2019-20 and 2020-21. Similar results were also reported by Visalakshmi *et al.,* 2014 who screened about 82 entries for two consecutive years and stated that the cultures CR 2711-76 and CR

Table 1. Standard evaluation system for rice stem borer (dead hearts) and gall midge (Silver shoots)

Damage score	Dead hearts (%)	Silver shoots (%)	Resistance rating
0	No damage	No damage	Highly resistant
1	1-10	< 1	Resistant
3	11-20	1-5	Moderately resistant
5	21-30	6-10	Moderately susceptible
7	31-60	11-25	Susceptible
9	61% and above	> 25	Highly susceptible

3005-230-5 were resistant to stem borer at reproductive stage during the study period.

The rice genotype NLR 3752 expressed moderately resistant (Scale 3) to stem borer with 14.29 and 16.35 per cent dead heart incidence at 30 DAT and 50 DAT, respectively during kharif, 2019-20. Where as during 2020-21 the said genotype expressed highly resistant reaction (scale 0) with nil dead heart incidence. The rice cultures viz., TP 10002, TP 10005, TP 10016, TP 10038 were rated as moderately resistant in any one of the years of the study amidst resistant and highly resistant scales (Preetha, 2017)

A total of 6 genotypes viz., NLR 3745, NLR 3749, NLR 3750 NLR 3753, NLR 3762 and NLR 3765 consistently reported resistant reaction (Scale 1) to stem borer during two years of study and at 30 and 50

Table 2. Screening of long duration promising rice genotypes against stem borer during kharif season

S. No.	Genotype	Stem borer (% Dead heart incidence)							
		2019-20				2020-21			
		30 DAT	DS	50 DAT	DS	30 DAT	DS	50 DAT	DS
1	NLR 3742	5.62	1	6.45	1	0.00	0	0.60	1
2	NLR 3743	6.85	1	19.15	3	12.50	3	2.01	1
3	NLR 3744	1.27	1	13.33	3	11.32	3	1.18	1
4	NLR 3745	7.61	1	6.98	1	7.03	1	0.60	1
5	NLR 3746	8.45	1	0.00	0	1.12	1	0.00	0
6	NLR 3747	1.28	1	9.86	1	0.00	0	1.03	1
7	NLR 3748	3.00	1	11.49	3	3.96	1	3.09	1
8	NLR 3749	1.23	1	1.16	1	9.76	1	1.27	1
9	NLR 3750	8.70	1	8.60	1	5.85	1	2.65	1
10	NLR 3751	12.68	3	11.96	3	9.41	1	1.60	1
11	NLR 3752	14.29	3	16.35	3	0.00	0	0.00	0
12	NLR 3753	7.41	1	3.37	1	0.54	1	2.47	1
13	NLR 3763	0.00	0	1.01	1	8.60	1	1.09	1
14	NLR 3762	2.78	1	4.05	1	8.54	1	3.13	1
15	NLR 3760	6.98	1	10.81	3	3.83	1	1.09	1
16	NLR 3765	4.26	1	4.94	1	2.19	1	0.49	1
	TN1	13.11	3	8.57	1	8.49	1	4.35	1

Table 3. Screening of long duration promising rice genotypes against gall midge during kharif season

S. No.	Genotype	Gall midge (% Silver shoot incidence)							
		2019-20				2020-21			
		30 DAT	DS	50 DAT	DS	30 DAT	DS	50 DAT	DS
1	NLR 3742	2.25	3	5.38	3	0.96	1	1.20	3
2	NLR 3743	4.11	3	7.45	5	0.57	1	0.00	0
3	NLR 3744	0.00	0	2.67	3	0.63	1	1.18	3
4	NLR 3745	8.70	5	3.49	3	1.62	3	0.60	1
5	NLR 3746	1.41	3	1.22	3	1.68	3	0.00	0
6	NLR 3747	0.00	0	2.82	3	0.92	1	0.00	0
7	NLR 3748	0.00	0	2.30	3	0.88	1	0.00	0
8	NLR 3749	0.00	0	3.49	3	0.61	1	0.64	1
9	NLR 3750	2.90	3	1.08	3	0.58	1	1.32	3
10	NLR 3751	2.82	3	0.00	0	0.00	0	1.07	3
11	NLR 3752	1.59	3	1.01	3	2.98	3	0.00	0
12	NLR 3753	3.70	0	3.37	3	0.00	0	1.23	3
13	NLR 3763	1.11	3	5.77	5	2.69	3	0.00	0
14	NLR 3762	1.39	3	4.05	3	0.50	1	2.50	3
15	NLR 3760	1.16	3	6.31	5	2.13	3	1.09	3
16	NLR 3765	1.06	3	4.94	3	2.19	3	0.98	1
	TN 1	3.77	3	4.81	3	2.36	3	1.89	3

DAT with dead heart incidence less than 10 per cent. Six rice germplasm lines viz., NP-973-3, RP Bio 5477-NH 686, Pusa 1718-19-8-152, CR 2829-PLN-36, CR 2829-PLN-97 and RP 5919-HP-9-IR 94923 were highly resistant with a constant damage rating scale '0' during kharif, 2014 and 2015 (Rana *et al.*, 2016).

Gall midge

Since the damage level was low during kharif, 2020-21, the test genotypes were evaluated based on the gall midge incidence levels recorded during Kharif, 2019-20.

Gall midge incidence among the 16 test genotypes was ranged from 0-8.70 per cent silver shoots during kharif, 2019-20. Among 16 rice genotypes screened against gall midge, five genotypes viz., NLR 3744, NLR 3747, NLR 3748, NLR, 3749, NLR 3753 were free from gall midge incidence and were scored '0' grade (Highly resistant) at 30 DAT. All other genotypes showed resistant reaction (Score 3) with 1.06 to 4.11 per cent silver shoot incidence where as one genotype called NLR 3745 was showed moderately susceptible (Score 5) reaction to gall midge with 8.70 per cent silver shoots incidence at 30 DAT. Sumathi and Manickam, 2013 tested different rice accession in field conditions 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.

At 50 DAT except NLR 3751 all test entries were either moderately resistant (Score 3) with 1.01 to 5.38 per cent silver shoots or moderately susceptible (Score 5) with 5.77 to 7.45 per cent silver shoots incidence. However, the genotype NLR 3751 found highly resistant (Score 0) with nil gall midge damage but was not consistent.

Although five genotypes viz., NLR 3744, NLR 3747, NLR 3748, NLR 3749 and NLR 3753 at 30 DAT and one genotype NLR 3750 at 50 DAT found highly resistant (score 0) during 2019-20 their expression was not consistent, rather they showed resistant to moderately resistant reaction though the silver shoot incidence levels were low during 2020-21. Seni and Naik, 2017 screened different rice entries in field condition at OUAT regional Research Station, Chiplima, Sambalpur during kharif, 2016 and observed that the entries W1263, INRC 3021, Sudu Hondarawala, PTB 26, RP 4686-48-1-937, RMSG-11, WGL 1147m WGL 1127, WGL 1121, WGL 1131, WGL 1141, JGL 27058 were found resistant to gall midge. In present study the genotypes viz., NLR 3744, NLR 3747, NLR 3748, NLR 3749 and NLR 3753 which were found highly resistant (Scale 0) to gall midge with nil incidence at 30 DAT were became moderately resistant (Scale 3) at 50 DAT with 1.22 to 3.49 per cent silver shoots. Similar trend was also noticed with NLR NLR 3751 and NLR 3753 which were highly resistant to gall midge with nil silver shoot incidence at 30 DAT were became moderately resistant at 50 DAT during 2020-21. This needs further confirmation

The genotypes NLR 3752, NLR 3753, NLR 3763, NLR 3762, NLR 3760 and NLR 3765 showed consistent results during two years of study period at 30 DAT. More over NLR 3753 consistently reported highly resistance reaction at 30 DAT and became moderately resistant at 50 DAT during two years of study. But the genotype NLR 3752 was moderately resistant during 2019-20 and highly resistant during 2020-21 at 50 ADT and moderately susceptible at 50 DAT during 2019-20 and highly resistant during 2020-21. Seni and Naik, 2019 conducted a screening study with 137 rice entries at Chiplima and Odisha and revealed that 52 germplasm lines were promising against gall midge

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