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Inakarla Paramasiva
Department of Entomology, Agricultural Research Station, Nellore, Andhra Pradesh, India

Chintala Sreelakshmi
Department of Genetics and Plant Breeding, Agricultural Research Station, Nellore, Andhra Pradesh, India

Ummanaboina Vineetha
Department of Agronomy, Agricultural Research Station, Nellore, Andhra Pradesh, India

Pinapedda Narasimhulu Harathi
Department of Entomology, Agricultural Research Station, Nellore, Andhra Pradesh, India

Pachipala Rajasekhar
Department of Entomology, Agricultural Research Station, Nellore, Andhra Pradesh, India

Corresponding Author:
Inakarla Paramasiva
Department of Entomology, Agricultural Research Station, Nellore, Andhra Pradesh, India

Screening of advanced rice cultures against stem borer, *Scirpophaga incertulas* (Walker) and leaf folder, *Cnaphalocrocis medinalis* (Guenee)

Inakarla Paramasiva, Chintala Sreelakshmi, Ummanaboina Vineetha, Pinapedda Narasimhulu Harathi and Pachipala Rajasekhar

Abstract
The different rice cultures were screened against stem borer, leaf folder of rice during kharif 2017 and 2018 at Agricultural Research Station, Nellore, Andhra Pradesh. An experiment was carried out to note the reaction of 28 promising advanced rice cultures with the susceptible check variety TN 1 against stem borer and leaf folder of rice with a view to identify resistant sources. Rice cultures were evaluated based on the Standard Evaluation System with a scale of 0-9. Among 28 rice advanced rice cultures screened against stem borer, nine cultures were found to be highly resistant to stem borer with nil dead heart incidence at 30 DAT during kharif, 2018. Eighteen cultures were resistant to stem borer with per cent dead hearts ranged from 1.5 to 10.14% at 50 DAT during kharif, 2017. The rice culture NLR 3542 recorded resistant reaction against leaf folder by recording 8.68 and 4.80% leaf damage during kharif 2017 and 2018, respectively with a grade 1.

Keywords: Stem borer, leaf folder, resistance, rice, screening

Introduction
Rice (*Oryza sativa* L.) is the most widely consumed stable food crop of Poaceae family for a large part of the worlds human population, especially in Asia and over half of the global population, depends on it for their feed [1, 2]. India, the second largest rice growing country has a production of 117.47 million tonnes and cultivation area of about 44.0 million hectares with an average productivity of 2.52 tonnes per hectare [3]. Andhra Pradesh ranks third in production in India which produces 128.95 lakh tons of rice and contributes 12% of total rice produced in the country.

Among several factors, insect-pests contribute substantially to yield loss in rice production and productivity. In India, approximately 100 insect species feed on rice and 20 of these are considered to be major pests, causing 30% yield loss [4]. Among these, yellow stem borer, *Scirpophaga incertulas* Walker and rice leaf folder, *Cnaphalocrocis medinalis* Guenee are the dominant and the most destructive insect-pest occurring throughout the country causing the yield loss of about 10-60 per cent [5]. Host plant resistance is identified as the most effective way of stem borer and leaf folder management in various regions. It has been emphasized as a major tactic in IPM for the motive of its monetary and environment friendly benefits. Host plant resistance is a relationship between the plant feeding insects and their host plants [6]. Host plant resistance enables plants to avoid, tolerate or recover from the effects of insect pest attack and has proved to be a successful toll against insects in many crops [7]. Plant genotypes, either due to environmental stress or genetic makeup, possess physiological and biochemical differenced which alter the nutritional value (Primary metabolites) for plat feeding insects. In some cases, the combined nutritional and allelochemical alteration either improve the quality of the host plant as a source of food and can therefore be considered favourable to herbivorous insect or make the quality of host plant as source of food unfavourable to phytophagous insects [8]. Varieties with adequate levels of resistance to insect pests will encourage farmers to reduce insecticide application, and thus minimizing the environmental hazards. Hence, it is necessary to identify resistant genotypes for the management of stem borer and leaf folder. Hence the present investigation was carried out to determine the level of resistance against *S. incertulas* and *C. medinalis* in promising advanced rice cultures of Agricultural Research Station, Nellore.

Materials and Methods

A total of 28 long duration promising advanced cultures were collected from Dept. Of Plant breeding, Agricultural Research Station, Nellore, A.P. for screening against stem borer, *Scirpophaga incertulas* and leaf folder, *Cnaphalocrocis medinalis* on rice under natural field conditions during kharif 2017-18 and 2018-19. Taichung Native 1 (TN 1) was used as a susceptible check. The crop was raised by adopting standard agronomic practices of irrigation and fertilizers except plant protection measured against pests throughout the study period. 28 rice cultures along with TN1 were sown in single row for each line on raised beds. Sowing was done during August, 2017 and 2018 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 and single row of TN 1 was planted after every ten cultures.

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 culture at 30 DAT and 50 DAT and the per cent dead hearts incidence was calculated using the following formula.

$$\text{Per cent stem borer incidence} = \frac{\text{Number of dead hearts}}{\text{Total number of tillers}} \times 100$$

Observation on the leaf folder incidence in terms of number of damaged leaves by leaf folder was recorded at the time of peak leaf folder infestation. The observations were recorded on 20 hills per culture and the per cent leaf folder damaged leaves were calculated as follows.

$$\text{Per cent leaf folder damage} = \frac{\text{Number of damaged leaves}}{\text{Total number of leaves}} \times 100$$

Table 1: Standard evaluation system for rice leaf folder [9, 10]

Damage score	Dead hearts (%)	Damaged leaves (%)	Resistance rating
0	No damage	No damage	Highly resistant
1	1-10	1-10	Resistant
3	11-20	11-20	Moderately resistant
5	21-30	21-35	Moderately susceptible
7	31-60	36-50	Susceptible
9	61% and above	51-100	Highly suscetible

Results

Stem bore

In kharif 2017 the stem borer infestation was low even on susceptible check TN 1 at 30 DAT and the per cent dead hearts ranged from 1.26 to 10.29 per cent. At 50 DAT among 28 rice cultures 18 were showed minimal incidence of stem borer, where as the susceptible check TN 1 showed 18.32 to 20.26 per cent damage. The cultures least preferred by *S. incertulas* were NR 3539, 3548, 3585, 3587, 3588, 3589, 3590, 3595, 3600, 3601, 3634, 3635 3636, 3637, 3639, 3641, 3644 and NLR 3646 with per cent dead hearts ranged from 1.50 to 10.14 per cent and rated under damage score '1'. Similar results were also reported by Visalakshmi *et al*., 2014 who screened 53 rice entries under natural field conditions to find out the resistance to stem borer and recorded that CR 2711-76, CR 3005-230-5 were resistant and CR 3005-77-2 was moderately resistant to stem borer. Among 28 cultures, eight cultures rated as moderately resistant with per cent dead hearts ranged from 11.18 to 18.24 per cent and rated under damage score '3' and only two cultures namely NLR 3598 and NLR 3647 found as moderately susceptible with 27.87 and 21.83 per cent dead hearts, respectively and rated under damage score '5'.

During kharif 2018, under natural field conditions, among the 28 rice cultures, nil dead heart incidence was observed in NLR 3548, 3582, 3585, 3589, 3601, 3635, 3637, 3643 and NLR 3647 at 30 DAT and were rated as highly resistant. Many workers screened out rice cultures/ genotypes/ entries/ varieties against stem borer and identified resistant/ tolerant lines [11]. Evaluated 202 semi deep water ice genotypes along with check varieties Jalpriya and Madhukar against YSB and reported that, Medak 13, WAB 878-4-2-2-3-P1-HP and NDGR 268 are highly resistant to yellow stem borer and may be used as donors for yellow stem borer resistance in breeding program. Chatterjee *et al*. (2011) screened out 51 rice entries along with check varieties and recorded that dead heart tolerant promising rice cultures were Anjali, Pusa RH 10, ADT 44, JKRH 10, Pant Dhan 19, Gorsa, CSR 27, IC 115737, LF 270 and after flowering CHOORAPUNDY, INRC 3021, PTB 12, CR-MR-1523, LF 256 AND AGANNI were the promising tolerant rice entries against white year head. Singh *et al*., 2006 screened 53 cultivars of rice against S. incertulas under natural infestation and revealed that 18 rice varieties were totally free from stem borer damage in terms of DH and WE. In the present study sixteen cultures i.e., NLR 3539, 3542, 3545, 3587, 3588, 3590, 3592, 3595, 3600, 3634, 3638, 3639, 3640, 3641 and NLR 3644 were resistant with '1' scale (1.4 to 8.1 per cent dead hearts) at 30 DAT. Two cultures, NLR 3598 and NLR 3636 were moderately resistant with damage scale '3' (17.1 and 13.7, respectively) which is similar to susceptible entry TN 1 with 19.0 per cent dead heart damage at 30 DAT. Balasubramanianan *et al*., 2000 **s**creened 178 advanced yield trial genotypes of rice for their reaction to insect pests under natural conditions. The damage score was recorded as per standard Evaluation System (SES) of IRRI, Philippines. The genotypes, IET-15742 and IET-15072 against stem borer and IET-16120 against rice leaf folder were found to be moderately resistant out of 178 total genotypes.

Leaf folder

During kharif, 2017 twenty eight long duration rice cultures were screened against leaf folder, *C. medinalis* under natural field conditions. Cultures were evaluated based on the standard evaluation scale of 0-9 (Table 1). The leaf folder infestation varied from 8.14 to 26.89 per cent of leaf damage in rice. The results of the present study showed that the 15 cultures *viz*., NLR 3542, NLR 3548, NLR 3582, NLR 3595, NLR 3598, NLR 3601, NLR 3634, NLR 3635, NLR 3636, NLR 3637, NLR 3641, NLR 3643, NLR 3644, NLR 3645 and NLR 3647 recorded resistant reaction by recording less than 10 percent leaf damage (8.06 to 10.18%) with a grade '1' (Table 2). These findings are in agreement with the findings of Pillai *et al*., 1979 who tested relative susceptibility of 491 genotypes against leaf folder and the lines *viz*., T 289, J 147, J1 45-7, Kallada chambavu and T 1340 were found to be the most tolerant ones. Sudhakar *et al*., 1991 evaluated 24 rice varieties in India for resistance against C. medinalis and recorded that IET 7564, ES 29-3-3-1, Pusa 2-21 and Type-3

were least susceptible entries. Chatterjee *et al*., 2011 found that out of 51 rice entries screened against rice leaf folder CSR 23, TMAU 831311, ARC 6626, IC 115737, AGANNI, IC 355876 and ARC 8982 were tolerant to rice leaf folder. In present study twelve rice cultures *viz*., NLR 3539, NLR 3545, NLR 3587, NLR 3588, NLR 3589, NLR 3590, NLR 3592, NLR 3600, NLR 3638, NLR 3639, NLR 3640 and NLR 3646 reacted moderately resistant (11.85 to 19.5% leaf damage) to leaf folder with a grade '3'. One rice culture NLR 3585 was moderately susceptible to leaf folder (23.03% leaf damage) with grade '5' and the susceptible check TN 1 was also recorded 26.89 and 32.25 per cent leaf damage. None of the cultures were free from leaf damage to be categorized as highly resistant with nil leaf damage. During kharif, 2018, across 28 rice cultures leaf folder incidence was ranged from 4.8 to 58.9 per cent (Table 2). Among 28 cultures, NLR 3542 recorded resistant reaction with 4.8% leaf damage with a grade '1'. Twenty five cultures were reacted moderately resistant (11.0 to 20.4%) to leaf folder with a grade of '3'. Two rice cultures *viz.*, NLR 3600 and NLR 3644 were moderately susceptible to leaf folder (25.7 and 21.2%, respectively) and the standard susceptible check (TN 1) was found to be highly susceptible with 58.9% leaf damage at 50 DAT. The variation in leaf folder incidence levels may be due to the changes in the environmental conditions of the location. The resistance in rice cultures may be due the presence of a strong repellent or a lack of feeding stimulus in the plants and either due to the presence of toxic material or nutritional deficiencies in the plant of leaf folder.

Table 2: Reaction of advanced rice cultures to stem borer and leaf folder

S. No.	Cultures	Stem borer (Mean % dead hearts)*								Leaf folder (Mean % leaf damage)*			
		2017-18				2018-19				2017-18		2018-19	
		30 DAT	DS	50 DAT	DS	30 DAT	DS	50 DAT	DS	60 DAT	DS	60 DAT	DS
1	NLR 3539	3.25	1	5.39	1	2.3	1	0.8	1	14.76	3	14.4	3
2	NLR 3542	4.83	1	11.21	3	4.4	1	0.9	1	8.68	1	4.8	1
3	NLR 3545	5.76	1	11.90	3	6.4	1	0.0	0	13.14	3	13.7	3
4	NLR 3548	2.72	1	9.02	1	0.0	0	1.8	1	9.88	1	19.3	3
5	NLR 3582	6.57	1	13.73	3	0.0	0	0.0	0	9.84	1	16.9	3
6	NLR 3585	1.88	1	7.69	1	0.0	0	0.0	0	23.03	5	15.5	3
7	NLR 3587	10.29	1	10.14	1	4.5	1	2.1	1	12.64	3	15.8	3
8	NLR 3588	4.67	1	1.50	1	1.9	1	0.0	0	13.50	3	15.2	3
9	NLR 3589	5.56	1	6.72	1	0.0	0	0.0	0	19.51	3	19.9	3
10	NLR 3590	4.17	1	6.98	1	1.7	1	0.0	0	14.89	3	13.7	3
11	NLR 3592	5.92	1	17.24	3	2.0	1	0.0	0	16.28	3	11.0	3
12	NLR 3595	8.98	1	5.19	1	1.9	1	0.0	0	9.85	1	15.2	3
13	NLR 3598	3.14	1	27.87	5	17.1	3	5.2	1	8.72	1	11.0	3
14	NLR 3600	3.95	1	8.87	1	6.8	1	0.0	0	18.34	3	25.7	5
15	NLR 3601	1.26	1	5.44	1	0.0	0	0.0	0	9.98	1	12.7	3
16	NLR 3634	5.44	1	4.67	1	1.4	1	2.7	1	10.18	1	17.1	3
17	NLR 3635	2.75	1	6.45	1	0.0	0	4.4	1	9.23	1	16.3	3
18	NLR 3636	3.76	1	6.12	1	13.7	3	0.0	0	8.14	1	19.1	3
19	NLR 3637	3.68	1	9.09	1	0.0	0	1.0	1	10.60	1	13.6	3
20	NLR 3638	4.94	1	11.18	3	8.1	1	0.6	1	12.32	3	17.8	3
21	NLR 3639	2.60	1	8.80	1	6.3	1	1.5	1	11.85	3	16.9	3
22	NLR 3640	9.85	1	15.56	3	1.7	1	0	0	13.02	3	13.7	3
23	NLR 3641	5.75	1	8.73	1	4.2	1	2.6	1	9.05	1	20.4	3
24	NLR 3643	9.34	1	18.24	3	0	0	0	0	9.47	1	15.6	3
25	NLR 3644	4.88	1	5.45	1	4.6	1	3	1	10.02	1	21.2	5
26	NLR 3645	4.52	1	11.36	3	0.0	0	0.0	0	8.06	1	13.7	3
27	NLR 3646	3.85	1	9.52	1	0.0	0	2.0	1	12.90	3	12.5	3
28	NLR 3647	7.35	1	21.83	5	0.0	.0	4.2	1	9.66	1	14.8	3
29	Sus. Check (TN 1)	5.44	1	18.82	3	19.0	3	3.75	1	26.89	5	38.7	7
30	Sus. Check (TN 1)	8.24	1	20.26	3	2.5	1	5.7	1	32.25	5	58.9	9

*Mean of 20 plants

Conclusions

As natural resistance in rice against insect pests is one of the important components of IPM program and highly compatible with other control measures, understanding of the resistance response of advanced rice cultures will be useful for the efficient utilization of the existing resistant sources for the development of resistant varieties against stem borer and leaf folder.

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