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Screening of rice cultures/germplasm for resistance to stem borer

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Abstract
Different rice cultures/ germplasms were screened for their reaction to stem borer during the *Kharif* season of 2013, 2014 and 2015 at Agricultural Research Station, Thirupathisaram of Tamil Nadu Agricultural University. The per cent infestation of stem borer varied between 0 and 45.71 during the *Kharif* season. Among the 46 rice cultures screened against stem borer, TP 10003, TP 10004, TP 10039 and TP 08095 were found to have no or minimal incidence and were rated as resistant category. TP 10002, TP 10005, TP 10016, TP 10038, TP 10051, TP 10052, TP 09048 and TP 09052 were rated as moderately resistant. Though it is a field screening, the incidence of stem borer upto 9 scales at Thirupathisaram, reveal it as a hotspot for screening rice for stem borers. The rice cultures/ germplasm which were rated as resistant have to be screened in artificial conditions with high insect pressure and may be used as donors in resistant breeding programmes against stem borer.

Keywords: Rice, Germplasm, Resistance, Stem borer

Introduction
Rice is the staple food crop in India and more than 100 species of insects are known to attack this crop and about 20 are of economic importance [1]. The rice stem borers are the principal devastators and responsible for economic crop losses under field condition [2]. They are common and serious pests in Asian countries responsible for annual damages of 5-10 per cent of rice crops [3]. Heavy infestation may cause yield loss up to 80 per cent [4]. The symptoms of this pest is characterized by drying of central shoot known as 'dead heart' at vegetative stage and 'white earhead' at reproductive stage. The affected tillers are unproductive resulting severe yield losses. Early damage in vegetative stage is compensated sometimes by the production of new tillers but incidence at heading stage causes total loss due to chaffy panicle. To overcome this insect damage, farmers mostly rely on different insecticides which lead to various undesirable consequences. The arbitrary use of insecticides resulted in the development of resistance in insects to insecticides, resurgence, secondary pest outbreaks, disruption of natural enemy complex, loss in biodiversity and environmental pollution [5].
Host plant resistance is identified as the most effective way of stem borer management in various regions. It has been emphasized as a major tactic in IPM for the motive of its monetary and environment friendly benefits [6]. 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. Rice is being cultivated in *Kharif* and *Rabi* seasons of Kanyakumari District. The incidence of stem borer is noticed from August month of *Kharif* season to the end of *Rabi* season. Hence, the present study was undertaken to evaluate different rice accessions against stem borer and to identify resistant source for evolution of rice variety resistant to stem borer.

2. Materials and Methods
The field experiments were conducted during *Kharif* season (June - September) for three consecutive years at Agricultural Research Station, Thirupathisaram to identify the resistant sources of rice stem borer. A total of 52 cultures available at our centre along with five rice varieties of Tamil Nadu Agricultural University and a susceptible check (TN 1) were screened under field conditions. Each entry was sown in raised beds and transplanting of seedlings was done on 20 days after sowing. The seedlings were planted in two rows of 4 m length with a spacing of 20 cm between rows and 15 cm between plants. The crop was raised based on the

Crop Production Guide [7] except for the plant protection measures against pests throughout the study period.

Observations on the incidence of stem borer in terms of white ear were recorded at 75 and 95 days after transplanting (DAT). Ten plants were selected at random per culture for recording the incidence of stem borer and the per cent white ear damage was calculated using the following formula [8].

$$\text{Per cent white ear} = \frac{\text{Number of white ears}}{\text{Number of productive tillers}} \times 100$$

The damage rating and scale was given for the test accessions using IRRI Standard Evaluation System for rice (Table 1) [9].

Table 1: Standard Evaluation System for screening resistance to rice stem borer

White Ear (WE)		
Damage (%)	**Scale**	**Status**
0	0	Highly resistant (HR)
1-5	1	Resistant (R)
6-10	3	Moderately resistant (MR)
11-15	5	Moderately susceptible (MS)
16-25	7	Susceptible (S)
26 & above	9	Highly susceptible (HS)

3. Results

3.1. *Kharif* 2013

The results of screening rice entries against stem borer revealed TP 10008, TP 10009, TP 10014, TP 10018, TP 10038, TP 10051, TP 10052, TP 08006, TP 08053, TP 08085, TP 09048 and TP 09049 as highly resistant with nil damage at 75 DAT. Twenty six cultures *viz.*, TP 10002, TP 10003, TP 10004, TP 10005, TP 10007, TP 10012, TP 10015, TP 10016, TP 10017, TP 10035, TP 10037, TP 10039, TP 10040, TP 10048, TP 10049, TP 10050, TP 08003, TP 08079, TP 08080, TP 08095, TP 09028, TP 09037, TP 09046, TP 09047, TP 09052 and TP 09054 showed resistant with white ear damage ranging between 1.15 - 5.88% at 75 DAT (Table 2).

The cultures *viz.*, TP 10038, TP 08079, TP 08085, TP 08095 and TP 09028 recorded nil incidence of stem borer at 95 DAT. The rice entries, TP 10001, TP 10002, TP 10003, TP 10004, TP 10005, TP 10009, TP 10010, TP 10012, TP 10039, TP 10040, TP 10051, TP 08080, TP 09037, TP 09046, TP 09047, TP 09049, TP 09052 and TP 09054 were rated under grade 1 (1.25 - 5.88% white ear). Among 46 rice accessions, ten and eight were rated as moderately resistant and moderately susceptible, respectively. TP 10035, TP 10048, TP 08003 and TP 09055 were found to be susceptible entries (Table 2).

Among the five different rice varieties TPS 5, ASD 16 and ADT 45 recorded nil incidence of stem borer and the susceptible check, TN 1 showed 29.79 and 40.35 per cent damage at 75 and 95 DAT, respectively.

3.2. *Kharif* 2014

During *Kharif* 2014 under natural field conditions, among the 46 rice genotypes, nil white ear damage was observed in TP 08079 and TP 09054 at 75 and 95 DAT and was rated as highly resistant. Ten cultures *i.e.*, TP 10003, TP 10004, TP 10006, TP 10016, TP 10018, TP 10035, TP 10039, TP 10052, TP 08095 and TP 09052 were resistant with '1' scale (1-5% white ear) at both 75 and 95 DAT. Ten genotypes were moderately resistant with '3' scale (6-10% white ear). Nine entries were moderately susceptible and seven entries were found susceptible. About eight entries *viz.*, TP 10007, TP 10008, TP 10009, TP 10042, TP 10050, TP 08003, TP 08080 and TP 09047 were highly susceptible with '9' scale (> 26% white ear) which is similar to susceptible entry TN 1 with 42.86% white ear damage at 95 DAT. Among the five test varieties, ADT 36 showed scale '0' at 95 DAT (Table 2).

3.3. *Kharif* 2015

In *Kharif* 2015, the stem borer infestation was not found at 75 DAT and the per cent white ear damage was recorded at 95 DAT alone. During this season, TP 10004, TP 10005, TP 10006, TP 10008, TP 10017, TP 10035, TP 10037, TP 10038, TP 10039, TP 10042, TP 10048, TP 10051, TP 10052, TP 08024, TP 08085, TP 08095, TP 09028, TP 09047, TP 09048, TP 09049 were scored under the scale "0" and rated as highly resistant. TP 10002, TP 10003, TP 10007, TP 10009, TP 10010, TP 10012, TP 10013, TP 10014, TP 10015, TP 10016, TP 10018, TP 10040, TP 10049, TP 10050, TP 08006, TP 08080 were found to be resistant. Two cultures were rated as moderately resistant; five cultures as moderately susceptible and the remaining three cultures as susceptible entries to rice stem borer (Table 2).

Among the five rice varieties ADT 43 was found to be resistant with scale 1 and the others *viz.*, TPS 5, ASD 16, ADT 36 and ADT 45 were rated under moderately resistant category. The susceptible check TN 1 showed scale "7" with 16.56 per cent damage in terms of white ear.

4. Discussion

The rice cultures *viz.*, TP 10003, TP 10004, TP 10039 and TP 08095 were found to show nil or minimal incidence of stem borer during the three years of study in the *Kharif* season (Fig. 1). Similar results were also reported by [10] who screened 29 and 53 entries during *Kharif* 2011 and 2012 and stated that the culture CR 2711-76 and CR 3005-230-5 were resistant to stem borer at reproductive stage during the period of investigation. A total of 23 medium duration rice cultures screened during *Kar* season (2013-14) against yellow stem borer revealed that the entries AS 12021, AS 12029, AS 12032, AS 12033, AS 12071, AS 12090 and AS ST 12010 showed nil incidences [11]. The screening of rice entries against yellow stem borer during the *Kharif* seasons of 2014 and 2015 [12] revealed that six germplasms *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 94293 were found to be highly resistant with a constant damage rating scale '0'. Among different rice entries evaluated [13] in *Kharif* 2014 showed lowest dead heart incidence in RP 5163-200-5-4-2 (0.70%) followed by RNT 14-1-1-2-2 (0.83%), IR 64 (0.49%) and RP 5588-B-B-B-B-76 (1.08%) and the lowest white ear was observed in CR 1898-32-69-CN-12-2 (0.90%) followed by RP Bio 4918-142 (1.45%) and RP 2068-18-3-5 (1.60%). Thirty six rice germplasms evaluated against yellow stem borer during *Kharif* 2009 and the identified resistant genotypes with less than 2 score were RP-4680-1-1-15, RP-4684-35-1-739, CR-AC34/997, RP-4656-IR-3687-6-9B, RP-4687-52-1182, RP-4681-16-2-569, RP-4687-52-1-1181, DRRH-2, Sahyadri-1, Sahyadri-2, Sahyadri-3 [14].

The rice cultures *viz.*, TP 10002, TP 10005, TP 10016, TP 10038, TP 10051, TP 10052, TP 09048 and TP 09052 were rated as moderately resistant in any one of the years of the study period amidst resistant and highly resistant scales (Fig. 1). This was in tune with the findings [15] stated that TP 10052 was resistant to rice stem borer with almost nil incidence in both vegetative and reproductive stages during *Kharif* 2011 and 2012. Another study also revealed that CR 3005-77-2 was

moderately resistant during *Kharif* 2011 and 2012 whereas CR 3006-8-2 was moderately resistant in one year and moderately susceptible in another year [10].

Table 2: Screening of rice cultures/ germplasms for their reaction to stem borer

S. N.	Rice cultures	White ear									
		Kharif 2013				Kharif 2014				Kharif 2015	
		75 DAT		95 DAT		75 DAT		95 DAT		95 DAT	
		%	Scale	%	Scale	%	Scale	%	Scale	%	Scale
1.	TP 10001	6.58	3(MR)	3.77	1(R)	6.77	3(MR)	1.64	1(R)	18.84	7(S)
2.	TP 10002	3.16	1(R)	1.25	1(R)	7.35	3(MR)	2.50	1(R)	4.08	1(R)
3.	TP 10003	3.26	1(R)	2.17	1(R)	4.92	1(R)	3.22	1(R)	2.04	1(R)
4.	TP 10004	2.86	1(R)	1.59	1(R)	3.80	1(R)	5.17	1(R)	0.0	0(HR)
5.	TP 10005	2.99	1(R)	1.27	1(R)	8.06	3(MR)	0.00	0(HR)	0.0	0(HR)
6.	TP 10006	14.89	5(MS)	6.52	3(MR)	3.45	1(R)	3.61	1(R)	0.0	0(HR)
7.	TP 10007	2.99	1(R)	6.94	3(MR)	0.00	0(HR)	36.54	9(HS)	4.26	1(R)
8.	TP 10008	0.0	0(HR)	11.48	5(MS)	6.67	3(MR)	39.56	9(HS)	0.0	0(HR)
9.	TP 10009	0.0	0(HR)	3.03	1(R)	0.00	0(HR)	33.90	9(HS)	2.56	1(R)
10.	TP 10010	8.47	3(MR)	1.82	1(R)	13.24	5(MS)	16.95	7(S)	2.50	1(R)
11.	TP 10011	6.15	3(MR)	13.73	5(MS)	0.00	0(HR)	24.70	7(S)	10.00	3(MR)
12.	TP 10012	2.99	1(R)	4.55	1(R)	10.91	3(MR)	23.72	7(S)	3.33	1(R)
13.	TP 10013	12.96	5(MS)	7.69	3(MR)	4.17	1(R)	20.63	7(S)	2.27	1(R)
14.	TP 10014	0.0	0(HR)	14.29	5(MS)	4.41	1(R)	7.50	3(MR)	2.04	1(R)
15.	TP 10015	3.45	1(R)	13.41	5(MS)	1.43	1(R)	9.09	3(MR)	1.89	1(R)
16.	TP 10016	1.15	1(R)	9.21	3(MR)	0.00	0(HR)	2.50	1(R)	1.67	1(R)
17.	TP 10017	5.56	1(R)	13.79	5(MS)	3.17	1(R)	10.22	3(MR)	0.0	0(HR)
18.	TP 10018	0.0	0(HR)	12.00	5(MS)	5.56	1(R)	4.88	1(R)	1.79	1(R)
19.	TP 10035	1.52	1(R)	16.92	7(S)	5.56	1(R)	2.63	1(R)	0.0	0(HR)
20.	TP 10037	1.25	1(R)	11.54	5(MS)	1.43	1(R)	9.76	3(MR)	0.0	0(HR)
21.	TP 10038	0.0	0(HR)	0.0	0(HR)	4.23	1(R)	8.75	3(MR)	0.0	0(HR)
22.	TP 10039	2.04	1(R)	1.54	1(R)	3.70	1(R)	0.00	0(HR)	0.0	0(HR)
23.	TP 10040	1.47	1(R)	5.88	1(R)	5.08	1(R)	11.12	5(MS)	4.35	1(R)
24.	TP 10042	10.98	3(MR)	7.27	3(MR)	12.33	5(MS)	29.30	9(HS)	0.0	0(HR)
25.	TP 10048	3.53	1(R)	19.61	7(S)	7.46	3(MR)	25.00	7(S)	0.0	0(HR)
26.	TP 10049	3.77	1(R)	7.55	3(MR)	14.58	5(MS)	4.88	1(R)	2.33	1(R)
27.	TP 10050	3.57	1(R)	8.93	3(MR)	6.00	3(MR)	35.83	9(HS)	2.06	1(R)
28.	TP 10051	0.0	0(HR)	2.04	1(R)	3.28	1(R)	9.38	3(MR)	0.0	0(HR)
29.	TP 10052	0.0	0(HR)	9.26	3(MR)	5.26	1(R)	3.23	1(R)	0.0	0(HR)
30.	TP 08003	5.88	1(R)	16.28	7(S)	5.41	1(R)	32.39	9(HS)	12.82	5(MS)
31.	TP 08006	0.0	0(HR)	9.80	3(MR)	6.25	3(MR)	15.52	5(MS)	5.88	1(R)
32.	TP 08024	6.78	3(MR)	15.22	5(MS)	2.08	1(R)	18.87	7(S)	0.0	0(HR)
33.	TP 08053	0.0	0(HR)	3.08	1(R)	0.00	0(HR)	11.63	5(MS)	13.33	5(MS)
34.	TP 08079	1.52	1(R)	0.0	0(HR)	0.00	0(HR)	0.00	0(HR)	16.67	7(S)
35.	TP 08080	1.61	1(R)	4.92	1(R)	17.24	7(S)	45.71	9(HS)	3.70	1(R)
36.	TP 08085	0.0	0(HR)	0.0	0(HR)	0.00	0(HR)	12.77	5(MS)	0.0	0(HR)
37.	TP 08095	2.35	1(R)	0.0	0(HR)	3.45	1(R)	4.69	1(R)	0.0	0(HR)
38.	TP 09028	2.78	1(R)	0.0	0(HR)	2.94	1(R)	13.16	5(MS)	0.0	0(HR)
39.	TP 09037	3.03	1(R)	3.45	1(R)	1.59	1(R)	15.66	5(MS)	14.71	5(MS)
40.	TP 09046	1.59	1(R)	1.75	1(R)	6.25	3(MR)	23.81	7(S)	14.55	5(MS)
41.	TP 09047	2.99	1(R)	1.56	1(R)	7.58	3(MR)	26.47	9(HS)	0.0	0(HR)
42.	TP 09048	0.0	0(HR)	9.84	3(MR)	8.20	3(MR)	6.15	3(MR)	0.0	0(HR)
43.	TP 09049	0.0	0(HR)	2.17	1(R)	13.79	5(MS)	0.00	0(HR)	0.0	0(HR)
44.	TP 09052	1.37	1(R)	1.49	1(R)	1.61	1(R)	2.67	1(R)	7.69	3(MR)
45.	TP 09054	3.17	1(R)	1.96	1(R)	0.00	0(HR)	0.00	0(HR)	11.76	5(MS)
46.	TP 09055	6.67	3(MR)	17.02	7(S)	0.00	0(HR)	6.45	3(MR)	18.18	7(S)
47.	TPS 5	0.0	0(HR)	0.0	0(HR)	0.00	0(HR)	32.61	9(HS)	10.94	3(MR)
48.	ASD 16	0.0	0(HR)	0.0	0(HR)	5.26	1(R)	33.33	9(HS)	9.80	3(MR)
49.	ADT 36	10.17	3(MR)	13.73	5(MS)	1.79	1(R)	0.00	0(HR)	10.64	3(MR)
50.	ADT 43	4.62	1(R)	6.12	3(MR)	3.17	1(R)	17.02	7(S)	2.17	1(R)
51.	ADT 45	3.45	1(R)	0.0	0(HR)	2.04	1(R)	8.20	3(MR)	10.91	3(MR)
52.	TN 1	29.79	9(HS)	40.35	9(HS)	23.73	7(S)	42.86	9(HS)	16.56	7(S)

White ear: 0 - No damage, 1 - 1 to 5% damage, 3 - 6 to 10% damage, 5 - 11 to 15% damage, 7 - 16 to 25% damage, 9 - 26% and above

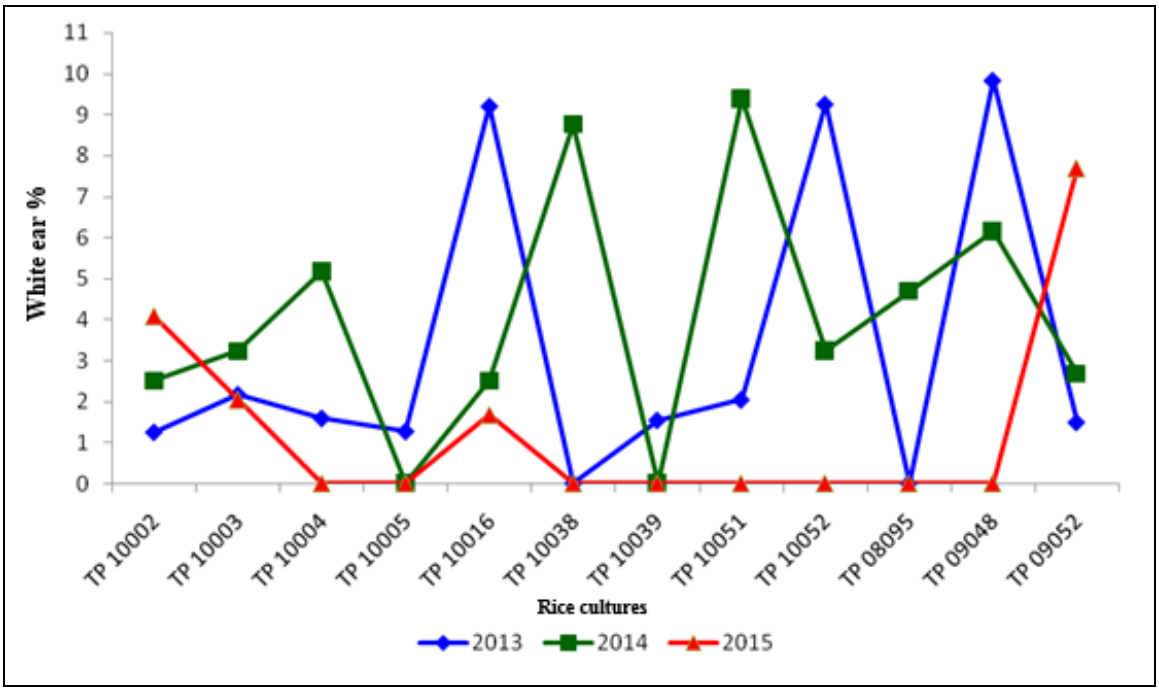

Fig 1: Response of resistant rice genotypes to stem borer in three year period (95 DAT)

5. Conclusion

Among the different genotypes, TP 10003, TP 10004, TP 10039 and TP 08095 were rated under the resistant category, which can be used for breeding programme as a resistant donor against rice stem borer. The incidence of rice stem borer upto 9 scale in all the three years reveal the test spot, Thirupathisaram as the hotspot for screening of rice varieties for stem borers.

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