



ISSN (E): 2277- 7695

ISSN (P): 2349-8242

NAAS Rating: 5.03

TPI 2020; 9(8): 211-214

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www.thepharmajournal.com

Received: 30-05-2020

Accepted: 22-07-2020

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Reaction of land races of rice against major chewing pest of rice under saline conditions

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Abstract

Rice, (*Oryza sativa* L.) is a vulnerable crop to climate variability or climate change and presence of pest certainly affects the crop productivity. Among these factors, insect-pests contribute substantially to yield loss in rice production and productivity. Field trials were taken up during 2017-18 and 2018-19 at ADAC & RI, Tiruchirappalli with a view to study the reaction of landraces of rice against major chewing pest under saline conditions. Fourteen landraces were raised in samba season for two years and evaluated for their resistance following the IRRI Standard Evaluation System of Rating (SESR). Among the land races screened Kudavalai, Thengapoo samba, Kanba samba, and Kandha sala were found to be highly resistant and recorded no pest in both the years of study and can be potentially used as donar sources for breeding for insect resistance in rice. Thengapoo samba Kanba samba Kandha sala and Kandavali were highly resistant to Rice yellow stem borer while Kuruvikar, Seeraga samba, Karudan samba and Kaivara samba Seeraga samba, Kandasala, Karudan samba and Thegapoo samba were observed as highly resistant sources to Gall midge and Leaf folder, respectively.

Keywords: Rice, chewing pests, land races, resistant sources

Introduction

Paddy, *Oryza sativa* L. is one of the most important cereal crops in the world. India has the largest area under rice cultivation in the world (44.6 million hectares) and ranks second in production (104.31million tonnes in 2011-12). In India, Rice is grown under different agroecological conditions viz., water logged, deep water, hills, high humidity, high temperatures, salinity, alkalinity and flood prone areas. The cropping intensity differs from one environment to the other with a maximum of three rice growing seasons in a year in the fertile deltaic regions due to availability of continuous irrigation. The rice crop is prone to stress throughout the crop growth period due to onslaught from different pests such as insects, nematodes, diseases, weeds and rats. Yield loss of 10 to 48 per cent was recorded by stem borer damage (Katti *et al.*, 2001)^[9]. In recent years the important insect pests that inflict damage to rice crop are, stem borer, leaf folder, brown plant hopper, white backed plant hopper, gall midge and green leafhopper in India and Karnataka. These pests infest the crop from seedling to maturity in overlapping generations. Among these, yellow stem borer assumes the number one status and attacks the crop at all stages of its growth (P). Misra and Parida (2004)^[11], estimated that, yellow stem borer, *Scirpophaga incertulas* (Walker) caused an yield loss of 38 to 80 per cent.

These pests occur regularly and ravage the crop from seedling stage to maturity and few acts as vectors of virus diseases also. The borer and leaf feeding pests of rice cause vulnerable damage to rice crop from nursery until grain filling leading to yield loss. Among the different insects associated with rice, the yellow stem borer, *Scirpophaga incertulas* Walker is one of the most destructive insect and is widely distributed monophagous insect in Indian subcontinent and has assumed the number one pest status and attacks the rice crop at all growth stages. The extent of rice yield losses due to YSB has been estimated as 20–70% Atwal and Dhaliwal, 2008^[2]. Insect larvae bore into the plant and feed on leaf-sheath tissue, on tassel buds, and on the stem. Damaged plants wither and their tassels die or become infertile leading to decreased grain production.

Muralidharan and Pasalu (2006)^[12] assessed the crop losses in rice ecosystems, due to stem borer damage and reported that, each unit (white head %) had a greater impact on rice yield than the dead heart damage. In irrigated ecosystem, 1% dead heart resulted in 0.3% or 12 kg/ha loss whereas, 1% white ear head caused 4.2%, 83 kg/ha loss in grain yields; the loss due to 1% infestation in both phases of stem borer damage was 4.6% or 201 kg/ha.

In rain fed lowlands, for 1% dead heart or dead heart and white ear head caused 2.3% or 76 kg/ha yield loss. Even at levels below the currently used economic threshold considerable losses can occur.

Materials and methods

Field trials was conducted at Anbil Dharmalingam Agricultural College and Research Institute, Tiruchirappalli District, Tamil Nadu, India for evaluation of land races of rice along with two check entries for their level of resistance to rice leaf folder, gall midge and rice yellow stem borer, during Samba 2017-18 and 2018-19. The standard agronomic practices recommended by Agricultural University were adopted except the plant protection practices. The test entries were kept unsprayed throughout the season. Incidence of damage leaves (%) for leaf folder, silver shoot (%), dead heart (%) and white ear (%) were recorded during the vegetative and reproductive stages respectively during the peak time of infestation. The observations were recorded from ten randomly chosen hills/accession or variety. The damage percentage was calculated by adopting the formula developed by Heinrichs *et al.*, (1985)^[8].

The damage rating and scale with reactions are followed as per the IRRI Standard Evaluation System of Rating (SESr). The pests and scales related are as follows.

Dead heart (Stem borer)

Scale	Damage (%)	Reaction
0	No damage	HR- Highly Resistant
1	1-20	R- Resistant
3	21-40	MR- Moderately Resistant
5	41-60	MS- Moderately Susceptible
7	61-80	S - Susceptible
9	81-100	HS - Highly Susceptible

White ears (Stem borer)

Scale	Damage (%)	Reaction
0	No damage	HR- Highly Resistant
1	1-20	R- Resistant
3	11-25	MR- Moderately Resistant
5	26-40	MS- Moderately Susceptible
7	41-60	S - Susceptible
9	61-80	HS - Highly Susceptible

Leaf folder infestation

Scale	Damage (%)	Reaction
0	No damage	HR- Highly Resistant
1	1-20	R- Resistant
3	21-40	MR- Moderately Resistant
5	41-60	MS- Moderately Susceptible
7	61-80	S - Susceptible
9	81-100	HS - Highly Susceptible

Gall midge

Scale	Scale (Infected tillers in field test) (%)
0	No damage
1	Less than 1
3	1-5
5	6-10
7	11-25
9	More than 25

Dead heart (%)=Number of dead hearts Total number of tillersX100

White ear (%)=Number of white ears Total number of productive tillers X100

D values were calculated using the formula,

D=Per cent dead or white ear in test genotype Percent dead heart or white ear in susceptible checkX100

The damage rating scale 0-9 was fixed based on the D values suggested by IRRI Standard Evaluation System for screening resistance to stem borer in rice as given below, Standard evaluation system for screening resistance to stem borer in rice by IRRI

Result and discussion

Reactions of rice germplasm entries to major insect pests during samba 2018-19 under field conditions

Land races were screened for their reactions to major pests like stem borer, gall midge and leaf folder under field conditions during 2017-18 and 2018-19. The pests were scored when there was enough incidence in the trial field. All the entries screened recorded below 10 % dead heart (Table 1). No stem borer damage was noticed in the entries Thengapoo samba, Kanba samba, Kandavali and Kandan samba land races. The highest damage of stem borer (65.33 %) was noticed in TN 1 which was the susceptible check and the lowest was noticed in kudavali (0.42 per cent). Six entries namely Kuruvikkar, Kanba samba, Seeraga samba, Karudan samba, Kanda sala and kaiveera samba recorded no silver shoot damage and only six land races showed damage which ranged from 0.33 to 1.98 %. The lowest damage of leaf folder (0.17 %) was observed in the Manakatthai and the highest damage of leaves was noticed in TRY 3 (2.69%). Thengapoo samba and Kandasala recorded no incidence of leaf folder. The land race Kanda sala was resistance to all the pest that were screened.

Among the 15 entries raised during the samba season during 2018-19. No stem borer damage was noticed in many of the the entries except Kuruvai kalangiyam (1.89 % dead heart) and Pongar (6.25 % dead heart) land races. Five entries *viz.*, Kuruvikkar, Kudavali, Thengapoo samba, Kanba samba, Seeraga samba, Karudan samba, Kuzhiadichan, Mankkathai, Kandavali and Kaiveera samba recorded no stem borer, silver shoot damage and leaf folder damage. The lowest damage of leaf folder of 1.23 per cent was observed in the Kuruvai kalangiyam and the highest damage of leaves was noticed in TN 1 (62.66 %). Most of the land races screened recorded a score of 0 to 3 for all the pest and rating was between Highly Resistant and Moderately Resistant.

Nalini and Baskaran (2013)^[13] screened 74 rice cultures during *rabi* 2011-2012 and reported that AD 08142, CB 08504, TM 08610, CB 06651 and TNRH 206 (hybrid) can be promoted as yellow stem borer resistant cultues. Visalakshmi *et al.* (2014)^[17] screened 29 and 53 entries during *kharif* 2011 and 2012 and revealed that the culture CR 2711-76 and CR 3005-230-5 were resistant to stem borer at reproductive stage during the study period. The culture CR 3005-77-2 was moderately resistant in both the years where as CR 3006-8-2 was moderately resistant in one year and moderately susceptible in another year.

Visalakshmi *et al.*, (2014)^[17] screened 29 and 53 rice germplasms for their resistance to rice stem borer and reported that, during *Kharif* 2011 and *Kharif* 2012 respectively. TN-1 was highly susceptible and six cultures were resistant with '1' scale. The culture RpPatho-02 was highly susceptible during *Kharif* 2012 with 13.13 per cent WE and five cultures were resistant with scale '1'. The culture

CR 3005-77-2 was moderately resistant in both the years where as CR 3006-8-2 was moderately resistant during *Kharif* 2011 and moderately susceptible during *Kharif* 2012. Preetha (2017) [15] screened 46 rice germplasms against yellow stem borer and reported that, the cultures TP 10003, TP 10004, TP 10039 and TP 08095 were resistant with no or minimal incidence of pest and the cultures TP 10002, TP 10005, TP 10016, TP 10038, TP 10051, TP 10052, TP 09048 and TP 09052 were rated as moderately resistant. The incidence of stem borer upto scale 9 revealed it as a hotspot for screening rice for stem borers. The promising rice genotypes ACK 14003, ACK 14004, BRNS-WP-6 recorded the scale of 1 (resistant) at the vegetative and reproductive stage for the stem borer at AC & RI, Killikulam during Pishanam season, 2015 -16 (Elanchezhyan *et al.*, 2017) [5].

The four rice cultivars, *viz.*, NDR 1058-1-4, IET 13310, NDR 2025-2, and Mahsuri, were free from leaf folder (Gupta *et al.*, 2002) [7]. Parijat, Rudra, Sankar, Khandagiri, Sarathi, Samanta, Meher and Rambha showed moderate resistance as per the report of Mishra *et al.* (2002) [10]. While, Nigam *et al.* (2008) [14] reported that, out of 25 rice germplasms tested at different cropping stages (tillering, booting and dough) for resistance to leaf folder, six germplasms such as IET 13310, NDR 6023, IET 10649-1, Mahsuri, NDR 6232 and NDR 6175, showed a consistent damage rating of one.

Girish *et al.* 2015 [6] field evaluated 231 paddy genotypes including one susceptible check (TN1) was carried out against rice leaf folder, during *Kharif* 2013 under rainfed ecosystem. Genotypes were evaluated based on the standard evaluation scale of 0-9. Per cent leaf damage by leaf folder at 80 days after transplanting (DAT) varied between 2.32 (resistant) and 44.36 (susceptible). Out of 231 genotypes, 48 genotypes proved to be resistant to leaf folder by recording less than 10 per cent leaf damage, 120 genotypes reacted as moderately resistant (11-20% leaf damage), 48 genotypes reacted moderately susceptible by recording less than 35 per cent leaf damage and 15 genotypes showed susceptible reaction by recording a leaf damage per cent in between 36 to 50 per cent. The susceptible check TN1 recorded 44.36 per cent leaf damage. None of the genotypes were free from leaf damage, to be categorized as highly resistant (0% leaf damage). Similarly, none of the genotype reacted as highly susceptible (51-100% leaf damage). The results are supported by field screening of rice cultivars under natural infestation of leaf folder, *Cnaphalocrocis medinalis*, by Ahmad *et al.* 2006 [1] during *Kharif* 2002 in Jammu, India. None of the 50 cultivars was immune or resistant to leaf folder. However, 18 cultivars were moderately resistant to the disease. The remaining

cultivars were moderately susceptible (25 cultivars), susceptible (6 cultivars) or highly susceptible (one cultivar).

A total of 15 medium duration rice genotypes with four check entries were screened against rice leaf folder, at Ambasamudram during Pishanam season, 2013-14. The leaf folder infestation varied from 3.76 to 52.13 % of leaf damage in rice. The genotype AS 12079 recorded resistant reaction by recording less than 10% leaf damage (3.76%) with a grade 1. Nine genotypes *viz.*, AS 12005, AS 12010, AS 12029, AS 12035, AS 12039, AS 12050, AS 12066, AS 12073 and ASRH 12001 reacted moderately resistant (11 - 20% leaf damage) to leaf folder with a grade of 3. Three rice genotypes *viz.*, AS 12033, AS 12071, AS 12104 were moderately susceptible reaction by recording less than 35% leaf damage (Grade 5) and one genotype AS 12051 expressed susceptible reaction by recording a leaf damage of 36.24% with a grade 7. The highly susceptible genotype AS 12008 recorded the maximum infestation of 52.13 per cent leaf damage (Grade 9) (Elanchezhyan and Arumugachamy, 2015) [4].

The different rice entries were screened out against stem borer, leaf folder and whorl maggot of rice during *kharif*, 2014 by Chatterjee *et al* (2016) [3]. The experiment was carried out to note the reaction of promising advanced cultures with four check varieties *viz.* DRRH 2, Surakha, IR 64 and Taichung Native 1 (TN 1) against insect-pests of rice with a view to identify multiple resistant varieties. CN 2008-3-2, CN 2017-3-2 and W 1263 are the multiple resistant entries against all the test insect-pests, CR 2274-2-3-3-1, RP 5587-B-B-B-305-13, CN 2015-5-4, IET 23148 and CN 1233-33-9 against stem borer and leaf folder and RP 2068-18-3-5, RP 5588-B-B-B-B-76 and RNT 14-1-1-2-2 against stem borer and whorl maggot

Sarao *et al.* (2012) [16] evaluated 66 lines/varieties under field conditions for two wet seasons against a yellow stemborer, leaf folder and whitebacked planthopper (WBPH) at the vegetative and panicle initiation crop stages. At the vegetative stage, over the 2 years, 18 lines/varieties showed leaf folder damage from 6.21 ± 0.33 to $9.99 \pm 4.07\%$, while at the panicle initiation stage, six lines/varieties showed damage from 8.77 ± 1.25 to $12.25 \pm 4.67\%$. The dead heart (DH) damage at the vegetative stage over the years was less than 1% in six lines/varieties, while at the panicle initiation stage, seven lines/varieties showed whitehead (WH) damage ranging from 1.29 to 1.92%. A highly significant correlation was observed between plant height and per cent DH and WH at the vegetative ($r = 0.73$) and panicle initiation stages ($r = 0.81$). Such a relationship was not observed between leaf width and stemborer infestation at both stages.

Table 1: Reactions of rice germplasm entries to major insect pests during samba 2017-18 under field conditions

S. No	Name of the entry	Stem borer (%dead heart)	Score/ Rating	Gall midge (% silver shoot)	Score/ Rating	Leaf folder (%infested leaves)	Score/ Rating
1.	Kuruvikkar	1.35	1(R)	0.00	0(HR)	2.56	1(R)
2.	Kudavalai	0.42	0(HR)	0.33	1(R)	1.52	1(R)
3.	Thengapoo samba	0.00	0(HR)	0.46	1(R)	0.00	0(HR)
4.	Kanba samba	0.00	0(HR)	0.00	0(HR)	1.07	1(R)
5.	Seeraga samba	1.58	1(R)	0.00	0(HR)	0.48	0(HR)
6.	Karudan samba	0.15	1(R)	0.00	0(HR)	0.00	0(HR)
7.	Kuzhiyadichan	1.53	1(R)	1.98	3(MR)	1.60	1(R)
8.	Manakatthai	0.41	1(R)	1.55	3(MR)	0.17	0(HR)
9.	Kandavali	0.00	0(HR)	0.87	1(R)	0.40	0(HR)
10.	Kaiveera samba	1.18	1(R)	0.00	1(R)	1.33	1(R)
11	Kuruvai kalangiyam	0.08	1(R)	2.45	1(R)	1.06	1(R)
12	Kandha sala	0.00	0(HR)	0.00	0(HR)	0.00	0(HR)
13	Koonbalai	1.06	1(R)	2.35	1(R)	2.66	1(R)

14	Poongar	5.06	1(R)	2.06	1(R)	2.33	1(R)
15	TN 1	65.33	7(S)	43.33	9(HS)	61.0	7(S)

Table 2: Reactions of rice germplasm entries to major insect pests during samba 2018-19 under field conditions

S. No.	Name of the entry	Stem borer (% dead heart)	Score/Rating	Gall midge (% shoot galls)	Score/Rating	Leaf folder (%infested leaves)	Score/Rating
	Kuruvikkar	0.00	1 (R)	0.00	0 (HR)	0.00	0 (HR)
	Kuruvai kalangiyam	1.89	1 (R)	1.89	3 (MR)	1.23	1(R)
	Kudavalai	0.00	0 (HR)	0.00	0 HR)	0.00	0 (HR)
	Thengapoo samba	0.00	0 (HR)	0.00	0 (HR)	0.00	0 (HR)
	Kanba samba	0.00	0 (HR)	0.00	0 (HR)	0.00	0 (HR)
	Seeraga samba	0.00	0 (HR)	0.00	0 (HR)	0.00	0 (HR)
	Kandha sala	0.00	0 (HR)	1.69	3 (MR)	0.00	0 (HR)
	Koonbalai	0.00	0 (HR)	4.87	3 (MR)	2.64	1(R)
	Karudan samba	0.00	0 (HR)	0.00	0 (HR)	0.00	0 (HR)
	Kuzhiyadichan	0.00	0 (HR)	0.00	0 (HR)	0.00	0 (HR)
	Manakkathai	0.00	0 (HR)	0.00	0 (HR)	0.00	0 (HR)
	Kandavali	0.00	0 (HR)	0.00	0 (HR)	0.00	0 (HR)
	Poongar	6.25	1 (R)	0.00	0 (HR)	2.15	1(R)
	Kaivara samba	0.00	0 (HR)	0.00	0 (HR)	0.00	0 (HR)
	TN 1	78.06	7(S)	46.65	9 (HS)	62.66	7(S)

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