Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

Journal of Entomology and Zoology Studies

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2017; 5(5): 1903-1905

Received: 02-07-2017
Accepted: 03-08-2017

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Evaluation of promising rice cultures against yellow stem borer, *Scirpophaga incertulas* Walker (Crambidae: Lepidoptera)

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Abstract
A total of eight promising rice cultures and six standard check varieties were screened against yellow stem borer *Scirpophaga incertulas* (Walker) (Crambidae: Lepidoptera) in rice under field condition at AC & RI, Killikulam during *Pishanam* season, 2015 - 16. None of the genotypes were free from a dead heart and whiter ear to be categorized as highly resistant. The stem borer infestation varied from 2.48 to 23.58% dead heart during the vegetative stage and 1.94 to 12.25% white ear during the reproductive stage in rice. The promising rice genotypes ACK 14003, ACK 14004, BRNS-WP-6 recorded the scale of 1 (resistant) at both dead heart at the vegetative stage and white ear at the reproductive stage for the stem borer damage in rice. All the resistant cultivars of the rice exhibited the highest phenol content compared to the susceptible one. The total phenols present in promising cultures were 2.72 mg to 4.08 mg equivalent of Pyrocatecho / g fresh weight of leaf sample. The highest phenol content was observed in resistant cultures *viz*., ACK 14004 (4.08 mg/ g fresh weight) followed by ACK 14003 (3.93 mg/g) and BRNS WP 6 (3.83 mg/g). Higher concentration of total phenols found in the resistance group could be one of the factors contributing towards tolerance with antibiotic effect against stem borer. Hence, they can be utilized in breeding programs as a source of resistance against yellow stem borer in rice.

Keywords: Germplasm, resistance, yellow stem borer, rice

1. Introduction
Rice (*Oryza sativa* L.) is the staple food for more than two billion people. Almost 90 per cent of the rice is grown and consumed in Asia. India is the second largest rice producing country in the world. In Tamil Nadu, rice was grown over an area of 17.9 million hectare with a total production of 79.5 million tonnes with an average yield of 4429 kg/ ha during 2014-2015 **[1]**. Nearly 300 species of insect pests infest in rice crop from sowing to harvest and among them only 23 species cause notable damage [10]. Crambids are the main insect pests in rice ecosystem in Tamil Nadu [11]. Rice stem borers have acquired the status of regular insect pests of rice in most of the rice grown area in the state. Yellow stem borer, *Scirpophaga incertulas* (Walker), a monophagous pest of paddy is considered as the most important nuisance of rainfed, low-land and flood prone rice ecosystems [2]. Globally, yellow rice stem borer alone causes yield loss of 10 million tons and 50 per cent of the insecticides are used for their management in the rice field [6]. The use of synthetic insecticides in insect pest management programmes around the world has resulted in the disturbance of eco-bio-balance. One of the safe measures to escape such a situation is to grow insect resistant crops. The use of resistant varieties is one of the important technique in integrated pest management. Host plant resistance plays an important role in changing scenario of insect pest management programme. Hence, it is necessary to screen rice germplasm against stem borer, a resistant source that can be identified and utilized in resistance breeding.

2. Materials and Methods
The present investigation was carried out under natural field conditions at Agricultural College and Research Institute, Killikulam during *Pishanam* season, 2015 - 16. A total of eight promising cultures and six check varieties were screened for their level of resistance to yellow stem borer in rice. The agronomic practices except plant protection were followed. The test entries were kept unsprayed throughout the season. The incidence of dead heart (%) and white ear (%) were recorded during the vegetative stage and pre maturity stage at the time of peak infestation [5]. The observations were recorded at 10 randomly selected hills per entry and the per cent dead heart and white ear were calculated as follows.

$$\text{Percent dead heart} = \frac{\text{Number of dead hearts}}{\text{Number of total tillers}} \times 100$$

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

The damage rating and scale were given to the test entries by following the IRRI Standard Evaluation System for rice shown in Table 1 [7].

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

Dead Heart (DH)			White Ear (WE)		
Damage (%)	**Scale**	**Status**	**Damage (%)**	**Scale**	**Resistance Rating**
0	0	Highly Resistant (HR)	0	0	Highly Resistant (HR)
1 - 10	1	Resistant (R)	1 - 5	1	Resistant (R)
11 - 20	3	Moderately Resistant (MR)	6 - 10	3	Moderately Resistant (MR)
21 - 30	5	Moderately Susceptible (MS)	11 - 15	5	Moderately Susceptible (MS)
31 - 60	7	Susceptible (S)	16 - 25	7	Susceptible (S)
61 & above	9	Highly Susceptible (HS)	26 & above	9	Highly Susceptible (HS)

2.1 Biochemical Basis of Resistance

2.1.1 Total Phenols

A quantity of 100 mg of plant sample was extracted with 80 per cent ethanol and centrifuged at 10,000 rpm for 20 minutes. The supernatant was evaporated to dryness and the residue was dissolved in 5 ml of distilled water. The aliquots of 0.2 to 2 ml was pipetted out and the volume was made up to 3 ml with distilled water. A quantity of 0.5 ml of Folin reagent and 2 ml of 20 per cent sodium carbonate solution was added. Then it was kept in a boiling water bath for one minute, cooled and the colour developed was measured at 650 nm wave length using Spectrophotometer (Spectronic 20). Phenol content was calculated by drawing a standard graph with catechol as standard and expressed as catechol equivalents.

3. Results and Discussion

3.1 Resistance expressed at vegetative stage: The stem borer infestation varied from 2.48 to 23.58% dead heart in rice during the vegetative stage (Table 2). In the present study, cultures *viz*., ACK 12001, ACK 13005, ACK 14001, ACK 14002, ACK 14003, ACK 14004 and BRNS-WP-6 and standard checks *viz*., ADT 39, ADT 43, I.W. Ponni were found to be resistant to scale '1'. The culture BRNS-WP-5 and check varieties *viz*., ASD 16, ADT 45 were moderately resistant with a grade of 3. The standard check variety TPS 5 recorded moderately susceptible reaction by recording 23.58% dead heart in rice. None of the genotypes were free from a dead heart to be categorized as highly resistant (0% dead heart).

3.2 Resistance expressed at reproductive stage: The stem borer infestation varied from 1.94 to 12.25% white ear in rice during the reproductive stage. Three cultures ACK 14003, ACK 14004, BRNS-WP-6 and four standard check varieties *viz*., TPS 5, ADT 39, ADT 43, ADT 45 were found to be resistant to scale '1'. Four cultures ACK 12001, ACK 13005, ACK 14001, ACK 14002 and one standard check ASD 16 were moderately resistant to stem borer in rice. The genotype BRNS-WP-5 was found to be moderately susceptible to rice stem borer with 12.25 per cent white ear rated under the scale '5' (Table 2).

Table 2: Evaluation of promising rice cultures against yellow stem borer, S*cirpophaga incertulas* in rice

S. No.	Cultures	Dead Heart (%)	Score	Status	White ear (%)	Score	Status
1.	ACK 12001	7.10	1	R	7.75	3	MR
2.	ACK 13005	7.13	1	R	5.48	3	MR
3.	ACK 14001	6.65	1	R	6.29	3	MR
4.	ACK 14002	7.34	1	R	6.31	3	MR
5.	ACK 14003	5.88	1	R	4.60	1	R
6.	ACK 14004	4.56	1	R	3.42	1	R
7.	BRNS-WP-5	12.55	3	MR	12.25	5	MS
8.	BRNS-WP-6	5.92	1	R	5.29	1	R
9.	ASD 16	12.96	3	MR	6.16	3	MR
10.	TPS 5	23.58	5	MS	3.93	1	R
11.	ADT 39	2.48	1	R	1.94	1	R
12.	ADT 43	7.19	1	R	3.77	1	R
13.	ADT 45	12.74	3	MR	4.50	1	R
14.	I.W.Ponni	2.62	1	R	5.48	3	MR

HR - Highly Resistance; R - Resistance; MR - Moderately Resistance; HS - Highly Susceptible

3.3 Resistance expressed at both vegetative and reproductive stage: Three promising rice genotypes ACK 14003, ACK 14004, BRNS-WP-6 recorded the scale of 1 (resistant) at both dead heart at the vegetative stage and white ear at the reproductive stage for the stem borer damage in rice (Table 2).

Nalini and Baskaran [9] 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 they have yellow stem borer resistance in addition to good yield. Visalakshmi *et al*. [12] 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. The genotype TP 10052 was resistant to rice stem borer with an almost nil incidence both in vegetative and reproductive stages during *kharif* 2011 and 2012. The genotypes TP 08033 and TP 09119 recorded almost nil incidence of the rice stem borer and found to be resistant during *rabi* season [8]. Elanchezhyan and

Arumugachamy [3] screened 23 medium duration rice cultures during *Kar* season, 2013-2014 under field condition at Rice Research Station, Ambasamudram and reported that the entries AS 12021, AS 12029, AS 12032, AS 12033, AS 12071, AS 12090 and AS ST 12010 recorded nil incidence of stem borer in rice. Elanchezhyan and Arumugiachamy [4] evaluated 15 medium duration rice cultures during *Pishanam* season, 2013- 2014 and reported that the entries AS 12035 and AS 12051 recorded grade 1. The cultures AS 12005, AS 12050, AS 12104 and ASRH 12001 recorded grade 3.

3.4 Biochemical Basis of Resistance to stem borer in rice:

Plant phenolics play an important role in resistance of the plant against biotic as well as abiotic stresses. All the resistant cultivars of the rice exhibited the highest phenol content compared to the susceptible one. The total phenols present in promising cultures were 2.72 mg to 4.08 mg equivalent of Pyrocatechol/ g fresh weight of leaf sample. The highest phenol content was observed in resistant cultures *viz*., ACK 14004 (4.08 mg/ g fresh weight) followed by ACK 14003 (3.93 mg/g) and BRNS WP 6 (3.83 mg/g) (Table 3). Higher concentration of total phenols found in the resistance group could be one of the factors contributing towards tolerance with antibiotic effect against stem borer. Higher content of total phenols in resistant varieties might have contributed to the defense mechanism of the plant against stem borer acting as antifeedants and repellants. Phenolics have been found to play an important role in determining resistance or susceptibility of a host to insect pests. They are associated with feeding deterrence or growth inhibition of insects.

Table 3: Biochemical basis of resistance to yellow stem borer in rice

S. No.	Cultures	Total Phenol (mg equivalent of Pyrocatechol/ g fresh weight
1.	ACK 12001	3.115
2.	ACK 13005	3.722
3.	ACK 14001	3.610
4.	ACK 14002	3.500
5.	ACK 14003	3.931
6.	ACK 14004	4.083
7.	BRNS-WP-5	2.832
8.	BRNS-WP-6	3.832
9.	TPS 5	2.722

4. Conclusion

The promising rice genotypes ACK 14003, ACK 14004, BRNS-WP-6 recorded the scale of 1 (resistant) at both dead heart at the vegetative and white ear at the reproductive stage for the stem borer damage in rice. All the resistant cultivars of the rice exhibited the highest phenol content compared to the susceptible one. The highest phenol content was observed in resistant cultures *viz*., ACK 14004 (4.08 mg/ g fresh weight) followed by ACK 14003 (3.93 mg/g) and BRNS WP 6 (3.83 mg/g). Higher concentration of total phenols found in the resistance group could be one of the factors contributing towards tolerance with antibiotic effect against stem borer. Hence, they can be utilized in breeding programs as a source of resistance against yellow stem borer in rice.

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