



Evaluation of biophysical traits in rice accessions conferring resistance to yellow stem borer *Scirpophaga incertulas* Walker (Crambidae: Lepidoptera)

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Abstract

Studies were conducted to evaluate resistance or susceptibility of eleven rice accessions against yellow stem borer, *S. incertulas* based on morphological traits. In this current investigation, stem diameter was significantly higher in susceptible accessions like TN-1 (5.003 mm), BA-270 (4.686 mm) and BPT-5204 (4.453 mm). However, most minimal measure of stem diameter was observed in resistant accessions *Viz.*, BA-132 and BA-155 (3.610 and 3.746 mm), respectively. Meanwhile, the maximum quantity of wax content was noticed in resistant accession BA-132 (0.95 mg/g on leaves and 0.74 mg/g on stems). This was however less in susceptible accession TN-1 (0.15 mg/g on leaves and 0.13 mg/g on stems), respectively. Trichome density was maximum on BA-132, BA-155 and BA-147 (112.00, 96.00 and 86.00 numbers per cm²). However, the lower trichome density was observed on TN-1 and BA-270 (14.67 and 18.33 numbers per cm²).

Keywords: yellow stem borer, stem diameter, trichome density, resistance

Introduction

Rice (*Oryza sativa*) is a crucial cereal crop and acts as an antecedent of calories for one-third of the sectors' populace (DES, 2012) [4]. Intensive or accelerated usage of fertilizers specifically nitrogenous fertilizers, high yielding varieties, sequential cropping and aimless or indiscriminate utilization of insecticides have brought various insect pest problems in rice vegetation. Among various depressing factors, biotic stress as insect pest infestation is the maximum crucial factor due to which rice production is unpredictable. In India, around one hundred insect pests are reported as pests of rice and 20 of those are thought about to be key pests and causing 30 per cent damage from seedling to maturity phase (Atwal and Dhaliwal, 2005) [1]. Among them, yellow stem borer (YSB) is the most calamitous and broadly occurring monophagous pest of rice crop. Newly emerged first instar larva enters into the stem for feeding on internal tissues at the vegetative and reproductive state of the crop (Rahman *et al.*, 2004) [10]. Stem borers might not be controlled with the utilization of pesticides alone because those are secured inside the stem all over the life cycles (Chaudhary *et al.*, 1984) [3]. To beat this difficulty other methods also are required to stay these pests below economic injury levels. During this context, Host Plant Resistance (HPR) in rice is a beneficial and alternate strategy that can be applied within the suppression of insect pests. In HPR, the idea of resistance can be different, in some genotypes; may be the results of physical components such as porosity, heavily sclerotized stem tissues, rigid stem surface and closely packed vascular bundle sheaths (Pathak *et al.*, 1971) [9]. In this way, identification of factors that confer resistance or susceptibility and study of their inheritance in rice plants would greatly improve the breeding strategy to release the resistant variety against insect pests.

Materials and Methods

Biophysical basis of resistance on rice accessions against *S. incertulas*

Estimation of stem diameter

Stem diameter (diameter of the basal portion of the main culm) of 10 randomly selected plants from each accession were measured in mm by using a digital vernier caliper at the maturity stage. The experiment was replicated thrice (Hosseini *et al.*, 2010) [5].

Estimation of plant surface wax

Surface waxes of rice accessions have been extracted by way of following the technique described by Woodhead and Padgham (1988) [15]. Rice tillers collected from all the test accessions have been weighed and immersed in chloroform (approximately in a 25-30 ml beaker) for 10 minutes. The extracts had been allowed to evaporate at room temperature. The weight of the condensed wax in and all over the bottom of the beaker was measured after evaporation. The experiment was carried out in three replications.

Estimation of Trichome density

The trichome density on leaves of rice accessions was assessed by following the technique portrayed by Maite *et al.*, (1980) [7]. Leaf samples gathered randomly from the selected rice accessions were cut into 1 sq.cm size and boiled in 20 ml of water in small glass vials for 15 minutes in a hot water bath at 85 °C. The water was then spilled out holding the leaves and boiled after adding 20 ml of 96 per cent ethanol for 20 minutes at 80°C. At that point, the alcohol was poured off. The boiling procedure with alcohol was rehashed to expel the chlorophyll totally from the leaves. Alcohol was again poured off and 90 per cent lactic acid was added and heated at 85 °C until the leaf fragments get cleared (approximately about 30 to 45 minutes).

Then the vials were cooled and leaf bits were taken and mounted on clean slides employing a drop of lactic acid to observe the trichome density. The number of trichomes per sq.cm was counted under the compound microscope (45x magnifications) for each sample.

Results and Discussion

Stem diameter

In the current inquiry, estimation of stem diameter fluctuated from 1.900 to 2.226 mm. Thus, from these outcomes, it tends to be interpreted that susceptible accessions (TN-1, BA-270 and BPT-5204) and moderately susceptible accessions (BA-175, BA-66 and BA-274) were recorded higher stem diameter (Fig-1). While, resistant and moderately resistant accessions such as BA-132, BA-155, BA-147, BA-142 and BA-96 indicated lower stem diameter at the maturity stage (Table-1).

Thus, in the light of prior outcomes, it might be presumed that the plant morphological characters concentrated in the prevailing investigation were found as a substantial character for varietal identification in paddy. The current findings are upheld by Mehla and Satish Kumar (2008) [8] who prior contemplated diverse rice varieties to know different morphological characters liable for recognition of rice cultivars and uncovered that plant morphological characters were significant for identification of rice cultivars. In like manner, Shahjahan and Hossain (2003) [12] prior detailed that the wider stem induced higher yellow stem borer infestation.

Table 1: Estimation of stem diameter on rice accessions against *S. incertulas*

S. No.	Accessions	Mean values of stem diameter (cm)	Stem diameter (cm)
1.	BA-66	4.210	2.052 ± 0.051 ^e
2.	BA-96	4.000	2.000 ± 0.458 ^g
3.	BA-132	3.610	1.900 ± 0.034 ^j
4.	BA-142	3.943	1.986 ± 0.026 ^g
5.	BA-147	3.840	1.960 ± 0.017 ^h
6.	BA-155	3.746	1.936 ± 0.043 ⁱ
7.	BA-175	4.116	2.029 ± 0.052 ^f
8.	BA-270	4.686	2.165 ± 0.105 ^b
9.	BA-274	4.303	2.074 ± 0.072 ^d
10.	BPT-5204	4.453	2.110 ± 0.078 ^c
11.	TN-1 (SC)	5.003	2.226 ± 0.087 ^a
	CD (0.05)		0.015
	SEd		0.007

*Means ± Standard error of three replications

Values were transformed by square root transformation

Plant surface wax content

The plant surface with which an insect pest first comes in contact assumes a significant role in insect plant interactions. Numerous herbivore insects seem to be attracted to their potential host plant by visual, olfactory or tactile smell dependent on the physical and chemical characteristics of the plant leaf surfaces. The insects look at the plant surface and get chemical cues to choose whether the plant is appropriate for oviposition, settling or feeding (Woodhead and Chapman, 1986) [14].

With this view, in the current investigation, wax content was essentially higher (0.85 to 0.95 mg/g in fresh leaves and 0.62 to 0.74 mg/g in fresh stems) on BA-132, BA-155 and BA-147. Wax content was consequently less (0.15 to 0.33 mg/g in fresh leaf and 0.13 to 0.29 mg/g in fresh stem) in

TN-1, BA-270 and BPT-5204, respectively (Table-2). It was also noticed that wax content was maximum in fresh leaves than stem. This is in verification with the discoveries of Chandramani *et al.*, (2009) [2].

Table 2: Estimation of Surface wax content on rice accessions

S. No.	Accessions	Wax content	
		mg/g fresh leaves	mg/g rice stem
1.	BA-66	0.52 (0.726) ^f	0.40 (0.632) ^f
2.	BA-96	0.67 (0.820) ^d	0.53 (0.726) ^d
3.	BA-132	0.95 (0.976) ^a	0.74 (0.860) ^a
4.	BA-142	0.77 (0.881) ^c	0.57 (0.755) ^d
5.	BA-147	0.85 (0.920) ^{bc}	0.62 (0.785) ^c
6.	BA-155	0.90 (0.950) ^{ab}	0.67 (0.821) ^b
7.	BA-175	0.59 (0.768) ^e	0.45 (0.671) ^e
8.	BA-270	0.24 (0.489) ⁱ	0.24 (0.493) ⁱ
9.	BA-274	0.44 (0.665) ^g	0.34 (0.586) ^g
10.	BPT-5204	0.33 (0.577) ^h	0.29 (0.538) ^h
11.	TN-1 (SC)	0.15 (0.391) ^j	0.13 (0.360) ^j
	CD (0.05)	0.039	0.030
	SEd	0.019	0.014

*Means of 3 replications

Figures in parentheses are square root transformed values

Trichome density

Morphological marker like trichomes acts as a defense mechanism of plants to insects, despite the fact that in certain occasions, they additionally give an appropriate substrate for egg laying and attachment (Sharma *et al.*, 2003) [13]. Several studies revealed that non-glandular trichomes imparted resistance to rice striped stem borer, *Chilo suppressalis* (Pathak *et al.*, 1971) [9] and maize spotted stem borer, *Chilo partellus* (Kumar, 1992) [6].

In the current investigation, the density of trichomes was essentially higher on BA-132 (112.00 per cm²) and BA-155 (96.00 per cm²), respectively (Table-3). Thus, the ovipositional preference of *S. incertulas* was enormously diminished in the above-mentioned accessions. The role of these trichomes on resistance might be by interfering with the initial larval establishment and consequent entry into the lumen leading to low dead heart and white earhead. Higher hair density had a positive relationship with the resistance. These outcomes are additionally in concurrence with the findings of Ramachandran and Khan (1991) [11] who detailed that the density of trichomes at TKM 6 was higher than that of susceptible accession TN-1.

Table 3: Estimation of trichome density on rice accessions against *S. incertulas*

S. No.	Accessions	Mean number of trichomes/cm ²	Number of trichomes/cm ²
1.	BA-66	43.33	6.579 ± 6.082 ^g
2.	BA-96	63.33	7.957 ± 5.291 ^e
3.	BA-132	112.00	10.579 ± 13.076 ^a
4.	BA-142	71.33	8.444 ± 5.567 ^d
5.	BA-147	86.00	9.272 ± 6.928 ^c
6.	BA-155	96.00	9.797 ± 6.244 ^b
7.	BA-175	54.33	7.369 ± 5.291 ^f
8.	BA-270	18.33	4.279 ± 2.645 ^j
9.	BA-274	35.67	5.967 ± 6.082 ^h
10.	BPT-5204	26.33	5.119 ± 7.810 ⁱ
11.	TN-1 (SC)	14.67	3.826 ± 2.645 ^k
	CD (0.05)		0.441
	SEd		0.212

*Means ± Standard error of three replications

Values were transformed by square root transformation

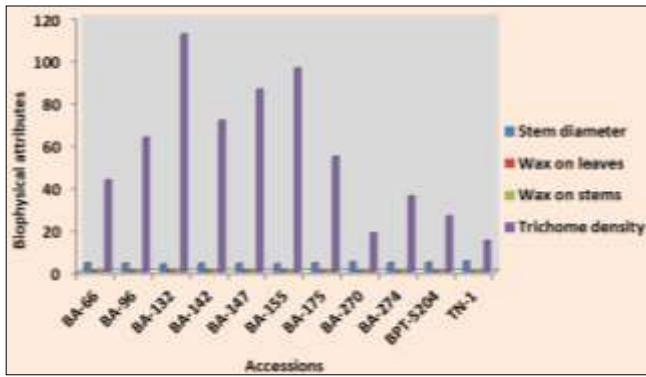


Fig 1: Biophysical basis of resistance on rice accessions against *S. incertulas*

Conclusion

The rice accessions with minimum stem diameter, maximum wax content on leaves and stems and maximum number of trichomes conferred resistance to yellow stem borer, since they are least preferred by the stem borer adults for oviposition and it is difficult for the larva to entering into the stem for feeding the internal tissues.

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