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RESEARCH ARTICLE

The Impact of Yellow Stem Borer, *Scirpophaga incertulas* (Walker) on Local Rice Landraces: Screening for Resilience

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ABSTRACT

Field evaluation of 50 local landraces against paddy yellow stem borer (YSB), *Scirpophaga incertulas* (Walker) was carried out at the College of Agriculture, V.C. Farm, Mandya during *Kharif* 2022. The per cent of damage by YSB on different genotypes was evaluated at 30, 60 and 90 days after transplanting (DAT). Based on the mean per cent incidence genotypes were grouped into different resistance categories using the Standard Evaluation System for Rice (SES) developed by IRRI. Results revealed ten genotypes exhibiting resistance with a damage score of 1, while 25 genotypes showed moderate resistance (score 3). Additionally, ten genotypes displayed moderate susceptibility (score 5), and five genotypes were susceptible (score 7) to YSB infestation. Notably, none of the genotypes were classified as highly resistant or highly susceptible. Promising resistant and moderately resistant genotypes, including Chinna Ponni – 5, Jeerige Sanna, Karimundaga, Kyasakki, Kariga Javele, Kari Doddi, Kari Dodi Budda, Laalya, Murkanna Sanna, and Sidda Sanna, were identified, offering potential for incorporation into breeding programs aimed at enhancing YSB resistance in rice cultivars.

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INTRODUCTION

Rice (*Oryza sativa* Linn.) is the staple food of more than half of the world's population (Kulagod, 2011). More than 92% of the world's rice is produced and consumed in Asia. Rice covers about one-fourth of the total cropped area and provides food for more than half of the Indian population. India is the second-largest producer and consumer of rice in the world after China with an area of 463.79 lakh ha with an annual production of 130.29 million tonnes and productivity of 2809 kg ha^{-1} (Anonymous, 2023). Paddy cultivation, a vital component of global food production, faces formidable challenges from various pests that jeopardize crop yield and quality. In modern agriculture, high-yielding rice varieties are extensively grown using fertilizers and manures. Such a cultivation pattern of rice accidentally or inadvertently offers infestation of many insect pests, which results in severe loss in crop yields (Neeta *et al*., 2013). Among these, the yellow stem borer poses a significant threat to paddy fields, causing substantial economic losses and compromising food security.

Rice yellow stem borer (YSB), *Scirpophaga incertulas* (Walker) is the most destructive pest causing about a 25-30% reduction in yield. This results in an annual yield loss of 27-34 per cent (Pasalu *et al*., 2002) of the production. During the vegetative stage of the crop, the newly emerged caterpillar bores into the stem and feeds on the internal content. As a result, the central shoot dries up and produces a dead heart. In the reproductive stage of the crop, grownup larvae bore into the peduncle leading to white ears and offering higher loss to the crop (Karthikeyan and Purushothaman, 2000). Given the substantial impact of YSB infestation on paddy crops, there is a growing need for effective and sustainable pest management strategies. Screening, a comprehensive and systematic

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approach, emerges as a pivotal tool in identifying and developing resistant varieties capable of withstanding the onslaught of YSB. This process involves the meticulous evaluation of diverse rice germplasm to pinpoint genetic traits that confer resistance to the yellow stem borer.

Several studies have also underscored the importance of screening initiatives in developing YSB-resistant paddy varieties. The work of Pathak and Khan (1994) emphasized the necessity of continuous screening efforts to stay ahead of evolving pest populations. Growing resistance variety is an excellent alternative compared to other management strategies. It is also highly compatible with all other methods of pest management. Hence identifying the source of resistance against yellow stem borer is an important step, so the current study aims to screen the genotypes for resistance to YSB under field conditions.

MATERIAL AND METHODS

Field evaluation of local landraces of rice, for resistance against YSB was conducted at A-block, College of Agriculture, Vishweshwaraiah Canal Farm, Mandya, UAS (B), Karnataka during *Kharif* 2022.

Screening material: A total of 50 local landraces of rice (Table 2,3) were collected from the Zonal Agricultural Research Station, V.C. Farm Mandya and sown separately for the evaluation. 25 days seedlings of local landraces were transplanted in 3 rows, with the spacing 20 x 15 cm between rows and plants, respectively. Each entry was raised as per the package of practice, except the plant protection measures (Anonymous, 2016).

In each genotype, the infestation of YSB was recorded during the vegetative stage (before panicle emergence) by counting the number of dead hearts to the total number of tillers, in 10 random hills in each test entry at 30 and 60 days after transplanting (DAT). Likewise, at pre-harvest, the infestation of YSB was recorded by counting the total number of ear-bearing tillers and white ears on 10 randomly selected hills and per cent white ears was worked out at 90 DAT.

$$\text{Dead heart (\%)} = \frac{\text{Number of dead hearts}}{\text{Total number of tillers}} \times 100$$

$$\text{White ear (\%)} = \frac{\text{Number of white ears}}{\text{Total number of productive tillers}} \times 100$$

The mean and standard deviation were worked out and based on the level of infestation, rice genotypes were grouped into different resistance categories for the data interpretation. Further, the scoring of rice yellow stem borer infestation was made and interpreted based on the Standard Evaluation System for Rice (SES) developed by the International Rice Research Institute (IRRI, 2013) (Table 1).

RESULTS AND DISCUSSION

Results revealed that, among 50 local landraces studied, the per cent incidence of YSB due to dead heart ranged from 5.58 ± 4.58 to 40.82 ± 5.91 per cent, in Kariga javele and Karpoora keli respectively, similarly the per cent incidence due to white ears ranged from 3.77 ± 4.39 to 19.41 ± 4.61 per cent in Kariga javele and G K – 5 respectively (Table 2). Overall, in *Kharif* 2023, 10 genotypes were found to be resistant (scale 1), 25 genotypes with score 3 were found to be moderately resistant, 10 genotypes were found to be moderately susceptible (scale 5) and 5

Table 1. Standard Evaluation System for Rice

For dead heart			For white ear		
Scale	Percent	Category	Scale	Percent	Category
0	No damage	Highly resistance	0	No damage	Highly resistance
1	1- 10%	Resistance	1	1-5%	Resistance
3	11- 20%	Moderately resistance	3	6- 10%	Moderately resistance
5	21-30%	Moderately susceptible	5	11-15%	Moderately susceptible
7	31-60%	Susceptible	7	16-25%	Susceptible
9	61% and above	Highly susceptible	9	26% and above	Highly susceptible

Table 2. Reaction of local landraces of rice against yellow stem borer, *S. incertulas*, *Kharif* 2022.

Sl. No.	Genotypes	%DH		%WE	Score	Category
		30 DAT	60 DAT	90 DAT		
1	Ani maanda	21.50 ± 3.80	23.25 ± 2.85	12.58 ± 2.08	5	MS
2	Bheema sale – 1	21.68 ± 4.53	24.85 ± 2.08	12.25 ± 4.85	5	MS
3	Babbayam	21.23 ± 3.75	23.71 ± 2.92	11.82 ± 2.43	5	MS
4	B. B	11.20 ± 3.27	13.36 ± 2.81	7.83 ± 2.42	3	MR
5	Bebbanna	22.64 ± 4.15	24.59 ± 4.52	13.44 ± 8.13	5	MS
6	Chinne ponni – 1	15.04 ± 7.89	16.19 ± 3.16	8.04 ± 4.30	3	MR
7	Chinna ponni – 5	7.41 ± 3.57	8.24 ± 4.12	3.93 ± 4.46	1	R
8	Chippige	23.80 ± 4.23	25.03 ± 3.36	13.46 ± 5.87	5	MS
9	Danggaia	15.97 ± 3.36	16.52 ± 3.08	6.21 ± 3.73	3	MR
10	Dappa playa	17.89 ± 3.50	18.64 ± 3.37	9.37 ± 2.08	3	MR
11	G K – 5	31.41 ± 8.86	33.46 ± 6.79	19.41 ± 4.61	7	S
12	Gangadale	21.77 ± 2.02	23.37 ± 2.24	12.08 ± 5.35	5	MS
13	Gudda parollul	24.70 ± 6.18	25.26 ± 5.22	12.38 ± 4.31	5	MS
14	Honne kattu	12.42 ± 1.86	15.13 ± 2.66	6.38 ± 4.88	3	MR
15	Hola batta	12.36 ± 4.74	15.14 ± 2.60	6.69 ± 2.96	3	MR
16	Jeerige sanna	7.91 ± 3.63	8.41 ± 2.68	4.31 ± 2.29	1	R
17	Karimundaga	8.17 ± 2.18	7.64 ± 2.21	4.40 ± 2.95	1	R
18	Kappu batta	17.05 ± 4.97	17.43 ± 3.43	8.64 ± 2.23	3	MR
19	Kagisale – 1	16.65 ± 3.96	15.4 ± 2.84	7.92 ± 3.98	3	MR
20	Kadulile	12.40 ± 3.2	14.22 ± 3.41	6.89 ± 3.85	3	MR
21	Kalanamak – 2	13.46 ± 4.00	14.65 ± 3.95	7.18 ± 1.87	3	MR
22	Kagesale	13.05 ± 3.48	15.23 ± 1.76	7.40 ± 2.20	3	MR
23	Kyasakki	6.10 ± 4.57	7.43 ± 3.83	3.84 ± 2.84	1	R
24	Kariga javele	5.58 ± 4.58	7.39 ± 4.53	3.77 ± 4.39	1	R
25	Kari doddi	6.28 ± 2.99	7.03 ± 2.81	4.73 ± 2.73	1	R
26	Karpoora keli	39.36 ± 8.78	40.82 ± 5.91	19.34 ± 4.83	7	S
27	Kyasare - 1	15.23 ± 4.78	17.36 ± 3.55	7.92 ± 3.88	3	MR
28	Kari jaddu	23.09 ± 2.30	24.62 ± 2.98	12.28 ± 2.20	5	MS
29	Kari dodi budda	8.40 ± 1.05	6.71 ± 2.02	4.19 ± 3.06	1	R
30	Kalakoli	15.73 ± 4.19	17.05 ± 3.35	7.27 ± 1.71	3	MR
31	Laalya	7.80 ± 3.62	8.82 ± 3.12	4.40 ± 2.41	1	R
32	Mugad suganda	22.25 ± 6.19	23.75 ± 4.57	11.62 ± 2.18	5	MS
33	Manjila	13.38 ± 3.95	15.04 ± 2.88	7.43 ± 1.79	3	MR
34	Musali	13.40 ± 2.15	15.17 ± 1.31	6.42 ± 3.81	3	MR
35	Malkod	13.72 ± 4.28	15.36 ± 3.6	6.48 ± 2.81	3	MR
36	Masuri	15.77 ± 3.36	16.67 ± 3.46	7.21 ± 3.51	3	MR
37	Mallige – 1	12.83 ± 3.81	15.29 ± 3.48	8.55 ± 1.73	3	MR
38	Mukkana rathna choodi	12.30 ± 4.36	14.09 ± 5.18	6.54 ± 4.07	3	MR
39	Mapilai samba – 2	13.61 ± 3.33	15.12 ± 3.28	7.28 ± 2.93	3	MR
40	Murkanna sanna	6.75 ± 3.79	7.65 ± 3.07	3.88 ± 2.66	1	R

Table 2 Continued

Sl. No.	Genotypes	%DH		%WE	Score	Category
		30 DAT	60 DAT	90 DAT		
41	Nati batta	14.19 ± 3.87	15.76 ± 3.25	7.65 ± 1.20	3	MR
42	Nagabatta	12.12 ± 3.10	14.01 ± 3.08	8.97 ± 3.02	3	MR
43	NLR 3449	12.23 ± 4.92	13.57 ± 4.70	9.02 ± 2.98	3	MR
44	Navara black	12.83 ± 5.13	14.88 ± 5.48	7.00 ± 2.75	3	MR
45	Navara	32.10 ± 5.55	33.50 ± 4.70	17.12 ± 2.81	7	S
46	RB	22.49 ± 6.63	24.51 ± 6.45	12.08 ± 2.85	5	MS
47	Sarjana	31.37 ± 4.1	33.12 ± 3.99	16.47 ± 3.02	7	S
48	Sidda sanna	6.03 ± 2.25	6.90 ± 2.52	4.09 ± 2.50	1	R
49	Santetala	13.75 ± 3.43	15.76 ± 3.89	8.62 ± 1.61	3	MR
50	Tagarhi	32.49 ± 5.11	34.41 ± 5.53	18.43 ± 2.82	7	S
51	TKM 6 (RC)	1.47 ± 2.40	3.09 ± 3.53	1.07 ± 2.34	1	R
52	TN -1 (SC)	48.94 ± 15.25	50.74 ± 5.52	23.17 ± 7.94	7	S

DAT- Days after transplanting, R- Resistance, MR- Moderately resistance, MS- Moderately susceptibility; S- Susceptible, RC – Resistant Check, SC – Susceptible Check: Resistance categories based on Standard Evaluation System of rice, IRRI, Philippines (IRRI, 2013); DH- dead heart; WE- white ears.

genotypes were susceptible with score 7. However, none of the genotypes were found to be highly resistant or susceptible with scores of 0 and 9 respectively.

At 30 DAT, per cent incidence due to dead heart ranged from 5.58 ± 4.58 to 8.4 ± 1.05 per cent in Kariga javele and Kari dodi budda and those landraces were categorized as resistant genotypes with score 1. In moderately resistant categories (score 3), the per cent dead heart ranged between 11.2 ± 3.27 and 17.05 ± 4.97 in the B. B and Kappu batta. Likewise, in moderately susceptible categories (score 5) the infestation varied from 21.23 ± 3.75 to 24.7 ± 6.18 per cent dead heart in the genotypes *viz*., Babbayam and Gudda parollul. However, per cent dead heart at 30 DAT was observed between 31.37 ± 4.1 and 39.36 ± 8.78 in Sarjana and Karpoora keli, which were categorized as susceptible (score 7). Of all the local landraces screened, none of the genotypes were found highly resistant (HR) and highly susceptible with scores of 0 and 9 (Table 2).

Similarly, at 60 DAT, none of the genotypes were found to be highly resistant and the genotypes with per cent incidence ranged from 6.71 ± 2.02 to 8.82 ± 3.12 in Kari dodi budda and Laalya were categorized as resistant genotypes with score 1. Whereas, in moderately resistant categories (score 3), the per cent dead heart showed between 13.36 ± 2.81 and 18.64 ± 3.37 in B. B and Dappa playa. Likewise, in moderately susceptible categories (score 5) the infestation varied from 23.25 ± 2.85 to 25.26 ± 5.22 per cent dead heart in the genotypes Ani maanda and Gudda parollul. However, per cent dead heart at 60 DAT was observed between 33.12 ± 3.99 and 40.82 ± 5.91 in Sarjana and Karpoora keli and was categorized as susceptible (score 7), meanwhile, none of the genotypes were found to be highly susceptible (score 9) (Table 2).

At 90 DAT, per cent white ear was observed between 3.77 ± 4.39 and 4.73 ± 2.73 in Kariga javele and Kari doddi, which were considered resistant varieties. Likewise, per cent white ear was observed between 6.21 ± 3.73 and 9.37 ± 2.08 in Danggaia and Dappa playa and was categorized as moderately resistant. The infestation varied from 11.62 ± 2.18 to 13.46 ± 5.87 per cent white ears in the genotypes Mugad suganda and Chippige and they were regarded as moderately susceptible genotypes. The infestation from 16.47 ± 3.02 to 19.41 ± 4.61 per cent white ear in Sarjana and G K - 5, were regarded as susceptible. However, none of the genotypes were found to be highly resistant and highly susceptible (Table 2).

The results of the present study corroborate with Balaji *et al*. (2023) who reported that out of 50 local landraces, five genotypes recorded resistance reaction with a damage score of 1, 23 genotypes were found to be moderately resistant with a score of 3, 17 genotypes reacted as moderately susceptible with score of 5 and five genotypes showed susceptible reaction with score of 7. Among all the screened popular cultivars four genotypes were found to be resistant, four genotypes showed moderately resistant reactions, one genotype was moderately susceptible and one genotype reacted as susceptible. None of the local landraces and popular cultivars were found to be highly resistant or highly susceptible to YSB.

Yadav *et al*. (2023) recorded that among the 20 rice accessions screened against *S. incertulus* during *Summer* 2022, the rice variety Radha-13 showed a lower infestation (about 0.547% dead heart) than other accessions against YSB. Moreover, the rice accessions Subarna Sub-1 and NR2188-13-5-2-5-1 were moderately resistant to YSB, with 9.95 per cent. Conclusively, most of the rice accessions evaluated had better plant resistance against YSB. Further, Rajadurai and Kumar (2017) reported that out of 193 genotypes screened, fifty-six genotypes were found resistant, ninety-five were found moderately resistant, twenty-eight were moderately susceptible, eight were susceptible and six were highly susceptible. The resistance in all the genotypes is due to the strong antibiosis and phenolics, as they cause mortality in rice stems (Zhu *et al*., 2002). Likewise, screening studies on fifty rice local landraces by Megha (2019) reflected high resistance in five genotypes, eight genotypes were recorded as resistant which included Kari munduga, Malgudi sanna-2, Jenugudu, Murkanna sanna, GK-1 and Adari batta. 14 genotypes were found to be moderately resistant. Similarly, seven genotypes were recorded as moderately susceptible and ten genotypes were reacted as susceptible genotypes.

Likewise, the results of the rice germplasm screening for resistance to stem borer recorded the white ear at 75 and 95 DAT. Out of forty-six rice cultures screened TP 10003, TP 10004, TP 10039 and TP 08095 were found minimal incidence and were rated as resistant categories. TP 10002, TP 10005, TP 10016, TP 10038, TP 10051, TP 10052, TP 09048 and TP 09052 were rated as moderately resistant (Preetha, 2017). Meanwhile, five accessions (AD 16124, AD 15101, AD 16189, AD 12182 and AD 12272) recorded no dead heart and white ear head damage and were found to be highly resistant. Three accessions (AD 16157, AD 12132, AD 16157) were found to be highly susceptible (Sharmitha *et al.,* 2019)

Similarly, Justin and Preetha (2014) reported that among the 77 genotypes screened during *Kharif* 2011, five genotypes were found to be highly resistant with scale '0'. During *Kharif* 2012, the genotypes *viz.,* seven genotypes were found to be highly resistant with scale '0'. During *Rabi* 2011, TP 10007 was found to be highly resistant without any dead heart or white ear damage. During *Rabi* 2012, fifty-seven genotypes were screened for resistance to rice stem borer and 15 genotypes recorded zero incidence of stem borer as per. Similarly, the highest incidence of stem borer (white ears) was observed in TN-1 and RpPatho-02 (13.13% WE) (Visalakshmi *et al.*, 2014). Meanwhile, among 40 genotypes screened against YSB, during *Kharif* 2022, 22 entries were ranked with '0' score (< 1% dead heart), which were found to be highly resistant to (Range 0.00 - 0.94 dead heart %). The 15 entries were found to be resistant with a score '1' (Range 1.29-10.00 dead heart %). Only 2 entries were found to be moderately resistant with score '3' (Range 11.11 - 13.27). The stem borer incidence overall ranged from 0.00 to 13.27 dead heart per cent (Kale *et al*., 2023).

Similarly, the results of the present study are in close agreement with the findings of Chatterjee *et al*. (2021) where the early duration variety viz. Narendra 97 and IR 50, the mid-early duration variety i.e., IR 64 and IET 17904 proved resistant against yellow stem borer (dead heart). The medium-duration variety, Ranjit was highly resistant against YSB and the variety, Pratiksha showed a fair degree of resistance against YSB; while Jarava, the late-duration variety exhibited high degree of resistance against yellow stem borer. Meanwhile among the 231 paddy genotypes screened against yellow stem borer, per cent white ears at 80 DAT varied between 0.84 (resistant) and 25.96 (susceptible). 74 genotypes proved to be resistant by recording less than 5 per cent white ears. Eighty-seven genotypes reacted as moderately resistant (6-10% white ear), forty-five genotypes showed moderately susceptible by recording less than 15 per cent white ears and twenty-five genotypes showed susceptible reaction by recording a white ear per cent in between 16 to 25%. The susceptible check TN1 recorded 25.96 per cent white ear. None of the genotypes were free from white ear, to categorized as highly resistant (0% white ear), similarly, none of the genotypes reacted as highly susceptible (26-100% white ear) (Girish *et al*., 2013).

CONCLUSION

Pest screening is necessary to evaluate the damage caused by different rice genotypes/varieties and investigate host plant resistance against insects as a pest-mitigating strategy. Moving forward, it is critical to investigate the mechanisms driving YSB resistance in rice. Understanding these pathways can help researchers plan future breeding programmes to generate YSB-resistant variants. This understanding may potentially lead to the use of novel technologies, such as genetic engineering and marker-assisted selection, to speed up the production of resistant rice varieties.

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