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DEFENSIVE RESPONSES OF RICE GENOTYPES AGAINST YELLOW STEM BORER, *SCIRPOPHAGA INCERTULAS* (WALKER)

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ABSTRACT

The response of rice genotypes to yellow stem borer *Scirpophaga incertulas* (Walker) infestation under natural climatic conditions was evaluated during kharif 2018-19 and 2019-20 at BHU, Varanasi. Findings revealed that deadhearts and white earheads caused by *S. incertulas* (Walker) varied significantly, indicating the presence of resistance-susceptibility. The dead hearts was significantly lower in resistant genotypes BRRI DHAN-64 (1.49%) and IR82475-110-2-2-1-2 (2.00%). The susceptible TN1 (17.45%), Swarna (14.98%), and IR-92960-75-1-3 (14.58%) had the highest amount of deadhearts. The least white earheads was recorded in IR82475-110-2-2-1-2 (1.16%) and AKSHYADHAN (1.19%), however the maximum percent of white earheads was observed in TN1 (13.37%), SWARNA (11.22%) and IR-92960-75-1-3 (9.87%). Infestation was significantly and positively correlated with total sugar, crude protein and total free amino acid; showed significant negative correlation with phenol, crude silica tannin.

Key words: *Oryza sativa*, germplasms, biochemical, total sugar, phenol, crude silica, crude proteins, total free amino acids, tannins, defensive reaction, *Scirpophaga incertulas*, resistance, susceptible

Rice (*Oryza sativa* Linnaeus) is a staple food for more than half of the world's population and requires a warm, humid climate that promotes the growth of insect pests (Sharma et al., 2023; Andargie et al., 2024). In Asia's rice ecosystem, over 250 insect pests and 350 beneficial arthropod species have been recorded (Sharma and Raju 2019; Raju et al., 2021). In India, out of more than 100 insect pests, twenty insect species are considered economically important because they cause severe damage to rice production (Sharma et al., 2018; Sharma et al., 2019; Ali et al., 2020). In the last two decades, rice crop yield losses have increased due to widespread outbreaks of certain insect pests of rice in the Indian subcontinent, especially yellow stem borer (*Scirpophaga incertulas* Walker) (Lepidoptera: Pyralidae), which cause millions of rupees in losses every year and threaten food security (Dash et al., 2020). *S. incertulas* is one of the most notorious and monophagous pests and its larvae infest the rice crop (Jeer et al., 2018). Crop yield losses could range between 10 and 90% (Vennila et al., 2019).

Interestingly, insect resistant varieties are pivotal for IPM and its compatibility with other methods play a major role in ecofriendly IPM (Pal et al., 2021; Rani et al., 2020). The resistance factors need to be explored. In several cases the accumulation of biochemical compounds in plants follow herbivory, and these biochemical constituents serve as sources of resistance (Sandhu et al., 2020). Thus, biochemical studies of rice genotypes will help to confirm the physiological antibiosis of germplasm. The current study is to examine the defensive response of rice genotypes to *S. incertulas* infestation.

MATERIALS AND METHODS

Fifty rice genotypes were sown in nursery beds, including two susceptible checks (Swarna and TN1), and screened out during two consecutive years kharif 2018-19 and 2019-20 at the Agricultural Research Farm, Banaras Hindu University, Varanasi. All genotypes were obtained from the Department of Genetics and Plant Breeding at BHU, Varanasi and the defensive responses of rice genotypes were determined under open field conditions. Seedlings were grown in natural open fields without any pest protection measures. After the 21 days of sowing, the test genotypes were transplanted in three rows of 2 m by 15 x 20 cm distance using a randomized block design with three replications. The susceptible checks were transplanted after every 30 rows of test genotypes. The incidence of deadheart (percentage) and white ear were observed during the crop's vegetative (35 days DAT) and reproductive (70 days DAT) stages, respectively. The observations were taken at five randomly selected hills per entry and % damage was calculated. Standard protocols were used to assess the biochemical constituents in rice leaves. During the crop's booting stage, leaf samples were collected and brought to the laboratory for the estimation of total sugars, phenols, tannins, and total free amino acids using the methods of Bray and Thorpe (1954) and Moore and Stein (1948). Methods suggested by Piper (1945) analysed the crude protein, and Yoshida et al. (1959) estimated the crude silica. The field data were subjected to ANOVA and Pearson's correlation, Tukey's test (p=0.05) and principal component analysis to identify the key plant traits responsive to infestation and its development using IBM SPSS (version 27).

RESULTS AND DISCUSSION

The result revealed that among 50 genotypes studied, of deadhearts varied from 1.49 to 17.45% and none of the genotypes was found to be free (Table 1). Among the genotypes screened, lowest infestation was recorded in BRRI DHAN-64 (1.49%) and IR82475-110-2-2-1-2 (2.00%). On the contrary, highest infestation was recorded in susceptible check variety TN1 (17.45%) and Swarna (14.98%). During reproductive stages the lowest infestation was found in IR82475-110-2-2-1-2 (1.16%), which was at par with Akshyadhan; conversely, the maximum was observed in susceptible check variety TN1 (13.37%) and SWARNA (11.22%). Eight rice genotypes were categorized as resistant (R), 17 were moderately resistant, 10 genotypes were moderately susceptible (MS), five genotypes were susceptible (S) and ten genotypes, including two check varieties were highly susceptible (HS) at vegetative stage (Table 1). Two varieties, IR82475-110-2-2-1-2 and Akshyadhan, showed the R category. Sixteen genotypes were graded as MR, while 15 genotypes exhibited as MS; and nine genotypes were graded as S and the remaining genotypes, including two susceptible checks, proved to be HS. Several researchers studied rice lines/ entries/ genotypes and varieties for resistant (Amsagowri et al., 2018; Balaji et al., 2024); Paramasiva et al., 2021; Mandloi et al.,2018; Rani et al., 2020) investigated 28 advanced rice cultures and discovered that eighteen were resistant. Nalla (2020) tested 196 rice accessions and observed five entries viz., 40 (OR 2324-8), 160 (RTN 62-6-7-1), 140 (CR 2698), 60 (HUR-913), and 150 (CN 1561-70-19-35-9-MLD 1) were resistant. Mishra and Singh (2019) tested eighteen rice germplasms and found Purrendu and IET20042 were resistant.

Interestingly, after the yellow stem borer infestation; there were many significant changes in the content of different biochemical traits (Table 2). Resistant genotypes AKSHYADHAN (12.72 mg/ g) had significantly lower total sugar content than highly susceptible genotypes TN1 (31.36 mg/ g). Total phenol content was significantly higher in the highly resistant genotypes IR82475-110-2-2-1-2 (9.33 mg/ 100g) and lowest total phenol content was found in susceptible BLACK GORA (4.17 mg/ 100g). Crude silica content in susceptible genotypes IR-92978-192-1-2 (CR-306) has the lowest (6.98%), and AKSHYADHAN having the highest (13.87%) infestation. The crude protein content was significantly lower in the resistant genotype IR82475-110-2-2-1-2 (2.16 mg/ g) and higher in the susceptible genotype BANSPHUL (7.81 mg/ g). The total free amino acids were found lowest (12.27 mg/ g) in resistant genotype CGZR-1, while the highly susceptible genotype DDR-42 had the highest total free amino acids content (27.11 mg/ g). Similarly, tannin content was significantly lower in the highly susceptible genotypes IET-20556 (0.43 mg/ g) than in the resistant genotypes HUR-105 (5.11 mg/ g). Numerous studies have found that plant biochemicals play an important role in insect pest resistance and damage prevention. These compounds inhibit insect growth via metabolic activity (War et al., 2012; Amsagowri et al., 2018).

Further in the present investigation, infestation of *S. incertulas* Walker showed significant positive correlation with total sugar (r = 0.367** with dead hearts and 0.504** with white earhead), crude protein (r = 0.811** with dead hearts and 0.867** with white earhead), total free amino acid (r = 0.827** with dead hearts and 0.878** with white earhead). Conversely, the infestation of *S. incertulas* Walker was significantly negatively correlated with phenol (r = -0.459** with dead hearts and -0.624** with white earhead), crude silica tannin (r = -0.605** with dead hearts and -0.704**with white earhead) and tannin (r = -0.807** with dead hearts and -0.875**with white earhead). As a result, total sugar, crude protein and total free amino acids were found to be related to susceptibility to *S. incertulas* Walker infestation as they favoured the development and growth of *S. incertulas* Walker. Whereas phenols, crude silica, and tannins content in leaves lowered the *S. incertulas* Walker infestation and

Table 1. Response of rice genotypes against *S. incertulas* infestation under open field condition during kharif 2018-19 and 2019-20 (Pooled data)

#Genotypes	Damage (%) at vegetative stage			Damage (%) at reproductive stage		
	#DH	D Value	Response	#WE	D Value	Response
HUR-105	2.20*(8.47)**	13.56	R	1.54 (7.09)	12.52	MR
IR82475-110-2-2-1-2	2.00 (7.95)	12.33	R	1.16 (6.17)	9.43	R
Sahbhagidhan	5.14 (13.09)	31.66	MR	2.88 (9.75)	23.41	MR
NDR-97	10.10 (18.47)	62.24	S	4.73 (12.49)	38.46	MS
Kalamkati: IRGC 45975-1	3.03 (9.77)	18.65	R	3.44 (10.67)	27.97	MS
Sambha Mansoori	7.09 (15.41)	43.68	MS	5.70 (13.79)	46.34	S
BRRI DHAN-72	4.89 (12.74)	30.15	MR	2.71 (9.45)	22.03	MR
HUR-3022	11.91 (22.29)	73.43	S	9.39 (17.82)	76.34	HS
HUBR-10-9	7.10 (15.32)	43.74	MS	5.15 (13.07)	41.87	S
Pusa Basmati-1	6.82 (14.97)	42.02	MS	1.52 (7.05)	12.36	MR
IET-22218	13.35 (21.16)	84.80	HS	6.07 (14.26)	49.35	S
IET-20556	14.21 (23.13)	87.61	HS	9.02 (17.02)	74.80	HS
IET-22225	9.60 (18.04)	59.19	MS	3.32 (10.38)	26.99	MS
HUR-5-2	13.99 (21.95)	86.25	HS	5.64 (13.65)	45.85	S
HUR-4-3	6.47 (14.44)	39.89	MR	4.65 (12.15)	37.80	MS
UGR-1	5.65 (13.71)	34.83	MR	2.54 (9.14)	20.65	MR
UGR-5	4.15 (11.66)	25.55	MR	1.71 (7.45)	13.90	MR
Nagina-22	6.21 (14.13)	38.29	MR	2.03 (8.18)	16.50	MR
Brri Dhan-64	1.49 (7.00)	9.19	R	2.50 (8.90)	20.33	MR
Gora White	10.10 (18.50)	62.24	S	3.85 (11.25)	31.30	MS
Bansphul	14.06 (21.99)	86.56	HS	6.58 (14.84)	53.50	S
CGZR-1	2.82 (9.48)	17.39	R	1.91 (7.79)	15.53	MR
R-RHZ-7	6.68 (14.79)	41.15	MS	4.96 (12.81)	40.33	MS
IR 96248-16-3-3-2B	5.11 (13.03)	31.47	MR	2.64 (9.32)	21.46	MR
Saryu-52	8.84 (17.26)	54.47	MS	4.51 (12.24)	36.67	MS
MTU-1010	4.74 (12.56)	29.19	MR	3.35 (10.53)	27.24	MS
Dudh Kandar	7.51 (15.84)	46.27	MS	4.25 (11.87)	34.55	MS
Sathi	9.32 (17.75)	57.43	MS	2.58 (9.23)	20.98	MR
IR-96248-16-3-3-1B	14.54 (22.39)	89.64	HS	7.66 (16.03)	62.28	HS
Pantdhan-12	2.75 (9.18)	16.92	R	1.65 (7.29)	13.41	MR
Akshyadhan	3.30 (10.45)	20.31	R	1.30 (6.49)	10.57	R
NDR-359	9.79 (18.21)	60.36	MS	6.98 (15.31)	56.75	S
Rajendra kasturi	6.41 (14.64)	39.49	MR	4.58 (12.35)	37.24	MS
Baranideep	4.07 (11.43)	25.06	MR	3.36 (10.55)	27.32	MS
Black Gora	9.79 (18.21)	60.33	MS	7.21 (15.57)	58.62	S
IR-92960-75-1-3	14.58 (22.42)	89.89	HS	9.87 (18.27)	80.24	HS
IR-92978-192-1-2(CR-306)	13.40 (21.45)	82.58	HS	9.74 (18.16)	79.19	HS
AZUCENA	5.62 (13.67)	34.62	MR	2.37 (8.83)	19.27	MR
Brri Dhan-62	5.64 (13.74)	34.77	MR	3.45 (10.69)	28.05	MS
SAMBHA SUB-1	10.29 (18.69)	63.41	S	5.69 (13.79)	46.26	S
MTU 7029	2.97 (9.72)	18.31	R	2.82 (9.64)	22.93	MR
BINA 11	4.39 (11.81)	27.07	MR	3.42 (10.61)	27.80	MS
Improve sambha	4.96 (12.85)	30.58	MR	2.43 (8.94)	19.76	MR
HUR-917	4.95 (12.30)	30.52	MR	4.61 (12.33)	37.48	MS
HUR-36	6.28 (14.50)	38.72	MR	3.33 (10.50)	27.07	MS
SWARNA SUB-1	5.22 (13.10)	32.15	MR	2.86 (9.71)	23.25	MR
DDR-42	13.73 (21.71)	84.68	HS	9.10 (17.53)	73.98	HS
DDR-44	10.38 (18.78)	64.03	S	6.34 (14.57)	51.54	S
SWARNA	14.98 (22.76)	-	HS	11.22 (19.55)	-	HS
TN1	17.45 (24.68)	-	HS	13.37 (21.43)	-	HS
S.E. (m)±	0.69	-		0.42	-	-
C.D. (p=0.05)	2.08	-	-	1.27	-	-
C.V. (%)	5.46	-	-	6.02	-	-

#DH- Mean % of deadheart/ 5 hills, #WE- Mean % of white earhead/ 5 hills, *Mean of three replications, **Figures in the parentheses are angular transformed values

Table 2. Analysis of important biochemical constituents of interest in rice genotypes associated with differential response to *S. incertulas* infestation (pooled data kharif 2018-19 & 2019-20)

Genotypes	Biochemical parameters					
	Total sugar (mg/g) *(Mean± SE)	Phenol (mg/ 100g) *(Mean± SE)	Crude silica (%) *(Mean± SE)	Crude Proteins (mg/ g) *(Mean± SE)	Total free amino acids (mg/ g) *(Mean± SE)	Tannins (mg/ g) *(Mean± SE)
HUR-105	13.84± 0.39	8.72± 0.27	12.52± 0.32	3.15± 0.16	17.23± 0.21	5.11± 0.13
IR82475-110-2-2-1-2	15.73± 0.52	9.33± 0.16	12.34± 0.27	2.16± 0.11	13.02± 0.15	5.04± 0.18
SAHBHAGIDHAN	21.10± 0.21	7.67± 0.11	10.80± 0.27	3.98± 0.18	18.23± 0.19	4.13± 0.12
NDR-97	22.41± 0.10	9.06± 0.30	9.79± 0.17	6.01± 0.16	20.37± 0.21	2.61± 0.09
KALAMKATI:: IRGC 45975-1	17.36± 0.69	7.78± 0.17	10.06± 0.16	6.43± 0.20	20.81± 0.26	2.33±0.10
SAMBHA MANSOORI	20.89± 0.69	5.19± 0.10	9.48± 0.09	5.96± 0.14	23.15± 0.30	1.11± 0.08
BRRI DHAN-72	18.44± 0.22	6.97± 0.14	11.46± 0.19	4.02± 0.18	15.84± 0.15	4.67± 0.13
HUR-3022	23.18± 0.40	6.84± 0.07	7.70± 0.08	7.55±0.21	26.27± 0.31	0.68± 0.05
HUBR-10-9	27.43± 0.79	5.12± 0.09	9.59± 0.14	6.21± 0.11	24.33± 0.19	1.21± 0.08
PUSA BASMATI-1	20.05± 0.13	8.5± 0.18	11.63± 0.28	4.16± 0.15	17.54± 0.11	3.85± 0.16
IET-22218	22.84± 0.27	6.21± 0.13	9.13± 0.20	7.28± 0.16	24.29± 0.16	1.37± 0.13
IET-20556	17.84± 0.17	6.92± 0.20	10.42± 0.13	7.02± 0.19	25.41± 0.24	0.43± 0.03
IET-22225	15.12± 0.20	6.19± 0.25	9.98± 0.22	5.67± 0.12	21.26± 0.18	3.05± 0.16
HUR-5-2	15.98± 0.11	8.00± 0.28	10.52± 0.15	6.31± 0.20	24.86± 0.29	1.81± 0.11
HUR-4-3	16.88± 0.09	7.72± 0.16	8.32± 0.28	5.12± 0.14	19.27± 0.18	2.67± 0.16
UGR-1	17.91± 0.30	8.17± 0.15	11.84± 0.25	3.94± 0.09	17.67± 0.17	4.51± 0.18
UGR-5	18.39± 0.12	8.24± 0.32	11.42± 0.31	3.45± 0.11	16.91± 0.11	4.16± 0.15
NAGINA-22	15.93± 0.38	8.79± 0.13	12.88± 0.23	3.16± 0.07	15.41± 0.18	4.67± 0.20
BRRI DHAN-64	18.52± 0.17	7.79± 0.08	12.61± 0.27	3.02± 0.10	15.05± 0.21	4.10± 0.13
GORA WHITE	27.24± 0.23	6.30± 0.06	8.78± 0.16	4.98± 0.18	19.75± 0.34	2.09± 0.11
BANSPHUL	15.31± 0.44	7.74± 0.06	9.89± 0.10	7.81± 0.16	23.91± 0.30	1.34± 0.09
CGZR-1	23.57± 0.54	5.31± 0.09	8.30± 0.08	3.88± 0.09	12.27± 0.17	3.92± 0.16
R-RHZ-7	27.82± 0.19	5.09± 0.03	7.01± 0.05	5.87± 0.18	21.70± 0.26	1.64± 0.07
IR 96248-16-3-3-2B	14.37± 0.12	8.09± 0.19	13.56± 0.28	4.01± 0.15	16.77± 0.35	4.55± 0.20
SARYU-52	15.75± 0.51	7.42± 0.13	10.43± 0.17	5.14± 0.19	21.08± 0.15	2.09± 0.13
MTU-1010	17.63± 0.60	7.32± 0.17	10.44± 0.24	5.67± 1.16	20.54± 0.24	3.41± 0.16
DUDH KANDAR	15.50± 0.23	8.27± 0.24	11.37± 0.28	5.27± 0.20	20.11± 0.34	2.68± 0.09
SATHI	14.72± 0.16	8.58± 0.29	10.71± 0.16	3.75± 0.10	15.67± 0.14	4.22± 0.13
IR-96248-16-3-3-1B	21.54± 0.61	6.06± 0.22	7.17± 0.12	7.49± 0.21	26.27± 0.19	0.75± 0.06
PANTDHAN-12	15.13± 0.22	8.49± 0.22	13.38± 0.33	3.71± 0.08	16.97± 0.12	3.75± 0.16
AKSHYADHAN	12.72± 0.17	9.00± 0.18	13.87± 0.24	2.67± 0.06	14.25± 0.10	5.01± 0.21
NDR-359	20.66± 0.29	7.73± 0.04	8.13± 0.13	6.82± 0.14	24.21± 0.31	1.30± 0.09
RAJENDRA KASTURI	24.08± 0.27	5.87± 0.09	9.44± 0.18	5.34± 0.12	21.08± 0.25	2.67± 0.13
BARANIDEEP	19.34± 0.20	6.36± 0.18	9.55± 0.25	5.87± 0.19	20.74± 0.21	3.00± 0.16
BLACK GORA	26.14± 0.50	4.17± 0.13	7.38± 0.07	7.05± 0.20	24.06± 0.27	1.06± 0.08
IR-92960-75-1-3	24.67± 0.41	5.91± 0.10	8.32± 0.15	7.67± 0.16	26.89± 0.20	0.51± 0.04
IR-92978-192-1-2(CR-306)	20.59± 0.50	5.30± 0.19	6.98± 0.21	7.25± 0.18	25.17± 0.23	1.08± 0.09
AZUCENA	29.27± 0.26	6.36± 0.30	8.52± 0.24	4.05± 0.10	16.54± 0.11	4.13± 0.18
BRRI DHAN-62	17.01± 0.34	8.24± 0.23	11.91± 0.13	5.81± 0.13	20.42± 0.17	3.16± 0.14
SAMBHA SUB-1	23.36± 0.47	5.75± 0.12	8.82± 0.14	6.43± 0.11	23.67± 0.28	1.55± 0.08

(contd.)

(contd. Table 2

MTU 7029	26.66± 0.15	7.51± 0.25	10.75± 0.25	3.81± 0.08	15.67± 0.10	4.98± 0.16
BINA 11	21.29± 0.30	5.62± 0.09	9.15± 0.16	4.89± 0.10	20.17± 0.23	2.29± 0.11
IMPROVE SAMBHA	15.49± 0.17	8.13± 0.21	12.89± 0.19	3.67± 0.06	16.57± 0.16	4.00± 0.18
HUR-917	14.70± 0.29	7.42± 0.11	10.10± 0.20	5.15± 0.13	21.06± 0.24	2.91± 0.14
HUR-36	19.86± 0.32	6.61± 0.15	10.81± 0.12	5.38± 0.09	21.97± 0.30	2.18± 0.10
SWARNA SUB-1	18.46± 0.23	6.30± 0.13	11.76± 0.23	4.05± 0.05	15.67± 0.11	4.48± 0.18
DDR-42	20.76± 0.67	5.13± 0.14	7.47± 0.08	7.62± 0.16	27.11± 0.39	0.79± 0.08
DDR-44	22.93± 0.52	5.60± 0.07	8.12± 0.20	6.81± 0.19	24.81± 0.38	1.64± 0.12
SWARNA	29.34± 0.60	4.90± 0.07	7.30± 0.12	7.43± 0.20	26.75± 0.41	0.52± 0.03
TN1	31.36± 0.87	4.27± 0.06	7.06± 0.07	7.21± 0.14	26.02± 0.34	0.67± 0.05
C.D. (p= 0. 05)	3.35	1.30	2.19	1.23	3.14	1.12
C.V. (%)	27.95	19.94	23.15	18.67	26.43	16.45

*Mean of three replications.

were associated with resistance to *S. incertulas* Walker in the test genotypes (Table 3). According to Singh et al. (2022), the expression of biochemical constituents such as total soluble and reducing sugars, free amino acids and total soluble proteins was lower in resistant genotypes, whereas total phenol content was higher in resistant genotypes. Rani et al. (2020) discovered that the higher the sugar content, the higher the occurrence of insect pests, despite the fact that the silica content of vulnerable susceptible varieties such as TN1 and BPT5204, as well as the resistant genotypes C-1247 and C-8 588, were the highest. However, Kumar et al. (2021) found that total and reducing sugars, free amino acids, nitrogen and phosphorus were higher in susceptible entries, while total phenols, potassium, and tannins were significantly higher in resistant genotypes.

Principal component analysis (PCA) was used to determine the relationships between the various characteristics (*S. incertulas* Walker infestation and biochemical parameters) used in the current study. Two principal components (PCs) were extracted for biochemical characteristics from screen plots with eigen values ≥1.0. Figure 1 shows the diversity of biochemicals and *S. incertulas* Walker infestation. PC1 displayed a variation of 74.49 percent, while PC2 displayed a variation of 14.18% (Fig. 1). Table 4 shows the component loadings of various factors that influence resistance to *S. incertulas* Walker in rice. The majority of the parameters, including dead hearts, white earheads, crude protein, total free amino acid, and tannins, have higher coefficient values in PC1, while only three components, total sugar, phenol, and crude silica, are represented by PC2. Positional proximity in the 2-D biplot was used to identify two main groups, each with its own set of parameters. Dead hearts, white earheads, crude protein, and total free amino acid were all close together on the 2-D plot, whereas phenol and crude silica were separated. Aside from these groups, tannins and total sugar were quite distant from the others, indicating a different trend (Fig. 1). The Pearson correlation matrix (Table 3) also

Table 3. Correlation co-efficients of biochemical characteristics of rice genotypes and insect infestation in rice due to *S. incertulas*

Variables	DH	WEH	TS	P	CS	CP	TFAA	T
DH	1.000	0.873**	0.367**	-0.459**	-0.605**	0.811**	0.827**	-0.807**
WEH		1.000	0.504**	-0.624**	-0.704**	0.867**	0.878**	-0.875**
TS			1.000	-0.728**	-0.732**	0.413**	0.394**	-0.470**
P				1.000	0.767**	-0.602**	-0.583**	0.655**
CS					1.000	-0.745**	-0.685**	0.761**
CP						1.000	0.951**	-0.935**
TFAA							1.000	-0.944**
T								1.000

DH dead hearts, *WEH* white earhead, *TS* total sugar, *P* phenol, *CS* crude silica, *CP* crude protein, *TFAA* total free amino acid, *T* tannins content. **Significant at 0.01 level

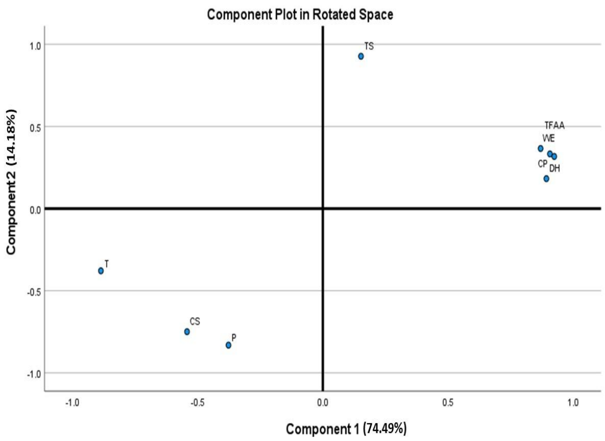

Fig. 1. 2-D plot of principal component analysis based on biochemical parameter and infestation caused by *S. incertulas* in different rice genotypes *DH* dead hearts, *WEH* white earhead, *TS* total sugar, *P* phenol, *CS* crude silica, *CP* crude protein, *TFAA* total free amino acid, *T* tannins content. *fp*

Table 4. Component loadings of bio-chemicals parameter and infestation caused by *S. incertulas* in different rice genotypes

S. No.	Parameters	Principal components	
		PC 1	PC 2
1	DH	0.893	0.194
2	WEH	0.866	0.376
3	TS	0.878	0.927
4	P	-0.367	-0.835
5	CS	-0.532	-0.756
6	CP	0.910	0.321
7	TFAA	0.929	0.277
8	T	-0.884	-0.385

DH dead hearts, *WEH* white earhead, *TS* total sugar, *P* phenol, *CS* crude silica, *CP* crude protein, *TFAA* total free amino acid, *T* tannins content

supported the preceding statement in terms of the degree of relationship between them. Rizwan et al. (2021) also examined the role of silicon in rice insect pest resistance. Similarly, Nisha (2023) found that resistant rice accession BA-132 and BA-155 had the highest levels of total phenol, OD phenol, and tannin content, while TN-1 had the lowest levels of these compounds. Pest damage frequently influences the production of a variety of biochemicals. Similarly, in the present study results the correlation analysis of phenolic compounds showed a negative association with infestation and impart resistance against in rice (Tenguri et al., 2023).

The current study's findings suggest that a thorough understanding of metabolic processes parallel to insect infestations at various phases of plant growth is critical. Furthermore, the germplasm must be subjected to appropriate screening conditions to identify potential sources of resistance and establish successful selection procedures. The resistant genotypes used against insect pests suggest lowering protection costs while preserving environmental sustainability. Furthermore, such genotypes should be used as donors in a hybridization programme to increase germplasm resistance to insect pests even further.

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AUTHOR CONTRIBUTION STATEMENT

KRS: Conceptualization, Methodology, Investigation, Writing - original draft, SVSR: Supervision, Data curation, Writing - review and editing, Writing - original draft. SKS: Writing - review and editing. RK: Writing - original draft, Visualization.

CONFLICT OF INTEREST

No conflict of interest.

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