

International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2026): 5.29
IJABR 2026; 10(3): 899-904
www.biochemjournal.com
Received: 07-01-2026
Accepted: 10-02-2026

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Mechanism of resistance to sorghum fall armyworm, *Spodoptera frugiperda*

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DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i3k.8005>

Abstract

A field investigation entitled, “Mechanism of resistance to sorghum fall armyworm *Spodoptera frugiperda*.” was conducted during the *Rabi*, 2024-25 at the All India Coordinated Sorghum Improvement Project, Mahatma Phule Krishi Vidyapeeth, Rahuri-413 722. Out of 22 genotypes, lowest number of per cent plant damage at 30 DAE was found in RSV-2622, RSV-2591, RSV-2395, RSV-2603, RSV-2641, RSV-1188, IS-2205, IS-18551 *i.e* (0.00%). These genotypes are promising against fall armyworm. Similarly, the promising test entries IS-2205, IS-18551, RSV-2395 and RSV-2641 also recorded lowest soluble protein and total sugar content along with the maximum phenol and total chlorophyll.

Keywords: *Spodoptera frugiperda*, genotypes, fall armyworm, *Sorghum bicolor*, fodder, variety

Introduction

Sorghum bicolor (L.), commonly known as jowar, originated in Africa and belongs to the Poaceae family, which includes about 25 species of flowering grasses. It is cultivated both as a cereal crop for human consumption and as forage for livestock. The fall armyworm, *Spodoptera frugiperda*, is a destructive lepidopteran pest native to the America. First reported in the mid-19th century, it infests maize, sugarcane, rice and other grasses across the southern United States.

Sorghum hosts nearly 150 insect species across Indian agroecosystems, with about 18 major pests reported in Maharashtra alone. Among them, shoot fly (*Atherigona soccata*), stem borer (*Chilo partellus*) and gall midge (*Stenodiplosis sorghicola*) cause substantial yield losses, estimated at 32% nationwide. Recently, the invasive fall armyworm (*Spodoptera frugiperda*) has emerged as a serious threat, contributing to nearly 16% yield loss in sorghum (Abrahams *et al.*, 2017) ^[1]. Its high fecundity, voracious feeding habit and polyphagous nature can lead to severe crop damage, with losses reported up to 94.72% in maize (Sena *et al.*, 2003) ^[15] and rapid spread across regions (Goergen *et al.*, 2016) ^[6]. Although chemical insecticides are widely used, their excessive application has resulted in resistance development, environmental pollution and adverse effects on non-target organisms. Therefore, sustainable management strategies, particularly host plant resistance within IPM frameworks, are essential. Screening sorghum germplasm along with biochemical characterization of defence-related traits offers a promising approach for developing resistant cultivars and reducing dependence on chemical control.

Materials and Methods

“Mechanism of resistance to sorghum fall armyworm, *Spodoptera frugiperda*.” was conducted during *rabi* season, 2024-2025 at the Sorghum Improvement Project, MPKV, Rahuri, Maharashtra. The experiment utilized a randomized block design, employing 22 sorghum genotypes selected based on their fall armyworm resistance. These genotypes were replicated twice to screen against fall armyworm, planted in plots with inter-row spacing of 45 cm, intra-row spacing of 15 cm, covering an area of 4 × 2.7 m. Observations were recorded for each genotype on their physical characteristics such as seedling vigour, leaf glossiness, leaf thickness. The observations are also recorded on trichome density (No.mm⁻²), per cent plant damage, larval count, leaf damage score at 30 and 60 days after emergence.

For biochemical evaluation, leaf samples of 22 *rabi* sorghum genotypes were collected from the same plot and soluble protein content, total chlorophyll, total phenol and total sugar were analyzed from the leaf tissues in the laboratory. The soluble proteins were estimated as per the method described by Lowry *et al.* (1951) [9]. Total chlorophyll was evaluated by the method of Arnon (1949) [2]. Total phenol content and total sugar content were determined by method of Bray and Thorpe (1954) [4] and Hedge and Hofreiter (1962) [7] respectively.

Results and Discussion

The sorghum genotype RSV-2591 was recorded maximum score of seedling vigour *i.e.* 1.00 and which was at par with genotypes RSV-2622, RSV-2395, RSV-2603, RSV-2641, IS-2205, RSV 1959, IS-18551, RSV-1188 and IS-2205 with recorded 1.50 score. The lowest score was recorded in DJ-6514 (4.50). The present findings align with Jayanthi *et al.* (2002) [8] who reported that higher seedling vigour in sorghum helps the crop escape early biotic stress, including pest infestation. (Table. 1) The genotypes IS-2205 and RSV-1188 was recorded maximum score of leaf glossiness *i.e.* 1.00 and which were at par with genotypes RSV-2622, RSV-2591, RSV-2395, RSV-2603, RSV 2611, RSV-2641, RSV-1959, IS-18551 recorded 1.50 score. The present

findings are in agreement with those of Chamarthi *et al.* (2010) [5] who reported that, sorghum germplasm exhibiting leaf glossiness tends to be resistant to shoot fly and other insect pests.

Trichome density was recorded highest in sorghum genotype RSV-1959 (14.50 No.mm⁻²) which was at par with genotypes RSV-2622 (13.50 No.mm⁻²), RSV-1188 (13.50 No.mm⁻²), RSV-2395 (13.50 No.mm⁻²), RSV-2603 (13.00 No.mm⁻²), IS-18551 (13.00 No.mm⁻²), RSV-2591 (12.50 No.mm⁻²), (12.00 No.mm⁻²), IS-2205 (11.50 No.mm⁻²), RSV-2620 (10.50 No.mm⁻²), RSV-2641 RSV-2192 (10.50 No.mm⁻²) and RSV-2628 (10.50 No.mm⁻²). DJ-6514 (1.50 No.mm⁻²) recorded minimum trichome density among different test entries. (Table.1). These results are in line with the findings of Moya-Raygoza (2016) [10], who reported that trichomes density reduces chewing damage by fall armyworm in maize. The genotypes RSV-2622, RSV-2591, RSV-2395, RSV-2603, RSV-2641, RSV-1188, IS-18551 recorded maximum leaf thickness 0.11 and 0.16 mm at 30 and 60 DAE respectively.

This finding is supported by Bergvinson *et al.* (1994) [3], who reported that hybrids with tougher leaves suffered significantly less feeding damage from the European corn borer than susceptible thin-leaved lines.

Table 1: Screening of sorghum genotypes for morphological characters against fall armyworm (*Spodoptera frugiperda*)

Sr. No.	Genotypes	Seedling vigour (1-5) 12 DAE	Leaf glossiness (1-5) 14 DAE	Trichome Density ** (No.mm ⁻²)	Leaf thickness (mm)	
					30 DAE*	60 DAE
1	RSV 2622	1.5	1.5	13.50 (3.74)**	0.11	0.16
2	RSV 2620	2.5	2.5	10.50 (3.31)	0.10	0.15
3	RSV 2636	2.5	2.0	10.00 (3.24)	0.10	0.15
4	RSV 2657	3.5	4.0	6.50 (2.67)	0.08	0.13
5	RSV 2591	1.0	1.5	12.50 (3.60)	0.11	0.16
6	RSV 2395	1.5	1.5	13.50 (3.74)	0.11	0.16
7	RSV 2192	2.5	3.5	10.50 (3.31)	0.10	0.15
8	RSV 2482	2.5	3.0	8.50 (3.00)	0.08	0.14
9	RSV 2514	2.5	3.5	8.50 (3.00)	0.09	0.14
10	RSV 2603	1.5	1.5	13.00 (3.67)	0.11	0.16
11	RSV 2611	2.0	1.5	10.25 (3.27)	0.10	0.15
12	RSV 2617	3.5	3.0	6.25 (2.59)	0.08	0.13
13	RSV 2641	1.5	1.5	12.00 (3.53)	0.11	0.16
14	RSV 2496	3.5	4.0	7.00 (2.73)	0.07	0.13
15	RSV 2467	3.0	4.0	7.50 (2.82)	0.08	0.13
16	RSV 2628	2.5	2.0	10.50 (3.31)	0.10	0.15
17	Swarna	3.0	4.0	2.00 (1.58)	0.09	0.14
18	IS 2205	1.5	1.0	11.50 (3.46)	0.10	0.15
19	RSV 1959	1.5	1.5	14.50 (3.87)	0.10	0.15
20	DJ 6514	4.5	5.0	1.50 (1.41)	0.06	0.08
21	IS 18551	1.5	1.5	13.00 (3.67)	0.11	0.16
22	RSV 1188	1.5	1.0	13.50 (3.74)	0.11	0.16
	S.Em ±	0.47	0.44	0.19	0.01	0.01
	C.D. at 5%	1.39	1.32	0.56	0.02	0.02

Table 2: Screening of sorghum genotypes for entomological traits against fall armyworm (*Spodoptera frugiperda*)

Sr. No.	Genotypes	Per cent plant damage		Larval count/plants		Leaf damage score (0-9)/Plants	
		30 DAE*	60 DAE	30 DAE	60 DAE	30 DAE	60 DAE
1	RSV 2622	0.00	1.66	0.00	0.50	0.00	0.50
		(0.00)*	(5.26)	(0.71)**	(1.00)		
2	RSV 2620	6.67	13.33	2.00	3.50	2.00	3.00
		(14.97)	(21.27)	(1.56)	(4.00)		
3	RSV 2636	6.67	13.33	2.00	3.50	2.00	3.00
		(14.97)	(21.27)	(1.56)	(4.00)		
4	RSV 2657	10.00	18.33	3.00	5.50	2.50	3.50
		(18.43)	(25.33)	(1.87)	(2.44)		
5	RSV 2591	0.00	1.66	0.00	0.50	0.00	0.50
		(0.00)	(5.26)	(0.71)	(1.00)		
6	RSV 2395	0.00	5.00	0.00	2.50	0.00	1.50
		(0.00)	(12.74)	(0.71)	(1.73)		
7	RSV 2192	6.67	13.33	2.00	4.00	2.00	3.00
		(14.97)	(21.27)	(1.56)	(2.12)		
8	RSV 2482	6.67	13.33	2.00	4.00	2.00	3.00
		(14.97)	(21.27)	(1.56)	(2.12)		
9	RSV 2514	6.67	13.33	2.00	4.00	2.00	3.00
		(14.97)	(21.27)	(1.56)	(2.12)		
10	RSV 2603	0.00	3.33	0.00	1.00	0.00	1.00
		(0.00)	(10.51)	(0.71)	(1.22)		
11	RSV 2611	3.33	10.00	1.00	3.00	1.00	2.50
		(18.43)	(18.43)	(1.22)	(1.87)		
12	RSV 2617	10.00	18.33	3.00	5.50	2.50	4.00
		(18.43)	(25.33)	(1.87)	(2.44)		
13	RSV 2641	0.00	5.00	0.00	1.50	0.00	1.50
		(0.00)	(12.74)	(0.71)	(1.41)		
14	RSV 2496	10.00	18.33	3.00	5.50	2.50	4.00
		(18.43)	(25.33)	(1.87)	(2.44)		
15	RSV 2467	8.33	16.66	2.50	5.00	2.00	3.50
		(16.70)	(24.10)	(1.73)	(2.34)		
16	RSV 2628	6.67	13.33	2.00	4.00	2.00	2.50
		(14.97)	(21.32)	(1.56)	(2.12)		
17	Swarna	8.33	16.66	2.50	5.00	2.00	3.50
		(16.70)	(24.10)	(1.73)	(2.34)		
18	IS 2205	0.00	3.33	0.00	1.00	0.00	1.00
		(0.00)	(10.51)	(0.71)	(1.22)		
19	RSV 1959	1.66	5.00	0.50	1.50	0.50	1.50
		(5.26)	(12.74)	(1.00)	(1.41)		
20	DJ 6514	1.66	6.67	0.50	2.00	0.50	2.00
		(5.26)	(14.97)	(1.00)	(1.56)		
21	IS 18551	0.00	1.66	0.00	0.50	0.00	0.50
		(0.00)	(5.26)	(0.71)	(1.00)		
22	RSV 1188	0.00	1.66	0.00	0.50	0.00	0.50
		(0.00)	(5.26)	(0.71)	(1.00)		
	S.E. m ±	1.87	2.05	0.56	0.61	0.43	0.47
	C.D. at 5%	5.51	6.03	1.66	1.81	1.27	1.39

*DAE: Days after emergence *The values in parentheses indicate arc sine values.

**The values in parentheses indicate $\sqrt{n+0.5}$ values.

At 30 DAE, minimum per cent plant damage, larval count and leaf damage score was recorded in genotypes RSV-2622, RSV-2591, RSV-2395, RSV-2603, RSV-2641, RSV-1188, IS-2205 and IS-18551. At 60 DAE, lowest per cent plant damage, larval count and leaf damage score of was recorded in genotypes RSV-2622, RSV-2591, RSV-1188 and IS-18551. whereas, highest per cent plant damage, larval

count and leaf damage score was recorded in RSV-2657, RSV-2617 and RSV-2496.

The present findings are in close agreement with those reported by Nandita and Sonali (2020) ^[11] who evaluated fall armyworm resistance in maize based on leaf damage, ear and cob damage scores at different growth stages.

Table 3: Biochemical evaluation of sorghum genotypes against fall armyworm

Sr. No.	Genotypes	Soluble protein (mg/g tissue)		Total chlorophyll (mg/g tissue)	
		30 DAE	60 DAE	30 DAE	60 DAE
1	RSV 2622	1.60	1.40	1.70	1.58
2	RSV 2620	1.65	1.44	1.60	1.47
3	RSV 2636	1.64	1.53	1.66	1.34
4	RSV 2657	1.83	1.54	1.50	1.19
5	RSV 2591	1.63	1.56	1.72	1.60
6	RSV 2395	1.42	1.34	1.99	1.75
7	RSV 2192	1.69	1.49	1.50	1.44
8	RSV 2482	1.62	1.19	1.63	1.25
9	RSV 2514	1.67	1.21	1.65	1.20
10	RSV 2603	1.72	1.55	1.98	1.85
11	RSV 2611	1.76	1.48	1.64	1.45
12	RSV 2617	1.79	1.53	1.64	1.19
13	RSV 2641	1.45	1.21	1.87	1.72
14	RSV 2496	1.78	1.59	1.66	1.17
15	RSV 2467	1.82	1.48	1.62	1.19
16	RSV 2628	1.65	1.43	1.67	1.56
17	Swarna	2.07	1.67	2.00	1.50
18	IS 2205	1.39	1.22	1.85	1.55
19	RSV 1959	1.48	1.23	1.79	1.66
20	DJ 6514	1.95	1.56	1.99	1.46
21	IS 18551	1.42	1.37	1.75	1.51
22	RSV 1188	1.58	1.47	1.78	1.59
	S.E. m $\pm$	0.06	0.08	0.05	0.06
	C.D. at 5%	0.19	0.24	0.14	0.17

DAE: Days after emergence.

At 30 DAE the lowest soluble protein content was recorded in the test entry IS-2205 (1.39 mg/g tissue), IS-18551 (1.42 mg/g tissue), RSV-2395 (1.42 mg/g tissue) which was at par with test entries RSV-2641 (1.45 mg/g tissue), RSV-1959 (1.48 mg/g tissue), RSV-1188 (1.58 mg/g tissue), RSV-2622 (1.60 mg/g tissue). The higher protein content was observed in genotypes Swarna (2.07 mg/g tissue). The lowest soluble protein content at 60 DAE was recorded in the test entry RSV-2482 (1.19 mg/g tissue), RSV 2514 (1.21 mg/g tissue), RSV 2641 (1.21 mg/g tissue) and was at par with test entries IS-2205 (1.22 mg/g tissue), RSV-1959 (1.23 mg/g tissue), IS-18551 (1.37 mg/g tissue), RSV-2395 (1.39 mg/g tissue), RSV-2622 (1.40 mg/g tissue), RSV-2628 (1.43 mg/g tissue). The higher protein content was observed in DJ-6514 (1.56 mg/g tissue), RSV-2496 (1.59 mg/g tissue), Swarna (1.67 mg/g tissue). The present findings indicate that fall armyworm susceptible genotypes exhibited higher leaf protein content compared to resistant ones. These results align with Praveen *et al.* (2013) [13], who reported that the biochemical traits of resistant varieties contribute to their ability to withstand pest attacks. Specifically, resistant genotypes tend to have lower levels of total soluble sugars and soluble proteins, which may play a role in conferring resistance against insect infestation. (Table.3)

Minimum chlorophyll content at 30 DAE was registered in test entries RSV-2657 (1.50 mg/g tissue), RSV-2192 (1.50 mg/g tissue) which were at par with test entries RSV-2620 (1.60 mg/g tissue), RSV-2467 (1.62 mg/g tissue), RSV-2482 (1.63 mg/g tissue). The highest chlorophyll content was recorded in Swarna (2.00 mg/g tissue). Total chlorophyll content of each sorghum genotype at 60 DAE which was ranged from 1.17 to 1.85 mg/g of tissue and it was statistically significant. Minimum chlorophyll content was recorded in test entries RSV-2496 (1.17 mg/g tissue), RSV-2657 (1.19 mg/g tissue), RSV-2467 (1.19 mg/g tissue), RSV-2617 (1.19 mg/g tissue) was at par with test entries

RSV-2514 (1.20 mg/g tissue), RSV-2482 (1.25 mg/g tissue), RSV-2636 (1.34 mg/g tissue). The higher chlorophyll content was recorded in test entries RSV-2603 (1.85 mg/g tissue), RSV-2395 (1.75 mg/g tissue), RSV-2641 (1.72 mg/g tissue). From the present outcomes it was concluded that fall armyworm susceptible entries had recorded lowest chlorophyll content as compared to resistant one. The present outcomes are in correspondence with Sau and Dhillon (2022) [14] tested maize genotypes for their resistance or susceptibility to pink borer *Sesamia inferens*. Genotypes CPM2, CPM4, CPM8, CPM 15 and CML 35 have a greater resistance to *S.inferens*. Biochemical studies revealed that these genotypes had higher amount of Chlorophyll a and Chlorophyll b in infested conditions while infested plants had reduced concentration of chlorophyll pigments. (Table.3)

Minimum phenol content was recorded in genotypes DJ-6514 (4.80 mg/g tissue), swarna (4.96 mg/g tissue) was at par with test entries RSV 2464 (5.21 mg/g tissue), RSV-2496 (5.23 mg/g tissue), RSV-2657 (5.56 mg/g tissue), RSV-2514 (5.59 mg/g tissue). The higher phenol content was recorded in test entries RSV-1188 (6.76 mg/g tissue), IS-18551 (6.75 mg/g tissue), RSV-1959 (6.74 mg/g tissue), IS-2205 (6.53 mg/g tissue). At 60 DAE phenol content was ranged from 5.10 to 7.22 mg/g of tissue and it was statistically significant. Minimum phenol content was registered in test entries DJ-6514 (5.10 mg/g tissue), swarna (5.32 mg/g tissue) which was at par with test entries RSV-2192 (5.83 mg/g tissue), RSV-2657 (6.00 mg/g tissue), RSV-2514 (6.05 mg/g tissue), RSV-2467 (6.09 mg/g tissue). The higher phenol content was recorded in test entries RSV-2620 (7.22 mg/g tissue), RSV-2636 (7.18 mg/g tissue), RSV-2622 (7.10 mg/g tissue), RSV-1959 (6.91 mg/g tissue), RSV-1188 (6.85 mg/g tissue), IS-18551 (6.82 mg/g tissue), IS-2205 (6.72 mg/g tissue). From the present outcomes it was concluded that the fall armyworm susceptible entries

had the lowest phenol content as compared to resistant one. The present outcomes are in correspondence with Praveen (2010) [12] reported that, the total phenol content was higher in the resistant group over the susceptible one in all the plant parts of maize. The highest total phenol content was observed in the leaves and stems of resistant variety NAC-6004 and was lowest in the leaves and stems of susceptible variety CM-300 at 30 DAS, 60 DAS, 90 DAS and 120 DAS, respectively. (Table.4)

Table 4: Biochemical evaluation of sorghum genotypes against fall armyworm

Sr. No.	Genotypes	Total Phenol (mg/g tissue)		Total Sugar (mg/g tissue)	
		30 DAE	60 DAE	30 DAE	60 DAE
1	RSV 2622	6.07	7.10	1.40	1.30
2	RSV 2620	6.00	7.22	1.41	1.31
3	RSV 2636	5.89	7.18	1.45	1.35
4	RSV 2657	5.56	6.00	2.60	2.50
5	RSV 2591	6.12	6.20	1.44	1.36
6	RSV 2395	6.03	6.10	1.43	1.28
7	RSV 2192	5.67	5.83	1.54	1.45
8	RSV 2482	5.80	6.20	1.87	1.72
9	RSV 2514	5.59	6.05	1.99	1.80
10	RSV 2603	6.24	6.31	1.50	1.39
11	RSV 2611	5.97	6.15	1.66	1.33
12	RSV 2617	5.75	6.48	2.12	1.65
13	RSV 2641	5.90	6.20	1.53	1.24
14	RSV 2496	5.23	6.15	2.10	1.67
15	RSV 2467	5.21	6.09	1.98	1.75
16	RSV 2628	6.06	6.27	1.67	1.32
17	Swarna	4.96	5.32	1.92	1.68
18	IS 2205	6.53	6.72	1.59	1.41
19	RSV 1959	6.74	6.91	1.70	1.50
20	DJ 6514	4.80	5.10	1.93	1.56
21	IS 18551	6.75	6.82	1.67	1.37
22	RSV 1188	6.76	6.85	1.66	1.45
	S.E. m ±	0.23	0.26	0.06	0.07
	C.D. at 5%	0.68	0.77	0.15	0.17

DAE: Days after emergence.

The data recorded on total sugar content of each genotype at 30 DAE which ranged from 1.40 to 2.60 mg/g of tissue and it was statistically significant. The lowest sugar content was recorded in the test entry RSV-2622 (1.40 mg/g tissue), RSV-2620 (1.41 mg/g tissue) and was at par with test entry RSV-2395 (1.43 mg/g tissue), RSV-2591 (1.44 mg/g tissue), RSV-2636 (1.45 mg/g tissue), RSV-2603 (1.50 mg/g tissue), RSV-2641 (1.53 mg/g tissue), RSV-2192 (1.54 mg/g tissue). The higher sugar content was observed in Swarna (1.92 mg/g tissue), DJ-6514 (1.93 mg/g tissue), RSV-2467 (1.98 mg/g tissue), RSV-2496 (2.10 mg/g tissue), RSV-2617 (2.12 mg/g tissue), RSV-2657 (2.60 mg/g tissue). The data recorded on total sugar content of each genotype at 60 DAE which ranged from 1.24 to 2.50 mg/g of tissue and it was statistically significant. The lowest sugar content was recorded in the test entry RSV-2641 (1.24 mg/g tissue), RSV-2395 (1.28 mg/g tissue) and was at par with test entry RSV-2622 (1.30 mg/g tissue), RSV-2620 (1.31 mg/g tissue), RSV-2628 (1.32 mg/g tissue), RSV-2611 (1.33 mg/g tissue), RSV-2636 (1.35 mg/g tissue), RSV-2591 (1.36 mg/g tissue), IS-18551 (1.37 mg/g tissue), RSV 2603 (1.39 mg/g tissue), IS-2205 (1.41 mg/g tissue). The higher sugar content was observed in DJ-6514 (1.56 mg/g tissue), RSV-2617 (1.65 mg/g tissue), RSV-2496 (1.67 mg/g tissue), Swarna (1.68 mg/g tissue), RSV-2467 (1.75 mg/g tissue), RSV-2657 (2.50

mg/g tissue).(Table.4)The present findings indicate that fall armyworm susceptible entries exhibited higher total soluble sugar content compared to resistant ones. These results are consistent with the observations of Praveen *et al.* (2013) [13], who reported that certain biochemical traits in resistant varieties contribute to their defense against pest attacks. Specifically, resistant genotypes tend to have lower percentages of total soluble sugars and soluble proteins, which may play a role in reducing susceptibility to insect infestation.

Conclusion

Evaluation of rabi sorghum genotypes for morphological traits revealed that RSV-2622, RSV-2591, RSV-2514, RSV-2603, RSV-2641, RSV-1959, RSV-1188, and IS-2205 exhibited higher seedling vigour, leaf glossiness, leaf thickness, and trichome density. These genotypes recorded minimum fall armyworm infestation and can be suggested as resistant source.

Biochemical analysis indicated that RSV-2622, RSV-2620, RSV-2591, RSV-2395, RSV-2603, RSV-2628, IS-2205, RSV-1959, RSV-1188, and IS-18551 had higher levels of total phenols and chlorophyll, and these genotypes also recorded minimum fall armyworm infestation. In contrast, RSV-2657, RSV-2617, RSV-2496, RSV-2467, Swarna, and DJ-6515 exhibited higher levels of total sugars and soluble proteins, and these genotypes recorded maximum fall armyworm infestation.

On the basis of all parameter genotypes RSV-2622, RSV-2620, RSV-2591, RSV-2395, RSV-2603, RSV-2628, IS-2205, RSV-1959, RSV-1188, and IS-18551 can be suggested as resistant source to fall armyworm.

Acknowledgement

I am grateful to Dr. U.K. Kadam, Dr. U.S. Dalvi Dr. R.S. Bhoge and Dr. V.B. Shinde for their invaluable guidance and support throughout my research work. Their expertise and encouragement have been instrumental in shaping this endeavour.

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