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Biochemical and Morphological Assessment of *Rabi* Sorghum Genotypes for Shootfly Resistance

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ABSTRACT

The present investigation was conducted at Sorghum Improvement Project and Department of Biochemistry, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra, India during *rabi* 2019–20 for assessment of *rabi* sorghum genotypes for shootfly through biochemical perspective. Sorghum is an important food and fodder crop of dry land agriculture. The experimental material consisted of 11 sorghum genotypes viz; RSV 1628, RSV 1023, RSV 1910, RSV 2371, RSV 1945, RSV 1838, RSV 2025, RSV 1918, RSV 1988, RSV 2391, RSV 1941, three varieties viz., Phule Vasudha, Phule Revati, M-35-1, three shootfly resistant checks viz., RSV 1188, IS 18551, RSE 3 and a susceptible check i.e. DJ 6514. The experiments were conducted under pot culture and field conditions at different stages. Resistance against shootfly in sorghum was governed by the physical and chemical genes. The morphological characters like trichome density, oviposition and dead heart percentage and biochemical attributes like polyphenol oxidase, peroxidise and chlorophyll content can be used as marker traits in shootfly resistance breeding programme to broaden the genetic base and increase the levels of resistance to sorghum. The sorghum genotype RSE 3, RSV 1945, RSV 1941, RSV 1188, and RSV 2371 recorded higher polyphenol oxidase activity at 28 DAE as compared to other genotypes. So, these sorghum genotypes are good source for shootfly resistance breeding. The genotype RSE 03, RSV 1941 and RSV 1188 exhibited positive results for shootfly resistance and can be used as donor for shootfly breeding programme.

KEYWORDS: Biochemical, genotypes, resistance, shootfly, sorghum, susceptible, trichome

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1. INTRODUCTION

Sorghum is one of the main staple foods for the poor and food insecure people across semi-arid tropics of the world (Dayakar Rao et al., 2010, Srinivas Rao, 2014). It is nutritionally superior to other cereals such as rice and wheat with high fiber content, minerals and slow digestibility (Gonzalez-Montilla et al., 2012, Tasie and Gebreyes, 2020) Sorghum was among the top 10 crops that feed the world. It is the dietary staple of more than 500 million people in over 30 countries primarily in the developing world (Kumar et al., 2011). It was grown in more than 90 countries in Africa, Asia, Oceania and the Americas. The top ten sorghum producers globally are the United States, India, Mexico, Nigeria, Sudan, Ethiopia, Australia, Brazil, China and Burkina Faso (Rakshit et al., 2014).

It is fifth important cereal in the world after wheat, maize, rice and barley (Ahmed et al., 2016). Maharashtra is foremost sorghum growing state in the country with an area, production, productivity of 16.60 lha, 17.35 lt and 1045 kg ha^{-1}, respectively (Anonymous, 2020–21).

Several biotic and abiotic constraints influence the production and productivity of sorghum. Due to shootfly damage, a loss of 80–90% of grain and 68% of fodder yield was recorded in India (Balikai and Bhagwat, 2009, Kahate et al., 2014). Identifying sorghum genotypes with stable shootfly resistance is highly important as it will help to reduce the cost of cultivation and stabilize the yields. Nearly 32% of the actual production of sorghum is lost because of insect pests in India (Okosun et al., 2021). More than 150 insect pests damage sorghum from seedling to harvesting stage, our of these, sorghum shootfly, *Atherigona soccata* (Rondani) is one of the major insect pests of sorghum (Sharma, 1985, Mohammed et al., 2016). Sorghum shootfly, *A. soccata* infests the sorghum plant from 7–30 days after seedling emergence (DAE) (Riyazaddin et al., 2016, Chamarthi et al., 2010)). Under humid conditions, shootfly females lay elongated cigar-shaped eggs on the abaxial surface of the leaf, parallel to the leaf midrib (Dhillon et al., 2006, Padmaja et al., 2010). After egg hatching, the maggot crawls to the central whorl of the leaves, reaches the growing point, cuts the central leaf, and feeds on it. As a result, the central whorl dries off and gives a typical dead heart symptom (Nwanze et al., 1990, Sherwill et al., 1999, Aruna and Padmaja, 2009). Adult flies are active during the morning and evening hours, and the complete life cycle lasts for 18–25 days (Gomashe et al., 2010). The maggot feeds on the decaying tissue of the central whorl. Sorghum shootfly completes its life cycle in 17–21 days.

Many approaches have been employed to minimize the losses caused by shootfly. These include agronomic practices, natural enemies, synthetic insecticides and host plant resistance (Kumar et al., 2008). However, it is not always feasible to implement all these approaches in practice. So, Host plant resistance (HPR) is the most important component of integrated pest management (IPM) in sorghum. It does not involve any extra cost or other methods of pest control. The negative effect of resistant genotypes on insect populations is continuous and cumulative over time.

The present study was aimed at characterizing a group of known resistant and susceptible genotypes for different physico-chemical characteristics to identify the factors responsible for resistance/susceptibility to shootfly in sorghum (Padmaja et al., 2014, Bhoge et al., 2017). The objective was to identify the key physico-chemical characteristics conferring resistance to shootfly, which could be used to select shootfly-resistant lines from the breeding materials for use in sorghum improvement.

2. MATERIALS AND METHODS

The present investigation was conducted at Sorghum Improvement Project and Department of Biochemistry, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra, India during *rabi* 2019–20. The experimental material for these studies was obtained from Senior Sorghum Breeder, Sorghum Improvement Project, MPKV, Rahuri. The experimental material consisted of 11 sorghum genotypes viz; RSV 1628, RSV 1023, RSV 1910, RSV 2371, RSV 1945, RSV 1838, RSV 2025, RSV 1918, RSV 1988, RSV 2391, RSV 1941, three varieties viz., Phule Vasudha, Phule Revati, M-35-1, three shootfly resistant checks viz., RSV 1188, IS 18551, RSE 3 and a susceptible check i.e. DJ 6514. The experiments were conducted under pot culture and field conditions at different growth stages.

The pot experiment was conducted at All India Co-ordinated Sorghum Improvement Project, M.P.K.V., Rahuri in year 2019–20. In this experiment two sorghum genotypes including shootfly susceptible (Swarna) and shootfly resistant check (RSV 1188) was sown for studies of biochemical attributes viz; polyphenols, soluble proteins, total chlorophylls, and enzyme activity studies of the seedlings related to shootfly resistance at 21 and 28 days after emergence of seedlings.

The field experiment was carried out in a Randomized Block Design with three replications. Normal agronomic practices were followed for rising the *rabi* sorghum crop and no insecticide were applied in experimental plot. In field experimental material eighteen sorghum genotypes including shootfly susceptible (DJ 6514) and shootfly resistant *rabi* sorghum check RSE 03 and IS 18551 were taken for various attributes related to shootfly. Data were recorded on number of eggs at 14, 21 and 28 DAE and plant with dead hearts at 14, 21 and 28 DAE. Data were recorded on plant morphological traits such as leaf glossiness and trichome density at 14, 21 and 28 DAE at 1–5 scales. Total number of trichomes were counted in microscopic fields selected at random and expressed the trichome density as number mm^{-2} (Sharma and Nwanze, 1997). The leaf glossiness was evaluated on a 1–5 rating at 14, 21 DAE in the early morning hrs when there was maximum reflection of light from the leaf surface (1=highly glossy, light green, shining, narrow and erect leaves; and 5=non glossy, dark green, dull, broad and dropping leaves) (Sharma and Nwanze, 1997). These observations are record in the morning when there is maximum reflection of light from the leaf surfaces (Sharma and Nwanze, 1997).

The biochemical analysis for polyphenols, soluble proteins and enzyme activities of the seedlings was analysed at 14, 21 and 28 days after emergence. Total polyphenol content was determined by using Denis reagent as described by Swain and Hills (1959). Soluble protein was estimated by Lowry et al. (1959) method. The peroxidase and polyphenol oxidase activities from different sorghum genotypes were accessed by the method described by Kumar and Khan (1982).

3. RESULTS AND DISCUSSION

3.1. Biochemical attributes in relation to expression of resistance to shootfly under pot culture study

Under pot culture experiment two *rabi* sorghum genotypes were evaluated for biochemical parameters and results were shown in (Table 1). Sorghum genotype Swarna which is susceptible to shootfly revealed that at 14 DAE almost all the biochemical attributes were comparative with shootfly resistant sorghum genotype RSV 1188, while at 28 DAE RSV 1188 recorded maximum Polyphenol oxidase and Peroxidase activity after shootfly infestation.

Table 1: Study of sorghum genotypes for biochemical constituents in relation to shoot fly under pot culture

Genotype	Total chlorophyll content (mg g^{-1} tissue)		Polyphenol content (mg 100 g^{-1})		Soluble Protein (mg g^{-1} tissue)		Peroxidase Activity (ΔO.D. m^{-1} g^{-1})		PPO Activity (ΔO.D. m^{-1} g^{-1})	
DAE	14	28	14	28	14	28	14	28	14	28
Swarna (SC)	1.66	2.01	2.56	4.24	1.82	2.24	0.77	1.03	0.29	0.38
RSV 1188 (RC)	1.46	1.64	2.70	5.94	0.94	1.16	1.18	1.82	0.48	0.93

The peroxidase activity increased in shootfly resistant sorghum genotype RSV 1188 with 1.18–1.82 ΔO.D. m^{-1} g^{-1} plant tissue from 14–28 DAE, while in shootfly susceptible genotype Swarna peroxidase activity increased from 0.77–1.03 ΔO.D. m^{-1} g^{-1} at same day's evaluation. Polyphenol oxidase activity of leaves also increased in RSV 1188 with 0.48–0.93 ΔO.D. m^{-1} g^{-1} as compared to Swarna with 0.29–0.38 ΔO.D. m^{-1} g^{-1} from 14–28 DAE. Total chlorophyll content and soluble protein estimated from the leaves showed that both these attributes were increased in shootfly susceptible genotype Swarna as compared to RSV 1188 after shootfly infestation at 28 DAE.

Polyphenols are one of the most important groups of plant defence chemicals responsible for antifeedant or antibiotic effects on the insects. Polyphenol content in leaves of shootfly susceptible sorghum genotype was increased from 2.56–4.24 mg 100 g^{-1} tissue and from 2.70–5.94 mg 100 g^{-1} tissue in RSV 1188 at 28 DAE. Bhise et al. (1996a) reported that the susceptible check, CSH 1 had the highest protein content, whereas the resistant variety, IS 5490 had the lower protein content. These results are in proximity with Swain and Hills (1959).

3.2. Field screening of sorghum genotypes for shootfly infestation at different growth stages through morphological and biochemical attributes

3.2.1. Morphological attributes

Oviposition (%) of sorghum genotypes at different growth stages was recorded and summarized in Table 2. The average egg laying on 14 DAE ranged from 2.01–19.1 eggs $plants^{-1}$ and the mean is 3.89. The minimum number of eggs $plant^{-1}$ was recorded on check, RSV 2025 (2.01%). The maximum number of eggs $plant^{-1}$ was recorded on susceptible check DJ 6514 (19.1). Oviposition recorded in all the sorghum genotypes at 14 and 21 DAE were comparable with resistant and susceptible checks but the oviposition percentage was increased in susceptible checks of sorghum at 28 DAE means after shootfly infestation. Ghoghari (2008) reported that the highest number of eggs $plant^{-1}$ was recorded in sorghum shootfly susceptible genotype DJ 6514. Susceptible check recorded highest number of eggs $plant^{-1}$ in all the stages, whereas, resistance check recorded significantly lower number of eggs laid on them. However lowest numbers eggs were laid on RSV 2391 genotype.

Trichome density of sorghum genotypes at different growth stages was recorded and summarized in Table 2. Trichomes or plant hairs are common anatomical features on leaves, stem and reproductive structures in higher plants. Trichomes on both the surface of lamina and leaf glossiness played important role in shootfly resistance (Gomashe et al., 2010). Sorghum shootfly resistant genotype RSV 1188, RSE 03 and IS 18551 showed greater number of trichomes, while susceptible check DJ 6514 is non trichomed and Swarna (2.6 mm^{-2}) showed few trichomes on leaf surface (Bhoge et al., 2017). Trichome density has a positive correlation with

Table 2: Effect of shoot fly on morphological characters of sorghum genotypes at different growth stages

Genotypes	Oviposition (Egg percentage)			Trichome density (number mm^{-1})			Leaf Glossiness (1–5)			Dead hearts percentage		
	14 DAE	21 DAE	28 DAE	14 DAE	21 DAE	28 DAE	14 DAE	21 DAE	28 DAE	14 DAE	21 DAE	28 DAE
RSV 1628	2.68	3.21	3.66	9.07	10.93	11.67	1.69	1.9	1.4	10.33	31.2	35.1
RSV 1023	2.91	2.44	3.99	10.23	11.49	11.98	1.02	1.18	1.42	10.23	32.23	36.7
RSV 1910	2.98	3.67	3.99	10.33	11.71	12.00	1.36	2.33	1.61	10.73	33.67	36.91
RSV 2371	2.10	3.03	3.41	17.87	18.98	21.21	1.27	1.63	1.97	9.09	31.24	35.01
RSV 1945	2.07	3.01	3.21	17.44	18.60	21.00	0.76	1.01	1.77	10	29.01	35.98
RSV 1838	2.06	2.97	3.2	17.21	18.23	21.75	1.25	1.98	2.1	9.67	28.4	35.61
RSV 2025	2.01	2.94	3.02	17.00	18.07	21.71	1.05	1.95	2.1	9.5	27.3	34.95
RSV 1918	2.23	3.07	3.33	8.06	8.65	10.20	0.79	1.78	1.37	11.2	32.42	34.94
RSV 1988	3.97	4.09	6.50	15.20	13.66	12.02	1.1	2.72	2.02	12.25	36.63	39.99
RSV 2391	2.18	2.99	3.01	16.99	17.63	21.23	1.03	1.67	2	10.23	31.72	33.91
RSV 1941	2.51	3.25	3.61	18.23	19.40	21.20	1.14	1.17	1.67	10.08	30.23	34.91
P. Vasudha (C)	5.22	6.00	6.23	9.57	5.90	6.20	1.3	1.7	1.98	9.87	20.02	35.23
P. Revati (C)	3.83	3.91	6.2	15.01	13.07	11.07	1.06	2.53	1.97	11.14	35.88	39.29
M-35-1	3.70	4.11	4.88	9.23	9.57	10.50	1.7	2.1	2.32	12.30	28.62	36.22
RSV 1188 (RC)	3.90	4.12	5.00	12.51	12.99	16.03	1.01	1.22	1.35	11.22	23.21	29.49
IS 18551 (RC)	3.83	4.71	5.21	16.57	18.08	20.23	1.1	1.4	2.2	10.43	23.30	29.62
RSE 3 (RC)	2.80	2.91	3.11	10.20	11.98	12.23	0.8	1.2	1.7	12.21	24	30.49
DJ 6514 (SC)	19.10	22.1	25.8	0.00	0.71	0.83	2.15	3.55	4.40	21.03	45.23	63.3
Mean	3.89	4.59	5.41	12.82	13.31	14.61	1.32	1.89	1.96	11.73	31.79	38.56
SEm±	0.17	0.16	0.22	0.06	0.08	0.12	0.05	0.06	0.07	0.33	0.34	0.31
CD (p=0.05)	0.60	0.53	0.69	0.20	0.27	0.37	0.15	0.19	0.22	1.06	1.08	1.00

resistance to shootfly in sorghum. Trichome density studies revealed that trichome density were ranges from 0–18.23 mm^{-1} and mean is 12.82 at 14 DAE, 0.71–19.4 mm^{-1} with mean is 13.31 at 21 DAE and 0.83–21.75 mm^{-1} with mean is 14.61 at 28 DAE. At 14 DAE, the trichome density was recorded minimum in resistance check RSE 3 (2.80) and 28 DAE, trichome density was recorded in check RSE (3.11).

Leaf glossiness was ranged from 0.76–2.15 at 14 DAE to 1.37–4.4 at 28 DAE. Leaf glossiness was recorded highest in susceptible check, DJ 6514 with 2.15 at 14 DAE, 4.40 at 28 DAE. RSV 1188 shootfly resistant check recorded 1.01–1.35 leaf glossiness respectively at 14 and 28 DAE. The RSV 1945 recorded minimum score of leaf glossiness (0.76). However, susceptible check, DJ 6514 recorded maximum score of leaf glossiness (4.40) which indicated non-glossiness of leaf. At 14 DAE, the leaf glossiness of RSV 1945 (0.76), RSV 1918 (0.79) was comparable to resistant check IS 18551 (1.1) and RSE 03 (0.8). At 21 DAE, the leaf glossiness of RSV 1945 (1.01), RSV 1941 (1.17) was comparable to resistant check IS 18551 (1.4) and RSE 03 (1.2). Susceptible genotype DJ 6514 was non-glossy and recorded leaf glossiness score 3.55. At 28 DAE, the leaf glossiness of RSV 1188 (1.35), RSV 1918 (1.37) was comparable to resistant check IS 18551 (2.2) and RSE 03 (1.7). Susceptible genotype DJ 6514 was non-glossy and recorded leaf glossiness score 4.40. Similar results were recorded by Patil et al. (2006) and Chikkarugi and Balikai (2011).

Dead heart percentage recorded highest in shootfly susceptible check DJ 6514 with 21.03–63.3 from 14–28 DAE, while dead heart percentage was increased from 11.22–29.49% in RSV 1188, 10.43–29.62% in IS 18557. Dead heart percentage ranged from 9.09–21.3% with mean of 11.73% at 14 DAE to 33.91–63.30% at 28 DAE. At 14 DAE, the minimum shootfly incidence was recorded in RSV 2371 (9.09%) and it was at par with in RSV 2025 (9.5%). The highest dead heart percentage was recorded in DJ 6514 (21.03%). At 21 DAE, the minimum shootfly incidence was recorded in P. Vasudha (20.02%) and it was at par with in RSV 1188 (23.21%). The highest dead heart percentage was recorded in DJ 6514 (45.23%). At 28 DAE, the minimum shootfly incidence was recorded in 1188 (29.49%). Similar finding recorded by Khandare et al. (2013).

3.2.2. Biochemical attributes

The average soluble protein on 14 DAE ranged from 0.81–1.98 mg g^{-1} tissue. The highest soluble protein was observed in the genotype, DJ 6514 (1.98 mg g^{-1}) which was higher than the rest of the genotypes. The lowest soluble protein was found in the genotype, RSV 1918 (0.81 mg g^{-1}). However, it was at par with the genotypes viz., RSV 1628, M-35-1 and RSV 2391.The average soluble protein content at 28 DAE ranged from 1.14–2.90 mg g^{-1} tissue. The highest soluble protein was recorded in sorghum shootfly susceptible genotype, DJ 6514 (2.90 mg g^{-1}) which was significantly higher than the rest of the genotypes. The lowest soluble protein was found in the genotype RSE 3 (1.14 mg g^{-1}). However, it was at par with the genotypes viz., M-35-1, RSV 2391, RSV 1941 and RSV 1918. Similar results observed by Padmaja et al. (2014) and Bhoge et al. (2017).

Shootfly resistant sorghum genotypes exhibited higher level of peroxidase and polyphenol oxidase activity as compared to susceptible genotypes. At 14 DAE, the average peroxidase activity ranged from 0.81–1.87 ΔO.D. m^{-1} g^{-1}. The maximum peroxidase activity was noticed in the check, RSV 1941 (1.87 ΔO.D. m^{-1} g^{-1}) and it was more than the rest of the genotypes. At 21 DAE, the average peroxidase activity ranged from 0.86–1.89 ΔO.D. m^{-1} g^{-1}. The maximum peroxidase activity was recorded in sorghum genotype RSV 1941 (1.89 ΔO.D. m^{-1} g^{-1}) and it was more than the rest of the genotypes. At 28 DAE, the average peroxidase activity ranged from 1.13–2.35 ΔO.D. m^{-1} g^{-1}. The maximum peroxidase activity was noticed in the resistant check, RSV 1188 (2.35 ΔO.D. m^{-1} g^{-1}). The minimum peroxidase activity was recorded in the susceptible check, DJ 6514 at 14, 21 and 28 days respectively which was lesser than the rest of the genotypes (Table 3). Shootfly resistant sorghum genotype

Table 3: Effect of shoot fly on biochemical attributes of sorghum genotypes at different growth stages

Genotypes	Soluble protein (mg g^{-1} tissue)			Peroxidase Activity (ΔO.D. m^{-1} g^{-1})			PPO Activity (ΔO.D. m^{-1} g^{-1})			Polyphenol (mg 100 g^{-1})		
	14 DAE	21 DAE	28 DAE	14 DAE	21 DAE	28 DAE	14 DAE	21 DAE	28 DAE	14 DAE	21 DAE	28 DAE
RSV 1628	0.86	1.23	1.39	1.20	1.25	1.51	0.31	0.34	0.40	3.59	3.81	4.23
RSV 1023	0.94	1.05	1.82	1.33	1.44	1.57	0.34	0.40	0.42	3.78	3.96	4.66
RSV 1910	0.81	1.12	1.38	1.40	1.49	1.60	0.4	0.41	0.45	3.38	3.61	4.13
RSV 2371	1.01	1.28	1.41	1.77	1.79	1.87	0.74	0.85	0.97	3.81	4.07	4.71
RSV 1945	1.86	2.01	2.29	1.68	1.72	1.79	0.72	0.92	0.99	3.85	4.39	5.51
RSV 1838	0.99	1.03	1.48	1.40	1.50	1.65	0.39	0.40	0.42	3.87	4.11	4.79
RSV 2025	0.98	1.00	1.32	1.38	1.49	1.60	0.38	0.43	0.48	3.81	4.02	4.73
RSV 1918	0.81	1.11	1.26	1.35	1.43	1.59	0.39	0.41	0.44	3.56	3.79	4.11
RSV 1988	1.10	2.10	2.32	1.42	1.51	1.62	0.40	0.41	0.45	3.61	4.12	5.30
RSV 2391	0.95	1.08	1.17	1.45	1.48	1.56	0.39	0.44	0.46	3.11	4.21	4.98
RSV 1941	0.97	1.1	1.21	1.87	1.89	1.94	0.64	0.75	0.97	3.91	4.23	4.97
P. Vasudha (C)	0.98	1.08	1.28	1.39	1.32	1.52	0.58	0.66	0.84	3.87	4.17	4.81
P. Revati (C)	1.02	1.18	1.56	1.37	1.38	1.50	0.35	0.46	0.61	3.90	4.12	4.83
M-35-1	0.94	1.07	1.15	1.37	1.43	1.57	0.39	0.43	0.70	3.07	3.99	4.72
RSV 1188 (RC)	1.03	1.16	1.28	1.72	1.88	2.35	0.52	0.65	0.96	3.61	4.03	5.40
IS 18551 (RC)	1.12	1.20	1.87	1.69	1.80	2.32	0.60	0.72	0.93	3.82	4.22	5.47
RSE 3 (RC)	0.96	1.09	1.14	1.42	1.62	2.19	0.55	0.76	0.99	3.82	4.45	5.23
DJ 6514 (SC)	1.98	2.11	2.90	0.81	0.86	1.13	0.28	0.30	0.35	3.01	3.10	3.99
Mean	1.07	1.27	1.56	1.44	1.51	1.71	0.57	0.59	0.62	3.63	4.02	4.80
SEm±	0.09	0.08	0.06	0.08	0.07	0.10	0.05	0.05	0.06	0.10	0.12	0.08
CD (p=0.05)	0.27	0.25	0.19	0.27	0.23	0.31	0.15	0.16	0.19	0.30	0.37	0.27

exhibited higher level of peroxidase activity as compared to susceptible genotype. These results are in proximity with Bhoge et al. (2017). Peroxidase enzyme activity increases in shootfly resistant sorghum varieties recorded by Padmaja et al. (2014).

At 14 DAE, the average polyphenol oxidase activity ranged from 0.28–0.74 ΔO.D. m^{-1} g^{-1}. The maximum polyphenol oxidase activity was recorded in the genotype RSV 2371 with 0.74 ΔO.D. m^{-1} g^{-1} and it was significantly more than the rest of the genotypes. The minimum polyphenol oxidase activity was observed in the sorghum genotype, DJ 6514 (0.28 ΔO.D. m^{-1} g^{-1}). At 21 DAE, the average polyphenol oxidase activity in leaves of sorghum genotypes ranged from 0.30–0.92 ΔO.D.m^{-1} g^{-1}. The maximum polyphenol oxidase activity was recorded in the sorghum genotype, RSV 1945 with 0.92 ΔO.D. m^{-1} g^{-1}. The minimum polyphenol oxidase activity was observed in the genotype, DJ 6514 (0.30 ΔO.D. m^{-1} g^{-1}) which was lesser than the rest of the genotypes. At 28 DAE, the average polyphenol oxidase activity in sorghum genotypes ranged from 0.35–0.99 ΔO.D. m^{-1} g^{-1}. The maximum polyphenol oxidase activity was recorded in the shootfly resistant check genotype, RSE 3 (0.99 ΔO.D. m^{-1} g^{-1}). The minimum polyphenol oxidase activity was observed in the genotype, DJ 6514 (0.35 ΔO.D. m^{-1} g^{-1}).

The resistant genotype RSV 1188, RSE 03 and IS 18551 exhibited higher polyphenol oxidase activity (0.78, 0.78 and 0.86 healthy plants) and (0.93, 0.96 and 0.91 affected plants). Susceptible check Swarna (0.29 and 0.38 in healthy and affected plants) and DJ 6514 (0.21 and 0.28 in healthy and affected plants) exhibited lower polyphenol oxidase enzyme activity as recorded by Bhoge et al. (2017) and Padmaja et al. (2014). Polyphenol content of the sorghum genotypes at different growth stages is summarized in Table 2. At 14, DAE the polyphenol ranged from 3.01–3.91 mg 100 g^{-1}. The maximum amount of polyphenol was recorded in the genotype, RSV 1941 (3.91 mg 100 g^{-1}), which was significantly higher than the rest of the genotypes. Significantly lower polyphenol content was observed in the genotype, M-35-1 with 3.01 mg 100 g^{-1}. At 28 DAE, the polyphenol content in leaves of different sorghum genotypes studied was ranged from 3.99–5.47 mg 100 g^{-1} with mean 4.80 mg 100 g^{-1}. The maximum amount of polyphenol was recorded in the sorghum genotype RSV 1945 with 5.51 mg 100 g^{-1}, which was significantly higher than the rest of the genotypes. Significantly lower polyphenol content was observed in the sorghum genotype DJ 6514 (3.99 mg 100 g^{-1}). Biochemical analysis for polyphenol indicated that higher phenol content in plant increased resistance to shootfly by influencing the biology and establishment of shootfly and played important role in the antibiosis mechanism. Phenols are one of the most important groups of plant defence chemicals responsible for antifeedant or antibiotic effects on the insects. These results are in conformity with Sharma et al. (1997). The low phenol content of these sorghum genotypes and masking of these effects by the morphological traits such as leaf glossiness and leaf trichome density, which have a major bearing on the expression of resistance to shootfly observed by Chamarthi et al. (2010).

4. CONCLUSION

The sorghum genotype RSE 3, RSV 1945, RSV 1941, RSV 1188, and RSV 2371 recorded higher polyphenol oxidase activity at 28 DAE as compared to other genotypes. So, these sorghum genotypes are good source for shootfly resistance breeding. The genotype RSE 03, RSV 1941 and RSV 1188 exhibited positive results for shootfly resistance and can be used as donor for shootfly breeding programme.

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