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Biochemical changes and enzyme activities in post-rainy sorghum infested by shoot fly

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Abstract
A research investigation focused on understanding the defense enzymes and protein activities in post-rainy sorghum and their role in resistance against shoot fly. Total soluble protein and chlorophyll content were found to be higher in susceptible genotypes Swarna and DJ-6514 as compared to resistant RSV-2432 and RSV-2391 genotypes. Enzymatic activity of polyphenol oxidase and peroxidase enzyme has been observed higher in the resistant parents than susceptible parents. RSV-2432 and RSV-2391, exhibit higher activity of peroxidase and polyphenol oxidase enzymes. This suggests that plants having higher activity of peroxidase and polyphenol oxidase enzyme shows resistance mechanism.
In a sorghum shoot fly resistance breeding program, using biochemical characters as marker traits can be a valuable strategy to broaden the genetic base and increase the level of resistance.

Keywords: Post-rainy sorghum, shoot fly, plant oxidative enzymes, protein, chlorophyll

Introduction
Sorghum [*Sorghum bicolor* (L.) Moench], a gifted grass genera of the tropics, is the fifth important cereal of the world after wheat, maize, rice, and barley (Dillon *et al*., 2007) [3]. Sorghum is believed to be originated in Africa and spread all over the world. Sorghum is known as great millet and guinea corn in West Africa, kafir corn in South Africa, dura in Sudan, mtama in eastern Africa, jowar in India, and kaoliang in China (Purseglove, 1972) [8].
Sorghum is unique in its adaptation to extreme environmental conditions. In India, there are two distinct growing seasons for sorghum i.e. rainy (*kharif*) and post rainy (*rabi*) seasons. *Rabi* sorghum is highly valued for consumption purpose due to the excellent quality of the grain, which matures during rain-free cool climate. Hence, this grain fetches a high market price; almost double that of *kharif* grain. But the average productivity of *rabi* sorghum (953 kg/ha) is much less as compared to *kharif* sorghum (1018 kg/ha). The main reason for the low productivity of *rabi* sorghum is low genetic diversity and higher susceptibility to shoot fly. Therefore, there is a need to increase productivity by focusing on the development of improved shoot fly resistant lines.
Identifying sorghum genotypes with stable shoot fly 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 (Borad and Mittal 1983) [2]. More than 150 insect pests damages sorghum from seedling to harvesting stage, of these, sorghum shoot fly, *Atherigona soccata* (Rondani) is one of the major insect pests of sorghum (Sharma 1993) [9].
Host plant resistance (HPR) is an effective and cost-effective approach to control shoot fly populations in sorghum and does not require additional input costs for the farmer. The resistance to shoot fly in sorghum depends on various quantitative characters, and their combined expression determines the plant's resistance level. HPR is considered a sustainable, economical, and environmentally reliable method for managing shoot fly populations and it's essential to understand the mechanisms of resistance for developing insect-resistant sorghum varieties. This knowledge helps in identifying and utilizing resistant sources from germplasm effectively. Although there has been progress in identifying germplasm with resistance to shoot fly, there's still limited understanding of the physiological and biochemical mechanisms that confer this resistance. The present study aims to investigate the role of specific proteins and enzymes in *rabi* sorghum plants and their contribution to host plant resistance against shoot fly infestation. The study focuses on four key parameters *viz*., Total soluble protein (mg/g fresh weight), Total chlorophyll (mg/g), Polyphenol oxidase (ΔO.D./min/g) and Peroxidase (ΔO.D./min/g).

These parameters were analysed among four genotypes from which two are resistant and remaining are susceptible for shoot fly.

2. Materials and Methods

The experiment was carried out at Sorghum Improvement Project, Mahatma Phule Krishi Vidyapeeth, Rahuri, during the period *Rabi*, 2022 and material for present study was obtained from Senior Sorghum Breeder, Sorghum Improvement Project, MPKV, Rahuri. Four *rabi* sorghum genotypes were selected for the experiment, from which two shoot fly resistant *viz*., RSV-2432 and RSV-2391\and two shoot fly susceptible genotypes *viz*., Swarna and DJ-6514. For this study four different parameters were selected *viz*., Total soluble protein (mg/g fresh weight), Total chlorophyll (mg/g), Polyphenol oxidase (PPO) (ΔO.D./min/g) and Peroxidase (POX) (ΔO.D./min/g). Analyses of these parameters were done among four genotypes from which two are resistant and remaining are susceptible for shoot fly.

The sorghum genotypes were planted in two rows. Each row having 4.5 meter length and the rows were spaced at 45 cm apart. The experiment followed a randomized block design with three replications. Normal agronomic practices were followed for cultivating the sorghum crop. Notably, no insecticide was applied in experimental plot.

At 28 days after emergence (DAE), seedlings from each sorghum genotype were collected for biochemical analysis. Soluble protein content in the seedlings was estimated using the method suggested by Lowry *et al*. in 1951 [5]. The enzyme extraction was done by following the procedure given by Kumar and Khan (1982) [4] and enzyme activity was expressed as change in absorbance per minute per gram fresh weight (ΔO.D./min/g).

3. Results and Discussion

The mean values of different genotypes for different biochemical characters of *rabi* sorghum have been presented in Table 1 and briefly discussed below.

3.1 Total soluble protein (mg/g fresh weight)

Total soluble protein was estimated more in the susceptible genotypes Swarna (2.42) and DJ-6514 (2.95) while lower in the resistant genotypes RSV-2432 (1.63) and RSV-2391 (2.18). From the analysis it was seems that after the infection of shoot fly, level of soluble protein increased and level increased activities were higher in the susceptible parents.

The similar results were observed by earlier workers, Padmja *et al*., (2014) [6] who reported an overall increase in total protein content compared with uninfected plant in sorghum, Bhoge *et al*., (2017) [1] and Patil *et al*., (2017) [7] also reported similar findings in sorghum.

3.2 Total chlorophyll (mg/g)

Chlorophyll content was observed higher in susceptible genotypes Swarna (1.89) and DJ-6514 (2.45) while lower in the resistant genotypes RSV-2432 (1.52) and RSV-2391 (1.47). From the analysis it was observed that after the infection of shoot fly, total chlorophyll was higher in the susceptible parents as compared to resistant parents.

Similar results were reported by Patil *et al*., (2017) [7], also reported significant differences for chlorophyll content among susceptible and resistant genotypes in sorghum.

Table 1: Biochemical parameters associated with shoot fly resistance in post-rainy sorghum

Sr. No.	Genotypes	Total soluble protein (mg/g fresh weight)	Total chlorophyll (mg/g)	Polyphenol oxidase (ΔO.D./min/g)	Peroxidase (ΔO.D./min/g)
1.	Swarna (S)	2.42	1.89	0.26	0.84
2.	DJ-6514 (S)	2.95	2.45	0.27	0.85
3.	RSV-2432(R)	1.63	1.52	0.37	1.79
4.	RSV-2391 (R)	2.18	1.47	0.31	1.26

3.3 Polyphenol oxidase (PPO) (ΔO.D/min/g)

Results of enzyme activities shown in Table 1 revealed that **t**he average polyphenol oxidase activities were higher in resistant genotypes RSV-2432 (0.37) and RSV-2391 (0.31) as compared to susceptible genotypes Swarna (0.26) and DJ-6514 (0.27). From these results, it was observed that activity of polyphenol oxidase increased after the infection of shoot fly. It has been earlier reported by Padmja *et al*., (2014) [6], Bhoge *et al*., (2017) [1] and Patil *et al*., (2017) [7].

3.4 Peroxidase enzyme (POX) (ΔO. D/min/g)

The average peroxidase activities ranged from 0.84 to 1.79 in susceptible and resistant genotypes. It was observed that activities of peroxidase enzyme increased after the infection by shoot fly and observed higher in the resistant genotypes as compared to susceptible genotypes. Highest value for peroxidase activity recorded by the resistant genotype RSV-2432, it means genotypes showing the resistance mechanism having higher activity of peroxidase enzyme.

These findings confined similar to the earlier research of Padmja *et al*., (2014) [6], Bhoge *et al*., (2017) [1] and Patil *et al*., (2017) [7].

4. Conclusion

The study's findings suggest that higher enzyme activity and protein content are associated with resistance in sorghum plants against shoot fly infestations. These biochemical traits can be used as markers in breeding programs aimed at developing sorghum varieties with increased resistance to shoot fly. By selecting for these traits, the genetic base of resistant sorghum can be broadened, potentially leading to more effective resistance against shoot fly pests.

In summary, this study contributes to our understanding of how plant biochemical traits, particularly enzyme activities and protein content, can play a crucial role in sorghum's resistance to shoot fly infestations. These findings may have practical applications in breeding programs to develop more resilient sorghum varieties.

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6. References

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