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EFFECT OF SHOOT FLY DAMAGE ON SORGHUM AND ITS CORRELATION TO WEATHER PARAMETERS

Kurru Charitha^{1*}, Pradyumn Singh¹, Neha Sharma¹, Naveen², Anita Kumari Pandey¹,
Pallavi Sonaniya¹, Shradha Parmar¹, Maneesha¹ and N.S. Bhadauria¹

¹College of Agriculture, Rajmata Vijayaraje Scindia Krishi Vishwavidyalaya, Gwalior, Madhya Pradesh, India

²ICAR- Central Institute for Cotton Research, Regional Station, Sirsa, Haryana, India

*Corresponding author E-mail: charithak2021@outlook.com

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ABSTRACT

The present study evaluated the seasonal incidence of sorghum shoot fly, *Atherigona soccata* (Rondani), and its association with selected weather parameters under field conditions in the Grid region of Madhya Pradesh. The investigation was conducted at the Research Farm, College of Agriculture, Gwalior, during Kharif 2024 and 2025 using sorghum genotype NTJ-5. The crop was maintained without insecticidal or fungicidal application, and shoot fly incidence was recorded weekly on ten randomly selected plants. Infestation was assessed as per cent dead heart formation. During both years, shoot fly damage started in the 29th SMW with 10.00% dead heart incidence and continued up to the 35th SMW. The maximum dead heart incidence was recorded during the 32nd SMW, reaching 60.00% in 2024 and 50.00% in 2025. At peak incidence, the corresponding weather conditions in 2024 included maximum temperature of 32.80°C, minimum temperature of 25.80°C, morning relative humidity of 88.90%, evening relative humidity of 69.90%, and rainfall of 28.40 mm. In 2025, peak incidence coincided with maximum temperature of 34.60°C, minimum temperature of 26.90°C, morning relative humidity of 84.10%, evening relative humidity of 50.70%, and no rainfall. The results indicated that minimum temperature and evening relative humidity were associated with variation in shoot fly-induced dead heart incidence during the study period.

Key words: sorghum, shoot fly, dead heart, seasonal incidence, minimum temperature

Introduction

In terms of global production, sorghum ranks fifth after maize, rice, wheat and barley, making it one of the most significant cereal crops. It is grown in over 100 nations, mostly in the semi-arid tropical and subtropical regions of the America, Asia, Africa and Australia (Rosentrater, and Evers, 2018). Sorghum is a climate-resilient crop that may maintain agricultural production in water-limited regions because of its exceptional adaptation to harsh climatic circumstances, such as drought, high temperatures and low soil fertility. Sorghum is widely used as livestock feed, forage, biofuel feedstock, starch, alcohol, syrup and other industrial goods in addition to being a staple diet for millions of people, especially in developing nations. Sorghum has drawn more attention as a health-promoting grain and a crucial part of

sustainable agricultural systems because of its high nutritional value, gluten-free status and abundance of dietary fibre, minerals, antioxidants and bioactive substances (FAOSTAT, 2024; Visarada and Aruna, 2019).

Atherigona soccata (Rondani) (Diptera: Muscidae), the sorghum shoot fly, is found in many tropical and subtropical areas of Asia, Africa and the Mediterranean basin. It is acknowledged as the main sorghum seedling pest and can cause serious harm from the time seedlings sprout until around 30 to 35 days after sowing. Due to environmental circumstances that promote its rapid proliferation and persistent activity, the pest is especially dangerous in late sown crops and under rainfed conditions. The typical symptom known as “dead heart”, in which the outside leaves stay green but the inner lead dries and is easily removed, is caused by the destruction

of the apical meristem, which disrupts normal plant growth. When plants are injured, they frequently develop weak side tillers that don't contribute much to grain production, which significantly reduces yield (Devanathan *et al.*, 2025). In order to comprehend pest population dynamics and critical times of pest occurrence, it is crucial to systematically examine the seasonal prevalence of major insect pests and determine their link with prevailing weather conditions. Such data can help with prompt monitoring, forecasting and the creation of successful integrated pest management plans for sorghum.

Material and Methods

The experiment was carried out at Research Farm, College of Agriculture, Gwalior during the period Kharif 2024 and 2025. A plot size of 10.8 m × 3 m was raised with sorghum genotype NTJ-5 and the crop was maintained without the usage of insecticides and fungicides throughout the crop period to study the incidence of insect pests. The crop was sown with a spacing of 45 cm × 15 cm and all the agronomic practices *viz.*, fertilizer application, irrigation, inter cultivation were followed as per recommendations. The incidence of major insect pest, namely shoot fly (*A. soccata*), was systematically recorded on ten randomly selected plants throughout the cropping season at weekly intervals. The incidence of shoot fly was assessed in terms of per cent dead heart formation.

$$\text{Percent dead heart} = \frac{\text{No. of plants with dead hearts}}{\text{No. of plants observed}} \times 100$$

The meteorological data prevailed during Kharif 2024

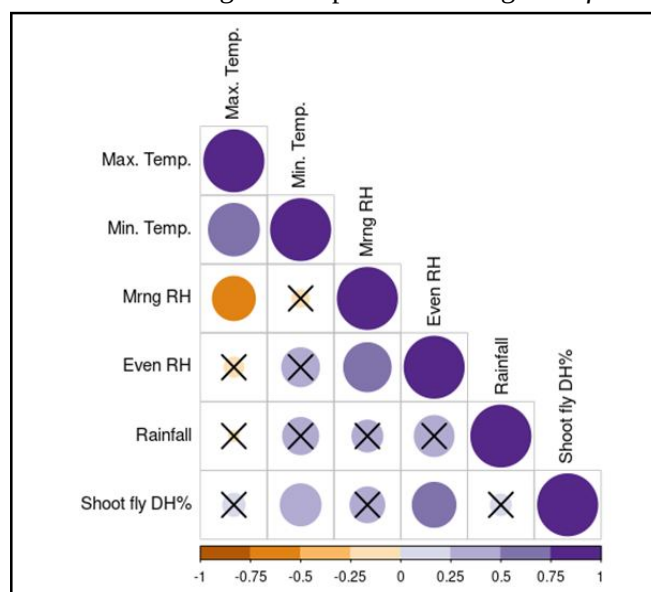


Fig. 1: The Pearson correlation matrix depicted for Kharif season 2024. Positive values showed in indigo colour and negative values are in brown colour. Marked circles identified as non-significant.

and 2025 was recorded at the meteorological observatory located at College of Agriculture, Gwalior. These are subjected to correlation and regression analysis to determine the seasonal incidence of shoot fly damage in relation to abiotic factors

Statistical analysis

The simple correlation was computed between shoot fly damage and environmental factors *viz.*, maximum temperature, minimum temperature, morning relative humidity, evening relative humidity and rainfall.

$$\text{Correlation 'r'} = \frac{\sum xy - \frac{\sum x \cdot \sum y}{n}}{\sqrt{\left\{ \sum x^2 - \frac{(\sum x)^2}{n} \right\} \left\{ \sum y^2 - \frac{(\sum y)^2}{N} \right\}}}$$

Where,

r = Simple correlation coefficient

x = Independent variable *i.e.*, abiotic factors

y = Dependent variable *i.e.*, biotic factors

n = Number of set of observations

Regression studies:

$$Y = a x + b$$

Where,

a = Regression coefficient

b = Intercept

Results

During Kharif 2024, the dead heart induced by shoot

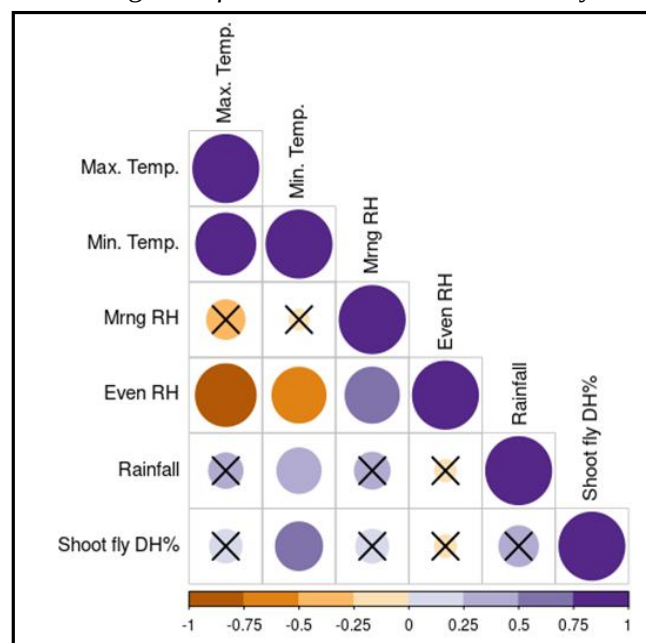


Fig. 2: The Pearson correlation matrix depicted for Kharif season 2025. Positive values showed in indigo colour and negative values are in brown colour. Marked circles identified as non-significant.

Table 1: Seasonal incidence of sorghum shoot fly.

Standard Metrological Week	Shoot fly (DH%)	
	2024	2025
29	10.00	10.00
30	20.00	30.00
31	40.00	40.00
32	60.00	50.00
33	50.00	30.00
34	20.00	20.00
35	10.00	10.00

fly commenced during the 29th Standard Metrological Week (SMW), with 10.00% and the infestation persisted until the 35th SMW, when 10.00% damage was observed. The infestation reached its peak during the 32nd SMW, recording 60.00%. This peak incidence coincided with prevailing weather conditions included an average maximum temperature of 32.80°C and a minimum temperature of 25.80°C, along with morning and evening relative humidity levels of 88.90% and 69.90% and 28.40 mm rainfall respectively.

During *Kharif* 2025, the dead heart induced by shoot fly commenced during the 29th SMW, with 10.00% and the infestation persisted until the 35th SMW, when 10.00% dead heart were observed. The infestation reached its peak during the 32nd SMW, recording 50.00%. This peak incidence coincided with prevailing weather conditions included an average maximum temperature of 34.60°C and a minimum temperature of 26.90°C, along with morning and evening relative humidity levels of 84.10% and 50.70% and no rainfall respectively.

According to the correlation studies, Table 2 shoot fly infestation was found significantly positively impacted by minimum temperature and evening relative humidity at 5% level of significance in *Kharif* 2024 and only minimum temperature in *Kharif* 2025.

From Table 3, it may be expressed that with every unit increase in minimum temperature there was a

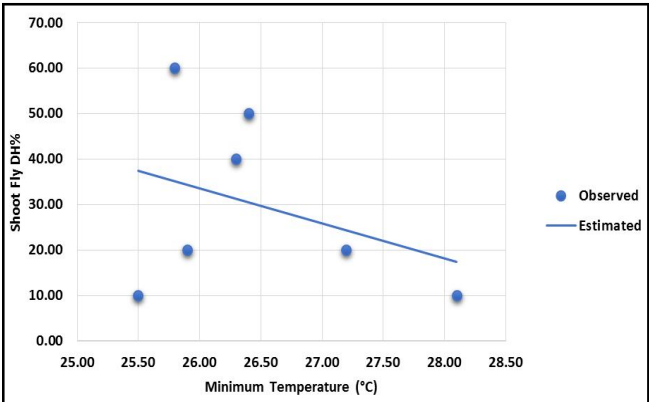


Fig. 3: Regression depicted between shoot fly dead heart per cent and minimum temperature during *Kharif* 2024.

Table 2: Correlation between shoot fly and prevailing weather parameters during *Kharif* season.

Weather parameters	Shoot fly (DH%)	
	2024	2025
Maximum Temperature	0.14	0.24
Minimum Temperature	0.46*	0.51*
Morning Relative humidity	0.34	0.25
Evening Relative humidity	0.53*	-0.11
Rainfall	0.12	0.36
*Significant at 5% level of significance		

decrease of 7.69% shoot fly infestation in 2024 and increase of 8.77% shoot fly infestation in 2025. In addition to this, every unit increase in evening relative humidity there was an increase in 2.54% shoot fly infestation in 2024.

Discussion

Present finding is full conformity with the findings of Yadav *et al.*, (2015), who reported that during *Kharif*, 2012, the incidence of shoot fly peaked during 32nd SMW, with an infestation of 47.36% dead heart. The current result was partially in line with Keerthi *et al.*, (2017), who noted the peak shoot fly infestation was recorded at 33rd SMW. In the same way, Khan *et al.*, 2024 stated that the *A. soccata* infestation was peaked during 35th SMW *i.e.*, fourth week after sowing. These variations in infestation of *A. soccata* may result from various growing seasons and variations in the weather parameters present at the time of experimental investigation. The current findings are partially supported with those made by Dattatray (2021), who noted that the infestation of shoot fly was peaked at second week of August. Similarly, Saxena *et al.*, 2022 observed the infestation of shoot fly starts at 27th SMW and peaked at 30th SMW *i.e.*, 28 days old crop. Similarly, Nayak *et al.*, 2025 and Sunitha *et al.*, 2021 recorded the infestation of shoot fly reached to peak at 28 days after emergence.

The main findings of this study indicate that the

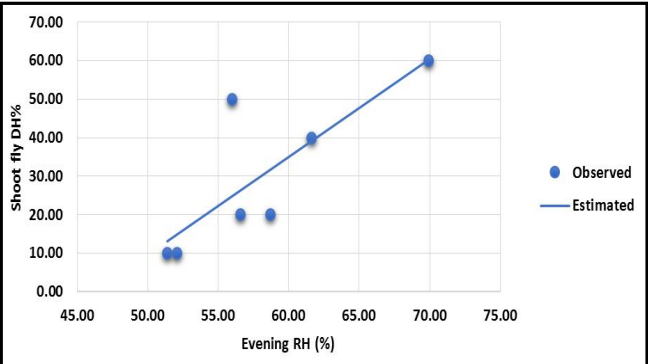
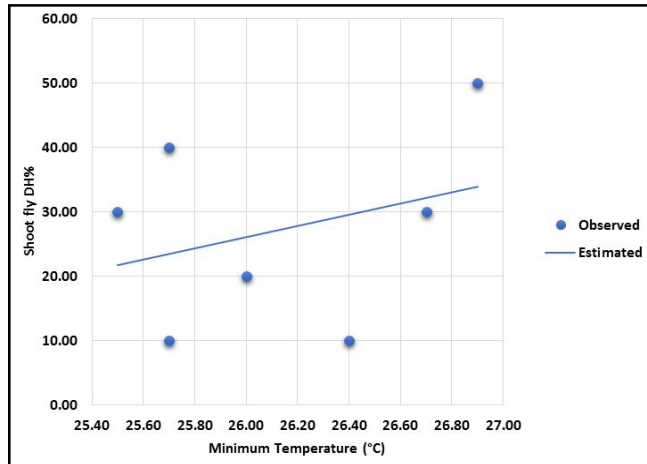


Fig. 4: Regression depicted between shoot fly per cent dead heart and evening relative humidity during *Kharif* 2024.

Table 3: Regression for sorghum shoot fly during *Kharif* season.

Year	Weather parameters	RE	CD
2024	Minimum temperature	$y = -7.69x + 233.63$	0.12
	Evening relative humidity	$y = 2.54x - 117.91$	0.64
2025	Minimum temperature	$y = 8.77x - 202.17$	0.10

RE: Regression equation; CD: Coefficient of determination (R^2)**Fig. 5:** Regression depicted between shoot fly per cent dead heart and minimum temperature during *Kharif* 2025.

infestation caused by shoot fly was influenced by minimum temperature, indicating a positive significant association in both the years. Because of the positive relationship, shoot fly-induced dead heart tend to increase as minimum temperatures increase. Minimum temperatures over a particular point may allow the pest to survive, resulting in an increase in per cent dead heart during *Kharif* season. The scientific evidences supporting the current findings, such as Saxena *et al.*, 2022, who observed that minimum temperature had a large favourable impact on per cent dead heart caused by shoot fly. The current finding is somewhat compatible with that of Sunitha *et al.*, (2021), who found that the dead heart caused by shoot fly was positively significant correlated with minimum temperature and dead heart infestation increased with increase in minimum temperature. In contrast to the current investigations, Gangaraju *et al.*, 2024 reported that the per cent dead heart caused by shoot fly showed a significant negative correlation with minimum temperature at 14, 21 and 28 DAE. Khan *et al.*, 2024, discovered a significant but negative correlation between per cent dead heart caused by shoot fly and minimum temperature.

Conclusions

Shoot fly incidence in sorghum was observed from the 29th SMW to the 35th SMW during both *Kharif* seasons. The highest dead heart incidence occurred during the 32nd SMW, with 60.00% infestation in 2024

and 50.00% infestation in 2025. The observed pattern suggests that minimum temperature may be an important weather parameter associated with shoot fly-induced dead heart formation under the study conditions. Evening relative humidity also showed an association with infestation during 2024. These findings indicate the need for regular monitoring of sorghum shoot fly during the early crop growth period, particularly around the 32nd SMW.

Declaration of AI Use

This manuscript was prepared through the combined contributions of all author(s), including contributions to the study design, data, content development, results, interpretation, and related scholarly work. The author(s) acknowledge the use of Grammarly and ChatGPT to assist with grammar checking, language refinement, reference formatting. These AI-assisted tools were not used as authors and did not replace the intellectual contributions or scholarly judgment of the author(s). All AI-assisted outputs, including content, references, and interpretations, were carefully reviewed, revised, verified, and approved by the author(s). The author(s) accept full responsibility for the accuracy, integrity, and final content of the manuscript.

Declaration: The authors declare that they have no conflict of interests.

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