International Journal of Advanced Biochemistry Research

ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2025): 5.29
IJABR 2025; SP-9(10): 281-284
www.biochemjournal.com
Received: 01-07-2025
Accepted: 05-08-2025

Anjana Patel
Banaras Hindu University, Entomology and Agricultural Zoology, Varanasi, Uttar Pradesh, India

Radheshyam Meena
Banaras Hindu University, Entomology and Agricultural Zoology, Varanasi, Uttar Pradesh, India

Corresponding Author:
Anjana Patel
Banaras Hindu University, Entomology and Agricultural Zoology, Varanasi, Uttar Pradesh, India

Seasonal abundance and climatic correlates of fall armyworm (*Spodoptera frugiperda* J.E. Smith) in a maize ecosystem

Anjana Patel and Radheshyam Meena

DOI: https://www.doi.org/10.33545/26174693.2025.v9.i10Sd.5837

Abstract

Fall armyworm (*Spodoptera frugiperda* J.E. Smith) has emerged as a major invasive pest of maize in India, causing significant yield losses through rapid population buildup and severe defoliation. The present study investigated the seasonal population dynamics and leaf damage caused by fall armyworm on maize during the Kharif season of 2024 at the Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi. A hybrid maize variety (Pusa Jawahar Hybrid Maize-1) was grown under natural infestation conditions without insecticidal intervention. Weekly observations were recorded from crop establishment to harvest to monitor larval abundance, percent plant infestation and leaf injury.Results indicated that larval incidence began in the 32nd SMW of August and persisted until the 44th SMW in late October. The larval population fluctuated between 0.97 and 4.08 larvae per plant, with the peak density observed during the 38th SMW (early September). Correspondingly, percent plant infestation rose steadily from 11.32% in August to a maximum of 83.60% in the 38th SMW, after which a gradual decline was noted as the crop matured. The most intense infestation occurred during September, coinciding with favorable weather characterized by mean temperatures of 29-30 °C and moderate rainfall. Correlation analysis between weather parameters and larval population revealed that wind speed (r = 0.60) and evaporation (r = 0.49) were strongly associated with pest abundance, while minimum and mean temperatures showed moderate positive effects. Rainfall and relative humidity exhibited weak associations, suggesting limited influence on pest buildup during the study period.

Keywords: Fall army worm, maize, damage potential, population dynamics, weather parameters

Introduction

Maize is a key cereal crop for billions of people worldwide serving as feed, fuel, industrial raw material etc. Globally the area for maize crop is 193.7 million ha in around 170 countries with a production of 1147.7 million tonnes and productivity of 5.75 t/ha (Anonymous, 2020). Maize is referred as the "Queen of Cereals" due to its tremendous genetic yield potential. "It is being cultivated both in the tropical and subtropical climatic conditions. At present, the average yields of cereal grains are lower in India due to variety of factors, among which, the insect pests have been considered as one of the most important constraints. It is estimated that as many as 141 insect pests cause different degrees of damage to maize crop from sowing to harvesting" [1]. "Among these, stem borer (*Chilo partellus*), cob borer (*Stenachroia elongella*) and shoot fly (*Atherigona soccata*) were found to be as major pests. Stem borers are the major insect pests followed by defoliators but now, the fall armyworm (FAW), *Spodoptera frugiperda* (J.E. Smith) (Noctuidae: Lepidoptera) a polyphagous and extreme pest of many important crops, including maize in India" [2]. The FAW invaded the Asian continent (Sharanabasappa *et al*., 2018) in May 2018 and has since spread across most of China and eastern Asia and Australia. FAW is a highly mobile, migratory, polyphagous pest that originated in Neotropics (Luginbill, 1928) [11].

FAW is serious threat in maize production capable of causing severe yield losses when left uncontrolled. Understanding its population dynamics is essential for effective pest surveillance and implementation of control strategies. Objective of this study to assess the pest's seasonal trends under field conditions. Results can help in identifying critical periods of infestation which is useful for planning appropriate and timely management interventions.

Materials and Methods

The field experiment was conducted during Kharif,2024 maize variety Pusa Jawahar Hybrid maize 1 was sown in an area of 336 m^2 with plot size 4 × 3.5 m and spacing is 60 × 25 cm at Agricultural Research Farm, Institute of Agriculture science, B.H.U., Varanasi. Throughout the cropping season, the crop was maintained without any pesticidal application to allow natural infestation and observation of FAW population dynamics. Weekly observations were carried out starting from the third week after germination and continued up to harvest stage. In each plot ten plants were randomly selected and the number of FAW larvae present on each plant was recorded. Based on these the mean larval population per plant was calculated individually for each SMW to monitor pest progression over time.

The mean larval population of fall armyworm was calculated as follows

$$\text{Mean Larval Population} = \frac{\text{Number of Larvae}}{\text{Ten Randomly selected plants}}$$

The number of plants infested with FAW larvae were observed for 10 plants from each plot, after the third week of germination and percent of infested plants (% IP) was calculated by using following formula

$$\text{Percent infested plants} = \frac{\text{Number of plants infested}}{\text{Total number of plants observed}} \times 100$$

The relationship between the FAW larval population and various weather parameters was analyzed by working out the correlation coefficients. The weather factors considered for this analysis included maximum temperature, minimum temperature, mean temperature, morning relative humidity, evening relative humidity, evaporation, bright sunshine hours (BSS) and rainfall. This analysis was undertaken to understand the influence of climatic conditions on the fluctuation and intensity of FAW infestation during the crop season. (Kumar *et al*., 2020) [8].

The data obtained on the population variables, damage ratings were transformed and statistically analyzed.

Results

The observations on population dynamics of mean larval population of fall armyworm, *Spodopetra frugiperda* present per 10 randomly selected plants and percent leaf damage by selecting fresh damaged leaves on top 5 leaves by selecting 10 random plants have been summarized in Table 1 and Table 2 respectively.

In the present study, the incidence of FAW was observed starting from the first week of August (32^{nd} Standard Meteorological Week) and continued until the last week of October (44^{th} SMW). During this period, the larval population ranged from 0.97 to 4.08 larvae per plant. Throughout the crop period, the larval population exhibited fluctuations. During 33^{rd}, 34^{th} and 35^{th} SMW 1.77,2.03, and 2.52 was the mean larval population respectively. During September month increase in the larval population was observed across SMW 36 to 38, followed by a slight decline after 38^{th} SMW. The larval population rise from 3.09 larvae per plant in SMW 36 to 3.78 in SMW 37 and peaked at 4.08 in SMW 38. A slight decrease was recorded in SMW 39, with the population decline to 3.57 larvae per plant. This indicates a buildup of the FAW larval population during the early weeks of September, potentially influenced by favorable climatic conditions. During September month mean temperature is ranging between 29.55 to 30.05 with rainfall 13.4 to 54.3 mm. During October month larval population showed a consistent declining trend, starting at 3.00 larvae per plant in 40^{th} SMW and reducing gradually to 2.74,2.02 and 1.04 in SMWs 41,42 and 43 respectively. By SMW 44, the larval population had dropped significantly to 0.49 larvae per plant.

Maize plant infestation starting from 32^{nd} SMW in august to 44^{th} SMW in October. Infestation range was varied between 11.32% to 83.6%. Starting from SMW 32, the infestation was recorded at 11.32%, which then increased steadily over the following weeks, reaching 32.65% in SMW 33,45.67% in SMW 34, and 54.32% in SMW 35. Increase in infestation was continued through SMW 36 which was 62.60% and SMW 37 was 78.54% and peaked during SMW 38 with the highest infestation observed was 83.60%. During SMW 37 and SMW 38 intense pest activity and rapid population build up happened. After SMW 38, a gradual decline in infestation was noted. During 39 SMW pest infestation was reduced to 81.3% still having considerable loss to maize. The data indicates that the during the October month onward slowly decline was observed, with infestation levels dropping to 80.00% in SMW 40, 78.12% in SMW 41, 74.33 in SMW 42, 73.2% in SMW 43 and reaching 70% in SMW 44.

Influence of weather factors on mean larval population of *S. frugiperda* on Kharif maize

The correlation analysis between weather parameters and the larval population of FAW has been depicted in table 3. Among all the parameters wind speed showed the highest positive correlation which is *r*= 0.60 with FAW larval population. This result indicate that increased in wind speed may accelerate the migratory movement of FAW from one plant to another probably supporting in their spread over cropping area. Evaporation exhibited a moderately high positive correlation which is r = 0.49, suggesting that less humid atmospheric conditions can possibly support the activity of FAW. In a similar manner minimum temperature (r = 0.40) and mean temperature (r = 0.38) were positively correlated, indicating that overall warmer conditions might be supportive for FAW survival and population increase. Bright sunshine hours also showed a positive correlation (r = 0.31), suggesting that increased in sunlight might be contributing factor for FAW population indirectly by affecting crop microclimate and insect behavior. Evening RH (r = 0.26) and mean RH (r = 0.20) had weak positive correlations, while morning RH was slightly negatively correlated (r =-0.14) suggesting that early day moisture may not in favor of FAW. The correlation of larval population with rainfall (r = 0.08) and maximum temperature (r = 0.09) indicated a very weak positive relationship, suggesting that these factors had minimal influence on FAW population buildup during the study period.

Discussion

The present study revealed that the larval population of *S. frugiperda* in maize was initiated from early August and peaked during September (37^{th}-38^{th} SMW), coinciding with favorable weather conditions of warm temperature, moderate rainfall, and higher evaporation. A gradual decline in larval population and infestation was observed from October onwards, likely due to less favorable climatic conditions and crop maturity. Similar trends have been reported by earlier workers, where peak activity of FAW was noticed during the vegetative to tasseling stage of maize under warm and humid conditions. The correlation analysis indicated that wind speed, evaporation, and temperature played a crucial role in pest buildup, whereas rainfall and relative humidity had little influence. These results suggest that September is the most critical period for FAW management in Kharif maize, and timely interventions during this phase could significantly reduce crop losses.

Table 1: Number of larvae of FAW during crop season 2024-25

Week after sowing	SMW	Month	No. of FAW/Plant	Max Temp (°C)	Min Temp (°C)	Mean Temp (°C)	Morning RH (%)	Evening RH (%)	Mean RH (%)	BSS (hr)	RF (mm)	WS (km/hr)	Evaporation (mm)
4	32	Aug.	0.97	33.7	25.9	29.8	93	83	88	1.8	48.1	1.9	2.6
5	33		1.77	35.8	26.1	30.95	92	78	85	3.9	29.7	1.1	2.0
6	34		2.03	34.5	25.8	30.15	92	80	86	2.4	61.9	2.1	2.3
7	35		2.52	34.4	27.3	30.85	91	76	83.5	5.8	66.6	2.0	3.4
8	36	Sep.	3.09	34.9	24.1	29.5	91	78	84.5	5.5	22.2	1.3	2.9
9	37		3.78	32.0	27.2	29.6	88	81	84.5	4.8	13.4	3.6	3.2
10	38		4.08	33.6	25.7	29.65	88	73	80.5	6.2	30.9	3.9	2.5
11	39		3.57	32.8	26.3	29.55	90	77	83.5	3.6	54.3	3.6	1.9
12	40	Oct.	3.00	34.3	25.8	30.05	90	65	77.5	7.8	3.6	2.7	2.9
13	41		2.74	34.4	24.1	29.25	89	54	71.5	4.9	0.0	1.6	2.9
14	42		2.01	33.4	31.9	32.65	82	64	73	6.1	0.0	1.2	2.4
15	43		1.04	30.6	22.1	26.35	87	63	75	5.8	0.0	2.5	2.1
16	44		0.49	33.5	20.6	27.05	89	50	69.5	5.9	0.0	1.1	1.9

Table 2: Percent leaf damage during crop season 2024-25

Week after sowing	SMW	Month	Percent leaf damage	Max Temp (°C)	Min Temp (°C)	Mean Temp (°C)	Morning RH (%)	Evening RH (%)	Mean RH (%)	BSS (hr)	RF (mm)	WS (km/hr)	Evaporation (mm)
4	32	Aug.	11.32	33.7	25.9	29.8	93	83	88	1.8	48.1	1.9	2.6
5	33		32.65	35.8	26.1	30.95	92	78	85	3.9	29.7	1.1	2.0
6	34		45.67	34.5	25.8	30.15	92	80	86	2.4	61.9	2.1	2.3
7	35		54.32	34.4	27.3	30.85	91	76	83.5	5.8	66.6	2.0	3.4
8	36	Sep.	62.60	34.9	24.1	29.5	91	78	84.5	5.5	22.2	1.3	2.9
9	37		78.54	32.0	27.2	29.6	88	81	84.5	4.8	13.4	3.6	3.2
10	38		83.60	33.6	25.7	29.65	88	73	80.5	6.2	30.9	3.9	2.5
11	39		81.3	32.8	26.3	29.55	90	77	83.5	3.6	54.3	3.6	1.9
12	40	Oct.	80	34.3	25.8	30.05	90	65	77.5	7.8	3.6	2.7	2.9
13	41		78.12	34.4	24.1	29.25	89	54	71.5	4.9	0.0	1.6	2.9
14	42		74.33	33.4	31.9	32.65	82	64	73	6.1	0.0	1.2	2.4
15	43		73.2	30.6	22.1	26.35	87	63	75	5.8	0.0	2.5	2.1
16	44		70	33.5	20.6	27.05	89	50	69.5	5.9	0.0	1.1	1.9

Table 3: One-way correlation analysis of FAW larvae population against weather parameters

Weather parameters	Correlation
Max. Temperature (°C)	0.09
Min. Temperature (°C)	0.4
Mean Temperature (°C)	0.38
Morning RH (%)	-0.14
Evening RH (%)	0.26
Mean RH (%)	0.20
Bright sunshine (hr.)	0.31
Wind speed (km/hr.)	0.60
Rainfall (mm)	0.08
Evaporation (mm)	0.49

Conclusion

The study clearly demonstrated that fall armyworm infestation in maize begins in early August and peaks during September, with the highest larval population and leaf damage recorded between the 37th and 38th SMW. Weather factors, particularly wind speed, evaporation, and temperature, were positively correlated with population buildup, indicating their major role in pest proliferation. In contrast, rainfall and relative humidity showed minimal influence. A consistent decline in both larval population and crop infestation was observed from October onward, coinciding with crop maturity and less favorable conditions. These findings emphasize September as the critical period for FAW management, underscoring the importance of timely control measures to minimize crop losses.

References

1. Alam T, Shivakumara MN, Prasad R, Narayan A. Studies on the population dynamics of fall armyworm, *Spodoptera frugiperda* (JE Smith) on maize in relation to weather parameters. Pharma Innovation Journal. 2022;11(10S):971-975.
2. Anandhi S, Saminathan VR, Yasotha P, Sharavanan PT, Rajanbabu V. Seasonal dynamics and spatial distribution of fall armyworm *Spodoptera frugiperda* (JE Smith) on maize (*Zea mays* L.) in Cauvery Delta Zone. Journal of Pharmacognosy and Phytochemistry. 2020;9(4):978-982.

3. Darshan R, Prasanna PM, Guruprasad GS, Hegde JN. Population dynamics of fall armyworm, *Spodoptera frugiperda* and its natural enemies in maize. Journal of Advances in Biology & Biotechnology. 2024;27(4):83-88.
4. Deshmukh SS, Prasanna BM, Kalleshwaraswamy CM, Jaba J, Choudhary B. Fall armyworm (*Spodoptera frugiperda*). In: Polyphagous Pests of Crops. 2021. p. 349-372.
5. Farias PRS, Barbosa JC, Busoli AC, Miranda VS, Ribeiro SM. Spatial analysis of the distribution of *Spodoptera frugiperda* (JE Smith) (Lepidoptera: Noctuidae) and losses in maize crop productivity using geostatistics. Neotropical Entomology. 2008;37(3):321-327.
6. Garcia AG, Ferreira CP, Godoy WA, Meagher RL. A computational model to predict the population dynamics of *Spodoptera frugiperda*. Journal of Pest Science. 2019;92:429-441.
7. Kalyan D, Mahla M, Babu SR, Swaminathan R, Meena A, Kalyan R. Population dynamics of fall armyworm, *Spodoptera frugiperda* (JE Smith) on maize. Indian Journal of Applied Entomology. 2019;33(2):110-114.
8. Kumar NV, Yasodha P, Justin CGL. Seasonal incidence of maize fall armyworm *Spodoptera frugiperda* (JE Smith) (Noctuidae; Lepidoptera) in Perambalur district of Tamil Nadu, India. Journal of Entomology and Zoology Studies. 2020;8(3):1-4.
9. Lestari P, Swibawa IG, Fitriana Y, Suharjo R, Utomo SD, Hartaman M. The population dynamics of *Spodoptera frugiperda* after its invasion in Lampung Province, Indonesia. Journal of Tropical Plant Pest and Disease. 2024;24:98-108.
10. Nimbekar JM, Lande GK, Bhalkare SK. Population dynamics of fall armyworm (*Spodoptera frugiperda*) and its natural enemies on maize. In: Mohammad Khan Ebadi, Tekale VS, Sarnaik SD, editors. 2020. p. 44-60.
11. Luginbill P. The fall army worm. US Department of Agriculture; 1928.