Journal of Scientific Research and Reports

Volume 30, Issue 9, Page 358-368, 2024; Article no.JSRR.122457
ISSN: 2320-0227

Seasonal Patterns and Abiotic Influences on Fall Armyworm Dynamics in Chhattisgarh's Maize Agroecology

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.9734/jsrr/2024/v30i92359

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/122457

Original Research Article

Received: 19/06/2024
Accepted: 23/08/2024
Published: 31/08/2024

ABSTRACT

The fall armyworm *Spodoptera frugiperda* (J. E. Smith), an invasive pest in India, exhibits variations in population dynamics and incidence levels compared to its native regions. Understanding these variations is crucial for developing effective management strategies. Given India's diverse agroecosystems and climatic conditions, continuous watch on pest dynamics is essential. In this context a fixed plot experiment for comprehensive analysis of fall armyworm population dynamics,

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Cite as: *Manoj, Marella Sai, Kailash Chander Sharma, and R.K. Murali Baskaran. 2024. "Seasonal Patterns and Abiotic Influences on Fall Armyworm Dynamics in Chhattisgarh's Maize Agroecology". Journal of Scientific Research and Reports 30 (9):358-68. https://doi.org/10.9734/jsrr/2024/v30i92359.*

incidence patterns across seasons, and damage potentials in the maize crop ecosystem of the Chhattisgarh plains, India was conducted across three seasons of the year 2022-23. The year-round activity of the pest and its potential to cause huge losses in the early stages of maize was reported. Specifically, the study provided insights into the comparative incidence of fall armyworm in the different maize growing seasons of the area with a maximum incidence in the rainy season (0.58 larvae/plant) followed by winter (0.56 larvae/plant) and summer (0.53 larvae/plant) seasons. Moreover, the incidence trends of fall armyworm in different growing stages of maize were analysed by considering egg laying pattern, leaf damage, larval incidence and plant damage parameters, which highlighted the plant age-dependent response of fall armyworm. The impact of various weather parameters in shaping the damage and population fluctuations was analysed, where the influence of temperature was significant. Results obtained in this study are crucial in devising ETL levels and developing integrated pest management strategies against fall armyworm.

Keywords: Spodoptera frugiperda; seasonal incidence; population dynamics; weather parameters; integrated pest management.

1. INTRODUCTION

The invasive insect pest Fall armyworm (FAW), *Spodoptera frugiperda* (J. E. Smith), is native to the America and is known as the most economically damaging pest of maize in both native and invading countries [1]. Outside of its native range, it was reported for the first time in Western Africa in 2016, causing huge economic losses to the maize farming community [2]. In India, an official report of the pest was obtained in May 2018 from the south Indian state of Karnataka [3,4]. The subsequent spread of the pest continued to major maize-growing tracks of the country and transboundary countries, shedding a blanket loss of maize yields [5]. The yield losses across the various countries of Africa were estimated between 2.5 to 6.3 billion US dollars [6] and in the event of an outbreak, it has the potential to cause maize losses of 4.1 to 17.7 million tons valued at 1.1 to 4.7 billion US dollars [7]. However, there are no concrete studies on maize yield loss due to FAW in India. Based on preliminary studies, it is attributed to range between 33-36 % [8,9].

Fall armyworm infestation on maize ranges from 15 % to 100 % [10] in most South Indian states, and in central Indian states such as Chhattisgarh, it is reported to be 35%–70% [11]. The fall armyworm is a known threat to maize crops in warm and humid conditions [12,13], causing significant damage. In tropical countries, population incidence tends to vary according to the season, with the highest population buildup occurring during rainy seasons and the lowest during dry seasons [14]. Population fluctuations and the effect of abiotic factors on incidence are crucial in the development of management strategies. The population dynamics and incidence patterns of FAW have been extensively studied in the United States and African countries. In Indian conditions, studies conducted on the influence of weather parameters on FAW population establishment are meagre establishing a positive impact of warm humid conditions favourability for the pest establishment [15-17]. After a thorough look into the studies conducted it is known that, in India, most studies are concentrated in the southern part of the country and many concentrated studies are inevitable. Given the above, we undertook the study to investigate the population dynamics, incidence pattern, and damage of fall armyworm in the Central-East Indian state of Chhattisgarh during three seasons of the year 2022-23.

2. MATERIALS AND METHODS

Experiment site: The investigation was carried out in a completely randomised block design in an area of 500 m^2 in the rainy season 2022 (27 to 43 SMW), winter season 2022–23 (44 to 9 SMW), and summer season 2023 (9 to 22 SMW) at the Research farm, ICAR- National Institute of Biotic Stress Management (NIBSM), Raipur, Chhattisgarh, India, geologically positioned at a height of 295.5 meters from the mean sea level with precise coordinates of 21° 14' 55.8312'' N latitude and 81° 38' 24.324'' E longitude. The maize hybrid JKMH- 4222 was cultivated with a spacing of 60 x 20 cm, and all agronomic practices were followed as recommended, except for pest control measures.

2.1 Design of the Experiment

The total area of 500 m^2 was divided into 5 equal blocks of 100 m^2. The maize developmental

Table 1. Treatment details of three seasons of the year 2022-23

Treatment	Crop stage	Rainy season (27 - 43 SMW)	Winter season (44 – 9 SMW)	Summer season (9 – 22 SMW)
T_1	Early whorl stage (VE-V6)	July	November	February
T_2	Late whorl stage (V7- VT)	August	December	March
T_3	Tasselling to Milking stage (R1-R3)	September	January	April
T_4	Maturity stage (R4-R5)	October	February	May

SMW – Standard Meteorological Week

stages as given by Prasanna *et al.,* [18] were considered for recording the data. (Table 1). A randomized block design model was used by considering 4 maize growth stages as different treatments, and each 100 m^2 block serving as a replication.

2.2 Observations Recorded

Number of larvae per plant, egg mass per plant, and plant damage percentage were collected from each treatment at weekly intervals from 10 randomly selected plants of each replication by scouting in a 'W' pattern in the field. Leaf damage was recorded using a visual rating scale score of 1 to 9 by Ramirez et al. [19] Davis and Williams (modified by CIMMYT, Mexico). Percentage plant damage was assessed by considering the fresh damage of FAW observed on whorl leaves in the maize vegetative stage and silk/cob damage in the maturity stage as number of damaged leaves to total number of leaves in plant. The pooled weekly mean data of the observations from 50 plants (5 – replications) were taken to correlate with abiotic factors such as temperature, rainfall, and relative humidity collected from the Agrometeorological Unit, ICAR-NIBSM, Raipur, India.

2.3 Statistical Analysis

The collected data were subjected to one-way ANOVA using IBM SPSS 2.0 software after appropriate transformations, and the means were separated using Tukey's HSD. Correlation analysis was performed in R - program (4.3.2) Software for all the parameters recorded with temperature, rainfall, and relative humidity.

3. RESULTS AND DISCUSSION

3.1 Fall Armyworm Larval Population

The larval incidence in the Rainy season ranged from 0.1 to 1.72 larvae/plant. Among the different stages (treatments), the early whorl stage recorded a maximum larval population of 1.19 ± 0.09 (one-way ANOVA, F = 116.91, *df* = 3,12, *P* < .001, Tukey's HSD), after which the larval load gradually decreased in consecutive stages where the crop reached maturity. A slight increase in larval population was observed in the silking stage of the crop. Infestation in the maturity stage of the crop in October was almost negligible. In the case of the Winter season, larval infestation started 10 days after crop emergence. The population of FAW ranged from 0.08 to 1.32 larvae/plant in the Winter season, with maximum incidence in the early whorl stage of the crop (1.09 ± 0.05) (one-way ANOVA, F = 177.59, *df* = 3,12, *P* < .001, Tukey's HSD) in November, similar to the Rainy season. Similar trends were noticed in the summer crop where the larval population ranged from 0.02 to 1.18 larvae/plant with maximum incidence during the early whorl stage (1.05 ± 0.03) (one-way ANOVA, F = 150.27, *df* = 3,12, *P* < .001, Tukey's HSD) of the crop in 2 FN from February to March. The larval population was gradually reduced to crop maturity, with no infestation in the late maturity stage of the crop (Fig. 1; Table 2).

3.2 Egg-Laying Pattern of FAW

The egg mass/plant in the Rainy season was maximum in July (0.22 ± 0.01) followed by August (0.11 ± 0.02) (one-way ANOVA, F = 72.85, *df* = 3,12, *P* < .001, Tukey's HSD). Similarly, the difference in egg mass/plant in the Winter season was maximum in November (0.27 ± 0.03) followed by December (0.10 ± 0.01) months, which are the early and late whorl stages, respectively (one-way ANOVA, F = 42.62, *df* = 3,12 *P* < .001, Tukey's HSD). The egg pattern was similar to the previous two seasons continued in the summer season (early whorl 0.28 ± 0.02; late whorl stage 0.08 ± 0.01)

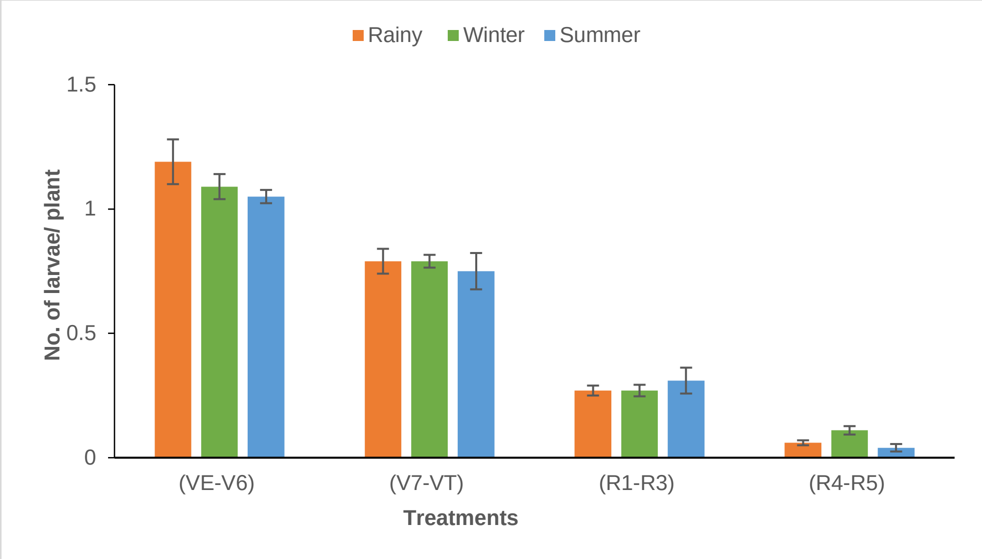

Fig. 1. FAW larval incidence in different seasons of 2022-23
VE-V6 – Early whorl stage; V7- VT – Late whorl stage; R1-R3 – Tasselling to Milking stage; R4-R5 – Maturity stage

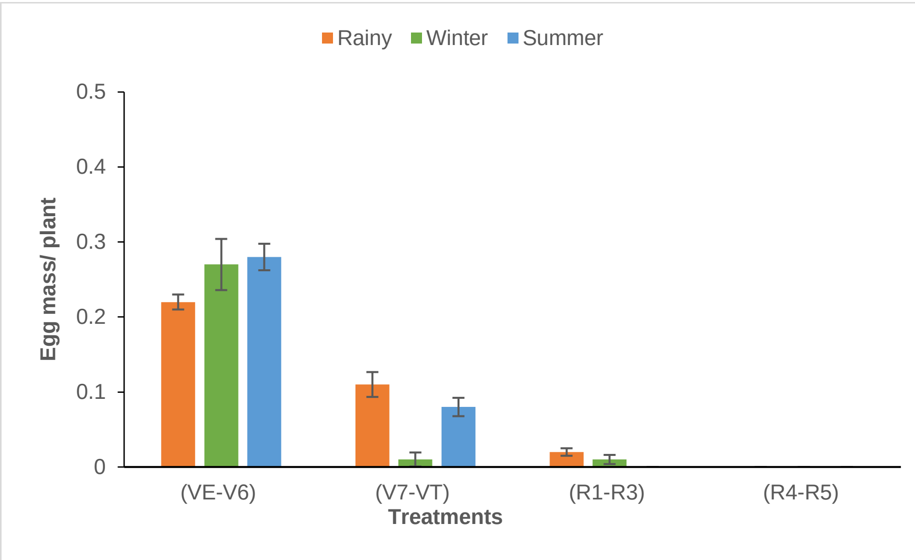

Fig. 2. FAW Egg laying pattern in different seasons of 2022-23
VE-V6 – Early whorl stage; V7- VT – Late whorl stage; R1-R3 – Tasselling to Milking stage; R4-R5 – Maturity stage

(one-way ANOVA, F = 152.42, *df* = 3,12, *P* < .001, Tukey's HSD) (Fig. 2; Table 2).

3.3 Leaf Damage Score

The leaf damage scores were maximum in the late whorl stage (V7-VT) of the crop in all three seasons investigated and were statistically different from the remaining months and stages of the crop. The maximum leaf damage in the Rainy season occurred in August (3.45 ± 0.18) (one-way ANOVA, F = 81.42, *df* = 3,12, *P* < .001, Tukey's HSD) followed by July (2.80 ± 0.02). In Winter season (one-way ANOVA, F = 80.57, *df* = 3,12, *P* < .001, Tukey's HSD) and Summer (one-way ANOVA, F = 85.72, *df* = 3,12, *P* < .001, Tukey's HSD), the maximum damage was recorded from December (3.38 ± 0.12) and March (3.56 ± 0.18), followed by November (2.29 ± 0.1) and February (2.8 ± 0.03), respectively (Fig. 3; Table 2).

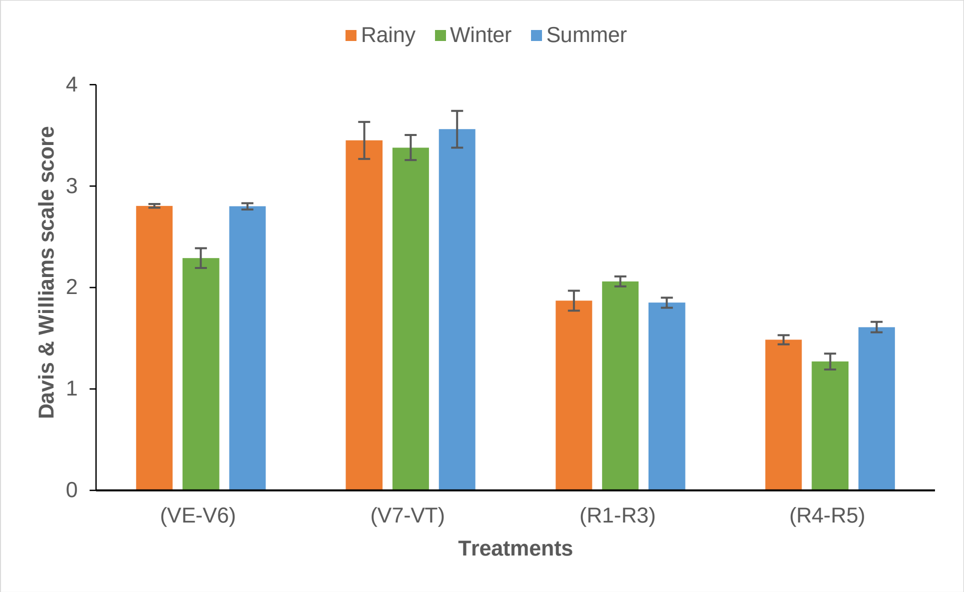

Fig. 3. Leaf damage of maize due to FAW in different seasons of 2022-23
VE-V6 – Early whorl stage; V7- VT – Late whorl stage; R1-R3 – Tasselling to Milking stage; R4-R5 – Maturity stage

3.4 Percentage of Plant Damage

In the initial two months (early and late whorl stages) of all seasons studied (July and August; November and December; February and March), there was a comparable percentage of plant damage that was not statistically significant. In subsequent months, relevantly significant variations have been noticed. Notably, in the Rainy season, peak infestation was observed during August (44.70 ± 3.01) (one-way ANOVA, F = 125.25, *df* = 3,12, *P* < .001, Tukey's HSD), November (39.80 ± 1.41) (one-way ANOVA, F = 198.16, *df* = 3,12, *P* < .001, Tukey's HSD) in Winter season and February (36.40 ± 0.68) (one-way ANOVA, F = 476.18, *df* = 3,12, *P* < .001, Tukey's HSD) in the summer season (Fig. 4; Table 2).

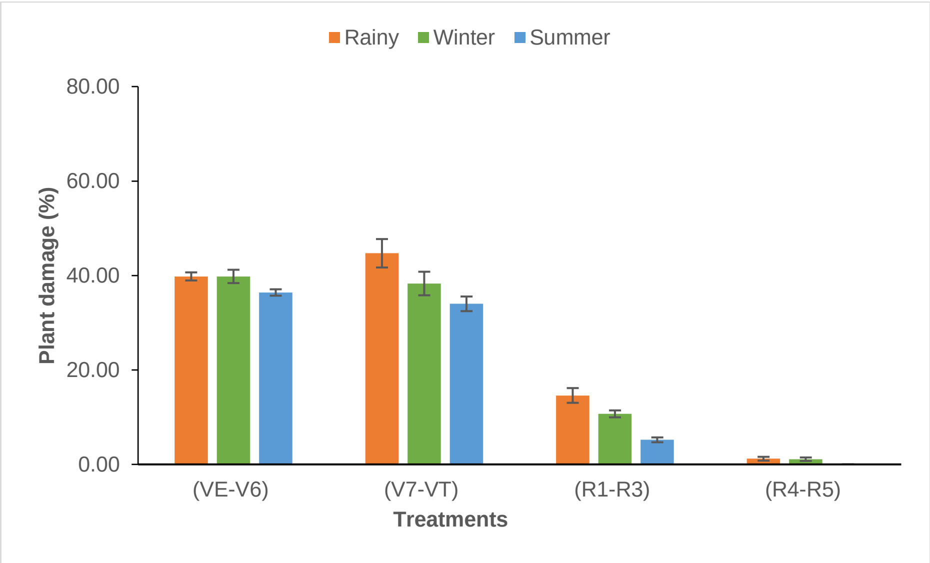

Fig. 4. Maize plant damage due to FAW in different seasons of 2022-23
VE-V6 – Early whorl stage; V7- VT – Late whorl stage; R1-R3 – Tasselling to Milking stage; R4-R5 – Maturity stage

Table 2. Population parameters of Fall armyworm in various seasons of Chhattisgarh plains during 2022-23

Crop stage	week	Rainy (27 - 43 SMW)				Winter (44 – 9 SMW)				Summer (9 – 22 SMW)			
		*Egg mass/plant	*No. of larvae/plant	*Leaf damage score	*Per cent plant damage	*Egg mass/plant	*No. of larvae/plant	*Leaf damage score	*Per cent plant damage	*Egg mass/plant	*No. of larvae/plant	*Leaf damage score	*Per cent plant damage
VE - V6	1	0.14(0.05)	0.42 (0.12)	1.3 (0.33)	12.8 (1.60)	0.28(0.12)	0.58 (0.12)	1.44 (0.10)	20 (5.22)	0.22(0.07)	0.7 (0.35)	1.28 (0.32)	28.4 (4.45)
	2	0.22(0.07)	1.12 (0.35)	2.22 (0.40)	44.4 (5.99)	0.34(0.17)	1.26 (0.26)	1.92 (0.31)	44 (5.51)	0.3 (0.11)	1 (0.11)	2.08 (0.43)	35.6 (3.44)
	3	0.28(0.04)	1.48 (0.21)	3.56 (0.62)	48 (3.35)	0.3 (0.13)	1.32 (0.04)	2.72 (0.50)	49.6 (11.13)	0.28(0.12)	1.18 (0.15)	3.56 (0.62)	40 (6.07)
	4	0.22(0.04)	1.72 (0.22)	4.14 (0.22)	54 (6.07)	0.14(0.08)	1.2 (0.09)	3.08 (0.32)	45.6 (11.34)	0.3 (0.06)	1.3 (0.31)	4.3 (0.21)	41.6 (4.27)
#Mean		0.22(0.05)	1.19 (0.49)	2.80 (1.11)	39.8 (15.96)	0.27(0.08)	1.09 (0.3)	2.29 (0.65)	39.8 (11.61)	0.28(0.03)	1.05 (0.23)	2.80 (1.19)	36.4 (5.11)
V7 - VT	1	0.2 (0.09)	1.18 (0.16)	4.02 (0.45)	54.8 (4.12)	0.14(0.08)	1.06 (0.08)	4.86 (0.34)	45.6 (6.25)	0.1 (0.06)	1 (0.11)	4.84 (0.96)	47.2 (7.65)
	2	0.12(0.04)	0.92 (0.20)	3.96 (0.48)	53.2 (6.88)	0.12(0.07)	0.92 (0.07)	3.6 (0.57)	46.8 (6.52)	0.12(0.07)	0.78 (0.13)	4 (0.63)	43.2 (2.04)
	3	0.06(0.05)	0.68 (0.07)	3.16 (0.38)	38.8 (11.29)	0.08(0.040	0.62 (0.16)	2.64 (0.48)	34.8 (8.82)	0.06(0.05)	0.62 (0.19)	3.4 (0.54)	22.8 (4.12)
	4	0.04(0.08)	0.36 (0.12)	2.66 (0.88)	32 (9.72)	0.04(0.05)	0.54 (0.10)	2.42 (0.16)	26 (8.10)	0.04(0.05)	0.58 (0.29)	2 (0.09)	22.8 (6.52)
#Mean		0.11(0.06)	0.79 (0.3)	3.45 (0.57)	44.7 (9.62)	0.1 (0.04)	0.79 (0.21)	3.38 (0.96)	38.3 (8.50)	0.08(0.03)	0.75 (0.17)	3.56 (1.04)	34 (11.29)
R1 - R3	1	0.04(0.05)	0.42 (0.04)	2.22 (0.20)	14.8 (2.71)	0.02(0.04)	0.32 (0.040	2.38 (0.44)	10 (2.19)	0 (0.00)	0.46 (0.21)	2.06 (0.29)	10.4 (2.94)
	2	0 (0.00)	0.28 (0.10)	2.14 (0.63)	16.4 (4.27)	0.02(0.04)	0.3 (0.00)	2.18 (0.21)	11.6 (2.94)	0 (0.00)	0.42 (0.21)	1.94 (0.33)	6.4 (1.50)
	3	0.04(0.05)	0.24 (0.10)	1.64 (0.42)	12 (4.38)	0.02(0.04)	0.24 (0.08)	1.92 (0.53)	9.2 (3.71)	0 (0.00)	0.18 (0.07)	1.82 (0.32)	0 (0.00)
	4	0 (0.00)	0.14 (0.05)	1.48 (0.13)	15.2 (6.76)	0 (0.00)	0.2 (0.09)	1.76 (0.56)	12 (4.20)	0 (0.00)	0.16 (0.08)	1.6 (0.18)	4 (2.83)
#Mean		0.02(0.02)	0.27 (0.1)	1.87 (0.32)	14.6 (1.61)	0.02(0.01)	0.27 (0.05)	2.06 (0.24)	10.7 (1.14)	0.00	0.31 (0.14)	1.85 (0.17)	5.2 (3.77)
R4 - R5	1	0 (0.00)	0.1 (0.00)	1.54 (0.08)	1.6 (1.50)	0 (0.00)	0.2 (0.09)	1.32 (0.31)	1.6 (1.50)	0 (0.00)	0.08 (0.07)	1.74 (0.32)	0 (0.00)
	2	0 (0.00)	0.1 (0.00)	1.6 (0.20)	3.2 (2.40)	0 (0.00)	0.16 (0.05)	1.2 (0.13)	2.4 (1.96)	0 (0.00)	0.02 (0.04)	1.56 (0.14)	0 (0.00)
	3	0 (0.00)	0.04 (0.05)	1.54 (0.19)	0 (0.00)	0 (0.00)	0.08 (0.07)	1.28 (0.19)	0 (0.00)	0 (0.00)	0.04 (0.05)	1.68 (0.15)	0 (0.00)
	4	0 (0.00)	0 (0.00)	1.26 (0.08)	0 (0.00)	0 (0.00)	0 (0.00)	1.3 (0.22)	0.4 (0.80)	0 (0.00)	0 (0.00)	1.48 (0.13)	0 (0.00)
#Mean		0 (0.00)	0.06 (0.04)	1.48 (0.13)	1.2 (1.33)	0 (0.00)	0.11 (0.08)	1.27 (0.05)	1.1 (0.95)	0 (0.00)	0.04 (0.03)	1.61 (0.1)	0 (0.00)
Overall Mean		0.09 (0.08)	0.58 (0.44)	2.4 (0.77)	25.08 (17.90)	0.09 (0.11)	0.56 (0.39)	2.25 (0.75)	22.48 (16.93)	0.09 (0.11)	0.53 (0.39)	2.46 (0.78)	18.9 (16.43)
F value		72.89	116.91	81.42	125.25	42.62	177.59	80.57	198.16	154.42	150.27	85.72	476.18
C.V value		29.53	18.2	9.21	16.47	43.64	13.51	9.61	13.81	26.07	15.36	8.82	10.28
C.D @ 1 %		0.04	0.2	0.42	7.97	0.08	0.14	0.41	4.27	0.04	0.15	0.41	2.67
F - test		Significant	Significant	Significant	Significant	Significant	Significant	Significant	Significant	Significant	Significant	Significant	Significant
S.E (d)		0.01	0.06	0.42	2.61	0.02	0.04	0.13	1.96	0.11	0.05	0.13	1.22

*Values in the parenthesis are Standard Deviation (S.D); *Mean of 50 plants observed; # Treatment wise / Month wise mean.*

Upon examining the levels of incidence across all three seasons – Rainy season, Winter season, and Summer – it became evident that the highest incidence occurred during the Rainy season, followed by Winter and Summer seasons. The elevated incidence during the rainy season can be attributed to increased sunlight and heightened photosynthesis rates, resulting in abundant food availability for fall armyworm larvae. This finding is consistent with prior researches [15,20,21]. In contrast, during the Winter and Summer seasons, the incidence rates were comparatively lower because of the influence of minimal and maximum temperatures, respectively. We also observed an increase in natural enemy activity during the Winter season, reducing fall armyworm incidence. The fluctuations in larval population across different seasons displayed a consistent pattern, with the maximum larval load observed during the early whorl stage (VE-V6) of the crop. Management actions are best advised to control the substantial vegetative losses in this stage of the crop. Subsequently, larval numbers gradually decreased, reaching their lowest levels during the crop maturity stages. Although a minor peak in the larval population occurred during the silking stage, the infestation rate remained relatively low during this phase. The late-stage damage to maize was mostly observed on the corn cobs rather than the foliage, resulting in almost negligible leaf damage during the maize cob development stage. These findings align with the previous reports [20], who noted a similar trend in fall armyworm population dynamics. Specifically, they observed that the maximum population of fall armyworms occurred during the early whorl stage of maize in both the Rainy and Winter seasons. Furthermore, the absence of moth catches per trap record after the dough stage of the crop in Karnataka during 2019 and 2020 corroborates our observations. Study conducted in Argentina [22] also observed multiple larvae in younger plants and single older larvae per plant in the late stages of crop production. The FAW egg laying on maize recorded a clear preference for the early stages of crop production was evident from maximum egg deposition. This choice of FAW for the early stages of maize crop can be attributed to the maximum availability of tender and soft leaves, facilitating the least adversity to emerging neonates [23]. Our findings align with existing researches [24] suggesting a correlation between egg-laying preference and the volatile profile of damaged leaves. Consistent with this, we observed maximum leaf damage in maize during the early stages of the crop. This trend suggests that egg laying and huge damage in the early stage of the crop by fall armyworm are complementary. However, few studies concludes that FAW moths attract undamaged maize plants rather than herbivore-damaged plants via volatile emissions [25]. The ovicidal and neem extracts are the best recommended at this early stage of the crop. In observing leaf damage readings of all three seasons, maize leaves reported the maximum leaf damage in the late whorl stage (V6 – V7), with subsequent damage in the early whorl stage (VE-V6) of the crop. FAW larvae are heavy defoliators of vegetative matter, reducing photosynthesis in late instars compared with early instars [26]. Notably, the prevalence of late instar larvae from the late whorl stage of maize was recorded, where they inflicted substantial damage to whorls, consuming huge amounts of plant matter and resulting in heavy leaf damage in this stage. Similar studies have pronounced our present observation of high leaf damage in the late whorl stage recording the total plant matter consumed by FAW was more in the 3 - 4 stage of maize than in the 1–2 stages [27]. In addition, we observed minimal damage to plant foliage after the Tasselling stage, a phenomenon likely attributed to larval preference for developing silk and cob over mature foliage during this stage [28]. On the other hand, plant damage revealed that both the early and late whorl stages exhibited maximum damage without any significant difference, surpassing damage incurred during later stages of crop development. This can be due to the greater dispersal of fall armyworm larvae during their early instar stages compared with the late stages [29] posing more sensitivity of maize crop to damage [30,31]. We strongly suggest that the reproductive stage of the maize crop was comparatively less susceptible to FAW, although the minimal damage in the reproductive stage of maize causes economic losses, the maximum incidence is concentrated in early stage of the crop. Studies conducted on damage potentials of FAW in reproductive stages like silking and tasselling recorded 25% – 50% respectively [32] with infestation rates of 49.20% [33].

3.5 Correlation between FAW Infestation and Abiotic Factors

The correlation of the weekly mean larval population with different abiotic factors revealed that the larval population has a positive correlation with the weekly mean of maximum and minimum temperature separately in the

Rainy season (max. temp, r = 0.05; min. temp, r = 0.49*) and Winter season (max. temp, r = 0.82**), except for minimum temperature in Winter season (r = 0.51*), while a significant negative correlation was recorded in the case of summer season (max. temp, r = 0.81**; min. temp, r = 0.83**). The damage parameters (leaf and plant) and egg mass data collected exhibited positive correlations with the weekly larval population of FAW across the seasons. The data on egg mass/plant had a significant negative correlation with temperature in the summer season (max. temp, r = 0.67**; min. temp, r = 0.81**) and a significant positive correlation with various FAW parameters in all seasons except for leaf damage in Winter season and Summer. The leaf damage score when correlated with weather parameters showed a significant negative correlation with maximum temperature as noticed in the Winter season (r = 0.59*) and Summer (r = 0.53*) seasons. The correlation between the FAW larval population and plant damage was significantly positive. The percentage of plant damage showed a significant positive correlation with minimum temperature in the Rainy season (r = 0.51*) and a significant negative correlation with both maximum (r = 0.67**) and minimum temperatures (r = 0.76**) in the summer. In addition, morning relative humidity (r = 0.57*) was significantly positively correlated with summer (Fig. 5).

In the assessment of weather parameters on the incidence and damage by FAW, the effect was generally modest, except for temperature, which exhibited a notable impact on FAW dynamics and damage to maize. The effect of temperature on FAW developmental factors was well-studied and concretely reported [34,19]. Our present findings align with the investigations conducted in south Indian conditions [1,35,36] where a positive correlation was observed between FAW larval load on maize and temperature during both the Rainy and Winter seasons of India. This might be attributed to the accumulation of more photosynthates in response to rising temperatures [37], maximizing the green matter availability to FAW larvae in maize during the rainy and winter seasons. In contrast to the pattern observed in the Rainy and Winter seasons, the summer temperature harmed the larval population, egg mass counts, and leaf/plant damage. This divergence can be attributed to the adverse temperature during the summer season, which surpasses the optimal developmental temperature range of 18 °C to 30 °C for FAW [38]. With this, it can be concluded that temperature is a primary influential weather parameter of FAW population dynamics and damage potential across seasons. Despite occasional reports [39,17] on the influence of rainfall and relative humidity, their impact remains marginal compared with the pronounced effect of temperature in our observation.

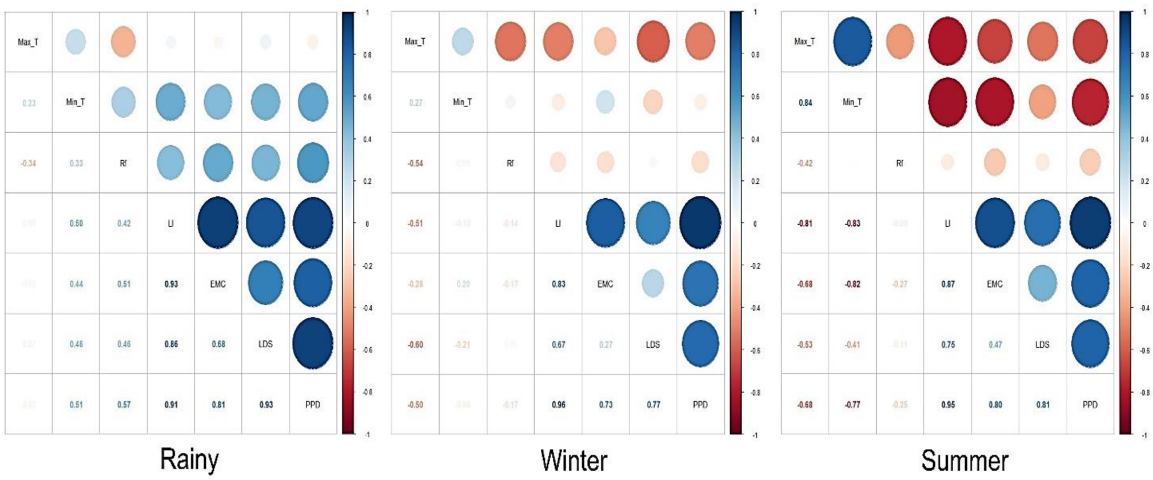

Fig. 5. Influence of abiotic factors on FAW dynamics in different seasons of the year 2022-23
Max_T - Maximum Temperature; Min_T - Minimum Temperature; Rf - Rainfall; LI - Larval Incidence; EMC – Egg Mass Count; LDS - Leaf Damage Score; PPD - Percent Plant Damage

4. CONCLUSION

Overall, this study highlighted the significant infestation pattern of FAW across different seasons, in the early stages of maize crop being more vulnerable to damage by FAW. The FAW preference for maize crop damage established a plant age-dependent response in which the phenological stage of the crop played a pivotal role. Among the seasons, the Rainy season was proved to have a higher incidence of FAW. The correlations studied reinforced the crucial effect of temperature on FAW infestation patterns and damage. These findings are promising foundations for location-specific forecasting models and in formulating effective managing strategies, and contribute to the growing body of literature on FAW biology and behavioural studies.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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