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Seasonal abundance of insect pests and natural enemies in maize (*Zea mays* L.) influenced by weather parameters

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Abstract

A field experiment was conducted during *rabi* 2025–26 at the Agricultural Research Station (ARS), Tornala, Siddipet District, Telangana to study the seasonal incidence of major insect pests and natural enemies of maize (*Zea mays* L.) in relation to prevailing weather parameters. The maize hybrid DHM-117 was grown under natural field conditions without plant protection measures and weekly observations on incidence were recorded on fall armyworm (*Spodoptera frugiperda*), pink stem borer (*Sesamia inferens*), aphids (*Rhopalosiphum maidis*), coccinellids and spiders. Fall armyworm infestation reached peak during the 52nd SMW with 6.40 larvae/ 10 plants with 52.00% plant infestation. Pink stem borer recorded its maximum incidence during 51st SMW with 4.60 larvae /plant and 32.00% dead hearts. Aphids first appeared during the 1st SMW and attained a peak density of 45.80 no.cm⁻² leaf area during 3rd SMW. Among natural enemies, coccinellids and spiders peaked during 52nd SMW and 50th SMW with 4.2 and 1.00 no./plant, respectively. Correlation analysis revealed that fall armyworm and pink stem borer populations showed strong negative correlation with maximum temperature ($r = -0.76^*$ & -0.69^*), minimum temperature ($r = -0.81^*$ & -0.79^*). In contrast, aphids exhibited positive and non-significant correlation with weather parameters.

Keywords: Maize, fall armyworm, pink stem borer, aphids, coccinellids, spiders, weather parameters, seasonal incidence, correlation

1. Introduction

Maize (*Zea mays* L.), popularly known as the "Queen of Cereals", belongs to the family Poaceae (Gramineae) and is one of the most important cereal crops cultivated worldwide for food, feed and industrial purposes. Among cereal crops, maize ranks third after rice and wheat and serves as a staple food for a substantial proportion of the world's population (Chaudhary *et al.*, 2014) [4]. Owing to its high genetic yield potential, adaptability to diverse agro-climatic conditions and wide range of end uses, maize has become an indispensable crop in global agriculture. Globally, maize is cultivated over an area of approximately 206.9 million hectares with a production exceeding 1.23 billion tonnes, making it the leading cereal in terms of total production (FAOSTAT- 2024) [12].

In India, maize occupies about 10.8 million hectares with an annual production of nearly 38.1 million tonnes and an average productivity of 3.5 t ha⁻¹ (Directorate of Economics and Statistics, 2024) [11]. The major maize-producing states in India include Karnataka, Madhya Pradesh, Bihar, Telangana, Maharashtra, Andhra Pradesh, Rajasthan, Tamil Nadu and Uttar Pradesh, which together contribute a major share of the national production.

However, its productivity is considerably affected by several biotic and abiotic constraints, particularly insect pests, which infest the crop from seedling emergence to harvest. More than 250 insect species have been reported feeding on maize, although only a limited number are considered economically important and capable of causing severe yield losses under favourable conditions (Mathur, 1992; Siddiqui and Marwaha, 1994) [18, 28]. In recent years, the invasive fall armyworm, *Spodoptera frugiperda* (J.E. Smith), has emerged as one of the most destructive pests of maize in India and many other countries, causing significant economic losses (Sharanabasappa *et al.*, 2018; Deshmukh *et al.*, 2022) [27, 9]. Besides fall armyworm, pests such as pink stem borer (*Sesamia inferens*) and aphids also cause considerable damage to maize, particularly during the *rabi* season.

Weather parameters play a crucial role in regulating the seasonal abundance and population dynamics of insect pests and their natural enemies by influencing their development, survival, reproduction, dispersal and feeding behaviour (Karuppaiah and Sujayanad, 2012) ^[16]. Variations in temperature, relative humidity, rainfall and other climatic factors associated with climate change are expected to alter pest incidence and their interactions with natural enemies, thereby influencing crop productivity (IPCC, 2023; Deutsch *et al.*, 2018) ^[14, 10]. Understanding the relationship between weather parameters and pest population dynamics is therefore essential for forecasting pest outbreaks and developing effective integrated pest management strategies.

2. Materials and Methods

A field experiment was conducted at the Agricultural Research Station (ARS), Tornala, Siddipet District, Telangana, during *rabi* 2025–26 to study the seasonal incidence of insect pests and natural enemies of maize in relation to meteorological factors. The maize hybrid DHM-117 was sown in an area of 300 m² at a spacing of 60 × 20 cm² by following the recommended package of practices under natural field conditions without adopting any plant protection measures.

The experimental area was divided into five equal quadrates, insect pest and natural enemies were recorded at each standard week on 15 randomly selected plants in each quadrate. Data on fall armyworm were recorded by counting larval population (no./plant), plant infestation (%) and cob damage (%), while incidence of pink stem borer expressed as larval population (no./plant) and dead hearts (%), aphids (No./cm² leaf area), natural enemies (no./plant). The simple correlation coefficients between insect pests, natural enemies and weather parameters were worked out using OPSTAT statistical software.

Results and Discussion

During the study period insect pests *viz.*, fall armyworm (*Spodoptera frugiperda*), aphid (*Rhopalosiphum maidis*), pink stem borer (*Sesamia inferens*), lady bird beetle (Coccinellids) and spiders were observed at different crop growth stages are presented along with their correlation coefficients in Table 1 and Fig.1.

Incidence of Fall armyworm (*Spodoptera frugiperda*)

The infestation of fall armyworm initiated during the 49th (SMW) with 3.20 (larvae/10 plants) mean larval population and 25.00% plant infestation. The larval population increased gradually and reached its peak during the 52nd SMW with 6.40 larvae/ 10 plants with the highest plant infestation (52.00%). Cob damage appeared during the 5th SMW (2.67%), reached a maximum of 14.67% during 7th SMW, and declined thereafter. Similar trends of peak infestation during the vegetative stage followed by a gradual decline have also been reported by Sharanabasappa *et al.* (2018) ^[27], Deshmukh *et al.* (2020) ^[9], and Sisodiya *et al.* (2022) ^[32]. Correlation analysis revealed a significant negative association with maximum temperature ($r = -0.76$), minimum temperature ($r = -0.81$), morning relative humidity ($r = -0.72$), and afternoon relative humidity ($r = -0.61$), whereas the associations with rainfall ($r = -0.26$) and sunshine hours ($r = 0.06$) were non-significant. These findings are in agreement with Sisodiya *et al.* (2022) ^[32].

Pink stem borer (*Sesamia inferens*)

The occurrence of pink stem borer was first recorded during the 49th SMW with a mean larval population and dead hearts of 0.40 no./plant and 5.00%, respectively. Larval numbers increased gradually and attained its maximum at 51st SMW with 4.60 larvae/plant and highest dead heart incidence (32.00%). Pink stem borer incidence indicated a significant negative association with maximum temperature ($r = -0.69$), minimum temperature ($r = -0.79$), morning relative humidity ($r = -0.62$) and afternoon relative humidity ($r = -0.62$), while rainfall ($r = -0.18$) and sunshine hours ($r = 0.21$) showed non-significant associations. Similar trends of peak infestation during the vegetative stage followed by a gradual decline with crop maturity have been reported by Kumar and Reddy (2018) ^[17] and Patel *et al.* (2021) ^[33].

Aphids (*Rhopalosiphum maidis*)

The incidence of aphids started during the 1st SMW with density of 10.00 aphids/cm² leaf area. The population gradually increased to a maximum of 45.80 numbers/ cm² during the 3rd SMW. Correlation analysis revealed a non-significant positive association with maximum temperature ($r = 0.02$), minimum temperature ($r = 0.14$) and morning relative humidity ($r = 0.24$), whereas afternoon relative humidity ($r = -0.17$), rainfall ($r = -0.19$), and sunshine hours ($r = -0.20$) showed non-significant negative associations. Similar observations were reported by Patel *et al.* (2020) ^[21] and Singh and Kumar (2021) ^[29]. Environmental conditions. Similar observations were also reported by van Emden and Harrington (2017) ^[13].

Coccinellids (Ladybird beetles)

The population of coccinellids was noticed during the 49th SMW with a mean population of 3.00 no./plant. The population increased slowly and attained its peak during the 52nd SMW, recording 4.20 no./plant. Correlation analysis revealed a significant negative association with maximum temperature ($r = -0.52$) and minimum temperature ($r = -0.52$), while a significant positive association was observed with morning relative humidity ($r = 0.66$). These results indicate that temperature and morning relative humidity played an important role in influencing the population of ladybird beetles. Similar trends in the seasonal abundance of coccinellids have been reported by Patel *et al.* (2020) ^[21] and Singh *et al.* (2021) ^[29].

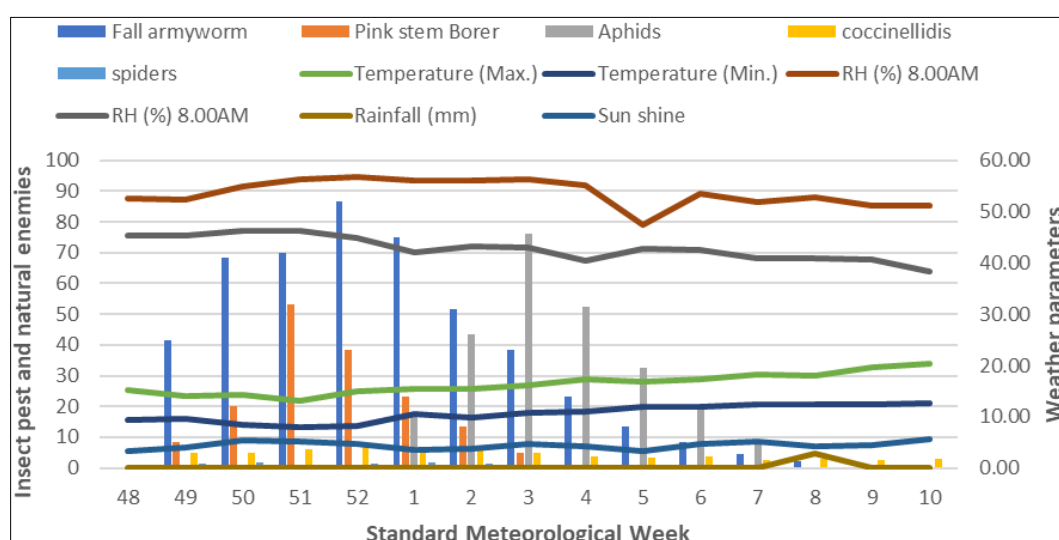
Spiders

Spiders were recorded during the 49th SMW with a mean population of 0.75 spiders/plant. The population increased gradually and reached its peak during the 50th SMW, recording 1.00/plant. The increase in spider population may be attributed to the higher availability of insect prey during the crop growth period. Correlation analysis showed a significant negative association with maximum temperature ($r = -0.72$), minimum temperature ($r = -0.73$), morning relative humidity ($r = -0.68$), and afternoon relative humidity ($r = -0.56$), whereas rainfall ($r = -0.25$) and sunshine hours ($r = -0.01$) exhibited non-significant associations. These findings suggest that temperature and relative humidity significantly influenced spider abundance, while rainfall and sunshine hours had little effect during this period. Similar, seasonal trends in spider abundance have been reported by Riechert and Lockley (1984) ^[34] and Nyffeler and Sunderland (2003) ^[19].

Table 1: Incidence of insect pest and natural enemies in maize along with weather parameters during *rabi*,2025-26

SMW	Fall army worm			Pink stem borer		Aphids (No./cm ²)	Coccinellids (No. / plant)	Spiders (No. / plant)	Temperature (°C)		RH (%)		Rainfall (mm)	Sun shine (Hrs)
	Larval population (No./10 plant)	Plant infestation (%)	Cob damage (%)	Larval population (No./plant)	Dead heart (%)				Max.	Min.	8.00 AM	2.00 PM		
48	0.00	0.00	0.00	0.0	0.0	0.00	0.00	0.00	25.40	15.60	87.70	75.40	0.00	5.60
49	3.20	25.00	0.00	0.4	5.0	0.00	3.00	0.75	23.40	15.80	87.30	75.70	0.00	6.70
50	4.40	41.00	0.00	0.8	12.0	0.00	3.00	1.00	23.60	14.10	91.60	77.00	0.00	8.90
51	4.60	42.00	0.00	4.6	32.0	0.00	3.60	0.50	22.00	13.30	93.70	77.30	0.00	8.50
52	6.40	52.00	0.00	3.4	23.0	0.00	4.20	0.75	25.00	13.70	94.50	74.60	0.00	7.80
1	5.20	45.00	0.00	2.2	14.0	10.00	4.00	1.00	25.70	17.40	93.60	70.30	0.00	5.80
2	3.80	31.00	0.00	1.2	8.0	26.00	4.00	0.75	25.90	16.50	93.60	72.10	0.00	6.40
3	3.10	23.00	0.00	0.4	3.0	45.80	3.00	0.50	27.00	17.90	93.90	71.70	0.00	8.00
4	2.20	14.00	0.00	0.0	0.0	31.40	2.20	0.25	28.90	18.40	91.90	67.30	0.00	6.90
5	1.50	8.00	2.67	0.0	0.0	19.60	2.00	0.00	28.10	19.70	78.90	71.40	0.00	5.50
6	0.80	5.00	6.67	0.0	0.0	12.00	2.20	0.00	28.80	20.00	89.30	71.00	0.00	7.90
7	0.00	2.70	14.67	0.0	0.0	5.00	1.60	0.00	30.40	20.80	86.60	68.30	0.00	8.50
8	0.00	1.30	8.00	0.0	0.0	0.00	1.80	0.00	30.20	20.70	88.00	68.30	4.60	7.20
9	0.00	0.00	1.33	0.0	0.0	0.00	1.60	0.00	32.70	20.50	85.40	67.60	0.00	7.30
10	0.00	0.00	0.00	0.0	0.0	0.00	1.80	0.00	34.00	21.00	85.30	64.00	0.00	9.30

*SMW= Standard Meteorological Week

**Fig 1:** Correlation coefficient of insect pest and natural enemies in maize along with weather parameters during *rabi*,2025-26

Conclusion

The present study revealed that the seasonal incidence of major insect pests and natural enemies in maize was influenced by prevailing weather conditions during the *rabi* season. Fall armyworm, pink stem borer and aphid populations exhibited distinct seasonal fluctuations, while coccinellids and spiders were the predominant natural enemies. Correlation analysis indicated that maximum temperature, minimum temperature and evaporation had a significant negative influence on fall armyworm, pink stem borer and spider populations, whereas relative humidity showed a positive association with most pests and natural enemies. The findings provide useful information for timely pest monitoring and developing effective integrated pest management strategies in maize.

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