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Epidemiology of *Spodoptera litura* in groundnut fields

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Abstract
A field study was conducted during *Kharif* 2023 and 2024 at the Main Oilseeds Research Station, Junagadh Agricultural University, to assess the epidemiology of *Spodoptera litura* in groundnut and its relationship with weather parameters. Weekly observations were recorded from crop emergence to harvest. To study the influence of various abiotic factors on pest incidence, a simple correlation and multiple linear regression analysis were worked out between the *S. litura* population and weather parameters. The results showed that *S. litura* infestation commenced three to four weeks after sowing, peaked between late August and mid-September and declined by the end of October in both years. Correlation analysis indicated that maximum temperature was significantly negatively correlated with *S. litura* population, while morning and evening relative humidity and rainfall had significant positive correlations. Multiple linear regression analysis revealed that weather factors accounted for 96.80% and 88.90% of the variation in *S. litura* population during 2023 and 2024, respectively.

Keywords: Correlation, epidemiology, groundnut, regression analysis, *Spodoptera litura*

1. Introduction
Groundnut (*Arachis hypogaea* Linnaeus) is a leguminous oilseed crop and belongs to South America as the cultivation of groundnut has been originated from South-America. Being a fourth most important oilseeds in the world, it is considered as a 'King of Oilseeds'. It is largest source of edible oil along with thirteenth rank among the food crops in the world (Ramanathan, 2001) [11]. India ranks second in the world in area (47.85 lakh hectares) and production (10.18 million tonnes). Among the Indian states, Gujarat stands first in area coverage with 19.17 lakh ha and production with 46.44 lakh tons (Anon., 2024) [2].
Among the limitations that prevents the groundnut from reaching its full potential, severe losses done by insect pests are considered as one of the major constraints of groundnut production in India (Singh, 1980) [15]. In India, more than one hundred species of insects have been reported on groundnut (Amin, 1988). Among the different insect pests infesting this crop in Gujarat, the tobacco caterpillar *S. litura* is considered as the key pest as its polyphagous nature and the prevailing favourable climate, it occurs throughout the year (Singh and Jalali, 1996) [14].
S. litura is reported to feed on 150 species of plants (Rao *et al.*, 1993) [12] causing 30-40% loss in pod formation (Joshi, 2005) [7] under field conditions. The larvae of *S. litura* start eating leaves along the midrib and proceed gradually to the margins (Ghewande and Nandagopal, 1997) [5]. The grownup larvae feed are voracious feeders and completely defoliates plants under severe infestations. The freshly hatched larvae feed gregariously on the leaf and food voraciously during night hours (Solanki *et al.*, 2022) [16].
Any insect's ability to survive, reproduce and grow is mostly influenced by the environment, host availability and natural enemy activity. Weather conditions have an impact on insect life cycles, reproduction and outbreaks (Pedigo, 2004) [9]. Insects are highly sensitive to climate conditions such as temperature, humidity, rainfall and wind speed, which can significantly influence their development, behavior and distribution. And abrupt modifications to these abiotic variables have a negative impact on insect population dynamics (Prasad and Logiswaran, 1997) [10]. Predicting outbreaks, improving pest control techniques and guaranteeing the sustainable production of groundnuts in the face of shifting climatic circumstances all depend on an understanding of how these meteorological elements interact with pest dynamics for predicting outbreaks, optimizing pest management strategies and ensuring the sustainable cultivation of groundnuts in the face of changing climatic conditions.

2. Materials and Methods

In order to study the population dynamics of *S. litura* in groundnut, the crop was sown at Main Oilseeds Research Station, Junagadh Agricultural University, Junagadh during *kharif*, 2023 and 2024. The crop was grown in plot size of 20 m × 20 m keeping 45 cm × 10 cm spacing between row to row and plant to plant. Plot was divided into 30 equal quadrates of size 0.9 m × 1 m. All the other agronomical operations were adopted as per the recommendations. The crop under the experiment was kept free from pesticides throughout the season. The observations on number of larvae of *S. litura* were recorded from one week after germination to the harvest of the crop at weekly interval on five randomly selected plants from each quadrate. Mean population of *S. litura* larvae per plant was worked out separately. To study the influence of various abiotic factors on pest incidence, a simple correlation and multiple linear regression analysis were worked out between the *S. litura* population and weather parameters (abiotic factors) (Gomez and Gomez, 1984) [6].

3. Results and Discussion

3.1 Incidence of *S. litura* in groundnut during 2023 and 2024

The incidence of *S. litura* in groundnut was monitored during *Kharif* 2023 and 2024 with *S. litura* population closely associated with prevailing meteorological conditions (Table 1). In 2023, *S. litura* infestation commenced in the last week of July (31st SMW), approximately three weeks after sowing and gradually increased, peaking at 4.00 larvae/plant during the 38th SMW (third week of September) followed by a consistent decline, reaching the lowest population of 0.60 larvae/plant in the 42nd SMW (third week of October) after which the pest disappeared. In 2024, infestation started in the 31st SMW (fourth week of July) about four weeks after sowing, peaking initially at 5.40 larvae/plant during the 35th SMW (fourth week of August). After a decline, a secondary peak of 3.50 larvae/plant was recorded in the 39th SMW (fourth week of September) then population started declining and reached 0.50 larvae/plant in the 42nd SMW with the pest population disappearing by the end of October.

Table 1: Incidence of *S. litura* in Groundnut during 2023 and 2024

Sr. No.	SMW	Month	Larvae/plant	
			2023	2024
1	31	July	0.57	0.50
2	32	August	1.60	1.70
3	33		2.59	2.48
4	34		3.00	3.51
5	35		2.00	5.40
6	36	September	1.19	3.40
7	37		1.42	2.30
8	38		4.00	1.10
9	39		2.10	3.50
10	40	October	1.30	1.97
11	41		1.01	0.89
12	42		0.60	0.50
13	43		0.00	0.00
Note: SMW: Standard Meteorological Week				

3.2 Correlation Coefficient of *S. litura* with different abiotic factors during 2023 and 2024

To establish a quantitative relationship between *S. litura* population and weather variables, simple correlation analysis was conducted between weekly *S. litura* incidence and key abiotic factors (Table 2). During *Kharif* 2023, the population of *S. litura* showed a significant negative correlation with maximum temperature (r = -0.568*) and significant positive correlations with morning humidity (r = 0.680*), evening humidity (r = 0.639*) and rainfall (r = 0.588*), while correlations with minimum temperature (r = 0.550), wind speed (r = 0.353) and sunshine hours (r = -0.544) were non-significant. Similarly, in 2024, maximum temperature had a significant negative correlation (r = -0.642*), whereas morning humidity (r = 0.624*), evening humidity (r = 0.555*) and rainfall (r = 0.663*) showed significant positive correlations with *S. litura* incidence. Minimum temperature (r = 0.037), wind speed (r = 0.462) and sunshine hours (r = -0.296) were positively or negatively associated, but not significantly. These results suggest that rainfall and humidity positively influenced pest buildup, whereas high maximum temperatures had a suppressive effect.

Table 2: Correlation between weather parameters and *S. litura* in groundnut

Abiotic factors	Larvae/plant	
	2023	2024
Maximum temperature, °C (Max. T)	-0.568*	-0.642*
Minimum temperature, °C (Min. T)	0.550	0.037
Morning Relative Humidity, % (RH_1)	0.680*	0.624*
Evening Relative Humidity, % (RH_2)	0.639*	0.555*
Wind Speed, $Kmhrs^{-1}$ (WS)	0.353	0.462
Bright Sunshine Hours, $hrday^{-1}$ (BSS)	-0.544	-0.296
Rain Fall (mm)	0.588*	0.663*
Note: *Significant at 5% level; r = 0.553; Significant at 1% level; r = 0.684 (n = 13 during both years)		

3.3 Relationship between Dependent and Independent Variables during 2023 and 2024

Multiple linear regression analysis revealed that weather parameters significantly influenced the population dynamics of *S. litura* in groundnut during both 2023 and 2024, explaining 96.80% and 88.90% of the variation, respectively (Table 3). In both years, a decrease in maximum temperature was associated with a notable increase in pest population (0.48 to 0.54 units per 1 °C drop), while a rise in minimum temperature led to a population increase (0.16-0.29 units per 1 °C). Morning and evening relative humidity generally showed a positive relationship with *S. litura* buildup, contributing up to 0.13 and 0.09 units increase per 1% rise in 2023 and 2024, respectively. Rainfall also exhibited a positive effect, with each 1 mm increase associated with a 0.003 and 0.005 unit rise in population in both years. Wind speed and bright sunshine hours had variable but generally positive influences, affecting the population by 0.04 to 0.65 and 0.12 to 0.36 units, respectively. These findings highlight the strong predictive value of abiotic factors, particularly temperature, humidity and rainfall in determining *S. litura* incidence in groundnut ecosystems.

Table 3: Multiple linear regression of abiotic factors with *S. litura* in groundnut during 2023 and 2024

Sr. No.	Year	Multiple linear regression equation with weather parameters	R^2
1	2023	$Y = 5.62 + -0.48X_1 + 0.29X_2 + 0.13X_3 - 0.04X_4 - 0.65*X_5 - 0.12X_6 + 0.003X_7$	0.968
2	2024	$Y = 7.44 + -0.54X_1 + 0.16X_2 + 0.002X_3 + 0.09X_4 - 0.04X_5 - 0.36X_6 + 0.005X_7$	0.889
Note: Where, Y = Dependent variable; X_1 = Maximum temperature (°C), X_2 = Minimum temperature (°C), X_3 = Morning relative humidity (%), X_4 = Evening relative humidity (%), X_5 = Wind speed (Km/hrs.), X_6 = Bright sunshine hours (hrs./day) and X_7 = Rainfall (mm) during both the years			

The present study revealed that the population dynamics of *S. litura* in groundnut during *Kharif* 2023 and 2024 were strongly influenced by prevailing weather conditions. Infestation commenced in late July in both years, coinciding with the onset of monsoon and peaked during August-September, followed by a decline towards October. Correlation analysis consistently showed a significant negative association of pest population with maximum temperature, indicating a suppressive effect of higher day temperatures, while morning and evening relative humidity and rainfall exhibited significant positive correlations, emphasizing their role in promoting pest buildup. Regression analysis further confirmed the combined influence of abiotic factors, with temperature, humidity and rainfall jointly explaining a high proportion of variation in *S. litura* population during both years. The positive contribution of minimum temperature, relative humidity and rainfall suggests that moist and moderate thermal conditions favor larval development, whereas excessive heat limits population growth. Overall, the findings highlight the critical role of key meteorological parameters in regulating *S. litura* incidence and their potential utility in weather-based pest forecasting and timely management in groundnut. The present findings align closely with earlier studies on *S. litura* incidence in groundnut and related crops. Arpit *et al.* (2021) [3] and Mishra *et al.* (2021) [8] reported initial pest appearance in the first week of August (32nd SMW) with peak activity observed in mid-September and persistence until late October. Dodiya *et al.* (2024) [4] similarly observed infestations from July to October with peak larval activity between the 35th and 39th SMWs. And stated rainfall, humidity and vapor pressure as key drivers of infestation with sunshine hours and maximum temperature having negative correlations. Regarding weather correlations, Rathod *et al.* (2024) [13] reported that increases in maximum and minimum temperature reduced larval population, while rainfall and sunshine hours contributed to its rise, further supporting the current study's conclusions on the influence of abiotic factors on *S. litura* epidemiology.

4. Conclusion

The study conclusively established that the incidence and population buildup of *S. litura* in groundnut during *Kharif* were largely governed by meteorological factors. Pest infestation initiated with the onset of monsoon, peaked during periods of moderate temperature coupled with high humidity and rainfall and declined as conditions became less favorable towards crop maturity. Maximum temperature exerted a suppressive effect, whereas minimum temperature, relative humidity and rainfall significantly favored pest development. The regression models highlight the reliability of weather parameters in predicting *S. litura* outbreaks. These findings emphasize the importance of incorporating weather-based monitoring and forecasting tools for timely and effective management of *S. litura* in groundnut ecosystems.

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