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# Influence of weather factors on population dynamics of lepidopteran pests of *Bt* cotton

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**Abstract**
The objective of this current study was to document the fluctuation in population of lepidopteran pests in *Bt* cotton fields and to assess the influence of weather parameters on their population dynamics. The data revealed that during *Kharif*-2020 and 2021, the presence of *Helicoverpa armigera* larvae on *Bt* cotton displayed varying patterns, ranging from 0.16 to 1.08 larvae per plant in 2020 and 0.20 to 1.14 larvae in 2021. The highest incidence occurred in the 37th MW of both years, reaching 1.04 and 1.14 larvae per plant respectively. Similarly, *Earias vittella* population followed a comparable trend, emerging in the 31st MW and persisting until the 41st MW, with the peak occurrence observed in the 35th MW, recording 1.46 and 1.64 larvae per plant in 2020 and 2021 respectively. *Spodoptera litura* larval population in 2020 ranged from 0.38 to 2.18 per plant, with the highest incidence in the 37th MW at 2.18 larvae per plant. During *Kharif* 2021, the range was 0.28 to 2.24 larvae per plant and reached its peak in the 37th MW at 2.24 larvae per plant.

**Keywords:** Population dynamics, *Bt* cotton *H. armigera*, *E. vittella*, *S. litura*, weather parameters, correlation

## Introduction
Cotton, a vital cash crop, faces significant challenges from lepidopteran pests, including *Helicoverpa armigera*, *Earias vittella* and *Spodoptera litura*. Understanding the population dynamics of these pests is crucial for effective pest management strategies in *Bt* cotton cultivation. The prevalence of lepidopteran pests in cotton fields has been a subject of extensive research due to their economic impact on cotton yields (Smith *et al*. 2018) [14]. *Bt* cotton, genetically modified to express insecticidal proteins from *Bacillus thuringiensis*, has shown promise in reducing pest damage (Lu *et al*. 2012) [10]. However, the effectiveness of *Bt* cotton can be influenced by various factors, including pest behavior and environmental conditions. Previous studies have emphasized the importance of monitoring and understanding the population dynamics of lepidopteran pests for effective pest management strategies (Liang *et al*. 2019 and Singh *et al*. 2020) [9, 13]. Additionally, investigations into the impact of weather parameters on pest populations have provided valuable insights into their behavior and distribution (Hussain *et al*. 2017 and Cui *et al*. 2020) [7, 2]. This study builds upon the existing knowledge by conducting a detailed analysis of pest populations in *Bt* cotton fields and their correlation with weather conditions. This study aims to provide a comprehensive analysis of the fluctuations in pest populations and their relationship with weather parameters in *Bt* cotton fields during *Kharif* 2020 and 2021.

## Material and Methods
The present study conducted at the All India Coordinated Cotton Improvement Project, MPKV, Rahuri, aimed to analyze lepidopteran pest population dynamics in *Bt* cotton during *Kharif*-2020 and 2021. The experiment utilized a 25m x 20m unprotected plot, following recommended agronomic practices. Observations on larval population of *E. vittella, H. armigera and S. litura* were recorded on randomly selected five plants from the net plot on whole plant basis and the average population per plant was worked out. Meteorological data for the respective seasons were obtained from the MPKV, Rahuri observatory and correlated with pest dynamics. The study employed simple and multiple correlation analysis to establish relationships between weather parameters and lepidopteran pests in *Bt* cotton cultivation.

## Results and Discussion

The data on Population dynamics of *H. armigera*, *E. vittella* and *S. litura* in *Bt* cotton during *Kharif* -2020 and 2021 are presented in Table 1.

### Population dynamics of *H. armigera*

The data revealed that during *Kharif*-2020, the incidence of *H. armigera* larvae was varied from 0.16 to 1.08 larvae per plant, commencing in the 33rd MW with 0.22 larvae per plant. The highest larval incidence was observed in the 37th MW, reaching 1.04 larvae per plant. Conversely, in *Kharif* 2021, *H. armigera* larval incidence was ranged from 0.20 to 1.14 larvae per plant. The peak occurrence (1.14 larvae/plant) was recorded during 40th MW followed by a gradual decline, reaching negligible levels in the 43rd MW. The results of present investigation are in agreement with Muchhadiya *et al*. (2014) [11] who reported that the larval population of *H. armigera* was ranged from 0.02 to 0.11 larvae per plant. Babu *et al*. (2016) [1] who observed that the incidence of *H. armigera* on cotton started from 38th MW. The peak incidence of *H. armigera* was recorded in 39th MW. Similarly, Raja *et al*. (2007) [12] reported that the maximum incidence of *H. armigera* in cotton was recorded during 14th and 15th weeks after sowing.

### Population dynamics of *E. vittella*

During *Kharif*-2020 and 2021, a consistent trend was observed in the population dynamics of *E. vittella*. The presence of *E. vittella* larvae commenced in the 31st MW and persisted until the 41st MW. The highest occurrence was recorded during 35th MW with 1.46 and 1.64 larvae per plant and maintained this level until the 41st MW during both the years. Similar results were endorsed by Kalkal *et al*. (2018) [8] who observed *E. vittella* larval population in the range of 0.00 to 4.00 larvae/5 plant in 2008 and 0.00- 4.65 larvae/ 5 plants in 2009. According to Daware *et al*. (2003) [3] population of *E. vittella* in cotton started in second week of August (33rd MW) and peak in third week of August to 3rd week of October (34-42 MW). Further, Raja *et al*. (2007) [12] reported the maximum incidence of *E. vittella* in cotton during 14th and 15th weeks after sowing.

### Population dynamics of *S. litura*

During *Kharif* 2020, the larval population of *S. litura* was ranged from 0.38 to 2.18 larvae per plant with highest incidence was recorded during 37th MW (2.18 larvae/plant). While, during *Kharif* 2021, it was ranged from 0.28 to 2.24 larvae per plant with highest incidence was noticed in 37th MW (2.24 larvae/plant). The present findings are in agreement with Muchhadiya *et al*. (2014) [11] who reported the larval incidence of *S. litura* from 1st week of August and reached its peak 0.18 per plant in 2nd week of October. Fenga *et al*. (2010) [6] who reported that incidence of *S. litura* on *Bt* cotton initiated in 32nd and 35th MW in 2004 and 2005, respectively.

**Table 1:** Population dynamics of *H. armigera, E. vittella, S. litura*

| MW | Duration | *H. armigera* | | *E. vittella* | | *S. litura* | |
|---|---|---|---|---|---|---|---|
| | | 2020 | 2021 | 2020 | 2021 | 2020 | 2021 |
| 31 | 30-05 Aug. | 0.00 | 0.00 | 0.34 | 0.38 | 0.00 | 0.00 |
| 32 | 06-12 Aug. | 0.22 | 0.20 | 0.44 | 0.42 | 0.38 | 0.28 |
| 33 | 13-19 Aug. | 0.38 | 0.36 | 1.06 | 0.86 | 0.90 | 0.44 |
| 34 | 20-26 Aug. | 0.54 | 0.42 | 1.22 | 1.32 | 1.28 | 0.96 |
| 35 | 27-02 Sept. | 0.74 | 0.68 | 1.46 | 1.64 | 1.56 | 1.42 |
| 36 | 03-09 Sept. | 1.04 | 0.82 | 1.18 | 1.38 | 2.04 | 2.10 |
| 37 | 10-16 Sept. | 1.08 | 1.06 | 0.78 | 0.48 | 2.18 | 2.24 |
| 38 | 17-23 Sept. | 0.72 | 0.92 | 0.62 | 0.34 | 2.04 | 2.16 |
| 39 | 24-30 Sept. | 0.46 | 1.10 | 0.38 | 0.26 | 0.84 | 1.08 |
| 40 | 01-07 Oct. | 0.38 | 1.14 | 0.26 | 0.18 | 0.52 | 0.92 |
| 40 | 08-14 Oct. | 0.24 | 0.52 | 0.14 | 0.12 | 0.76 | 0.78 |
| 42 | 15-21 Oct. | 0.20 | 0.34 | 0.00 | 0.00 | 0.98 | 0.86 |
| 43 | 22-28 Oct. | 0.16 | 0.22 | 0.00 | 0.00 | 1.12 | 0.38 |
| 44 | 29-04 Nov. | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 45 | 05-11 Nov. | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 46 | 12-18 Nov. | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 47 | 19-25 Nov. | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 48 | 26-02 Dec. | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 49 | 03-09 Dec. | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 50 | 10-16 Dec. | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 51 | 17-23 Dec. | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 52 | 24-31 Dec. | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

**Table 2:** Correlation between weather parameters and *H. armigera, E. vittella, S. litura* in *Bt* cotton

| Pests | Year | Correlation coefficient (r) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Max. Temp. | Min. Temp. | RH-I | RH-II | Rainfall | BSS | WS | EVP |
| *H. armigera* | 2020 | 0.516** | 0.235 | -0.258 | -0.071 | -0.116 | -0.022 | 0.445 | 0.141 |
| | 2021 | 0.402* | 0.367 | -0.362 | -0.281 | 0.557* | 0.174 | -0.398 | -0.556 |
| *E. vittella* | 2020 | -0.545* | 0.087 | 0.721** | -0.645* | -0.162 | 0.504 | -0.292 | 0.056 |
| | 2021 | -0.641* | -0.532* | 0.624* | -0.652* | 0.580* | -0.172 | -0.102 | -0.312 |
| *S. litura* | 2020 | 0.417* | 0.350 | 0.476 | 0.222 | 0.513 | -0.106 | -0.220 | 0.281 |
| | 2021 | 0.386* | 0.314 | 0.156 | 0.454 | 0.492 | 0.398 | -0.395 | 0.372 |

*Significant at 5% level **Significant at 1% level

### Simple correlation between weather parameters and larval population of *H. armigera, E. vittella* and *S. litura*

#### *H. armigera*

The data on correlation between weather parameters and larval population of *H. armigera* are presented in Table 2. The data revealed that during both the year of experiment *H. armigera* larval population showed positively significant correlation with maximum temperature (r=0.516**) and (r=0.402*) during *Kharif* 2020 and 2021, respectively. Whereas, the correlation between minimum temperature, exhibited positive non-significant relationship (r=0.235) and (r= 0.367) with larval population during *Kharif* 2020 and 2021, respectively. During *Kharif* 2020, rainfall showed negative non significant relationship (r=-0.116) with larval population of *H. armigera*. Whereas during *Kharif* 2021, it showed positive significant relationship (r=0.557*) with larval population of *H. armigera*.

#### *E. vittella*

The data pertaining to correlation between weather parameters and larval population of *E. vittella* revealed that the larval population of spotted bollworm showed significant and negative correlation with maximum temperature (r=-0.545* in 2020 and r=-0.641* in 2021), while positive

significant correlation with morning relative humidity (r=0.721** in 2020 and r=0.624* in 2021). However, it showed negative significant relationship with evening relative humidity (r=-0.645* in 2020 and r=-0.652* in 2021). Rainfall showed negative non significant relationship (r=-0.162) with larval population in *Kharif* 2020.

***S. litura***

During *Kharif* 2020 and 2021 (Table 2) *S. litura* population was positively significant correlated with maximum temperature (r=0.417* and r=0.386*) and positively non significant (r=0.350 in 2020 and r= 0.314 in 2021) correlated with minimum temperature. Whereas, rainfall exhibited positive non significant relationship (r= 0.513 in 2020 and r=0.492 in 2021) with *S. litura* larval population. However, during *Kharif* 2020 and 2021, morning and evening relative humidity showed positive non significant relationship with the larval population of *S. litura*.

The results of present investigation are in conformity with the findings of Mucchadiya *et al*. (2014) [11] who reported significant negative correlation of *H. armigera*, *E. vittella* and *S. litura* population with rainfall (r=-0.542) (r= -0.610) and (r=-0.631), respectively. Dhaka and Pareek (2008) reported that the temperature had negative significant effect on all the three bollworms, while, evening RH showed negative significant effect on all the three bollworms. Desai *et al*. (2009) [4] observed positive and significant correlation was observed with larval population of American and spotted bollworm.

**Table 3:** Multiple regression equation for *H. armigera*, *E. vittella* and *S. litura* and meteorological conditions in *Kharif* 2020 and 2021

| Pest | Year | Regression equation | $R^2$ |
|---|---|---|---|
| *H. armigera* | 2020 | $Y = -12.64 - 0.205X_1 + 0.351X_2 + 0.095X_3 - 0.004X_4 + 0.002X_5 + 0.046X_6 + 0.130X_7 + 0.513X_8$ | 0.69 |
| | 2021 | $Y = -9.118 + 0.295X_1 - 0.365X_2 + 0.053X_3 + 0.060X_4 - 0.001X_5 + 0.232X_6 - 0.164X_7 + 0.286X_8$ | 0.87 |
| *E. vittella* | 2020 | $Y = -12.43 - 0.162X_1 + 0.164X_2 + 0.130X_3 + 0.005X_4 - 0.01X_5 + 0.139X_6 + 0.002X_7 + 0.492X_8$ | 0.78 |
| | 2021 | $Y = 11.21 - 0.431X_1 + 0.528X_2 - 0.065X_3 - 0.055X_4 + 0.013X_5 - 0.102X_6 + 0.289X_7 - 0.540X_8$ | 0.84 |
| *S. litura* | 2020 | $Y = -19.62 + 0.206X_1 + 0.146X_2 + 0.106X_3 + 0.019X_4 + 0.004X_5 + 0.136X_6 + 0.073X_7 - 0.004X_8$ | 0.49 |
| | 2021 | $Y = 2.99 + 0.180X_1 - 0.246X_2 - 0.039X_3 + 0.049X_4 + 0.005X_5 + 0.288X_6 + 0.124X_7 - 0.578X_8$ | 0.73 |

Where,

Y = Pest, $X_1$ = max temperature, $X_2$ = min temperature, $X_3$ = morning RH, $X_4$ = eve. RH, $X_5$ = rainfall, $X_6$ = wind speed, $X_7$ = BSS, $X_8$ = evaporation and $R^2$ = Coefficient of determination.

The ($R^2$) coefficient of determination reveals the shared variability between weather parameters and various aspects of *Bt* cotton cultivation. During *Kharif* 2020, weather factors influenced 69 percent of *H. armigera*, 78 percent of *E. vittella* and 49 percent of *S. litura* larval population. In contrast, during *Kharif* 2021, these figures increased to 87 percent, 84 percent, 73 percent, respectively. These findings underscore the enhanced reliability of using weather parameters for predictions in *Kharif* 2021 compared to the preceding year.

## Conclusion

The lepidopteran pests prevails as a prominent threat in cotton crops. Its prevalence is intricately linked to particular environmental elements, particularly minimum temperature, rainfall and humidity. The current study affirms that these weather conditions exert a substantial influence on population of lepidopteran pests in *Bt* cotton. This emphasizes that weather stands as the pivotal factor governing pests population dynamics. Equipped with this understanding, farmers and extension workers can formulate targeted pest management approaches, poised to enhance cotton yields.

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