

## Original Research Article

### Effect of weather parameters on incidence of leaf miner (*Lirimomyza trifolii* Burgess) infesting tomato (*Solanum lycopersicum* L.)

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#### Abstract

A field experiment was conducted during the *Rabi* seasons of 2021-22 and 2022-23 to study the influence of various meteorological parameters on the population dynamics of leaf miner-infested tomatoes (*Solanum lycopersicum* L.). The study was carried out at the Central Experiment Station, Wakawali, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli. During *Rabi* 2022-23 the leaves were infested by leaf miners, *L. trifolli* ranged between 12.02 to 41.03 percent. While in *Rabi* 2023-24 it ranged from 4.30 to 43.13 per cent. The peak pest infestation was observed during the 8<sup>th</sup> and 10<sup>th</sup> SMW in *Rabi* 2022-23 and *Rabi* 2023-24, respectively. However, pooled data on both years revealed that the leaf infestation was in the range of 8.16 to 39.98 percent and a peak was observed during the 9<sup>th</sup> SMW. During *rabi* 2022-23 the leaf miner showed a significant negative correlation with evening relative humidity ( $r=-0.684^{**}$ ), while significant positive correlation with evaporation ( $r=0.617^{**}$ ). During *rabi* 2023-24, the pest showed a significant positive correlation with maximum temperature ( $r=0.0.589^*$ ), bright sunshine hours ( $r=0.600^*$ ), wind speed ( $r=0.935^{**}$ ), and evaporation( $r=0.847^{**}$ ), while significant negative correlation with morning relative humidity ( $r=-0.702^{**}$ ) and evening relative humidity( $r=-0.564$ ). The coefficient of determination ( $R^2$ ) indicated that the weather parameters contributed to 90 percent in *Rabi* 2022-23 and 95 percent in *Rabi* 2023-24 of total variation in the population of leaf miners on tomatoes.

**Keywords:** *Lirimomyza trifolii*, Tomato, Seasonal incidence, correlation

## **Introduction**

Tomatoes hold significant importance across various sectors, particularly in nutrition, agriculture, and industry. They are a rich source of essential nutrients, including vitamins C and K, as well as antioxidants like lycopene and  $\beta$ -carotene, which are associated with various health benefits such as improved heart health and reduced risk of certain cancers (Efremov *et al.*, 2022; Sattar *et al.*, 2024). Their high water content and low-calorie count make them ideal for weight management and promoting digestive health (Sattar *et al.*, 2024). In India, tomato cultivation spans an area of 872.9 thousand hectares, yielding 21,238.1 thousand metric tons, with a productivity rate of 24.33 metric tons per hectare (Anonymous, 2023). Among the insect pests affecting tomato crops, *Liriomyza trifolii* (Burgess), commonly known as the serpentine leaf miner, has emerged as a significant threat in recent years (Medeiros *et al.*, 2005). Originally native to the United States, this pest has spread to various regions, including India, where its destructive feeding habits have made it a major concern for tomato production (Kasar and Jha 2021; Cortez-Mondaca & Valenzuela-Escoboza, 2013). The infestation of *L. trifolii* in India has been increasing at an alarming rate (Al-Habib *et al.*, 2022), elevating it to the status of a major pest in tomato cultivation (Rai *et al.*, 2013). The serpentine leaf miner primarily feeds on the leaves of tomato plants, forming characteristic serpentine mines that significantly reduce the photosynthetic capacity of the plant. Abiotic factors, particularly warmer temperatures, play a crucial role in influencing population dynamics, with peak activity observed during these conditions (Khaliq & Shankar, 2020). The pest is responsible for substantial yield losses, with untreated infestations causing damage rates exceeding 47% in tomato crops (Ravipati *et al.*, 2021). Given its economic significance, understanding the seasonal incidence of *L. trifolii* is critical for developing effective management strategies.

## **Material and methods**

A field experiment was carried out at the Vegetable Improvement Scheme, CES, Wakawali, during the *Rabi* seasons of 2022–23 and 2023–24 to investigate the seasonal incidence of leaf miners on tomatoes. The tomato cultivar *Konkan Vijay* was grown in plots measuring 27.72 m<sup>2</sup> with a spacing of 60 × 60 cm.

## **Method of recording observations**

The infestation of leaf miner was recorded by counting healthy and infested leaves per plant at weekly intervals during the morning on ten randomly selected and tagged plants in each plot and expressed in percent leaf infestation. (Wade *et al.*, 2020)

Percent leaf infestation of *L. trifoli* was calculated by the following formula (Khan et al. 2019)

$$\text{Percent leaf infestation} \times 100$$

## **Statistical analysis**

The data on percent leaf infestation on tomato crops were averaged, and correlation and regression analysis was conducted to examine the relationship between leaf miner infestation and weather parameters. These analyses were performed using Microsoft Excel.

## **Result and discussion**

### **Seasonal incidence of leaf miner infesting tomato**

The data on seasonal incidence of leaf miner infesting tomatoes during *Rabi* `2022-23, *Rabi* 2023-24 and pooled data are presented in Table 1 and graphically depicted in Fig. 1.

The data revealed that during *Rabi* 2022-23 the incidence of percent leaf infestation by leaf miners ranged from 12.02 to 41.03 percent. The pest incidence was first noticed in the 49<sup>th</sup> SMW (03<sup>rd</sup> December to 09<sup>th</sup> December) *i.e.* 12.02 percent leaf infestation, then incidence increased continuously up to the 8<sup>th</sup> SMW (19<sup>th</sup> February to 25<sup>th</sup> February) and then it showed a declined trend but remained till maturity of the crop. The maximum pest incidence (41.03 percent leaf infestation) was recorded in the 8<sup>th</sup> SMW (19<sup>th</sup> February to 25<sup>th</sup> February) and the minimum pest incidence (12.02 percent leaf infestation) was recorded in the 49<sup>th</sup> SMW (03<sup>rd</sup> December to 09<sup>th</sup> December).

During *Rabi* 2023-24, the incidence of percent leaf infestation by leaf miners ranged from 4.30 to 43.13 percent. The pest incidence was first noticed in the 49<sup>th</sup> SMW

(03<sup>rd</sup> December to 09<sup>th</sup> December) *i.e.* 4.30 percent leaf infestation, then incidence increased continuously up to the 10<sup>th</sup> SMW (05<sup>th</sup> March to 11<sup>th</sup> March) and then it showed a declined trend but remained till maturity of the crop. The maximum pest incidence (43.13 percent leaf infestation) was recorded in the 10<sup>th</sup> SMW (05<sup>th</sup> March to 11<sup>th</sup> March) and the minimum pest incidence (4.30 percent leaf infestation) was recorded in the 49<sup>th</sup> SMW (03<sup>rd</sup> December to 09<sup>th</sup> December).

The pooled data of both years revealed that the incidence of percent leaf infestation by leaf miners was in the range of 8.16 to 39.98 percent. The pest incidence started from 49<sup>th</sup> SMW (03<sup>rd</sup> December to 09<sup>th</sup> December) *i.e.* 8.16 percent leaf infestation, then incidence increased continuously up to the 9<sup>th</sup> SMW (26<sup>th</sup> February to 04<sup>th</sup> March) and then it showed a declined trend but remained till maturity of the crop. The maximum pest incidence (39.98 percent leaf infestation) was recorded in the 9<sup>th</sup> SMW (26<sup>th</sup> February to 04<sup>th</sup> March) and the minimum pest incidence (8.16 percent leaf infestation) was recorded in the 49<sup>th</sup> SMW (03<sup>rd</sup> December to 09<sup>th</sup> December).

**Table 1: Seasonal incidence of percent leaf infestation of leaf miner, *L. trifolii* infesting tomato during Rabi 2022-23,2023-24and pooled data**

SMW	Period	Per cent leaf infestation of <i>L. trifolii</i>		
		2022-23	2023-24	Pooled
<b>49</b>	03 Dec – 09 Dec	12.02	4.30	8.16
<b>50</b>	10 Dec – 16 Dec	17.23	10.14	13.69
<b>51</b>	17 Dec – 23 Dec	21.18	13.23	17.21
<b>52</b>	24 Dec – 31 Dec	25.11	18.19	21.65
<b>1</b>	01 Jan – 07 Jan	28.28	21.82	25.05

<b>2</b>	08 Jan – 14 Jan	32.41	26.11	29.26
<b>3</b>	15 Jan – 21 Jan	34.09	29.02	31.56
<b>4</b>	22 Jan – 28 Jan	37.30	32.42	34.86
<b>5</b>	29 Jan – 04 Feb	34.10	34.25	34.18
<b>6</b>	05 Feb – 11 Feb	32.13	33.12	32.63
<b>7</b>	12 Feb – 18 Feb	37.68	32.02	34.85
<b>8</b>	19 Feb – 25 Feb	41.03	38.31	39.67
<b>9</b>	26 Feb – 04 Mar	38.15	41.8	39.98
<b>10</b>	05 Mar – 11 Mar	36.01	43.13	39.57
<b>11</b>	12 Mar – 18 Mar	35.81	39.63	37.72
<b>12</b>	19 Mar – 25 Mar	34.02	38.03	36.03
<b>13</b>	26 Mar – 01 Apr	33.80	37.95	35.88
<b>SD (±)</b>		<b>7.95</b>	<b>11.67</b>	<b>9.65</b>
SMW- Standard Meteorological Week				

**Fig. 1: Seasonal incidence of percent leaf infestation by leaf miner infesting tomato during *Rabi* 2022-23, *Rabi* 2023-24, and pooled data**

### **Correlation and regression between percent leaf infestation by leaf miner and weather parameters**

#### **Correlation studies**

The data on the correlation coefficient of percent leaf infestation by leaf miners concerning different weather parameters during *Rabi* 2022-23 and *Rabi* 2023-24 are shown in Table 2.

During *Rabi* 2022-23, the percent leaf infestation by leaf miners exhibited a positive correlation with maximum temperature and bright sunshine hours while a negative correlation with minimum temperature and morning relative humidity. The wind speed ( $r=0.586^*$ ) and evaporation ( $r=0.617^{**}$ ) recorded a positive significant correlation, whereas evening relative humidity ( $r=-0.684^{**}$ ) had a negative highly significant correlation with percent leaf infestation by leaf miner. Other parameters were non-significantly correlated with percent leaf infestation by leaf miners.

**Table 2: Correlation coefficient of percent leaf infestation of leaf miner, *L. trifolii* infesting tomato concerning different weather parameters during *Rabi* 2022-23 and *Rabi* 2023-24**

<b>Weather parameters</b>	<b>Correlation coefficient (r)</b>
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	2022-23	2023-24
<b>Temp. Max.</b>	0.436	0.589*
<b>Temp. Min.</b>	-0.323	-0.169
<b>RH-I</b>	-0.374	-0.702**
<b>RH-II</b>	-0.684**	-0.564*
<b>BSS</b>	0.250	0.600*
<b>WS</b>	0.586*	0.935**
<b>EVP</b>	0.617**	0.847**

\* Correlation is Significant at the 0.05 level 'r' value = 0.482

\*\* Correlation is significant at the 0.01 level 'r' value = 0.606

The percent leaf infestation by leaf miners during *Rabi* 2023-24 showed a negative correlation with minimum temperature. The percent leaf infestation by leaf miner had a positive significant correlation with maximum temperature ( $r= 0.589^*$ ), bright sunshine hours ( $r=0.600^*$ ), wind speed ( $r=0.935^{**}$ ) and evaporation ( $r=0.847^{**}$ ) whereas negative significant correlation with morning relative humidity ( $r= -0.702^{**}$ ) and evening relative humidity ( $r= - 0.564^*$ ). The remaining parameters were non-significantly correlated with percent leaf infestation by leaf miners.

### Multiple linear regression studies

The multiple regression was worked out between percent leaf infestation by leaf miner and weather parameters during *Rabi* 2022-23 and regression coefficient (b) and intercept (a) are presented in Table 3.

The regression equation of *Rabi* 2022-23 was worked out as follows

$$Y= 171.761+ 0.309 X_1 -4.057X_2 - 0.258X_3 -0.787X_4 -4.109X_5 + 16.484X_6 -4.350X_7$$

The coefficient of determination ( $R^2$ ) represents the proportion of common variation in the two variables. The investigation revealed that the weather parameters contributed to 90 percent of the total variation in the percent leaf infestation of leaf miners on tomatoes.

**Table 3: Multiple linear regression between percent leaf infestation of leaf miner, *L.***

*trifolii*, and weather parameters during *Rabi* 2022-23

Sr. No.	Weather parameters	Regression coefficient (b)	S.E. (b)	't' values
(X <sub>1</sub> )	Temp. Max.	0.309	1.483	0.208
(X <sub>2</sub> )	Temp. Min.	-4.057	0.690	-5.873
(X <sub>3</sub> )	RH-I	-0.258	0.272	-0.946
(X <sub>4</sub> )	RH-II	-0.787	0.518	-1.518
(X <sub>5</sub> )	BSS	-4.109	1.503	-2.733
(X <sub>6</sub> )	WS	16.484	7.246	2.274
(X <sub>7</sub> )	EVP	-4.350	3.717	-1.170
<b>Intercept (a) = 171.761, N=15, F value = 12.117, R<sup>2</sup>=0.90</b>				

During *Rabi* 2023-24, the multiple regression was worked out between percent leaf infestation by leaf miner and weather parameters, and regression coefficient (b) and intercept (a) are presented in Table 4.

The regression equation worked out of *Rabi* 2023-24 is as follows

$$Y = 17.497 - 0.266 X_1 - 1.077 X_2 - 0.529 X_3 - 0.451 X_4 - 3.216 X_5 + 16.741 X_6 + 2.172 X_7$$

The coefficient of determination (R<sup>2</sup>) represents the proportion of common variation in the two variables. The investigation revealed that the weather parameters contributed to 95 percent of the total variation in the percent leaf infestation of leaf miners on tomatoes.

**Table 4: Multiple linear regression between percent leaf infestation of leaf miner, *L. trifolii*, and weather parameters during *Rabi* 2023-24**

Sr. No.	Weather parameters	Regression coefficient (b)	S.E. (b)	't' values
(X <sub>1</sub> )	Temp. Max.	-0.266	0.992	-0.268
(X <sub>2</sub> )	Temp. Min.	-1.077	0.685	-1.571
(X <sub>3</sub> )	RH-I	0.529	0.544	0.972
(X <sub>4</sub> )	RH-II	-0.451	0.204	-2.211
(X <sub>5</sub> )	BSS	-3.216	1.830	-1.757
(X <sub>6</sub> )	WS	16.741	3.673	4.556

(X <sub>7</sub> )	EVP	2.172	3.223	0.673
<b>Intercept (a) =17.497, N=15, F value = 25.225, R<sup>2</sup> = 0.95</b>				

## Discussion

The present findings conform with Reddy and Kumar (2005) reported that the peak incidence of *L. trifolii* in tomato was noticed during March – April, which coincided with the vegetative and reproductive stages of the crop. Variya and Bhut (2014) reported that the highest infestation levels of *L. trifolii* were observed during the third week of January, with an average of 10.26 mines per leaf. Shinde (2007) observed the presence of this pest on tomato crops from the vegetative stage throughout the cropping season. The present study conforms with Sharma *et al.* (2013) observed that leaf mining was positively significantly correlated with minimum temperature in tomatoes. Similarly, Khaliq and Shankar (2020) reported that the correlation showed a highly significant and positive association between the population of leaf miners and maximum temperature (0.120\*\*), while, a significant and negative correlation with relative humidity in the evening (-0.488\*) and rainfall (-0.538\*) in another crops field (Khan *et al.*, 2020). The overall impact of abiotic factors on the population build-up of leaf miners was ( $R^2 = 0.803$ ) 80.30 percent in tomatoes.

## Conclusion

From the present investigation, it can be concluded that leaf miner infestation, measured as percent infested leaves, reached its first peak (34.86%) during the fourth week of January and its highest peak (39.98%) during the ninth standard meteorological week. The seasonal occurrence of the leaf miner on tomato crops is strongly influenced by weather parameters such as maximum and minimum temperatures, morning and evening relative humidity, bright sunshine hours, wind speed, and evaporation rates. The pest population exhibited distinct peaks under favorable climatic conditions, highlighting the significant role of meteorological factors in its dynamics. Understanding these seasonal trends is essential for developing timely and effective pest management strategies, ultimately contributing to improved crop protection and optimized yields.

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