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Effect of Weather Parameters on Incidence of Leaf Miner (*Lirimomyza trifolii* Burgess) Infesting Tomato (*Solanum lycopersicum* L.)

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Authors' contributions

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

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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 infesting tomato (*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

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leaves were infested by leaf miner, *L. trifolli* ranged between 12.02 to 41.03 per cent. While in *Rabi* 2023-24 it ranged from 4.30 to 43.13 per cent. The peak pest infestation was observed during the 8th and 10th SMW in *Rabi* 2022-23 and *Rabi* 2023-24, respectively. However, pooled data on both the years revealed that the leaves infestation was in the range of 8.16 to 39.98 per cent and peak was observed during the 9th 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 per cent in *Rabi* 2022-23 and 95 per cent in *Rabi* 2023-24 of total variation in the population of leaf miner on tomato.

Keywords: Lirimomyza trifolii; Tomato; Seasonal incidence; correlation; Meteorological parameters.

1. 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 β-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, 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 its 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.

2. MATERIALS 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 miner on tomato. The tomato cultivar *Konkan Vijay* was grown in plots measuring 27.72 m² with a spacing of 60 × 60 cm.

2.1 Method of Recording Observations

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

Per cent leaf infestation of *L. trifoli* was calculated by the following formula,

$$\text{Per cent leaf infestation} = \frac{\textit{No. of infested leaf observed}}{\textit{Total no of leaf}} \times 100$$

2.2 Statistical Analysis

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

3. RESULTS AND DISCUSSION

3.1 Seasonal Incidence of Leaf Miner Infesting Tomato

The data on seasonal incidence of leaf miner infesting tomato 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 per cent leaf infestation by leaf miner ranged from 12.02 to 41.03 per cent. The pest incidence was first noticed in the 49th SMW (03rd December to 09th December) *i.e.* 12.02 per cent leaf infestation, then incidence increased continuously up to the 8th SMW (19th February to 25th February) and then it showed declined trend but remained till maturity of the crop. The maximum pest incidence (41.03 per cent leaf infestation) was recorded in 8th SMW (19th February to 25th February) and minimum pest incidence (12.02 per cent leaf infestation) was recorded in 49th SMW (03rd December to 09th December).

During *Rabi* 2023-24 the incidence of per cent leaf infestation by leaf miner ranged from 4.30 to 43.13 per cent. The pest incidence was first noticed in the 49th SMW (03rd December to 09th December) *i.e.* 4.30 per cent leaf infestation, then incidence increased continuously up to the 10th SMW (05th March to 11th March) and then it showed declined trend but remained till maturity of the crop. The maximum pest incidence (43.13 per cent leaf infestation) was recorded in the 10th SMW (05th March to 11th March) and minimum pest incidence (4.30 per cent leaf infestation) was recorded in the 49th SMW (03rd December to 09th December).

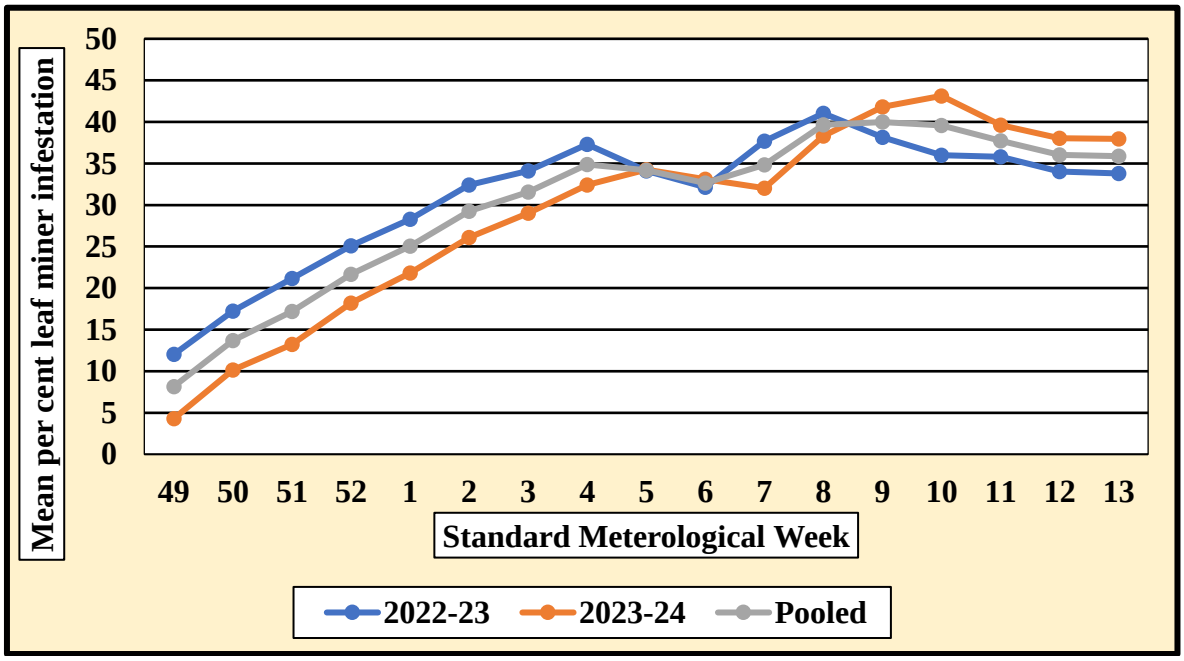

Fig. 1. Seasonal incidence of per cent leaf infestation by leaf miner infesting tomato during *Rabi* 2022-23, *Rabi* 2023-24 and pooled data

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

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

SMW	Period	Per cent leaf infestation of *L. trifolii*		
		2022-23	2023-24	Pooled
2	08 Jan – 14 Jan	32.41	26.11	29.26
3	15 Jan – 21 Jan	34.09	29.02	31.56
4	22 Jan – 28 Jan	37.30	32.42	34.86
5	29 Jan – 04 Feb	34.10	34.25	34.18
6	05 Feb – 11 Feb	32.13	33.12	32.63
7	12 Feb – 18 Feb	37.68	32.02	34.85
8	19 Feb – 25 Feb	41.03	38.31	39.67
9	26 Feb – 04 Mar	38.15	41.8	39.98
10	05 Mar – 11 Mar	36.01	43.13	39.57
11	12 Mar – 18 Mar	35.81	39.63	37.72
12	19 Mar – 25 Mar	34.02	38.03	36.03
13	26 Mar – 01 Apr	33.80	37.95	35.88
SD (±)		**7.95**	**11.67**	**9.65**

SMW- Standard Meteorological Week

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

3.2 Correlation and Regression between Per Cent Leaf Infestation by Leaf Miner and Weather Parameters

Correlation studies: The data on the correlation coefficient of per cent leaf infestation by leaf miner in relation to different weather parameters during *Rabi* 2022-23 and *Rabi* 2023-24 are shown in Table 2.

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

The per cent leaf infestation by leaf miner during *Rabi* 2023-24 showed a negative correlation with minimum temperature. The per cent leaf infestation by leaf miner had a positive significant correlation with maximum temperature (r= 0.589*), bright sunshine hours (r=0.600*) and 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 per cent leaf infestation by leaf miner.

Multiple linear regression studies: The multiple regression was worked out between per cent 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 is as follows

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

The coefficient of determination (R^2) represents the proportion of common variation in the two variables. The investigation revealed that the weather parameters contributed for 90 per cent of total variation in the per cent leaf infestation of leaf miner on tomato.

During *Rabi* 2023-24, the multiple regression was worked out between per cent 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

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

Table 2. Correlation coefficient of per cent leaf infestation of leaf miner, *L. trifolii* infesting tomato in relation to different weather parameters during *Rabi* 2022-23 and *Rabi* 2023-24

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

Table 3. Multiple linear regression between per cent 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_1)	**Temp. Max.**	0.309	1.483	0.208
(X_2)	**Temp. Min.**	-4.057	0.690	-5.873
(X_3)	**RH-I**	-0.258	0.272	-0.946
(X_4)	**RH-II**	-0.787	0.518	-1.518
(X_5)	**BSS**	-4.109	1.503	-2.733
(X_6)	**WS**	16.484	7.246	2.274
(X_7)	**EVP**	-4.350	3.717	-1.170
Intercept (a) = 171.761, N=15, F value = 12.117, R^2 =0.90				

Table 4. Multiple linear regression between per cent 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_1)	**Temp. Max.**	-0.266	0.992	-0.268
(X_2)	**Temp. Min.**	-1.077	0.685	-1.571
(X_3)	**RH-I**	0.529	0.544	0.972
(X_4)	**RH-II**	-0.451	0.204	-2.211
(X_5)	**BSS**	-3.216	1.830	-1.757
(X_6)	**WS**	16.741	3.673	4.556
(X_7)	**EVP**	2.172	3.223	0.673
Intercept (a) =17.497, N=15, F value = 25.225, R^2 = 0.95				

The coefficient of determination (R^2) represents the proportion of common variation in the two variables. The investigation revealed that the weather parameters contributed for 95 per cent of total variation in the per cent leaf infestation of leaf miner on tomato.

3.3 Discussion

The present findings confirm with Reddy and Kumar (2005) reported that the peak incidence of *L. trifolii* on tomato was noticed during March – April, which coincided with vegetative and reproductive stages of the crop. Variya and Bhut (2014) reported that the highest infestation levels of *Liriomyza trifolii* were observed during the third week of January, with an average of 10.26 mines per leaf. Shinde (2007) observed that the presence of this pest on tomato crop from vegetative stage throughout the cropping season. The present study confirms with Sharma et al. (2013) observed that leaf miner was

positive significant correlated with minimum temperature in tomato. Similarly, Khaliq and Shankar (2020) reported that the correlation was showed highly significant and positive association between the population of leaf miner and maximum temperature (0.120**), while, significant and negative correlation with relative humidity evening (-0.488*) and rainfall (-0.538*). The overall impact of abiotic factors on the population build-up of leaf miner was (R^2 = 0.803) 80.30 per cent in tomato.

4. 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 favourable 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.

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 this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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