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### Population Fluctuation of Tomato Leaf Miner *Liriomyza Sativae* (Diptera: Agromyzidae) in Tomato

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#### ABSTRACT

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*Liriomyza sativae* is a serious pest of several economically important vegetable crops, including tomato. The larvae produce characteristic serpentine mines within the leaves of host plants, disrupting leaf tissues and reducing the photosynthetic capacity of the plant. The study was conducted to investigate the infestation percentage of *L. sativae* on tomato leaves. The observations were taken weekly by counting the number of total and infested leaves with *L. sativae* to calculate its infestation percentage. A total of ten plants per replication with total fifty plants were observed in the study. The symptoms of *L. sativae* infestation were recorded since the transplanting of tomatoes till their final harvesting. According to the results, during the first week of observation, the infestation percentage of *L. sativae* was recorded as  $85 \pm 2.35\%$  that was significantly the highest per week mean percentage recorded during the entire duration of the study. The infestation percentage of *L. sativae* was then declined due to the increasing number of total tomato leaves per plant, despite an increasing trend in infestations during remaining weeks of observations. At the final harvesting stage during twenty-fourth week, the infestation percentage of *L. sativae* was recorded as  $18.5 \pm 1.54\%$ . Moreover, among the abiotic factors, temperature showed a highly significant, positive, and strong relationship with the mean infestation of *L. sativae* ( $r = 0.7135$ ,  $P < 0.05$ ), whereas rainfall exhibited a significant negative relationship. In contrast, relative humidity and wind velocity showed no significant effect on infestation. These findings indicate that temperature and rainfall play an important role in the population dynamics of *L. sativae* and may be useful for developing timely and effective management strategies for tomato leaf miner under local conditions.

## Introduction

Tomato (*Solanum lycopersicum* L.) is one of the most important vegetable crops worldwide and is consumed fresh in salads and cooked dishes, while also being extensively processed into ketchup, paste, sauces, and other food products (Méndez - Carmona et al., 2023). Tomato fruits are an important source of essential nutrients, including fiber, antioxidants, potassium, vitamin A, and vitamin C (Kalia & Singh, 2023). The demand for tomatoes has increased because of the growing global population. In Pakistan, tomatoes are grown in several regions and are accessible all year round in local markets (Terefe et al., 2023). During 2022-23, overall cultivation of tomatoes in Pakistan was done on 68,863 hectares that yielded 762,737 tons of tomatoes (GoP, 2023). Sindh province is the major contributor in Pakistan for the total area and production of tomatoes as during 2022-2023, it produced 194,890 tons of tomatoes from 26,431 hectares cultivated area (GoP, 2023). Tomato production is affected by several insect pests that attack plants at different growth stages, from seedling to fruit development. Among these, leaf-mining flies of the genus *Liriomyza* Mik are important pests of vegetable and ornamental crops. *Liriomyza* species belong to the family Agromyzidae (Diptera) and are widely distributed in agricultural production systems. Several species are recognized as economically important because of their broad host range and ability to damage leaves of cultivated crops (Gao et al., 2017; Maino et al., 2023). Among them, *Liriomyza sativae* Blanchard is an important leaf-mining pest associated with several vegetable crops, including tomato and other crops belonging to the Solanaceae, Cucurbitaceae, and Fabaceae. *Liriomyza sativae* causes damage through the feeding activities of both adults and larvae. Adult females puncture leaves for feeding and oviposition, while the larvae develop within the leaf tissue and produce characteristic serpentine mines. Increasing numbers of mines reduce photosynthetic capacity, interfere with normal physiological processes, and cause premature leaf senescence under severe infestation. Consequently, heavy infestation can reduce plant vigor and contribute to yield and economic losses (Rauf et al., 2000; Mani, 2022; Liu et al., 2015). The pest is distributed across different geographical regions and can infest a wide range of cultivated, ornamental, and wild host plants. Its occurrence on vegetable crops, particularly tomato, makes it an important pest requiring regular monitoring and effective management.

The abundance of *L. sativae* is not constant throughout the cropping season but may vary considerably with crop growth stage and prevailing environmental conditions (Tokumaru et al., 2007). Environmental factors, particularly temperature and relative humidity, can influence the survival, reproductive activity, oviposition, and fecundity of *L. sativae*, thereby affecting its population development (Costa-Lima et al., 2010). Understanding seasonal population fluctuation is therefore essential for determining periods of pest activity and identifying the stages of the crop that are most vulnerable to infestation. Such information can assist in developing timely and environmentally sound management strategies and can help avoid unnecessary insecticide applications. Management of *Liriomyza* species has become challenging because indiscriminate and repeated application of broad-spectrum insecticides can adversely affect parasitoids and other natural enemies and may contribute to the development of insecticide resistance (Saw et al., 2023). Therefore, knowledge of the seasonal abundance and population dynamics of *L. sativae* is important for improving pest monitoring and determining appropriate intervention periods. Information on the seasonal population fluctuation of *L. sativae* on tomato under local agroecological conditions remains limited. Therefore, the present study was conducted to determine the population fluctuation of *L. sativae* on tomato crop during the growing season and to provide baseline information useful for developing effective and timely management strategies against this pest.

## Material and Methods

### Study Area

The study was conducted at the Experimental area of Plant Protection Research Institute, Agriculture Research Centre, Tandojam.

### Experimental design

Tomato variety (Desi) was cultivated at its recommended rate of 150 grams per acre and after the germination, twenty-one days old nursery was transplanted in the experimental area of 20\*20 feet. The distance between row to row and plant to plant was maintained at 4 and 2 feet, respectively. Total five replications were maintained for the experiment where each replicated plot size was 4\*5 feet. All the agronomic practices of weeding, fertilization, and irrigation in the experiment were used as per the standard recommendations, and no synthetic insecticides were used in the tomatoes during the entire study duration.

### Data collection

The data collection of the infestation of *L. Sativae* was started since the transplanting of tomato nursery and continued on a weekly basis till final harvesting of the crop. Five plants per replication were observed to record the infestation of *L. sativae*

by observing the characteristic mining symptoms on the leaves. Entire tomato plants were observed to count the total infested number of leaves by calculates the infestation percentage using the following formula:

$$\text{Infestation percentage} = (\text{Infested leaves} / \text{total leaves}) * 100$$

### Data analysis

Data of various weather parameters such as temperature, relative humidity, wind velocity, and rainfall were collected from the local Meteorological Station, Tandojam to determine the population of *L. sativae* in tomato field. Infestation percentage was calculated by using Pearson's correlation. Moreover, the collected data of infestation of *L. sativae* over entire duration of study were analyzed by using Analysis of Variance to determine the fluctuation in the infestation. The STATISTIX 8.1 computer software was used to run the analysis.

## Results

### Weekly mean infestation of *Liriomyza sativae* on tomato

The experiment was conducted to determine the infestation percentage of *Liriomyza sativae* on tomato leaves under field conditions at Agriculture Research Institute, TandoJam. Figure 1 shows that due to a smaller number of leaves on tomatoes immediately after transplantation, comparatively higher infestation percentage of *L. sativae* was observed. During the first week after the transplanting as the initial infestation recorded during first week was  $85 \pm 2.35\%$  that was significantly the highest per week mean percentage recorded during the entire duration of the study. Afterwards, although number of leaves infested by *L. sativae* showed an increasing trend but due to the increasing number of tomato leaves due to its continuous development, a decline in infestation percentage was recorded as its infestation percentage recorded during remaining weeks of observations till final harvesting during twenty-fourth week after transplanting were  $85 \pm 2.35$ ,  $82.5 \pm 2.5$ ,  $79.5 \pm 2.76$ ,  $75 \pm 2.94$ ,  $71.5 \pm 2.74$ ,  $68 \pm 2.67$ ,  $63.5 \pm 2.55$ ,  $59.5 \pm 2.66$ ,  $56 \pm 2.65$ ,  $52 \pm 2.47$ ,  $51.5 \pm 2.64$ ,  $48 \pm 2.57$ ,  $45.5 \pm 2.34$ ,  $42 \pm 2.12$ ,  $39.8 \pm 1.98$ ,  $37.35 \pm 1.8$ ,  $34.75 \pm 2.06$ ,  $32 \pm 1.79$ ,  $29 \pm 1.56$ ,  $26 \pm 1.23$ ,  $24.5 \pm 1.69$ ,  $22.25 \pm 1.38$ ,  $20.75 \pm 1.67$  and  $18.5 \pm 1.54\%$  respectively.

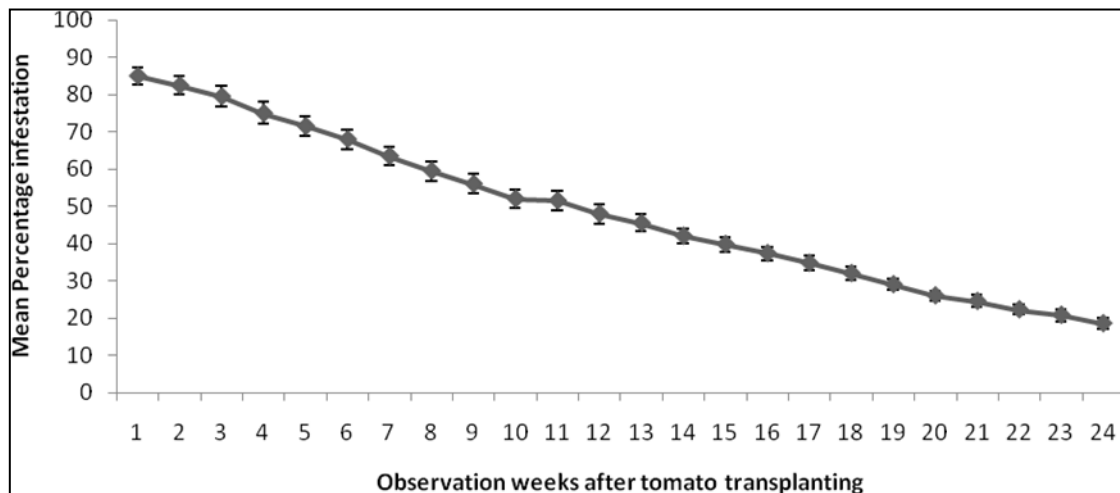


Figure 1: Weekly mean infestation of *Liriomyza sativae* on tomato

Table 1 describes the results regarding the relationship of the mean infestation of *L. sativae* on tomato leaves with the environmental factors of temperature, relative humidity, wind velocity and rainfall. According to the results, temperature showed a highly significant, positive and strong impact ( $r=0.7135$ ,  $P<0.05$ ) was observed on the mean infestation percentage of *L. sativae* on tomato leaves. Moreover, rainfall also exhibited a negative and moderate but significant influence ( $r= -0.3066$ ,  $P<0.05$ ) was observed on the mean infestation percentage of *L. sativae* on tomato leaves. However, no significant role of relative humidity ( $r= 0.2517$ ,  $P=0.1562$ ) and wind velocity ( $r= 0.1705$ ,  $P>0.05$ ) was observed on the mean infestation percentage of *L. sativae* on tomato leaves.

Table 1 Correlation coefficient of weekly mean infestation percentage of *Liriomyza sativae* with weather parameters

| Weather parameter | <i>Liriomyza sativae</i> infestation |
|-------------------|--------------------------------------|
| Temperature       | $r= 0.7135$ , $P < 0.001$            |
| Relative humidity | $r= 0.2517$ , $P = 0.1562$           |

|               |                         |
|---------------|-------------------------|
| Wind velocity | $r = 0.1705, P > 0.05$  |
| Rainfall      | $r = -0.3066, P < 0.05$ |

## Discussion

The tomato is a flowering plant in the Solanaceae family and commonly known as “poor man’s orange” (Singh et al., 2021). The vegetable leaf miner *Liriomyza sativae* is a significant pest that attacks a wide range of vegetable crops, leading to economic losses (Hamza et al., 2023). The study investigated that the infestation percentage of tomato leaf miner *L. sativae* and its correlation with weather parameters, revealing a high infestation rate after transplanting the nursery. The significant initial infestation observed may be attributed to the optimal conditions for *L. sativae* development shortly after transplanting. The infestation percentage declined, which could be due to a combination of increased plant defences and reduced suitability of older leaves for the larvae. The stable infestation rates observed during the 10th and 11th weeks suggest a potential equilibrium between the pest population and plant defences. At the end of 24th week, the infestation percentage was lower. The decline in infestation percentage towards the end of the observation period indicated that either the pest population decreased due to reduced food availability or that the plant's resistance mechanisms became more effective over time. The present findings are in conformity with the findings obtained by Zoebisch et al. (1984) revealed that the pest *Liriomyza trifolii* on tomato was first appearance in 8th and 9th standard meteorological week i.e. (February and March), attain peak population in 14th and 17th (April), respectively. Whereas, Selvaraj et al. (2016) also more or less confirmed the results of the present investigation, who found that in tomato the adult population of leaf miner, *L. trifolii* to be high during April and May, and decreasing in June. The adult population observed during autumn was at its peak in mid-November and then dropped down at the end of December. Asalatha, (2002) and Reddy and Kumar, (2004) reported *Liriomyza spp.* as a major pest in tomato. Shinde, (2007) also reported the presence of this pest on tomato crops throughout the cropping season. Correlation coefficient between leaf miner infestation and meteorological parameters exhibited significantly positive correlation with the maximum and minimum temperature, where as it exhibited negatively non-significant correlation with the relative humidity and shown positively non-significant correlation with the rainfall. These findings are partially in agreement with Kachave et al. (2020) revealed that the maximum temperature had significant role on number of mines and rainfall is positively correlated with the number of mines. Ravipati et al., (2020) reported that minimum temperature has significant influence on leaf 13 miners and relative humidity had non-significantly negative impact on *L. trifolii* population. Khaliq and Shankar, (2020) recorded that leaf infestation (%) by leaf miner and pest population on leaf miner was positively correlated with maximum temperature and negatively correlated with relative humidity and minimum temperature on tomato crop. Whereas, Ulubilir and Yabas, (2000) reported that the maximum temperature had positive correlation with the population of *L. trifolii* on tomato, whereas rainfall and relative humidity had negative association with the population of leaf miners. Choudhary and Rosaiah (2000) reported that relative humidity was negatively correlated with incidence of *L. trifolii*. Incidence of *L. trifolii* was noticed from the fourth week of December 2022 to second week of March 2023. The maximum population was recorded during the third week of January 2023. During the initial period of the crop growth, there was a less population of leaf miner which gradually increased. Similar findings were reported by Wade et al. (2020), increasing trend of pest population was observed during the crop growth stages. The present findings were similar with the (Ravipati et al., 2020). These results are totally different as compared to our findings. About leaf miner infestation in our observation the entire crop growing season i.e. Sep-Feb, significant and positive correlation was obtained with maximum, minimum and average temperature. While relative humidity was no significant but positive correlation with leaf miner infestation. The infestation of *L. trifolii* was started at transplanting and persisted till the end of the crop season. The percentage of infested leaves reached its peak in the tenth week after transplanting in the second week of January, after which it steadily declined until harvest. Reports of Hath and Das (2004) and Reddy and Kumar (2004) indicated peak infestation of leaf miner (*L. trifolii*) during March to April and there after population declined. The slightly different trend in the present investigation could be due to different sowing periods as well as different agro-ecological conditions where the crop was raised. The overall population of insect pests and their damage was positively correlated with the relative humidity in the morning, evening, and an average. The number of insect pests was positively correlated with sunshine hours and rainfall, except for the percentage of leaves damaged by leaf miners, which was adversely correlated. Moreover, our study aimed to explore the infestation dynamics of the tomato leaf miner *L. sativae* and its correlation with weather parameters throughout the cropping season. Our results revealed a significant variation in leaf miner infestation over time, with key trends aligning with findings from previous studies, although some differences were observed, likely due to differing agro-ecological conditions and sowing periods. Therefore, in continuation of previous studies, our study also demonstrated that *L. sativae* is a potential threat to tomato cultivation in Sindh province where its population trends can be correlated with fluctuations in various weather parameters, especially temperature.

## Conclusion

The initial infestation of *Liriomyza sativae* increased during the first week after transplanting and subsequently declined as leaf number increased. Temperature showed a highly significant positive relationship with *L. sativae* infestation, whereas rainfall had a significant negative effect. In contrast, relative humidity and wind velocity showed no significant relationship with pest infestation. These findings highlight the importance of temperature and rainfall in determining the population dynamics of *L. sativae* on tomato.

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