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**MK Ghelani**

Assistant Professor, Department of Entomology, College of Agriculture, Junagadh Agricultural University, Junagadh, Gujarat, India

**BB Kabaria**

Senior Scientist & Head, Krishi Vigyan Kendra, Junagadh Agricultural University, Targhadia (Rajkot), Gujarat, India

**KD Shah**

Assistant Professor, Department of Entomology, College of Agriculture, Junagadh Agricultural University, Junagadh, Gujarat, India

**YH Ghelani**

Associate Professor, Office of the Registrar, Junagadh Agricultural University, Junagadh, Gujarat, India

**Corresponding Author:****MK Ghelani**

Assistant Professor, Department of Entomology, College of Agriculture, Junagadh Agricultural University, Junagadh, Gujarat, India

## Biology of serpentine leaf miner, *Liriomyza trifolii* (Burgess) on tomato

**MK Ghelani, BB Kabaria, KD Shah and YH Ghelani**

**Abstract**

Investigations on biology of serpentine leaf miner, *Liriomyza trifolii* (Burgess) were carried out under laboratory condition at Department of Entomology, College of Agriculture, Junagadh Agricultural University, Junagadh during 2018-19. The average incubation period, hatching per cent (%), first, second & third instar, total larval and pupal period of *L. trifolii* were  $2.57 \pm 0.65$ ,  $90.44 \pm 5.56\%$ ,  $1.10 \pm 0.18$ ,  $1.69 \pm 0.28$  &  $1.97 \pm 0.33$ ,  $4.76 \pm 0.79$  and  $9.42 \pm 1.15$  days, respectively. The oviposition period was  $2.48 \pm 0.54$  days while the fecundity was  $101.84 \pm 36.07$  eggs /female. The longevity & entire life span of male and female fly was  $5.05 \pm 0.78$  &  $21.20 \pm 1.15$  and  $6.09 \pm 1.15$  &  $23.42 \pm 1.26$  days, respectively.

**Keywords:** Biology, *Liriomyza trifolii* (Burgess), serpentine leaf miner, tomato

**1. Introduction**

Tomato (*Lycopersicon esculentum* Mill.) is one of the most important vegetables grown worldwide under both natural as well as protected conditions. As it is a relatively short duration crop and gives high yield, it is economically attractive and the area under cultivation is increasing day by day. Tomato belongs to the Solanaceae family. This family also includes other well-known species, such as potato, tobacco, peppers and eggplant (aubergine). Tomato has its origin in the South American Andes. It is an important source of vitamins and an important cash crop for small landholders and medium-scale commercial farmers [16]. Tomato ranks third in priority after potato and onion in India but ranks second after potato in the world. Tomatoes contribute to a healthy, well-balanced diet. They are rich in minerals, vitamins, essential amino acids, sugars and dietary fibres. Tomato contains much vitamin B and C, iron and phosphorus.

The American serpentine leaf miner, *Liriomyza trifolii* (Burgess) (Diptera: Agromyzidae) a minute golden agromyzid fly, suspected to have been introduced in India during 1990-91 [19]. This leaf miner is native to Southern North America and spread in 1980 to the most tropical regions. The international trade in cut chrysanthemum is a cause of its initial spread from Florida to the other countries. It is believed to be a native of Florida, USA [17] introduced probably along with the cut chrysanthemum flowers during early 1970s to California, USA [11] and now widely spread in most of the countries including India. In India, it was first time reported in the proceeding of the annual castor research workers' group meeting held at Hyderabad in 1991 [1]. It has been appeared in between 1988-90 in Gujarat (Targhadia Centre) and got identified in 1992 [5]. A larva of *Liriomyza* creates serpentine mines, which are initially very narrow and gradually enlarge often twisting through the leaf. Its damage is characterized by sharply curled and contorted leaf mines that have continuous black trail of frass. The mines of the maggots in leaf and ovipositional punctures of adults reduce the photosynthetic ability of tomato resulting in reduced yield.

**2. Materials and methods****2.1 Biology of serpentine leaf miner, *Liriomyza trifolii* (Burgess) on tomato**

Present investigation on biology of serpentine leaf miner, *L. trifolii* (Diptera: Agromyzidae) was carried out in PG laboratory, Department of Entomology, College of Agriculture, Junagadh Agricultural University, Junagadh during 2018-19.

**2.1.1 Maintenance of culture**

Culture of leaf miner was initiated by collecting the infested leaves of tomato from the poly

house of Department of Horticulture, College of Agriculture, JAU, Junagadh. The insect culture was further maintained in insect rearing cages containing the tomato seedling /plant. During the day period, insect rearing cage was remained as it is while during the night time it was covered with a black colored muslin cloth. The culture so maintained was used throughout the period of investigation. The emerged adult flies were collected carefully by opening the cage with the help of small plastic vials. Male and female flies were identified with their typical morphological characters and paired.

Five tomato seedlings and twenty five pairs of male and female fly of leaf miner were introduced in cage for oviposition. Eggs laid by female fly on the leaves of tomato were marked and numbered. The eggs were observed every day to know the further development. The leaf having pupa was kept in glass Petri dish (70 cm × 1.5 cm) containing moist blotting paper till the emergence of fly from pupae. To know the fecundity of 25 numbers of female fly and longevity 25 numbers of adults, freshly emerged fly were paired and transferred in a cage box containing tomato seedling. Five per cent honey solution was provided as a food for adult. During the experimentation the observations were also made on larval instars, and these observations on developing stages were continued till the adult formation and its subsequent death.

### 2.1.2 Egg stage

Leaves containing eggs were separate out by examining under microscope and used for further study. Tomato leaves with leaf miner eggs so obtained were maintained in a Petri dish (10 cm diameter) for incubation. Daily twenty leaves from the day of oviposition to egg hatching were dissected to determine the incubation period and per cent hatching.

### 2.1.3 Larval period

On hatching, a leaf miner larva was allowed to feed individually inside the leaves in a Petri dish (10 cm diameter). Every day, mines were dissected out to see the different stages of the larvae. The dissection of leaves /mines was made up to the pupal stage. The period between egg hatching and pupation was observed as larval period.

### 2.1.4 Pupal period

The pupal period of the pest was studied by observing the same larvae for pupation inside or outside the leaf mine. This was maintained and the observation was made till the adult

emergence. The period between formation of pupae till the adult emergence was noted as pupal period.

### 2.1.5 Adult longevity

The adults emerged from the pupa was introduced individually in to a glass tube to study the fecundity and longevity. Fresh tomato leaves were provided in to glass tube for food and oviposition. The leaves were changed after 24 hours and the older leaves confined to another glass tube for emergence of progenies. Observations on fecundity, longevity and ovipositional period of adults were recorded. The statistical analysis was carried out by mean ± standard deviation method.

## 3. Results and discussion

### 3.1 Biology of serpentine leaf miner, *Liriomyza trifolii* (Burgess) on tomato

During the study, it was observed that the highest activities of the adult flies of *L. trifolii* were found in the morning hours in poly house as well as in laboratory. The results are presented here under.

#### 3.1.1 Egg stage

The female flies laid eggs near the margin of the leaves. It was observed that white or transparent eggs were laid singly and in close proximity to each other inside the epidermal tissue of leaves' upper surface. However, sometimes, the egg laying was also found on the central part of the leaves. While, the eggs were deposited on both *i.e.*, adaxial /abaxial surfaces<sup>[13]</sup>. Looking to the previous reviews<sup>[13]</sup> and present investigation, the egg laying behaviour of leaf miner is still not clear.

#### 3.1.1.1 Incubation period

The required days to hatch the eggs from the date of lay the eggs were considered as an incubation period of leaf miner. Immediately after the emergence of larvae it began to mine inside the tomato leaves. The recorded data (Table 1) revealed that incubation period was varied from 1.9 to 4.2 days with an average of  $2.57 \pm 0.65$  days at the temperature range of 22.4 to 28.9 °C and relative humidity 84.0 to 93.0 per cent. The results were in close conformity with the results of<sup>[18, 14, 7 & 20]</sup> as incubation period was  $3.39 \pm 0.62$ ,  $2.52 \pm 0.71$ , 3-4 and 2.5 days on tomato, respectively. Thus, the present investigations are in close agreement with the earlier findings.

**Table 1:** Period of different stages of tomato leaf miner, *L. trifolii*

S. No.	Particulars	Period (Days)			
		Min.	Max.	Av. ± S.D.	
1.	Egg period	1.9	4.2	2.57 ± 0.65	
2.	Larval period	1 <sup>st</sup> instar	0.91	1.42	1.10 ± 0.18
		2 <sup>nd</sup> instar	1.45	2.18	1.69 ± 0.28
		3 <sup>rd</sup> instar	1.63	2.54	1.97 ± 0.33
3.	Total larval period	3.99	6.14	4.76 ± 0.79	
4.	Pupal period	7.90	12.00	9.42 ± 1.15	
5.	Adult period	Male	3.50	6.20	5.05 ± 0.78
		Female	4.40	8.50	6.09 ± 1.15
6.	Total life period	Male	18.50	22.90	21.20 ± 1.15
		Female	21.50	26.00	23.42 ± 1.26
7.	Oviposition period of eggs	2.00	3.90	2.48 ± 0.54	

#### 3.1.1.2 Hatching percentage

The hatching percentage of leaf miner eggs were varied from 80 to 100 per cent with an average of  $90.44 \pm 5.56$  per cent (Table 2) at the temperature range of 22.4 to 28.9 °C and

relative humidity 84.0 to 93.0 per cent. 92 per cent of hatching on tomato<sup>[20]</sup>. Similar observations were also reported by<sup>[14, 4]</sup>.

**Table 2:** Hatching percentage of serpentine leaf miner, *L. trifolii* eggs on tomato

No. of eggs observed	Hatching percentage		
	Minimum	Maximum	Av. $\pm$ S.D.
50	80	100	90.44 $\pm$ 5.56

### 3.1.2 Larval period

Newly hatched larvae were observed individually up to pupation for the study of larval duration of this pest. The cylindrical and maggot like larvae just after the emergence was found colourless and it becomes darken to yellowish during consecutive instars. Larva mines in the tomato leaves in serpentine manner and moves forward by feeding the mesophyll content and so it destroyed the entire chlorophyll content of the mines. As the larvae develop, both the diameter of the mine and the rate of mine formation increased. Generally, the larva emerges from the leaves during early day light hours. From the present investigations, it was found that the larval stages of *L. trifolii* were passed through three different instars before entering in to the pupal stage. The description of each larval stage and total larval period are given as under.

#### 3.1.2.1 First instar

First instar larvae of serpentine leaf miner were colorless after hatching of eggs. The period of first instar larva (Table 1) was ranged from 0.91 to 1.42 days with an average 1.10  $\pm$  0.18 days and it was confirmed with the report of [12], who found 0.85 days of first instar larval period.

#### 3.1.2.2 Second instar

Second instar larvae of serpentine leaf miner were pale yellow-orange in colour. From the Table 1, it can be seen that the second instar larval period was ranged from 1.45 to 2.18 days with an average 1.69  $\pm$  0.28 days and it was in the conformity with the results obtained by [12], who found 1.23 days of first instar larval period.

#### 3.1.2.3 Third instar

The third instar larvae of *L. trifolii* were dark yellow-orange in colour. The third instar larval period (Table 1) was ranged from 1.63 to 2.54 days with an average 1.97  $\pm$  0.33 days. The third larval period was 1.42 days [12].

#### 3.1.2.4 Total larval period

The data on total larval period (Table 1) revealed that it was varied from 3.99 to 6.14 days with an average of 4.76  $\pm$  0.79 days at an average temperature of 26.12 °C and 85.14 per cent relative humidity. The average total larval period of 4.96  $\pm$  0.84 days on tomato at an average temperature of 27.09 °C and 87.14 per cent relative humidity [14]. The duration of larval periods was recorded with a mean of 2.87  $\pm$  0.33 days on tomato [18]. Hence, the present finding is in close agreement with the above findings.

### 3.1.3 Pupal period

As the larva becomes full grown and ready to pupate, it cuts a semi-circular slit at or near the end of the leaf mine. Larvae occasionally pupate on leaves or at base of leaves, stems or stalks. Pupation normally takes place inside the soil but under laboratory condition the larva easily pupated on sides and bottom of the rearing cage. The colour of pupa was almost similar to that of full-grown larva.

The pupal period was worked out by examining 25 larvae and data are given in Table 1. It is evident from the data (Table 1)

that pupal period of serpentine leaf miner was observed on an average 9.42  $\pm$  1.15 days with a range of 7.90 to 12.00 days at an average temperature of 26.6 °C and 84.2 per cent relative humidity. The same result on pupal period was recorded by [14, 8, 7 & 20], which was (12.28  $\pm$  1.82 days), (8.37  $\pm$  0.14 days), (5-7 days) and (8-10 days) on tomato, respectively. So, present findings are in close conformity with the above findings.

### 3.1.4 Adult longevity

It was observed that the adult flies immediately after the emergence from the pupa, climbed upon the wall of rearing cage. Adults usually emerged during early morning hours. The adult of *L. trifolii* was a small fly with yellow head and having plump red eyes. The thorax and abdomen were greyish black with a noticeable yellow patch at the hind end of mesonotum. The underside of the body and legs were mostly pale yellow. The fore wings were transparent and hind pair was modified into halteres.

The data in Table 1 revealed that the longevity of male and female adults was varied from 3.50 to 6.20 days with an average of 5.05  $\pm$  0.78 days and 4.40 to 8.50 days with an average of 6.09  $\pm$  1.15 days, respectively at an average temperature of 26.80°C and 85.2 per cent relative humidity. It was confirmed with the report of [14], who found average longevity of male and female adults of 4.96  $\pm$  1.059 days and 6.04  $\pm$  1.09 days, respectively at an average temperature of 27.80 °C and 75.55 per cent relative humidity. According to [15], female longevity was 3.8 days on tomato, while **the average longevity of male and female adults was 4.76  $\pm$  1.012 and 5.84  $\pm$  1.248 days, respectively on cucumber [10]. Hence,** the present findings are in close agreement with the earlier findings.

#### 3.1.4.1 Ovipositional studies

The majority of adults mate soon after emergence. The sexes may remain coupled for shorter period of time, while some were observed in hours also. Males and females mate more than once. Mating was observed at any time of the day, but it generally occurs during early morning hours. Most females begin oviposition after mating and the period up to which it laid eggs was considered as oviposition period.

The data in Table 1 revealed that the oviposition period varied from 2.00 to 3.90 days with an average of 2.48  $\pm$  0.54 days at an average temperature of 26.30 °C and 84.40 per cent relative humidity. Duration of average oviposition lasted for 2.41  $\pm$  0.63 days with range of 2.00 to 4.00 days of leaf miner on tomato [18]. The mean oviposition period lasted for 4.2 days of *L. trifolii* on watermelon [3]. Hence, the present finding is in close agreement with the findings of earlier researchers.

#### 3.1.4.2 Fecundity

The newly emerged male and female were released in a rearing cage having tomato plants. The female fly laid eggs inside the leaf tissues of upper surface of leaf. The eggs were counted and recorded. The results are summarized in Table 3. The data in Table 3 revealed that a single female laid on an average 101.84  $\pm$  36.07 eggs with a range of 50 to 174 under laboratory condition at the temperature range of 22.4 to 28.9 °C and 84.0 to 93.0 per cent relative humidity. The fecundity *L. trifolii* was recorded as 135 eggs on bean [2], 250 eggs on chrysanthemum [11], 380 eggs on castor [6]. Variation in fecundity of *L. trifolii* might be due to different hosts on which the pest was reared.

**Table 3:** Fecundity of serpentine leaf miner, *L. trifolii* on tomato

No. of female observed	Average no. of eggs / female		
	Minimum	Maximum	Av. $\pm$ S.D.
25	50.00	174.00	101.84 $\pm$ 36.07

### 3.1.5 Total life span

The duration of entire life span of *L. trifolii* from egg to death of adult was recorded and summarized in Table 1.

The data (Table 1) revealed that the entire life span of male and female fly of leaf miner was observed on an average of  $21.20 \pm 1.15$  and  $23.42 \pm 1.26$  days with a range of 18.50 to 22.90 days and 21.50 to 26.00 days, respectively at an average temperature of  $26.2^\circ\text{C}$  and 83.7 per cent relative humidity. The same result on total life span of leaf miner was recorded by <sup>[14]</sup> (average of  $20.50 \pm 0.87$  and  $23.00 \pm 1.12$  days), <sup>[9]</sup> (ranged from 19.9 to 24.69 and 21.32 to 27.59 days) for male and female fly on tomato, respectively. So, present findings are in close conformity with the above findings.

### 4. Conclusion

The average incubation period, hatching per cent (%), total larval and pupal period of *L. trifolii* were  $2.57 \pm 0.65$ ,  $90.44 \pm 5.56\%$ ,  $4.76 \pm 0.79$  and  $9.42 \pm 1.15$  days, respectively. The longevity & entire life span of male and female fly was  $5.05 \pm 0.78$  &  $21.20 \pm 1.15$  and  $6.09 \pm 1.15$  &  $23.42 \pm 1.26$  days, respectively.

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