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Population Abundance of the Serpentine Leaf Miner *Liriomyza trifolii* (Burgess) (Diptera: Agromyzidae) on Four Winter Host Plants

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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

Background: The American serpentine leafminer, *L. trifolii* (Burgess), is one of the most problematic insect pest species attacking large number of vegetable crops, weeds and, ornamentals.
Objectives: The purpose of this study is to investigate population abundance and host plant preference of *L. trifolii* on four winter host plants under Libyan conditions.
Methods: Four winter host plants were studied [broad bean (*Veciafaba*), pea (*Pisum sativum*), fenugreek (*trigonella finum gradum*) and snow thistle *(Sonchus oleraceus*)]. The experimental field was about 1600m^2 which divided to 12 equal plots (4 plots for each plant). Hundred leaflets infested with *L. trifolii* were taken from each host plant. Samples were kept in plastic bags and transferred to be examined in the laboratory. Number of living *L. trifolii* larvae were counted and recorded.
Results: Four winter host plants were targeted for this study [broad bean (*Veciafaba*), pea (*Pisum sativum*), fenugreek (*Trigonella foenum graecum*) and snow thistle *(Sonchus oleraceus*)] during the

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growing season 2018/2019 in Alejelat region. *L trifolii* showed low populations in December on all studied host plants. then, developed high populations in February and March then the population decreased till the end of the growing season. *L trifolii* recorded four peaks of abundance on all host plants, except snow thistle (3 peaks) the highest peak recorded 488, 322, 152 and 187 individuals/ 100 infested leaflets on broad bean, pea, fenugreek and snow thistle respectively.
L. trifolii showed its highest monthly average numbers in February on Broad bean, Pea and, Fenugreek recording (383.25 ± 81.05, 256.75 ± 55.18 and, 101.5 ± 37.36 individuals / 100 infested leaflets) respectively and, (153.27 ± 27.10 individuals / 100 infested leaflets) for Snow thistle in April. On the other hand, the lowest monthly average numbers occurred in April on the four studied host plants recording (240.71 ± 113.11, 176.48 ± 59.22, 71.28 ± 24.05 and, 106.28 ± 47.73 individuals / 100 infested leaflets).

Keywords: Abundance; leafminer; L. trifolii; host plant.

1. INTRODUCTION

Agromyzidae is a family of small flies whose larvae feed on the internal tissue of plants, often as leaf miners and stem miners. The majority of Agromyzids are either host-specific or oligophagous. However, a few highly polyphagous species including *Liriomyza* genera have become agricultural and horticultural pests in many parts of the world [1]. *L. trifolii* is originally from North, Central and South America, has been spread to large parts of Europe, Africa, Asia and the Pacific [2]. It is highly polyphagous and has been recorded from 25 plant families [3] and, more than 400 cultivated and wild plant [4]. The most economically important crops it attacks are beans, celery, chrysanthemums, cucumbers, gerberas, *Gypsophila*, lettuce, onions, potatoes and tomatoes [5]. According to Schuster et al. [6] found that the nightshade *Solanum americanum*; Spanish needles, *Bidens alba*; and pilewort, *Erechtites hieracifolia*; were suitable weed hosts in Florida. According to Mothershead [7] and, Robin [8] added that, the vegetable leaf miner, *Liriomyza sativae*, and the serpentine leaf miner L. *trifolii* are major pests of solanaceous and cucurbit crops.

L. trifolii larvae undergoes their development in the plant leaf tissue and forms serpentine mines within the leaves. Damage is caused mostly by larvae that feed their way inside the plant mesophyll, and adult females' puncture both upper and lower leaf surfaces to feed and deposit eggs. This behavior decreases the plant's photosynthesis, provides entry sites for phytopathogens, and reduce the aesthetic appearance of leaves [9,10]. Moreover, *L. trifolii* larvae mine the upper surface of the leaves between leaf veins, and mines are normally long, linear, and narrow, although the shape is strongly influenced by the host plant and leaf size. *L. trifolii* pupates externally, either on the foliage or in the soil just beneath the surface. Pupa is adversely affected by high humidity and drought. On average, females live longer than males [11]. Under the current temperature conditions, potentially 20–32 generations per year can develop in tropical countries, 12–20 generations per year in most of the subtropical regions, and 3–12 generations per year in temperate zones. For the Mediterranean region, 12–20 generations per year were predicted [12]. Furthermore *L. trifolii* is considered one of the three most-damaging polyphagous leaf miners of horticultural crops in the New World [13]. Leaf miners have a relatively short life cycle. The time required for a complete life cycle in warm environments is often 21–28 days, so numerous generations can occur annually in warm climates [14]. On the other hand, [15] and [16] recorded 3-4 peaks of abundant of *L. trifolii* on even winter or summer host plants in Egypt and the same number of peaks recorded by [17] and [18] on broad bean in Libya.

A physiological responses of potato to leafminer, *L. trifolii* were evaluated in Kearney, Nebraska, USA. The leaflets were examined 7 and 14 days post infestation for leaf area injury, photosynthetic rates and fluorescence. Leafminers caused up to 13% leaf area loss due to leafminer injury with no effect on the photosynthetic rates of the remaining leaf tissue thus having similar effects as other gross tissue removers. However, fluorescence measures revealed changes in the photosynthetic efficiency and depend of the type of injury it may lead to early leaf senescence [19].

It is clear that, *L. trifolii* has become a cosmopolitan species and is reported as a pest for large number of vegetables, filed crops, ornamentals, weeds and, also is abundant in greenhouses. Therefore, the present investigation to study the Natural abundance of the serpentine leaf miner *L. trifolii* in, Libya. On the other hand, Parasitism has not been considered in the present study, which aimed also to investigating the effects of host plant role on the populations of *L. trifolii*

2. MATERIALS AND METHODS

The present study was carried out in Alejelat region. Four winter host plants were targeted for this study [broad bean (*Veciafaba*), pea (*Pisum sativum*), fenugreek (*Trigonella foenum graecum*) and the associated weed snow thistle *(Sonchus oleraceus*)] during the growing season 2018/2019. The experimental field was about 1600m^2. which divided to 12 equal plots (4 plots for each plant). Hundred leaflets infested with *L. trifolii* were taken from each host plant. Samples were kept in plastic bags and transferred to be examined in the laboratory. leaflets were dissected under a strew binuclear microscope (48X). Number of *L. trifolii* larvae were counted and recorded. Normal agricultural practices of fertilizing and irrigation were followed and no chemical control measurements were applied. Samples took place from the appearance of the emergence of the first leaves and continued weekly until harvest.

3. RESULTS

Data presented in Figs. (1,2,3 and,4) shows the population abundance of *L. trifolii* larvae on four winter host plants.

3.1 On Brad Bean

L. trifolii larvae recorded low numbers in the beginning of the season in early December, then the population increased recording four peaks of abundance (333, 488, 398 and 256 individuals/ 100 infested leaflets) occurred in 7th of January, 4th of February, 4th of March and, 25th of March respectively.

3.2 On Pea

L. trifolii larvae recorded low numbers in the beginning of the season in early December, then the population increased recording four peaks of abundance (201, 282, 322 and 261 individuals/ 100 infested leaflets) occurred in 24st of December, 21th of January, 11th of February and, 11th of March respectively.

3.3 On Fenugreek

L. trifolii larvae recorded low numbers in the beginning of the season in early December, then the population increased recording four peaks of abundance (129, 119, 152 and 81 individuals/ 100 infested leaflets) occurred in 31st of December, 28th of January, 18th of February and, 25th of March respectively.

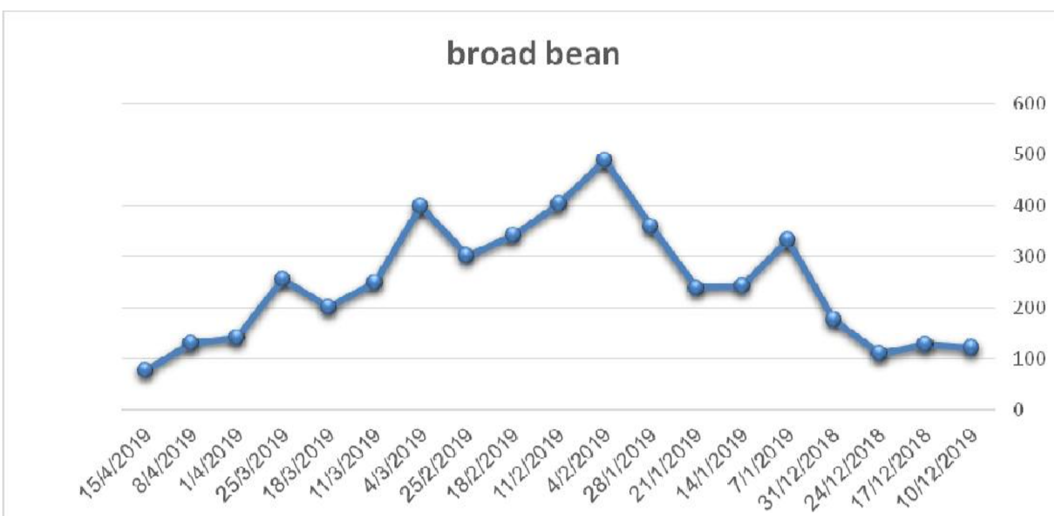

Fig. 1. Population abundance of the serpentine leaf miner *L. trifolii* on broad bean

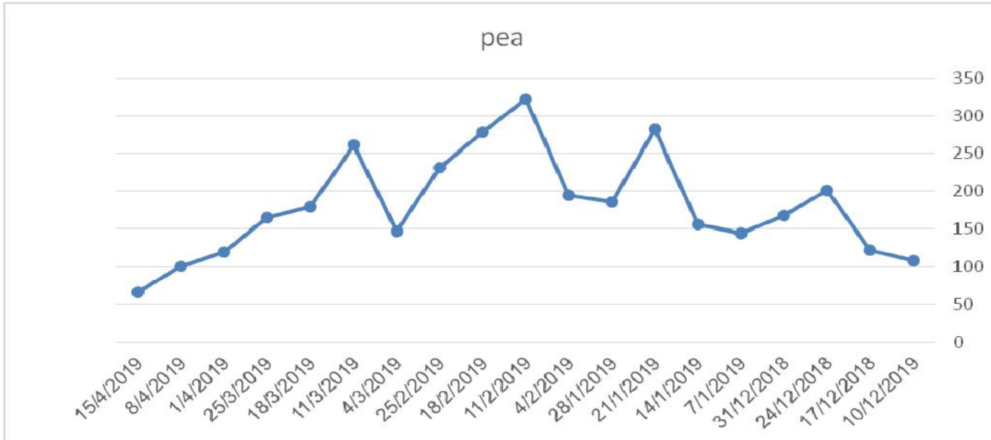

Fig. 2. Population abundance of the serpentine leaf miner *L. trifolii* on pea

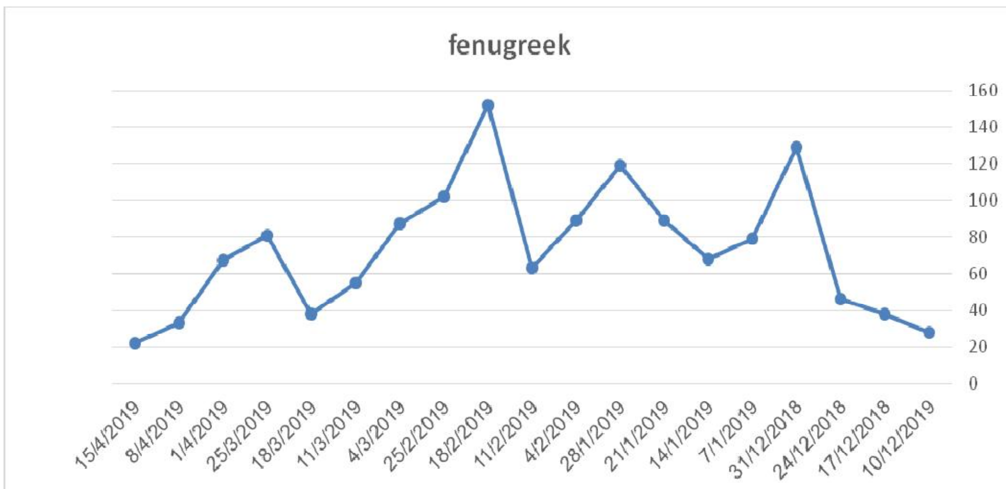

Fig. 3. Population abundance of the serpentine leaf miner *L. trifolii* on fenugreek

Fig. 4. Population abundance of the serpentine leaf miner *L. trifolii* on snow thistle

3.4 On Snow Thistle

L. trifolii larvae recorded low numbers in the beginning of the season in early December, then the population increased recording three peaks of abundance (161, 169 and 187 individuals/ 100 infested leaflets) occurred in 7tht of January, 4th of February and, 11th of March respectively.

As shown in Table 1 *L. trifolii* showed its highest monthly average numbers in February on Broad bean, Pea and, Fenugreek recording (383.25 ± 81.05, 256.75 ± 55.18 and, 101.5 ± 37.36 individuals / 100 infested leaflets) respectively and, (153.27 ± 27.10 individuals / 100 infested leaflets) for Snow thistle in April. On the other hand, the lowest monthly average numbers occurred in April on the four studied host plants recording (240.71 ± 113.11, 176.48 ± 59.22, 71.28 ± 24.05 and, 106.28 ± 47.73 individuals / 100 infested leaflets).

As shown in Fig. 5 *L. trifolii* showed high preference towards broad bean followed by pea, snow thistle and, fenugreek respectively.

4. DISCUSSION

The population of *L. trifolii* larvae showed (3- 4) peaks of abundance on all studied host plants, recording low populations in the beginning of the growing season, then reaching its highest peaks in February and March, then the population decreased towards the end of the growing season. Similar results for *L. bryoniae* were obtained by [20] who found that *L. bryoniae* recorded the same number of population peaks on broad bean, mallow, pea and, snow thistle as winter host plants under Libyan climatic

Table 1. Monthly average numbers of the *L. trifolii* larvae on four winter host plants

Months	Broad bean	Pea	Fenugreek	Snow thistle
December	134.25 ± 29.46	150.25 ± 42.16	60.25 ± 42.42	55.25 ± 20.71
January	293.75 ± 61.92	191.75 ± 62.57	88.75 ± 21.91	127.5 ± 25.75
February	383.25 ± 81.05	256.75 ± 55.18	101.5 ± 37.36	140.75 ± 20.30
March	276.0 ± 84.92	188.0 ± 50.39	65.25 ± 22.86	153.27 ± 27.10
April	116.33 ± 34.42	95.66 ± 27.39	40.66 ± 23.45	54.66 ± 25.77
Mean ± S. D	240.71 ± 113.11	176.48 ± 59.22	71.28 ± 24.05	106.28 ± 47.73

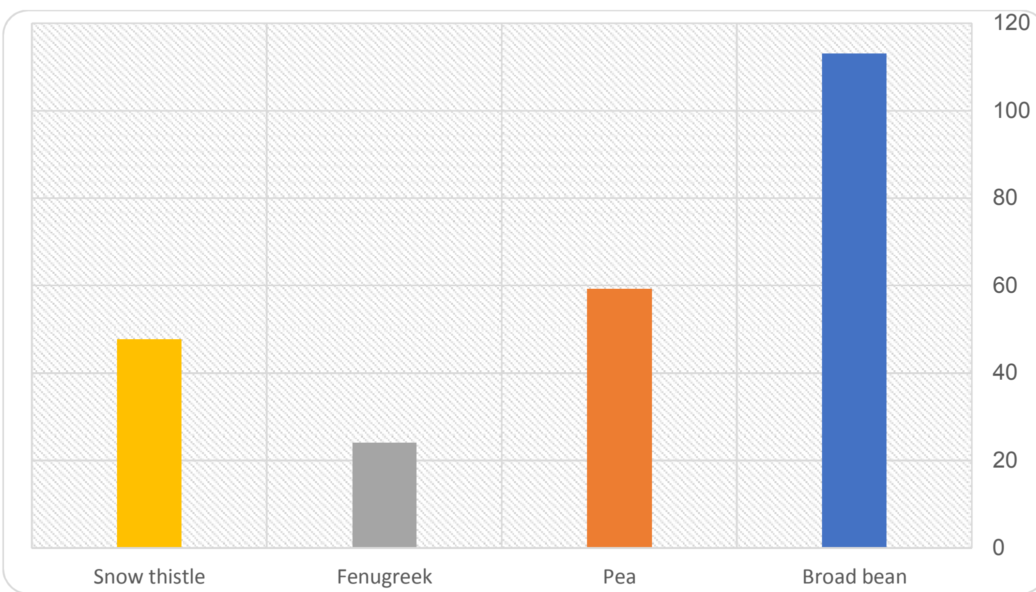

Fig. 5. Host plant preference by the serpentine leaf miner *L. trifolii* as affected by monthly average means for the studied host plants

conditions. These results are also in agreement with those of [15] who found that the *L. trifolii* recorded the same number of population peaks on broad bean, fenugreek and, sour clover as winter host plants under the Egyptian climatic conditions. These results are also in line with those of [11] who found that, *L. trifolii* could developed, 12–20 generations per year in Mediterranean region.

L. trifolii showed high preference towards broad bean followed by pea, snow thistle and, fenugreek respectively. It is clear that the heavy foliated legume plants are more preferred host plants for *L. trifolii*. [21] stated that, host plants of *L. trifolii* are found in 27genera of the Compositae which is almost 40% of the total number of hostplant genera. The next Preferred family are the Leguminosae, in which 10genera (almost 15%). On the other hand, the preference of *L. trifolii* towards snow thistle (Asteracea) than fenugreek may be related to the great foliage area of snow thistle compared with fenugreek.

According to Nuessly and Nagata [22] *L. trifolii* females showed a preference for fully expanded leaves in the upper middle portion of lettuce plants for feeding and/or oviposition. Moreover, a positive relationship between leaf area and the number of mines per leaf was demonstrated by [23] in *L. huidobrensis* on cucumber, Swiss chard, and beans. The present finding supported by the theory suggested by [24] of optimal foraging, which postulates that insects choose hosts that maximize adult performance and fitness rather than offspring performance.

A total of 28 parasite species of *L. trifolii* have been identified [25]. With regard to this finding, it could be noticed that, the populations of *L. trifolii* on different host plants whether they are winter or summer hosts is always under a high pressure of the parasitoid complex so, the population of *L. trifolii* has a great fluctuations on most studied host plants. On the other hand, the relatively high abundance of *L. trifolii* in the beginning of the season may be due to the low abundance of the larval pupal endoparasitoids. While the larval ectoparasitoid *D isaea* could successfully keep the population of density of *L. trifolii* under control during the growing season.

Facknath [26], suggested that, the selection pressure and evolution of the ovipositional preference exhibited by *L. trifolii* adults for the older, larger, thicker and lower leaves of the potato plant may be dictated by factors other than resource quality for larvae, such as easier feeding and oviposition conditions, increased longevity and fitness for adults, at the expense of maximum nutritional/chemical suitability for larval development. This finding could support our data because the heavy foliated host plants (broad bean and pea); which also have a larger and thicker foliage hosted large numbers of *L. trifolii* compared with the other two host plants. Furthermore, our results could be supported by those of [27] who suggested that, trichomes also play an important role in host acceptance and colonization by *Liriomyza* spp. The numbers of trichomes per leaf remaining constant, leaf expansion with age results in lower trichome densities in the older leaves. The larger surface of area, and fewer trichomes on, lower leaves may be important factors contributing to the preference of *Liriomyza* for these leaves. This finding could explain the low abundance of *L. trifolii* on fenugreek. A similar results were carried out by [15] on sour clover as a winter host plant.

Lower larval survival on the smaller leaves could also be due to intraspecific competition among larvae. Spatial confinement maximizes intraspecific effects by concentrating individuals on the same restricted resource. [28] has demonstrated that intraspecific competition in *L. trifolii* leads to the development of smaller larvae, smaller and fewer pupae, and smaller and less vigorous adult females. According to Tuomi *et al.* [29] showed that larval mass decreased significantly with increasing numbers of larval mines per leaf. Furthermore, the cannibalism exhibited by *Liriomyza* larvae under conditions of competition [30], can also have an important bearing on larval survival.

5. CONCLUSION

L. trifolii larvae showed (3- 4) peaks of abundance on all studied host plants, recording low populations in the beginning of the growing season, then reaching its highest peaks in February and March, then the population decreased towards the end of the growing season. On the other hand, *L. trifolii* showed high preference towards broad bean followed by pea, snow thistle and, fenugreek respectively. Moreover, the host plant leaflet size and the foliar plant density and morphology could play an important role of the infestation by *L. trifolii*

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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