Seasonal abundance of eggplant leafminer Liriomyza sativae (Blanchard, 1938) (Diptera, Agromyzidae) in plastic-house

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Abstract. The eggplant Solanum melongena L. crop is attacked by one of the most common pests which is the leafminer Liriomyza sativae (Blanchard, 1938); therefore, this investigation was conducted to study the seasonal abundance of the eggplant leafminer in eggplant Plastic-house. The results showed that the highest average of infested leaves was 6.67 leaf, the highest average of tunnels by leaf miner was 9.87 tunnels and the highest percent of infestation was recorded 30.5% in 23. April 2017. This study showed the parasitoid Diglyphus isaea (Walker, 1838) (Hymenoptera, Eulophidae) was recorded as a natural enemy to control the pest and the highest incidence of parasitism was 32.2 parasites on average in 16. April 2017.

1. Introduction
Eggplant S. melongena L. is an important and main agricultural crop that belongs to the Solanaceae family; it contains more than 1400 species that grow on all continents except Antarctica [1]. The family Solanaceae includes tomato, potato, tobacco, and petunia, and contains economically important species, because it is a food source such as potato, tomato or pharmaceutical important or ornamental plants [2]; the eggplant found as a wild crop in India and then distributed to other countries [3] and attacks by many pests, such as: mites, aphids, whiteflies and leafminers [4].

The leafminers are a well-known group of small and similar to flies in morphological features. There are about ten thousand species of leaf miners belong to insect orders, such as, Coleoptera, Diptera, Lepidoptera, and Hymenoptera [5]. The damage by leafminer pests is caused by both larvae and adults; adult females puncture the leaf epidermis with their ovipositor to feed and lay eggs, while larvae mine the palisade mesophyll and consumed the parenchyma tissue 'figure 1' thereby disrupting photosynthesis and cause falling the leaves causing bacteria and fungi attraction [6].

The plant leaves are more attractive to the adult females oviposition and the lower leaf surface is more infested than the upper surface [7]; the control of this pest generally is complicated because of protected habit of leafminers larvae [8]. All Agromyzid species have a very similar lifecycle [9]; in Iran, the study by [10] who reported that the adult of this insect takes eight days, egg stage takes six days, larval stage takes four days with three instars, pupa stage takes from two to seven days till two months depending on the environmental conditions. The duration of each generation is 18-25 days. There are five species belonging to five genera under three families, the parasitoids are: Diglyphus isaea (Walker, 1838), Pediobius metallicus (Nees, 1834), Cirrospilus vittatus (Walker, 1838), and Halticoptera circulus (Walker, 1838) of Agromyza [11]; at least 114 species have been recorded as leafminers in Australia [12].

Due to a few studies of leaf miners in Iraq, therefore, the purpose of this study was to evaluate the biological outcomes of leaf miner Agromyza sp. On eggplant leaves in glasshouses.
2. Materials and Methods

2.1 Study area

The present study was conducted in the plastic house of the College of Agriculture/ University of Baghdad, Iraq during the spring planting season for the period of March to May 2017; in order to study the biological aspects of leafminer on eggplants, the Hagen AL-Mustakabel variety of eggplant was planted in glasshouse (5 m wide x 36 m length x 3 m high) in ten lines and as a five split plots, the space between each plant and other was 70 cm.

2.2 Insect collection

The average of the number of the total leaves per plant, average of infested leaves per plant, average numbers of tunnels per leaf and infestation percentages during months were counted from 19. March. 2017 to 28. May. 2017. In order to identify the leafminer species, the five eggplant leaf samples were chosen randomly and kept in plastic cases with all information (date and plant length) and took to the laboratory in order to get the parasites that preserved in 70% alcohol to send to the Natural History Research Center and Museum/ University of Baghdad for the purpose of identification.

3. Results and Discussion

The data that presented in (table 1) showed that the highest average of the total number of leaves of eggplant plants 55.33 leaves/plant was counted in 21. May. 2017; while the lowest average of the total number of leaves of eggplant plants 5.20 leaves/plant was counted at the beginning of the growth season in 19. March. 2017 then increase to 7.53 leaves/plant at the beginning of April until the end of April reached to 21 leaves/plant.

The first infestation of leaf miner was recorded at the beginning of growth season and the results were low 0. 3 infested leaves/plant. Later, numbers of infested leaves were increased until it reached its peak 6.67 leaves/plant in 23. April. 2017 with significant differences between months. The results also showed that the lowest number of tunnels was 0.67 in 19. March. 2017 then increased to the highest (9.87) in 23. April. 2017. These results are consistent with a study by Flaih [13] who found that the infested leaves by leaf miner and the average number of tunnels per leaf increased gradually then reached the highest when cucumber plant growth reached their the maximum.

The results in ‘figure 2’ showed that the infestation percentage of eggplant by leafminer L. sativae; the highest was 30.5% in 23. April. 2017, while the lowest 2.2% that recorded in 28. May. 2017.

Many important economic crops in the world are often attacked by leafminer that can cause significant yield losses; for example, the L. sativae reduce tomato and onion crops production by 80% In Florida [14]; in another investigation the L. sativae reduce tomato production by 70%. Leafminer control with the natural wasp parasitoides, including, Diglyphus isaea (Walker), Diglyphus crassinervis (Erdös), Pediobius metallicus (Nees), Neohcrysocharis formsa (Westwood), Cirrospilus

Figure 1. The damages of eggplant leaves by leafminer
vittatus Walker, Halticoptera circulus (Walker), Opius sp. and Ratzeburgiola incomplete Boucek [15, 16].

The highest percentage of parasitism of the parasite Diglyphus isaea on leafminer L. sativae was 32.2% in 16. April. 2017, while the lowest percentage of parasitism was 2.5% in the beginning of the study 19. March. 2017 ‘figure 3’. These results are consistent with a study [17]; in this investigation, the highest percentage of parasitism of Neohcrysocharis formas on weed leafminer Phytomyza horticola was 35%

**Table 1.** The averages of total number of leaves per plant, average infested leaves per plant and average numbers of tunnels per plant during study period

| Date       | Average of total number of leaves/plant | Average of infested leaves/plant | Average number of tunnels/leaf |
|------------|----------------------------------------|---------------------------------|-------------------------------|
| 19/03/2017 | 5.20                                   | 0.30                            | 0.67                          |
| 26/03/2017 | 6.27                                   | 0.67                            | 1.13                          |
| 02/04/2017 | 7.53                                   | 1.33                            | 3.73                          |
| 09/04/2017 | 8.27                                   | 1.33                            | 7.00                          |
| 16/04/2017 | 10.60                                  | 1.47                            | 8.80                          |
| 23/04/2017 | 15.87                                  | 6.67                            | 9.87                          |
| 30/04/2017 | 21.00                                  | 5.00                            | 8.00                          |
| 07/05/2017 | 32.33                                  | 2.00                            | 8.20                          |
| 14/05/2017 | 44.93                                  | 3.67                            | 5.93                          |
| 21/05/2017 | 55.33                                  | 1.33                            | 3.40                          |
| 28/05/2017 | 54.80                                  | 1.27                            | 0.93                          |
| L.S.D      | 4.70                                   | 2.55                            | 1.03                          |

**Figure 2.** The infestation percentages of eggplant leaf by leaf miner L. sativae.
Figure 3. The percentage of parasitism of the parasite Diglyphus isaea on leafminer L. sativae.

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