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SEASONAL ABUNDANCE OF *LIRIOMYZA SATIVAE* (BURGESS) (DIPTERA: *AGROMYZIDAE*) AND ITS PARASITOIDS ON OKRA PLANT IN BAGHDAD, IRAQ

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Abstract

A study was conducted to investigate the population density, percentage of infection and intensity of *Liriomyza sativae* on okra plant in one of the experimental fields at the Faculty of Agriculture, University of Baghdad -AL Jadriya. The obtained results showed that the highest peak for virgins reached 2.06 parasite/leaf on 4 of April 2016 as well as the presence of 6 peaks, and the highest density of the adult was6 1.2 parasite/leaf on 3 of August 2016. The presence of incomplete Ratzeburgiola (which belongs to Hymenoptera species and Pteromalidae family) was noted and the highest peak reached 0.53 parasite/leaf while the percentage of parasitism was 100% and varied according to the months to be decreased at the end of the season because of the lack of lesion and death of the crop. The highest intensity of the level of infection was 3 parasite/leaf to suit the plant in terms of leaf area and the availability of nutrients for the growth and development of the insect as well as it was found that the highest percentage of infection amounted to 100%.

Key words : *Liriomyza sativae, Abelmoschus esculentus,* population density

Introduction

Abelmoschus esculentus (okra, Combo) belongs to the Malvaceae family and is one of the most important and widespread summer vegetable crops (Kedar *et al.,* 2014). It is cultivated in all parts of Iraq from early March and continues until late May and it considered as annual plant that lives more than a year in the same soil especially when the winter is warm. It is believed that the original home of okra was Middle Africa while others believed that the Nile Valley was the original home and transferred to Europe after the Arab conquest of Spain and then transferred to America after they were discovered (Muhammadi and Abdul-Jabbar, 1989). Additionally, it is nutritional importance due to the content of carbohydrates, proteins and valuable nutrients such as calcium, magnesium, phosphorus and vitamins. Its flowers were also used after boiling for medicinal purposes (Alwan and Firas, 2010).

The okra plant was infected with a variety of insect and non-insect pests, including aphid, thrips, white flies, mites, and leaf miners (Burgess, 1880) *Liriomyza sativae*, which was recently recorded on the okra by Jurani *et al.,* (2017). The damage caused by leaf miners with their plant families was through the activities and feeding of adults and larvae. The adults make punctures on the surface of the leaf through the egg-laying machine to feed them first and then lay the eggs later. These holes were also used by males for the purpose of nutrition, either the damage of the larvae and after hatching of eggs begin to work tunnel in the mesophilic tissue of the leaf to feed on its contents which was initially narrow and thin and then widen with the progress of the larva in evolution and size. The feeding rate of the third larval age was found to be 50 times higher than in the first larval age. Parrella *et al.,* (1985) pointed that the larvae of leaf miners (*Liriomyza sativae)* make a twisted tunnel in the plant leading to destroy the mesophilic tissue and reducing the process of photosynthesis causing a fall in plant leaves and through these tunnels the bacteria and fungi enter and ultimately reduce the value of the product and reduce the value of marketing.

Evryen (2008) notes that the *Lambioyza sativae* has a wide spread as it feeds on annual vegetable crops. Varela *et al.,* (2003) indicated that okra plant was exposed to *L. trifolii* and *Liriomyza sativae*, an important pests that is frequently found on tomatoes. Furthermore, Mau and Martin kessing (2007) reported that there were 47 vegetarian species belonging to 10 plant families attacking by *Liriomyza sativae*, including celery leaf miners. They are an economic pest on the Solanaceae family and Cucurbitaceae family. They also attack annual crops such as okra plant and chrysanthemum plants. The okra plant is ranked third among the main vegetable crops in Sudan. It is attacked by a number of pests, including *Lirimoyza* spp. There are more than 300 species, and two species were recorded in Sudan (Fadwal *et al.,* 2012). Al-Gusani *et al.,* (2016) detected that *Larimoyza sativa* caused infection rate of 75% in cucumbers plant while *hryomatomyia horticola* resulted in 48.3% in the milk plant. Leibee (1984) studied the life cycle of the *Liriomyza sativae* and found that it was short in Florida, between 21-28 days at 25 ° C, taking 19 days from the egg laying until adult maturity. The same researcher added that eggs need 2.7 days for hatching and the three larval ages need 1.4 - 1.8 days for growth and the virgin need 9.3 days to develop and the pre - egg time was 1.3 days as a general average at 30 ° C. Mikenbery (1988) explained that the critical temperature for growth and development was 6-10 ° C and that eggs need at least to develop more than 12 ° C. In addition, the female absorbs the plant juice and has a short life cycle, 19 days of laying eggs to exit the adult at 25 ° C. The rate of laying eggs between 400-200 eggs on celery and the duration of the virgin stage of 11 - 8 days under glass house conditions. Falih and Hamza (2009) noted that there were a number of parasites attacking leaf miners on ornamental plants that reduce their population density. These parasites are: *Diglyphus begina* (Ashmead), *D. intermedius* (Girault), *D. pulchripes*, and *Chrysomcharis parksi*. Due to the presence of the pest on the okra plant and the absence of previous studies in the area of the study as well as the damage of the insect on many crops, this study was proposed to investigate the population density, percentage of infection and severity on the okra plant and the diagnosis some of the parasitic insects.

Materials and Methods

An experimental field was selected in the Faculty of Agriculture / University of Baghdad / Al-Jadriya with an area of 400 m^2. After plowing, settling and adjusting, the field was divided into lines with 60 cm width for each line and the distance between lines was 80 cm. The seeds of okra plant were from batra specie (local type) and planted on both sides of the lines on the first days of Marc and 2 seeds were planted in one hole and the distance between hole and another 30 cm. When the germination was completed, one plant was left in each hole and all the agricultural operations required to serve the crop were presented (Obeidi, 1980). The field was divided into three equal parts and after the composition of leaves samples were taken weekly at a rate of 10 leaves from each section of the experimental field and in the orthogonal way. The leaves of each department were placed in a special bag and then transferred to the laboratory. The number of larvae and virgins was calculated in each leaf, and the leaves were placed separately in the petri dishes to obtain adult females and parasites. Additionally, the samples were taken from the first week of April and continued throughout the crop growth to the first week of October. Samples were saved in glass tubes with 70% alcohol preservative were sent to the Natural History Museum for diagnostic purposes.

Seasonal presence and population density

The seasonal presence and population density of insect stages (larvae, virgins and adults) was determined through the weekly sampling program.

Percentage of infection

The percentage of infection was calculated using symptoms or signs of infection on weekly samples and using the following formula:

Infected leaves (%) = (Number of the infected leaves) / (total leaves number) × 100

Intensity of injury

The severity of the infection was estimated in conjunction with the study of the seasonal presence and the numerical density. The samples that represent the weekly density of the insects were calculated to estimate the severity of injury (Jubouri, 2010) by calculating the number of tunnels on the leaves which indicates the following criteria based on the number of tunnels per leaf

0	Un damaged leaves
1	Number of tunnels 1-5
2	Number of tunnels 5-10
3	Number of tunnels 10-15
4	Number of tunnels 15-20

The following equation was used to calculate the severity of injury (Mckinneg, 1923).

Severity of injury= (Number of tunnels with degrees of 0×0) + (Number of tunnels with degrees of 1×1) + (Number of tunnels with degrees of 2×x2) + (Number of tunnels with degrees of 3×3) + (Number of tunnels with degrees of 4×4) / (Total leaves number).

Results and discussion

The rates of virgins per leaf were indicated (Fig. 1). There was a fluctuation in the density of *Liriomyza sativae* on the *Abelmoschus esculentus* throughout the crop season. The results showed that there were 6 peaks of the leaves of *Liriomyza sativae* at a density rate of 2.06 parasite/leaf on 4 of April 2016, the tunnel maker preferred leaves of high moisture content for egg laying and nutrition while the leaves whose walls were thick, low-moisture and age-old (wei *et al.,* 2000) were not preferred with the lowest rate of 0.13 on 7 of November 2016. The results showed that there were changes in the population density for the period from 23 of June to 27 of July 2016 with a rate of 1.4, 1.13, 1.26 and 1.13 parasite/leaf respectively, followed by a sudden increase of 1.86 parasite/leaf on 4 of July 2016 then decreased to the rate of 1.06 parasite/leaf on 11 of July 2016. Furthermore, it has been noted that a decrease in the number of parasites for the period from 14 of September to 7 of November 2016, fluctuated between 0.73, 0.33, 0.8, 0.45, 0.33 and 0.13) parasite/leaf respectively. These findings are consistent with the findings of I, *et al.,* (2014) who reported that *Liriomyza sativae* was 196 and 159 larva per 10 leaves and was close to the finding of the Falih, (2016) who found that the leaf L. *bryoniae* reached the highest population density of 10.33 on 7 of April 2014 parasite/leaf and the lowest rate of 1.33 parasite/leaf on 19 of February 2014. Additionally, the obtained results were in agreement with Abbas, (2018) who pointed that the number of generations was analyzed to 8 generation during the year, due to the large size of the leaf or the environmental conditions suitable for adults to lay eggs.

Fig. 1 showed the rate of the *Liriomyza sativae* numbers which had 6 peaks for the crop season and the highest peak rate was 1.2 parasite/leaf on 3 of August and 29 of August 2016 and the lowest rate of 0.13 parasite/leaf on 4, 12 and 13 of October 2016. It also showed that the highest rate of population density was 0.6 parasite/leaf on April and then increased and decreased in fluctuation form on May and June to reach the highest density of 0.53 parasite/leaf on 23 of June 2016 and the lowest rate of 0.4 parasite/leaf on 30 of June 2016, and then it was observed that the density of the population has gradually increased again and decreases once a month during July and August due to the environmental conditions. In September, the results of Fig. (1) showed that the highest density of the population was 0.53 parasite/leaf on 7 of September 2016 and the lowest was 0.4 parasite/leaf on 28 of September 2016. After that, the rates were decreased from February 2016 to reach 0.13 parasite/leaf which was due to the end of crop growth and the adults do not prefer old leaves.

The results of Fig. 1 showed that the numbers of the incomplete Ratzeburgiola, which included the presence of 5 peaks, and the highest peak reached 0.53 parasite/leaf while the lowest rate was 0 parasite/leaf on 19 of October 2016. Moreover, the numbers of the parasites were equal for the period from 4 of April to 11 of April followed by a sudden increase to reach rate of 0.26 parasite/leaf on 18 of April 2016, and then the rate was decreased to 0.4 parasite/leaf on 30 of June 2016. Then after, the number of parasites gradually rising to an average of 0.53 parasite/leaf while the numbers of parasites were equal on the same period from 10 of August to 31 of August with rate of 0.46 parasite/leaf followed by a sudden decline for the period from 7 of September to 19 of October to reach the lowest rate of 0 parasite/leaf. Abdul-Rassoul and Alsaffar (2014) reported that the numbers of parasites and parasitism rates were important to study each other's role in reducing pest numbers.

Fig. 2 showed the intensity of infection of *Liriomyza sativae* on the plant of *Abamia Abelmoschus esculentus*, the highest intensity of infection was 3 tunnel/leaf on 16 of April 2017 while the lowest infection rate was 0.4 tunnel/leaf at the end of the season. Fig. 3 showed the percentage of infection of *Liriomyza sativae* on *Abelmoschus esculentus* plant with the highest percentage of 100% for April, June and July while the lowest percentage of infection was 26.2% on November 2017. Furthermore, there were differences between the increase and decrease throughout the season where it was 73.1 %, 73.1-100, 86.2-100, 66.2-86.2%, 73.1-86.2%, 26.2-86.2% and 26.2% for months May, June, July, August, September, October and November. This was in line with the availability and optimum temperature for growth and humidity. These results were close to the finding of Abbas, (2018) who demonstrated that the percentage of infection with *Liriomyza sativae* was between 96.6% and 100%.

Fig. 2 shows the severity of *Liriomyza sativae* larvae on *Abelmoschus esculentus* plant. The results showed that the 2016 spring season was higher than the autumn season 2016, with the highest incidence of infection of 3 parasites/leaf on 11 of April 2016 while the lowest infection rate was 0.3 parasites/leaf at the end of the 2016 season. Additionally, the intensity of the injury fluctuated throughout the high and low season. The results also showed that the highest severity was 1.46 parasites/leaf for May, June and July 2016 followed by 1.5, 1

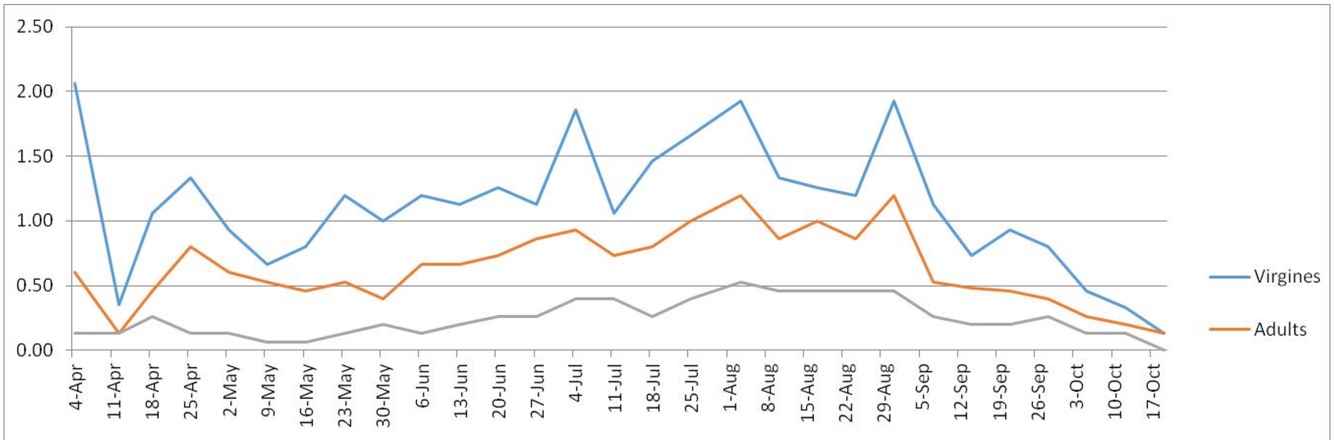

Fig. 1: The rate of the densities of virgins, adults and parasites of the *Liriomyza sativae* on *Abelmoschus esculentus* plant.

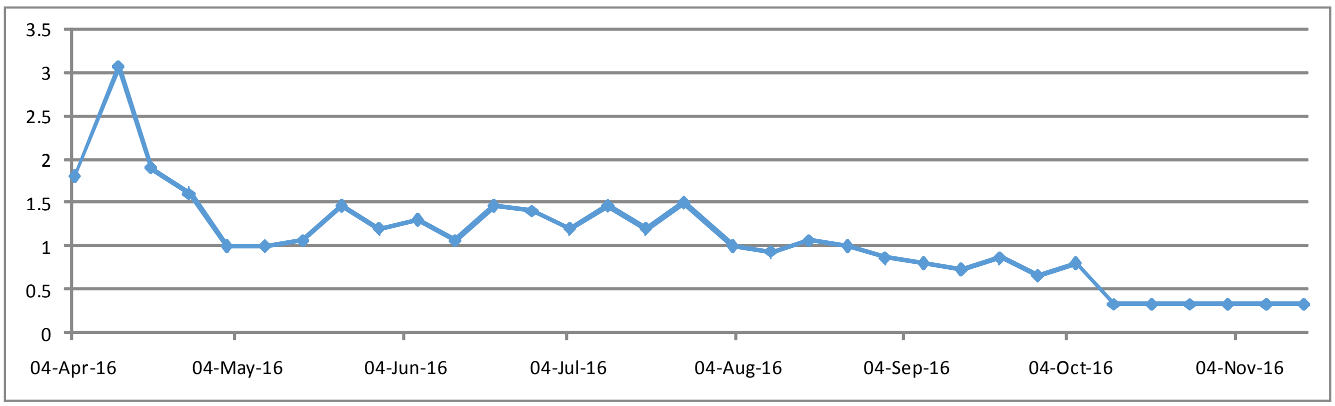

Fig. 2: The severity of injury to the leaves of *Liriomyza sativae* on *Abelmoschus esculentus* plant.

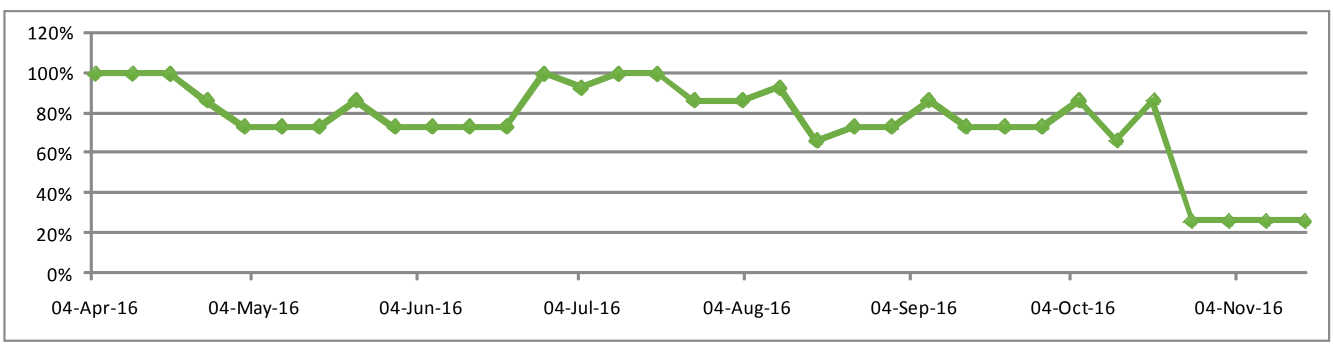

Fig. 3: The percentage of infection of *Liriomyza sativae* on *Abelmoschus esculentus* plant.

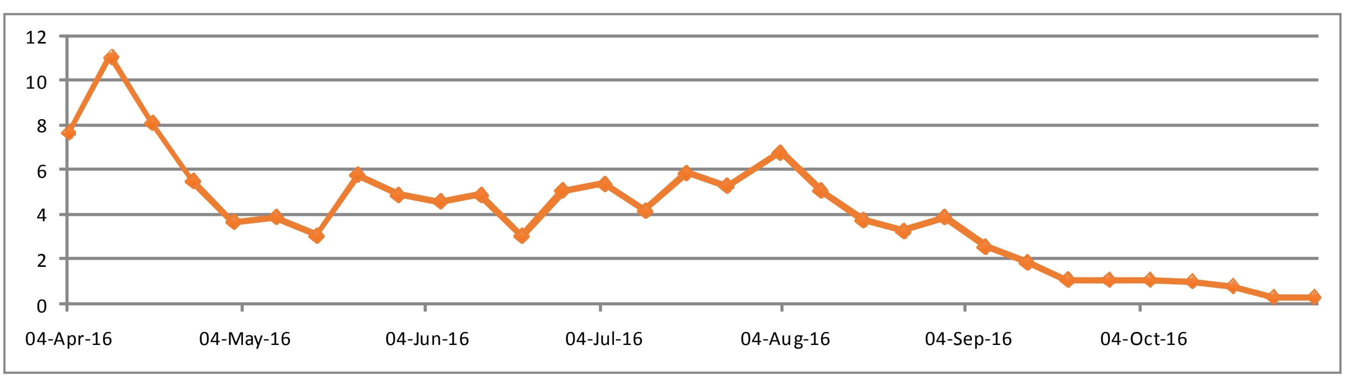

Fig. 4: The amount of tunnels for the injury of *Liriomyza sativae* on Abammoschus esculentus plant

parasite/leaf for August and September 2016 respectively. Then, the severity of infection was gradually decreased to reach 0.33 parasite/leaf on November 2016. It can be attributed to the end of the occurrence, the changes in the environmental conditions and the lack of the biological enemy and all these factors were considered as natural resistance factors (Zubaidi, 1995). This was due to the availability of suitable temperatures and humidity as well as the plant's suitability in terms of water and the availability of nutrients for the growth and evolution of the insect's roles. These results are consistent with finding of Abbas, (2018) who revealed that the highest density was 2.83 parasite/leaf and the lowest was 0.4 parasite/leaf. Fig. (4) shows the tunnels number of the *Liriomyza sativae*, with the highest density of 11.8 tunnel/leaf on 12 of April 2016 while the lowest number was zero tunnel/leaf as well as a decrease in the number of tunnels was recorded for April and May and the tunnel number continued to decrease and rise but within 4 - 6.1 tunnel/leaf to be reduced at the end of crop growth and completion on October. These results were close to the finding of Abbas (2018) who noted that the highest density of the number of tunnels per leaf amounted to 11.6 tunnel/leaf on 19 of October 2016.

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