Egypt. J. Agric. Res., 81 (4), 2003.

STUDIES ON THE LEAFMINERS; *LIROMYZA CICERINA* (RONDANI) AND *LIRIOMYZA BRYONIAE* (KALTENBACH) (DIPTERA: AGROMYZIDAE) AND THEIR PARASITOIDS IN FABA BEAN IN EGYPT

EL-SERWY S. A.

Plant Protection Research Institute, Agricultural Research Centre, Dokki, Giza, Egypt.

(Manuscript received March 2003)

Abstract

Liriomyza cicerina (Rondani) is a new recorded pest species attacking faba bean, *Vicia faba* L., at Damnhour and with *L. bryoniae* (Kaltenbach) at Sids and El-Zarka. *L. bryoniae* was found with *L. sativae* (Blanchard) and *L. congesta* (Becker) at Luxor. Mine density, larval and pupal parasitism were studied on untreated faba bean plants at Damnhour and Sids during 1999-2000 season. Mine density was generally higher at Sids than at Damnhour. It coincided 35.6, 37.3% and 1.6, 10.9% of larval and pupal parasitism. In both regions, mine density increased gradually then declined at the peaks of parasitism, after two weeks from infestation and during March. Larval parasitism and mine density harboured the highest levels on the lower and middle leaflets when compared with the other two levels. The majority of flies and larval parasitoids, which were *Diglyphus isaea* (Walker), *Hemiptarsenus zilahisebessi* (Erdös), "Chrysonotomia (*Achrysocharella*) sp.", *Pnigalio* sp. and *Cirrospilus* sp. (Eulophidae) emerged during the active season. Synchronization was found between time of host emergence and abundance of the larval parasitoid *D. isaea* in active season, but not in diapause season. Asynchrony was observed between the larval-pupal parasitoid *Opius* sp. (Braconidae) and flies, also, for *Halticoptera circulus* Walker (Pteromalidae) and *Chrysocharis* sp. (Eulophidae) in both seasons. The emerged flies species were *L. cicerina* at Damnhour and mainly *L. bryoniae* with a small number of *L. cicerina* and *L. sativae* at Sids. The population growth rates of larval parasitoids were lower than those of flies, which retarded the biological control, particularly at the beginning of the season. To conserve and promote parasitoids pesticides must be entirely avoided. Also, the bio-effectiveness of the parasitoids is indicated by the decrease in emergence flies from diapausing pupae. It is noteworthy to suggest that some agricultural practices i.e. spreading the harvested plants on plastic sheets to facilitate collection of the accumulated pupae, deeply plowing and dropping kerosene at a rate of 30 liter/feddan = 4200 m^2 into water irrigation can be used as safe and tactic control methods against pupae.

INTRODUCTION

In Egypt, the leafminers caused considerable losses in green and dry faba bean yields (Aly and Makady, 1990; Salem *et al.*, 1998). The leafminers *Liriomyza cicerina* (Rondani) and *Liriomyza bryoniae* (Kaltenbach) are the most serious pest species in faba bean (*Vicia faba* L.). Damage by agromyzids results from larval feeding on the mesophyll tissue although the formation of feeding punctures in the leaves by female ovipositors, also can cause significant damage (Spencer 1973; Parrella *et al.* 1985). Serveral authors studied the biology, ecology and parasitism of *L. trifolii* and *L. congesta* (Hafez *et al.*, 1974; Saleh *et al.*, 1983; El-Serwy, 1993 and 1994; Mesbah and Sherif, 1994).

The purpose of the work was to study some biological and ecological aspects of the leafminers and their parasitoids in order to promote and approach towards the control of these pests in faba bean.

MATERIALS AND METHODS

Two untreated faba bean fields (one feddan each) were selected at two sites: Damnhour(Behira Governorate - western Delta) and Sids (Beni-Sueif Governorate - Middle Egypt). Seven hundred infested leaflets were randomly collected from the detached leaves of different plants at two weekly intervals from December 20, 1999 at Sids and January 3, 2000 at Damnhour to March 28, 2000 in both regions. A hundred and fifty infested leaflets were collected from each of the lower, middle and upper leaves levels of five randomly-selected plants at biweekly intervals from Februray 14 to March 14, in each region. Also, additional samples of 700 leaflets were collected once on February 14 from infested fields at El-Zarka (Demmiatta Governorate - Eastern Delta) and by early March from Luxor (Qena Governorate - Upper Egypt).

In each sampling date, the detached vegetative leaflets were taken on a paper sheet in the laboratory. Healthy larvae (pupated) were collected and counted daily and placed in petri dishes (10 cm in diameter). Emerged flies and pupal parasitoids were collected, classified and recorded. Dried leaflets were placed into glass containers and daily-emerged larval parasitoids were also collected, classified and counted. After two months, puparia of emerged flies or pupal parasitoids were excluded and the remained

pupae are considered to be in diapause. They were collected and counted and placed in new petri dishes. Also, the dried leaflets were placed into new glass containers. Daily inspection resumed again on October 1, 2000 and emerged flies and pupal and larval parasitoid adults were collected, classified and recorded.

Mine density per leaflet was estimated by dividing the total number of live larvae, pupated and emerged larval parasitoids by the number of leaflets of each sample. However, larval or pupal parasitism rate was calculated by taking the sum of the number of emerged larval or pupal parasitoids and dividing by the total number of alive host larvae (pupated) plus emerged larval parasitoids or emerged flies and pupal parasitoids X 100. It could be calculated on each collection date by applying the following formulas:

$$\text{Mean no. of mines per leaflet} = \frac{\text{Total no. of (live larvae, pupated + emerged larval parasitoids)}}{\text{No. of infested leaflets}}$$

$$\text{Rate of pupal parasitism} = \frac{\text{Total no. of emerged pupal parasitoids}}{\text{Total no. of emerged flies and pupal parasitoids}} \times 100$$

$$\text{Rate of larval parasitism} = \frac{\text{Total no. of emerged larval parasitoids}}{\text{Total no. of (live larvae, pupated + emerged larval parasitoids)}} \times 100$$

RESULTS AND DISCUSSION

1. Mine Density

Mine density was generally higher at Sids than at Damnhour, with a general mean of 5 and 4 mines/leaflet, respectively. At the begining of the season, a mean of 4 mines/leaflet was found in both regions, Fig. 1a. It declined to 2 and 3 after two weeks then increased gradually to reach a maximum of 10 and 7 by late Februray at Sids and Damnhour, respectively. Afterwards, it declined to one mine per leaflet by late March, in both regions. Mine density was two fold greater at Sids than at Damnhour during mid-Februray to mid-March. It varied markedly at different plant levels. The general mean of mines was 4 per leaflet at the lower leaves in both regions. It reached a maximum of 5 and 11 and declined to 3 and 10 at the middle and upper leaves at Damnhour and Sids, respectively. The highest density 27 mines/leaflet was observed at mid-

dle leaves by mid-February at Sids.

2. Rate of Parasitism

Rate of parasitism on larvae or pupae was generally higher at Damnhour than at Sids. The general mean of the rates were 37.3, 35.6, 10.9 and 1.6%, respectively. Larval parasitism started with high and low rates of 20.8 and 2.4 % by late December and early January at Sids and Damnhour, respectively, Fig. 1b. Peaks of 25.3 and 42 % were attained after two weeks, then declined to 2.1 and 25.9 % by late January and mid-February. It increased progressively and reached the highest values of 90 and 85.9 % by late March at Sids and Damnhour, respectively. Parasitism decreased obviously from lower to upper parts of the plant. Rates of 49.8, 15834.4 and 18.3 % were recorded at the lower, middle and upper leaf levels at Damnhour, respectively. Respective rates at Sids were 57.4, 45 and 21.7 %.

Pupal parasitism appeared in a low rate about 0.5% by late December and early January at Sids and Damnhour, respectively, Fig. 1c. Peaks of 14.2 and 20.2 % were observed after two weeks from infestation, then decreased gradually to reach 0.4 and 6.9 % by late February at Sids and Damnhour, respectively. It increased again during March to reach 18.7 and 12.2 % by the end of the month. Pupal parasitism had no obvious trend at different plant levels. General rates were 14.1, 12.7 and 29.1 % at the lower, middle and upper leaves at Damnhour, respectively. Such correspondent rates were 4.2, 5.7 and 2.9 % at Sids.

In conclusion, higher parasitism resulted in lower mine density at Damnhour than at Sids. In both regions, mine density followed the same trend, which declined by the peaks of parasitism in two weeks after infestation and during March. Infestation appeared on the lower leaves and extended to upper parts resulting in the highest mine density on the middle leaves during February. On the contrary, parasitism was higher on the lower leaves and lower on the other two levels. This agrees with the findings of (Hafez *et al.*, 1974; Saleh and Guirguis, 1983; Aly and Makadey, 1990) on *L. congesta.*

3. Adult Emergence

3.1. Flies: The total number of emerged flies during the active season were 18986 and 9532 which accounted for 88.9 and 71.5 % of the total numbers of emerged flies

during active and diapause seasons at Sids and Damnhour, respectively. Flies emerged from active pupae during the first and the third weeks of January at Sids and Damnhour, respectively and continued until the third week of April in both segions, Fig. 2a. A peak of 3830 and 1778 was recorded by the first and the third weeks of March at Sids and Damnhour, respectively. In both regions, flies emerged from diapause by the third week of October and continued until mid-December with a distinct peak of 940 and 1662 by early and mid-November in Sids and Damnhour, respectively.

Flies emerged from active pupae were markedly reduced from lower to upper leaves during mid February and March in both regions. The total number of emerged flies from active pupae were 813, 660 and 241 which accounted for 80.2, 68.5 and 42.4 % of the total number of emerged flies from active and diapause pupae at the lower, middle and upper leaves levels at Damnhour, respectively. Respective values were 1425, 3711 and 2017 with 91.6, 78.3 and 68.3 at Sids. They emerged by late February in Sids and early March in Damnhour and continued until early April in both sites. Peaks of 432, 306 and 135 were attained by the third week of March at the lower, middle and upper leaves at Damnhour, respectively. However, the highest numbers of 2019, 371 and 830 were recorded by the first, the second and the third weeks of March at the middle, lower and upper leaves at Sids. The flies emerged from diapause by the third week of October in both regions and continued until the first and the third weeks of December at Damnhour and Sids, respectively. A distinct peak of 38, 319 and 303 & 87, 145 and 164 was recorded by the first and the second weeks of November at the lower, middle and upper leaves at Sids and Damnhour, respectively. The leafminer *L. cicerina* was the only species to emerge at Damnhour. However, at Sids *L. bryoniae* was the common species, with a few flies of *L. cicerina* and *L. sativae* recorded. *L. bryoniae* and *L. cicerina* were found at El-Zarka, while *L. bryoniae, L. sativae* and *L. congesta* occurred at Luxor.

The emerged leafminers *L. cicerina* and *L. bryoniae* are common and widely distributed species at Delta and with *L. sativae* at middle Egypt. However, *L. congesta* was found also with the last two species at Upper Egypt. *L. cicerina* has never previously been recorded attacking faba bean, but is commonly reared from chick-pea *Cicer arietinum* L., and onions species including *arvensis* L., *hircina* Jacq., *repens* L.; *Spinoza* L. *Hymenocarpus circinnatus* (L.) (Spencer, 1973). *L. bryoniae* is a highly polyphagous

species of economic importance on cucurbits and faba bean in Egypt (Hafez *et al.*, 1970; Salem *et al.*, 1998). This is the first record of *L. sativae* on faba bean in Egypt, however, it was previously reported on the same host in Oman (Deeming and Mann, 1999). Deeming (1992) reported that *L. trifolii* and *L. sativae* are closely related species, native to Americas, and well-known pests of a variety of crops and have many wild host-plants. *L. congesta* is a polyphagous species and had previously been recorded on faba bean (Hafez *et al.*, 1974). Earlier workers were confused by this species and *L. trifolii* (Burgess). By the distinctive differences in male genitalia it could be confirmed that *congesta* is limited to Europe and parts of Asia. At the time of publication of Spencer's book on Agromyzidae of economic importance (1973) *Liriomyza trifolii* was known only from the Americas, but in 1985 Spencer was able to report that this species had invaded the Old World and record it from most countries in Europe, Kenya, Tanzania, Reunion, Mauritius, Senegal and Israel. Furthermore, there is in Cardiff museum materials from Turkey collection 1986, Sudan 1996-97 and Yemen 2001 (J. Deeming, personal communication).

3.3. Parasitoid Species: Larval parasitoids followed the same pattern of flies emergence in their active and diapause seasons, at both regions. The total number of emerged wasps during the active season were 12170 and 14630 which accounted for 97.8 and 98.2 % of the total number of emerged wasps in active and diapause seasons at Damnhour and Sids, respectively. Synchronization was found between the time of host emergence and occurrence of larval parasitoids during the active season, but it was a week earlier than the host in case of diapaused flies, in both regions. A peak of 2399 was observed by late March at Damnhour, while highest number of 3235 attained by early April at Sids, Fig. 2 b. Wasps emerged from diapause in few numbers from mid to late October, in both regions. The percentage of about 99 % of larval parasitoids emerged during active season at the different leaf levels, in both regions.

Parasitoids emerging from pupae had no obvious emergence trend. The total number of emerged wasps from active pupae were 603 and 189 which accounted for 36.9 and 52.8 % of the total number of emerged wasps from active and diapause pupae at Damnhour and Sids, respectively. In Damnhour, wasps emerged from active pupae by late January and continued until early April with a peak of 282 by mid-February, Fig. 2 c. However, the emergence period prolonged from the third week of January to

the third week of April with a high number of 90 by late January at Sids. They emerged from diapause by mid-October and continued until the second and the third weeks of December with a peak of 37 and 191 by mid-October at Sids and Damnhour, respectively. At the different leaf levels, highest numbers of 31 and 22 emerged from active pupae by mid and late March at the upper and middle leaves at Damnhour and Sids, respectively. However, a peak of 28 and 22 was recorded in the first and the third weeks of November on upper and middle leaves at Damnhour, respectively. In Sids, the highest number of 20 was observed by the second week of November on the middle leaves.

Five hymenopterous parasitoid species: namely *Diglyphus isaea* (Walker), *Hemiptarsenus zilahisebessi* (Erdös), "*Chrysonotomia* (*Achrysocharella*) sp.", *Pnigalio* sp. and *Cirrospilus* sp. (Eulophidae) had emerged from parasitized larvae during the active season at Damnhour, Sids and El-Zarka, but the first species emerged only at Luxor. *D. isaea* was the most abundant species and emerged during the diapause season in the first three regions. The dominant larval-pupal parasitoid *Opius* sp. (Braconidae), as well as *Halticoptera circulus* Walker (Pteromalidae) and *Chrysocharis* sp. (Eulophidae) emerged from the active and diapause pupae at all regions, except the last species at Luxor.

In conclusion, larvae pupated in the soil and plant debris with the majority of host adults and larval parasitoids emerging from in the active season, in both regions. However, pupal parasitoids emerged in relatively high and equal numbers from diapause at Damnhour and Sids, respectively. In both regions, synchronization was found between the timing of the host emergence and abundance of the larval parasitoid *D. isaea* in active season, as well as for the abundance of the larval-pupal parasitoid *Opius* sp. in both seasons. Emerged larval parasitoids increased relatively to emerged host adults during the faba bean growing season. They represent 13.7, 46.7 and 77.6 % as well as 46.7, 60.1 and 83.9 % of the total emerged flies and wasps during the period from the first and the second weeks of January until the end of February, March and April, at Sids and Damnhour, respectively. The dominant species *D. isaea* seemed to be the main regulating factor affecting the larvae. Its population was higher at Damnhour than at Sids. Minkenberg (1989) reported that both developmental time and pupal size of *D. isaea* differed according to host species and activity of host-feeding by adult females

was more at lower than higher temperatures. On the other hand, the larval-pupal parasitoid *Opius* sp. was more active in Delta than in Middle or Upper Egypt. The other larval parasitoids *H. zilahisebessi*, "*Chrysonotomia* (*Achrysocharella*) sp.", *Pnigalio* sp. and *Cirrospilus* sp. or the larval-pupal parasitoids *H. circulus* and *Chrysochairs* sp. seemed to have a minor role in biological control of these pests.

It can be recommended that pesticides application must be entirely avoided to conserve and promote parasitoids, also, the bio-effectiveness of the parasitoids is indicated by the decrease in emergence flies from diapausing pupae. Thus, could be achieved by applying some suggested agricultural practices i.e. spreading the harvested plants on plastic sheets to facilitate collection of the accumulated pupae, deeply plowing and dropping kerosene at a rate of 30 liter/feddan = 4200 m^2 into water irrigation can be used as safe and tactic control methods against pupae to reduce the population of the emerged flies.

ACKNOWLEDGMENT

The author wishes to thank Dr John C. Deeming (Natural Museums & Galleries of Wales, Cardiff, UK) for identification of *Liriomyza* spp. and reviewing the manuscript and Dr Michael von Tschirnhaus (Universität Bielefeld, Fakultät für Biologie, Bielefeld, Germany) for confirmation of *L. cicerina* identification. Thanks also are due to Dr E. Eric Grissell (Systematic Entomological Laboratory, Agricultural Research Service, US Department of Agriculture) for identification of the Braconidae and Pteromalidae species.

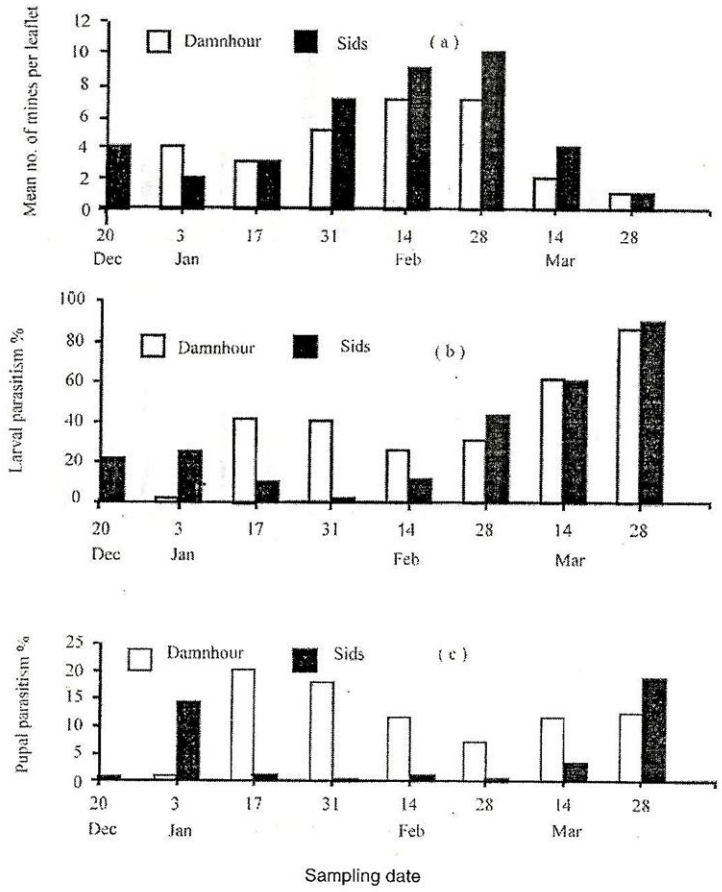

Fig. 1. Mean no. of mines per leaflet (a) percentages of larval (b) and pupal (c) parasitism on the leafminers; *Liriomyza* spp. during December 1999- March 2000 at Damnhour and Sids regions.

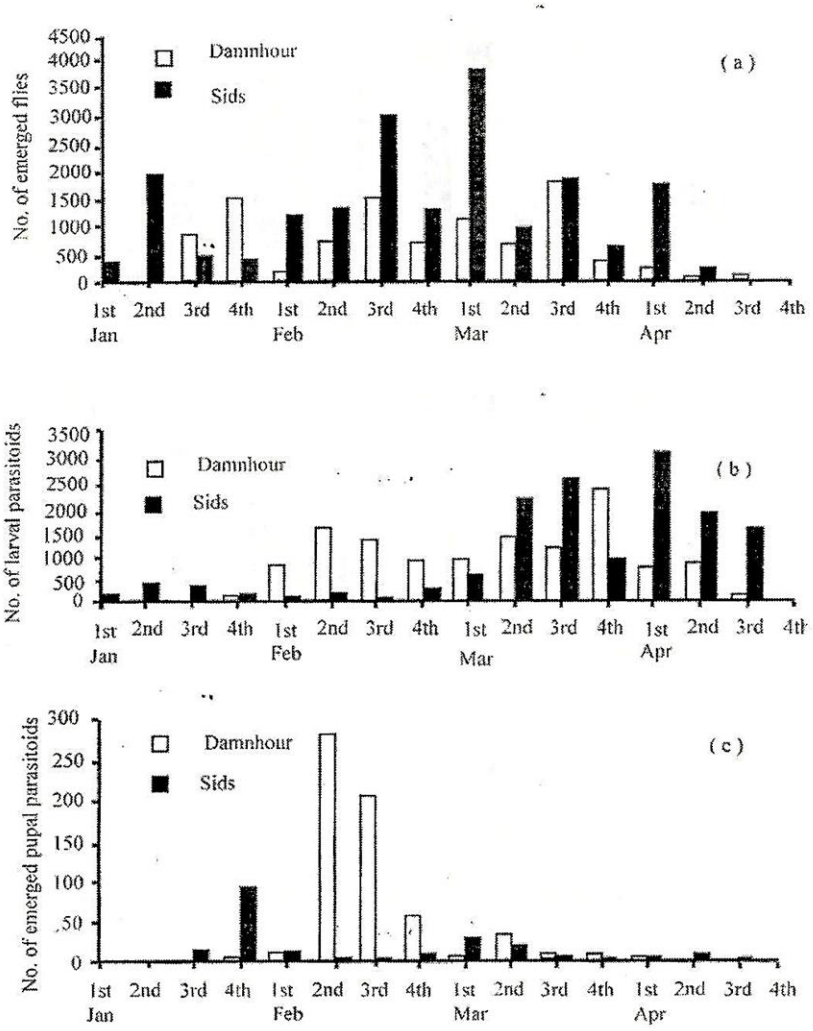

Fig. 2. Distributions no. of emerged flies (a) larval (b) and pupal (c) parasitoids in active season during January- April 2000 at Damnhour and Sids regions.

REFERENCES

1. Aly Radi, F. K., M. A. Makadey. 1990. Population density of *Liriomyza congesta* (Beck.) in relation to infestation and yield of broad bean. Bull. Ent. Soc. Egypt, 69: 123-128.

2. Deeming, J. C. 1992. *Liriomyza sativae* Blanchard (Dipera: Agromyzidae) established in the Old World. Tro. Pest. Man., 38: 218.

3. Deeming, J. C., D. J. Mann. 1999. Distributional notes on two economically important Agromyzidae (Dipt.) in west Africa. Entomologist s. Month. Mag., 135: 205-206.

4. El-Serwy, S. A. 1993. Preliminary field obserations on the infestation, mine density, larval and pupal parasitism of *Liriomyza trifolii* (Burgess) (Diptera: Agromyzidae). Bull. Ent. Soc. Egypt, 71: 75-81.

5. El-Serwy, S. A. 1994. A study on the incidence of diapause and parasitism of *Liriomyza trifolii* (Burgess) (Diptera: Agromyzidae). Bull. Ent. Soc. Egypt, 72: 153-162.

6. Hafez, M., S. El-Ziady, N. Z. Dimetry. 1970. Leaf mining Diptera of vegetables and crops in Egypt. Bull. Ent. Soc. Egypt, 54: 389-414.

7. Hafez, M., A. H. El-Kifl, M. N. Donia, A. E. A. Wahab. 1974. Studies on parasites of *Liriomyza congesta* (Becker) in Egypt. Bull. Ent. Soc. Egypt, 58: 249-259.

8. Mesbah, I. I., M. R. Sherif. 1994. Population studies on *Liriomyza congesta* (Becker) (Diptera: Agromyzidae) in faba bean fields and its parasitoids at Kafr El-Sheikh region. J. Agric. Mansoura Univ., 19: 1215-1222.

9. Minkenberg, O. P. J. M. 1989. Temperature effects on the life history of the eulophid *Diglyphus isaea*, an ectoparasitoid of leafminers (*Liriomyza* spp.), on tomatoes. Ann. Appl. Biol., 115: 381-397.

10. Parrella, M. P., V. P. Jones, R. R. Youngman, L. M. Lebeck. 1985. Effect of leaf mining and leaf stippling of *Liriomyza* spp. on photosynthetic rates of chrsanthemum. Ann. Entomol. Soc. Am., 78: 90-93.

11. Saleh, M. R. A., M. W. Guirguis. 1983. Population dynamics of *Liriomyza congesta* (Beck.) on broad bean and relation between infestation and yield of plants (Diptera: Agromyzidae). Zagazig J. Agric. Res., 3: 419-423.

12. Saleh, M. R. A., M. W. Guirguis, M. A. Tantawy, N. El-Attar. 1983. Population dynamics of *Liriomyza congesta* larvae and their parasites on broad bean. Annals Agric. Sci. Fac. Agric. Ain-Shams Univ. Cairo, Egypt, 28: 1735-1745.

13. Salem, R. M., S. A. Mahmoud, E. M. E. Khalafalla, M. M. Radi. 1998. Identification of leafminers attacking faba bean, *Vicia faba* (L.) and yield losses caused by their infestation in north Delta. Alex. Sci. Exch., 19: 269-275.

14. Spencer, K. A. 1973. Agromyzidae (Diptera) of economic importance. Series Entomologica. 9, W. Junk: The Hague: xi + 418 pp.

15. Spencer, K. A. 1985. East African Agromyzidae (Diptera): further descriptions, revisionary notes and new records. J. Nat. His., 19: 969-1027.

16. Spencer, K. A. 1990. Host specialization in the World Agromyzidae (Diptera). Dordrech Boston London: Kluwer Aca. Pub.: x + 444 pp.

دراسات على صانعتي أنفاق الأوراق *LIRIOMYZA CICERINA* (RONDANI) و*LIRIOMYZA BRYONIAE* (KALTENBACH) وطفيلياتها فى حقول الفول البلدى فى مصر

سمير عوض السروى

معهد بحوث وقاية النباتات – مركز البحوث الزراعية – الدقى – الجيزة – مصر.

سجلت صانعة أنفاق الأوراق *Liriomyza cicerina* (Rondani) من عائلة صانعات أنفاق ورتبة ذات الجناحين كآفة جديدة على الفول فى دمنهور مع النوع *Liriomyza bryoniae* (Kaltenbach) فى سدس والزرقاء، كما وجد النوع *L. bryoniae* مع النوعان *L. sativae* (Blanchard) و *L. congesta* (Becker) فى الأقصر.

تم دراسة كثافة الأنفاق والتطفل على اليرقات والعذارى على نباتات فول غير معاملة فى دمنهور وسدس خلال موسم ١٩٩٩-٢٠٠٠. وتشير النتائج المتحصل عليها إلى ارتفاع كثافة الأنفاق فى سدس مقارنة بدمنهور حيث يتوافق ذلك مع انخفاض نسب التطفل على اليرقات والعذارى إلى ٣٥,٦ و ١,٦ ٪ وارتفاعها إلى ٣٧,٣ و ١٠,٩ ٪ على التوالى. زادت كثافة الأنفاق تدريجيا ولكنها انخفضت عند ذروات التطفل بعد أسبوعين من الإصابة وخلال مارس كانت أعلى معدلات التطفل اليرقى وكثافة الأنفاق على الوريقات السفلى والوسطى مقارنة بالمستويين الآخرين. ويخرج غالبية كاملات الذباب وطفيليات اليرقات (Walker) *Diglyphus isaea* و *Hemiptarsenus zilahisebessi* (Erdös) و *Pnigalio sp.* و "*Chrysonotomia* (*Achrysocharella*) sp." و *Cirrospilus* sp. فى موسم النشاط حيث يتزامن وقت خروج العائل مع طفيلى اليرقات الأكثر شيوعاً *D. isaea*، بينما لا يتوافق هذا التزامن فى منوسم السكون ومن جهة أخرى فإنه لا يوجد تزامن بين الكاملات وطفيلى اليرقات. وجد أن عذارى *Opius* sp. هى الأكثر شيوعاً و *Halticoptera cirulus* Walker و *Chrysoch-aris* sp. الأقل شيوعاً فى كلا الموقعين. تخرج أنواع الذباب *L. cicerina* فى دمنهور وبصفة رئيسية النوع *L. bryoniae* مع أعداد قليلة من *L. cicerina* و *L. sativae* فى سدس. ينخفض معدل نمو أعداد طفيليات اليرقات مقارنة بأعداد الذباب مما يعرقل المكافحة الحيوية خاصة فى بداية الموسم. لحفظ وإدامة تلك الطفيليات ينبغى تفادى الاستخدام الكلى للمبيدات، ولزيادة فعاليتها يجب تنظيم الكثافة العددية لأعداد الذباب الخارج من السكون. ويقترح إجراء بعض العمليات الزراعية مثل جمع المحصول ونشره على مفرش بلاستيكى لسهولة جمع العذارى والتخلص منها كما أن الحرث العميق للأرض وإضافة السولار بمعدل ٣٠ لتر/فدان إلى ماء الري يؤديا إلى قتل العذارى بالتربة وبالتالى انخفاض أعداد الذباب الخارج من السكون.