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Incidence of Parasitoids on the Leaf-miner Species, *Liriomyza trifolii* (Burgess) (Diptera: Agromyzidae), in Tomato Fields, at Qaluobia Governorate, Egypt

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ABSTRACT

Field studies were carried out to determine the population density of the leaf-miner, *Liriomyza trifolii* (Burgess) attacking early summer plantations of tomato fields and percentages of parasitism on it. The incidence of naturally major parasitoid species of the pest recorded during the two successive seasons, 2008 and 2009, at Qaluobia Governorate, Egypt, were also investigated. Obtained data revealed that, the common surveyed parasitoid species of *L. trifolii* were; *Chrysocharis* sp., *Cirrospilus* sp., *Diglyphus crassinveris*, *D. isaea* and *Neochrysocharis* sp. The surveyed parasitoid species played an important natural role in suppressing the pest population density. The total parasitism rate increased when all parasitoid species occurred together at the same time, compared to the existence of each parasitoid separately. The two common recorded parasitoid species; *D. isaea* and *Neochrysocharis* sp., are candidates to be mass reared for controlling *L. trifolii* in tomato fields and/or greenhouses.

Key words: Tomato, pests, *Liriomyza trifolii*, parasitoids, interaction, Egypt.

INTRODUCTION

Tomato, *Lycopersicon esculentum* Mill. (Family: Solanaceae) is one of the familiar and popular vegetable crops throughout most temperate and tropical countries (Oji and Ali, 2005).

Many insect pest species were known attacking tomato plants, particularly, the leaf miner, *Liriomyza trifolii* (Burgess) (Diptera: Agromyzidae) (Uygun *et al.*, 1995; Akihito *et al.*, 1999; Misayo *et al.*, 2003 and Mostafa 2006). However, this pest worldwide represents one of the most destructive insect pest species not only to different vegetables, but also to ornamental crops (Gahbicheh, 2001).

Extensive studies have been continuously encouraged and developed in the field of biological control of insect pests using many biocontrol agents such as parasitoids. Recent control strategies depend principally on knowing pest natural enemy relationship. Also, the use of biological control does requires detailed knowledge of pest biology and population dynamics, as well as, the natural enemies associated with the pest and their impact (Bekheit, 2005 and Mostafa, 2006).

The present work was conducted to study *L. trifolii* population densities and to estimate percentages of parasitism on it, in early summer plantations of tomato, at Qaluobia Governorate, Egypt. The study also focused on recording the interactions existed naturally among major recorded parasitoid species of the pest.

MATERIALS AND METHODS

Studies were carried out at Qaluobia plantations of tomato of the two successive seasons, 2008 and 2009. An area of one feddan (at El-Manaial district), was annually selected. Experimental area received all regular recommended agricultural practices, except use of chemical insecticides.

Population of the Leaf miner *L. trifolii* and percentage of parasitism

At the age of 45 days of planting, in the second week of January of the two seasons of study, weekly samples of 500 leaflets (5 leaflets/plant × 100 plants), were collected. Leaflets were directly transferred to the laboratory in paper bags for inspection and for actual weekly counting of *L. trifolii* larvae, using a stereomicroscope. The percentages of tomato leaflets damage by the pest were also estimated. Collected infested leaflets were placed in glass jars (17 cm height x 11 cm diameter), provided daily with filter papers (to absorb moisture).The pest larvae were left until pupation and subsequently adults' emergence of either *L. trifolii* or its parasitoid species.

Emerged parasitoid species were weekly collected, classified by the aid of a stereomicroscope and counted. Emerged parasitoid species were identified at the Biological Control Research Department, Plant Protection Research Institute, Agricultural Research Center (ARC), Giza, Egypt. Percentages of parasitism on *L. trifolii* larvae were estimated, according to the equation described by El-Khawas and El-Khawas (2005). Natural interactions existed between the recorded *L. trifolii* and its parasitoid species, and the percentages of their occurrence to each others were also studied. Inspection of tomato leaflets was ended in the third week of May in the two studied seasons 2008 and

Obtained data were weekly recorded, monthly tabulated and statistically analyzed according to procedures outlined by Snedecor and Cochran (1980). The least significant differences (L.S.D.) were used to compare the mean values at 5%, using SAS program (SAS Institute, 1994). Means of temperature and relative humidity were obtained from the Meteorological Station of A.R.C. The correlations existed between the weather factors (means of temperature and relative humidity), monthly total numbers of *L. trifolii* larvae and monthly total numbers of its major recorded parasitoid species were recorded.

RESULTS AND DISCUSSION

Population of the leafminer *L. trifolii*

Table (1) showed that, the total monthly population of the leafminer *L. trifolii* started to appear, in low numbers (54 and 26 larvae/500 leaflets), in January, 2008 and 2009, respectively. The maximum total numbers of L. *trifolii* larvae (328 and 270 larvae / 500 leaflets), were recorded during February, 2008 and 2009, respectively. The mean total numbers of pest larvae for each season were; 136.80 (7-328) and 101.80 (1-270) larvae, for 2008 and 2009 seasons, respectively. The mean total number of *L. trifolii* larvae for both seasons was 119.30 (1-328) larvae. Abou-Elhagag and Salman (2002) found that *L. trifolii* population, in southern Egypt showed three peaks in the first season 2000/01, during the 3rd week of January, 3rd week of February and the last week of March. While, in the second season of the study 2001/02, the peaks were recorded during the 1st week of January, 1st week of February and the 3rd week of March.

Statistical analysis of obtained data showed a significant difference, between the mean total numbers of the leafminer larvae, in the two studied seasons, 2008 and 2009 (Table 1).

Percentages of the leaf miner *L. trifolii* damage

Highest monthly total percentages of tomato leaflets damage (48.25 and 31.25 %), were estimated during February, 2008 and 2009, respectively. The mean total percentage of tomato leaflets damage for each season was; 22.41 (5.53-48.25) and 13.43 % (1.24-31.25), respectively. The mean total percentage of damage for the two seasons together was 17.92 % (1.24-48.25) (Table 1).This result was confirmed by the highest monthly total numbers of the leaf miner larvae counted during February in both seasons of the study.

Parasitism on the leaf miner *L. trifolii*

Concerning common parasitoid species of *L. trifolii*, obtained data revealed the presence of five hymenopterous parasitoid species; three ectoparasitoids; *Cirrospilus* sp., *Diglyphus crassinervis* and *D. isaea* (Walk.) and two endoparasitoids; *Chrysocharis* sp. and *Neochrysocharis* sp., parasitizing *L. trifolii* in the early summer plantations of tomato. All are belonging to family Eulophidae.

Table (1): Monthlytotal numbers of *L. trifolii* larvae and the percentages of damage in early summer plantations of tomato in seasons, 2008 and 2009, at Qaluobia Governorate

	Months	Total no. of pest larvae	Mean total % of damage/ 500 leaflets	Weather factors	
				Mean °C	Mean R.H.%
2008	January,	54	20.00	10.6	47.7
	February	328	48.25	14.5	50.6
	March	197	25.52	20.3	50.8
	April	98	12.75	22.5	50.2
	May	7	5.53	24.9	48.1
Mean/season		136.80 A (7-328)	22.41 % (5.53-48.25)	18.6 (10.6-24.9)	49.5 % (47.7-50.8)
2009	January,	26	4.45	22.0	42.7
	February	270	31.25	19.6	37.8
	March	148	19.95	21.4	38.3
	April	64	10.25	25.3	43.0
	May	1	1.24	23.8	40.0
Mean/season		101.80 B (1-328)	13.43 % (1.24-31.25)	22.4 (19.6-25.3)	40.4 % (37.8-43.0)
Mean/ 2 seasons		119.30 (1-328)	17.92 % (1.24-48.25)	20.5 (10.6-25.3)	45.0 % (37.8-50.8)

L.S.D. 0.05 (between /2 seasons), in comparing the total numbers of pest larvae 4.48

Similarly, the mentioned parasitoid species were previously recorded attacking the pest; *Chrysocharis* sp. (Del-Bene, 1989); *N. formosa* (West.) (Cikman *et al.*, 2006) and *D. isaea* (Ohio *et al.*, 1999 a & b; Godinho *et al.*, 2000 and El-Khawas, 2008). However, Mostafa (2006) recorded five parasitoid species on *L. tifolii* in faba bean and tomato fields at Qaluobia Governorate; including; *Chrysocharis parksi, Cirrospilus ambiguous* Girault, *D. isaea, Hemiptarsenus varicornis* Girault and *Neochrysocharis* sp.

Moreover, it was found that, the highest monthly total percentages of parasitism (24.61 and 18.54%), were estimated during March, 2008 and 2009, respectively. The mean total percentage of parasitism in each season was; 16.68 (0.00-24.61) and 8.83 % (0.00-18.54) for 2008 and 2009 seasons, respectively. The mean total percentage of parasitism for the two seasons together was 12.75% (0.00-24.61) (Table 2).

As shown in Table (3), the parasitoid *Neochrysocharis* sp. had the highest recorded total numbers (74 and 27 in seasons, 2008 and 2009,

Table (2): Monthly mean total percentages of parasitism on *L. trifolii* larvae, in early summer plantations of seasons, 2008 and 2009, at Qaluobia Governorate

Months	Season 2008	Season 2009	Mean monthly/ 2 seasons
January	13.27	2.78	8.03
February	24.06	17.42	20.74
March	24.61	18.54	21.57
April	21.46	5.40	13.43
May	0.00	0.00	0.00
Mean/season	16.68 % (0.00-24.61)	8.83 % (0.00-18.54)	12.75 % (0.00-24.61)

Table (3): Monthly total numbers all surveyed parasitoid species on *L. trifolii* larvae and total numbers of each parasitoid in early summer plantations of seasons, 2008 and 2009, at Qaluobia Governorate

	Months	Total no of parasitoids	*D. isaea*	*D. crassinveris*	*Neochry-Socharis* sp.	*Cirrospilus* sp.	*Chrysocharis* sp.
2008	January	12	1	0	7	2	1
	February	67	2	3	28	0	13
	March	45	23	0	28	0	4
	April	24	10	0	11	0	3
	May	0	0	0	0	0	0
Total/season		148	48	3	74	2	21
2009	January	2	1	0	1	0	0
	February	36	14	4	8	8	2
	March	27	7	0	18	1	1
	April	3	2	0	0	0	1
	May	0	0	0	0	0	0
Total/season		68	24	4	27	9	4
Mean / 2 seasons		108.00 (68-148)	36.00 (24-48)	3.50 (3-4)	50.50 (27-74)	5.50 (2-9)	12.50 (4-21)

Table (4): Percentages of occurrence of *L. trifolii* parasitoid species, in early summer plantations of seasons 2008 and 2009, at Qaluobia Governorate

Parasitoid species	Season 2008	Season 2009	Mean / 2 seasons
D. isaea	32.43	35.29	33.86
D. crassinveris	2.03	5.88	3.96
Neochrysocharis sp.	50.00	39.71	44.85
Cirrosipilus sp.	1.35	13.24	7.29
Chrysocharis sp.	14.19	5.88	10.04

respectively), compared to the other surveyed parasitoid species parasitizing the pest. This result was confirmed by estimating the percentages of occurrence of the different recorded parasitoid species of *L. trifolii* to each others. On the other side, Mostafa (2006) revealed that, the predominant parasitoid species on *L. trifolii* attacking tomato and faba bean plants at Fayoum Governorate, Egypt

Obtained data given in Table (4) revealed that, the sequence of the percentages of occurrence of the parasitoid species in the two studied seasons together were descending as follow; *Neochrysocharis* sp. (44.85%) > *D. isaea* (33.86%) > *Chrysocharis* sp. (10.04%) > *Cirrospilus* sp. (7.29%) > *D. crassinveris* (3.96%). Similar findings were reported by Cabello *et al.*, (1994) who reported that, the parasitoid *Neochrysocharis formosa* was the most abundant parasitoid species found in greenhouses with or without pest control of *L. trifolii* on tomatoes in greenhouses in Southern Spain. They added that, the other recorded parasitoid species were the eulophids; *Cirrospilus vittatus* and *D. isaea*.

Interaction between *L. trifolii* and its Parasitoids

As shown in Tables (1) and (2), results indicated that, at the highest monthly total numbers of the pest larvae counted in March, the percentages of parasitism were also at their peak. Occurrence of *L. trifolii* parasitoid species together in the same time had increased the total percentages of parasitism, indicating a positive natural control, when all recorded parasitoid species, parasitized the pest larvae occurred in the same period. In similar results, El-Khawas (2008) stated that a significant relationship was found between the infestation levels of the leafminer *L. brassicae* attacking *Brassica rapae* plants and the total percentages of parasitism of the pest larvae by the two major parasitoid species *D. isaea* and *D. crassinveris*, when they were found together at the same time.

Generally, the natural role of the common surveyed parasitoid species represented one of the main important factors for suppressing the natural population density of *L. trifolii* (Fig. 1). The period of parasitoid species occurrence was synchronized with that of the highest pest population.

Results are in agreement with those of Godinho *et al.*, (2000) who indicated that, the natural control of *L. trifolii* by the two parasitoid species *D. isaea* and *D. crassinveris* was frequently enough to maintain the pest populations on tolerable levels, that was based on the activity of autochthonous fauna.

In addition, Salvo and Valladares (2007) reported that, natural enemies of leaf miners are the most frequent source of mortality for this herbivore insect, with parasitoids being the most effective and best represented source. They added that, parasitoids of leaf miners are predominantly generalists, and can thus rapidly include other pests in their host ranges. Finally, they concluded that, classical and augmentative biological control strategies are

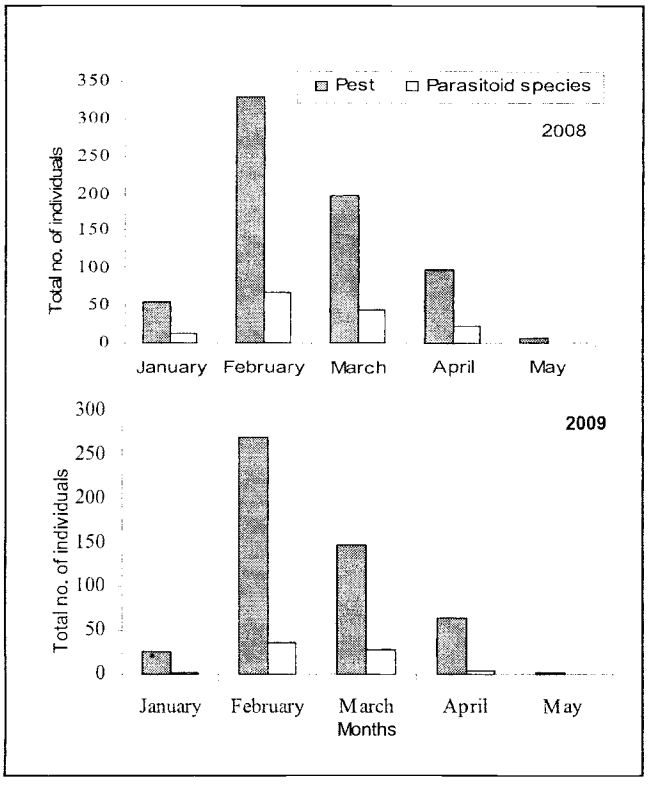

Fig. (1): Monthly total numbers of *L. trifolii* larvae and surveyed parasitoid species, in early summer plantations in seasons, 2008 and 2009, at Qaluobia Governorate.

From the present study, *Neochrysocharis* sp. and *D. isaea* are candidates to be mass reared for controlling *L. trifolii* in tomato fields and/or greenhouses that are subjected to the pest attack.

Correlations with weather factors

Correlations existed between weather factors (means of temperature and relative humidity) and monthly total numbers of *L. trifolii* larvae or monthly total numbers recorded parasitoid species, in both seasons, were shown in Table (5).

Table (5): Correlations between monthly total numbers of *L. trifolii* larvae or total numbers of parasitoid species at Qaluobia Governorate, in relation to means of temperature and relative humidity, recorded in the two seasons, 2008 and 2009.

In conclusion, the common surveyed parasitoid species (*Chrysocharis* sp., *Cirrospilus* sp., *D. crassinervis, D. isaea* and *Neochrysocharis* sp.), showed a promising important natural role against the leafminer *L. trifolii* in tomato fields, at Qaluobia Governorate. So, the two common recorded parasitoid species; *Neochrysocharis* sp. and *D. isaea*, can be used for the biological control of *L. trifolii*, attacking tomato fields or other related fields that are subjected to pest attack. Many successful attempts were made to use these bio-control agents against the pest. For example, Cabitza *et al.* (1993) released the parasitoid *D. isaea* against the pest attacking spring tomato in greenhouses. They found that the parasitoid was effective in controlling the pest; in spite of the high levels of pest infestation (which reached 74 mines/ plant).They also added that, the level of pest parasitism was up to 100% after releasing the parasitoid species. Akihito (2001) used the parasitoid *D. isaea* for controlling *L. trifolii* on tomatoes in greenhouses and found that the frequency of *L. trifolii* population was by far lower than that recorded in the control. Finally, the recorded parasitoid species can be included in Integrated Pest Management (I.P.M.) strategies against the pest, side by side with other available safe control methods, to protect environment from pollution.

Table (5): Correlations between monthly total numbers of *L. trifolii* larvae and major parasitoid species, in relation to means of temperature and relative humidity, recorded in the two seasons, 2008 and 2009, at Qaluobia Governorate.

Tested factors	Season 2008		Season 2009	
	R-value	Equation of correlation	R-value	Equation of correlation
Monthly total no. of *L. trifolii* larvae × means of temperature	0. 33	Y= -7.13 X + 269.14	0.77	Y= -38.08 X+955.61
Monthly total no. of *L. trifolii* larvae × means of relative humidity	0.79	Y= 68.95 X - 327.10	0.73	Y= -32.80 X+1425.70
Monthly total no. of all parasitoid species × means of temperature	0.31	Y= 1.40 X + 55.67	0.83	Y = - 6.26 X +153.97
Monthly total no. of all parasitoid species × means of relative humidity	0.83	Y= 15.18 X +721.47	0.70	Y= - 5.78 X + 247.04

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