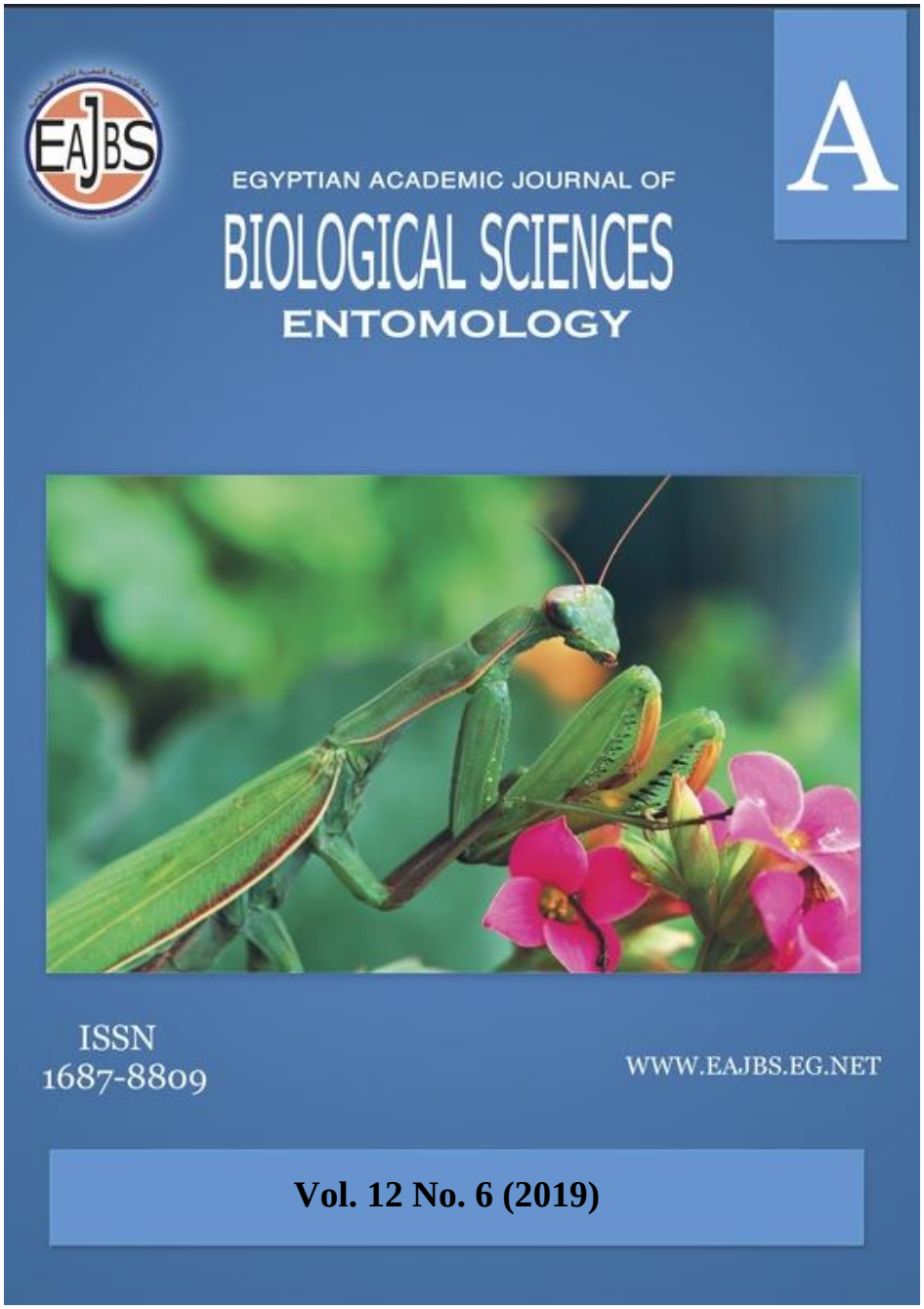

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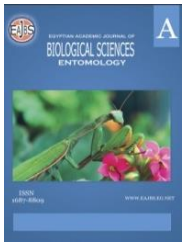

Population Dynamics of Citrus Leafminer, *Phyllocnistis citrella* Stainton (Lepidoptera: Gracillariidae) and Its Parasitoids on Mandarin Trees in Sharkia Governorate, Egypt.

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ABSTRACT

The present work was conducted to study the population dynamics of citrus leafminer (CLM) and its associated parasitoids on mandarin trees during two successive years of 2013-14 & 2014-15 all in relation to climatic factors [temperature and relative humidity (R. H.)]. The citrus leafminer larval population had 6 peaks of abundance on mandarin trees in each studied year. The higher population peaks of the pest were noticed during two main periods. The first period was in late May and the second period observed in late August and the middle of September. Generally, springtime is considered the most abundant season for *Phyllocnistis citrella* infestation followed by either summer or autumn seasons. In winter, there is a complete absence of CLM infestation. There is a positive relationship between CLM population abundance and both temperature and R.H.%. The associated parasitoids *Semielacher petiolatus* (Girault) and *Cirrospilus ingenuus* (Gahan) had five peaks of abundance during each studied year. The highest parasitism was 42.5% at the beginning of August in 2013-14 and 19.2% in the middle of September in 2014-15. The effect of a combination of parasitoids and climatic factors on CLM population was presented as explained variance (E.V.) which was 36.9 % in the first and 34.7% in the second studied year.

INTRODUCTION

Citrus involve a great number of species and attack by many diseases and insect pests that are harmful to citrus production. Citrus leafminer (CLM), *Phyllocnistis citrella* Stainton (Lepidoptera: Gracillariidae), is the most important pest attacks citrus and other species of Rutaceae family and some related ornamental plants. (Heppner, 1993 and Abbas *et al*., 2013). During the early summer of 1994, citrus trees in El-Sharkia and Ismailia Governorates were severely infested by CLM (Abdel-Aziz, 1995 and Eid, 1998). From that time the insect spreads rapidly throughout the citrus growing area in Egypt.

The citrus leafminer is an important pest because the larvae cause serious damage to the citrus leaves. Larval feeding affects plant photosynthesis as the larva consumed between 1 and 7 cm^2. The edge of the leaves curls upward, followed by chlorosis and later by necrotic spots. Larvae enter the leaf through mine or tunnels and start feeding. These mines may occur in stems or fruits. Nursery trees and newly planted citrus trees suffer a reduction in growth as a result of heavy leafminer infestation (Knapp *et al*., 1995). CLM larvae just eat a little layer of the spongy parenchyma tissue forming a wound which facilitates the spread of citrus

canker caused by bacteria *Xanthomonas axonopodis* pv. *Citri*, as the most important citrus diseases (Heppner, 1993; and Stelinski *et al*., 2009). The symptoms occur in the form of necroticlesions on the leaves, stems, and fruits. Severe infections may induce defoliation, fruit drop and death of the twigs (Stall& Seymour, 1983 and Schoulties *et al.*, 1987).

For qualitative and quantitative increase of citrus yield, sustainable approaches for CLM management are very much essential. Various control methods have been proposed, these include cultural practices, chemical control, biological control, etc. (Muthaiah *et al.*, 1998; Shivankar *et al.*, 2002) The effect of insecticides in citrus orchards against the CLM is difficult to achieve the maximum CLM larval mortality because several generations of CLM are usually overlapping and the CLM larvae are protected by a cuticular layer of the leaves in the serpentine mine and the pupal stage is also protected by the rolled leaf margins (Raga *et al*., 2001). Moreover, it is necessary to be aware of the effect of these insecticides on beneficial insects including parasitoids and predators (Besheli, 2007). In this regard, higher costs would involve insecticides multiple applications and the development of resistance to these insecticides should be considered (Yumruktepe *et al*., 1996).

In spite of the above problems associated with insecticidal control, Michaud and Grant (2003) recommended that insecticides could be applied to protect new flushes of growth when the leaves are most susceptible to CLM damage.

Biological control is generally regarded as the most economically sound and environmentally sustainable management practice for *P. citrella* (Knapp *et al*., 1995; Hoy and Nguyen, 1997). Several predatory arthropods are known to feed on *P. citrella*, including lacewing larvae, ants, and hunting spiders (Argov and Rossler, 1996, Pomerinke, 1999; Amalin *et al*., 2001a, b; Xiao *et al*., 2007), and many of these studies have identified predation as the most important natural mortality factor acting on *P. citrella* in many parts of the world (Chen *et al*., 1989; Amalin *et al*., 1996, 2002; Hoy *et al*., 2007).

The present work was conducted to study population dynamics of CLM during two successive years, 2013-2014 and 2014-2015 in a mandarin orchard located in Sharkia Governorate in relation to CLM associated parasitoids mainly *Semielacher petiolatus* (Girault) and *Cirrospilus ingenuus* (Gahan) as well as climatic factors especially temperature and relative humidity. These studies about the target pest may be important for building-up an efficient integrated management program for this pest in the study area.

MATERIALS AND METHODS

The present work was conducted during two successive years of 2013-14 and 2014-15. All the experiments were conducted after the Ethics Committee of the Faculty of Agriculture, Al - Azhar University, Cairo, approved the protocol of experiments and procedures used in the study.

The population dynamics of citrus leafminer, (CLM), *Phyllocnistis citrella* Stainton and its favorable associated parasitoids [*Semielacher petiolatus* (Girault) and *Cirrospilus ingenuus* (Gahan) (Hymenoptera: Eulophidae)] were investigated in the field.

A mandarin orchard (about 2 feddans, contained 180 trees/ feddan) located in Samy Saad (Manshiet Redwan), Al-Salhia district, Sharkia Governorate was chosen for the present study. It is surrounded by other mandarin orchards. Regular irrigation provided constant growth of the trees which were 5 years old and spaced 5m apart between the rows and 3m within the rows. That orchard did not receive any insecticidal treatments during the last two years. A preliminary experiment was conducted to study the parasitoids of CLM host. Citrus leaves were collected randomly and those contained CLM larvae or pupae were placed into plastic bags and aerated as described by Elekcioglu and Uygun (2006). The bags were kept under laboratory conditions until the emergence of parasitoid adults that were examined and identified according to MAC (Ministry of Agriculture Insect Collection), Plant Protection

Research Institute. Five parasitoids (*Semielacher petiolatus* (Girault), *Cirrospilus ingenuus* (Gahan), *Cirrospilus pictus* (Nees), *Quadrastichus sp.* (Girault) (Hymenoptera: Eulophidae) and *Ageniaspis citricola* (Hymenoptera: Encyrtidae) were identified. Because the first two parasitoids were more abundant, they were selected for the present study.

Weekly samples were taken randomly from 15 citrus trees, all over the studied area. Each sample consisted of 5 twigs (each twig was 15 cm length of new flushes contained 10 leaves) collected randomly from each tree.

The citrus leaves were placed in plastic bags, transported to the laboratory and examined under a microscope to determine the numbers of CLM larval stages and its selected parasitoids (*Semielacher petiolatus* and *Cirrospilus ingenuus*). Thus, each sample represents the average number of CLM larvae and its selected parasitoids/ 50 leaves/ week. The parasitized CLM numbers relative to CLM total population were used to calculate the percentage of parasitism.

Sampling procedures started from 9th of March, 2013 and extended to 28th of February, 2015. The climatic factors such as daily maximum temperature, daily minimum temperature, and R.H. % recorded during the above studied period were obtained from Meteorological Administration, Kobry El – Kobba, Cairo one week earlier from the insect inspection or sampling.

Statistical Analysis:

Simple correlation and partial regression values of the mean number of associated parasitoids, daily maximum and minimum temperatures and daily mean percent relative humidity on the population density of CLM on mandarin trees during 2013 -14 and 2014-15 were undertaken and subjected to statistical analysis SAS Institute (1998).

RESULTS AND DISCUSSION

The study includes the seasonal abundance of Citrus leafminer (CLM), *Phyllocnistis citrella* on mandarin trees during the studied period (from 9th March, 2013 to 28th February 2015) in relation to certain climatic factors (minimum temperature, maximum temperature and % relative humidity), and associated parasitoids (mainly *Semielacher petiolatus* Girault and *Cirrospilus ingenuus* Gahan). Also, the efficacies of four insecticides used for controlling CLM pests were undertaken.

3.1-Population Dynamics of CLM and Its Parasitoids On Mandarin Trees.

The population density of *P. citrella* on mandarin trees during 2013-14 is shown in Table (1) and Figure (1). Results revealed that CLM larval population had 6 peaks of abundance appeared on 13th of April, 18th of May, 20th of July, 24th of August, 14th of September and 12th of October with numbers of 6.7, 21.7, 7.7, 15.7, 10.0 and 8.3 larvae/sample, respectively. However, the larval population declined to zero during the winter months.

The population density of CLM during 2014 – 15 was presented in Table (2) and Fig.ure (2). which revealed that CLM larval population fluctuated with 6 peaks of abundance. These peaks were noticed on 3rd and 24th of May, 19th of July, 23rd of August, 6^{th,} and 27th of September with numbers of 12.3, 25.7, 8.6, 13.2, 10.0 and 17.0 larvae/ sample, respectively. The CLM population was disappeared during the winter months.

For the two studied years, the strong generations of the pest (higher population peaks) were coincided with the availability of new flushes, and therefore they were noticed during two main periods in each studied year. The first period was in late May with a peak of 21.7 larvae/sample in 2013-14 (Table 1) and 25.7 larvae/sample in 2014 – 15 (Table 2). The average registered temperature was about 23^{o}C and 73% R. H.at that period. The second period for the higher CLM population had two minor peaks observed in late August and the middle of September during 2013- 14 with numbers 15.7 and 10.0 larvae/sample (Table1).

Table 1: Weekly mean numbers of *Phyllocnistis citrella* larvae and its parasitoids per 50 leaves in mandarin orchard during 2013-14, in relation to climatic factor (temperature & relative humidity).

Date	Mean No. of CLM	Mean NO. of parasite	%parasite	Max. Temp. (C°)	Min. Temp. (C°)	R.H. % average
09/03/2013	0.0	0.0	0.0	20.1	14.3	68.5
16/03	0.3	0.0	0.0	22.7	15.3	66.9
23/03	1.3	0.0	0.0	20.3	14.6	66.4
30/03	1.6	0.0	0.0	21.9	14.9	70.4
06/04/2013	2.4	0.0	0.0	22.9	16.9	71.9
13/04	6.7	0.0	0.0	23.1	16.0	72.3
20/04	5.0	0.0	0.0	21.6	15.3	72.6
27/04	1.4	0.3	21.4	20.7	15.9	74.4
04/05/2013	3.1	0.6	19.4	24.0	20.4	80.9
11/05	8.3	0.7	8.4	25.6	20.3	89.3
18/05	21.7	0.3	1.4	25.9	19.4	76.3
25/05	20.5	0.3	1.5	27.4	22.4	80.9
01/06/2013	19.0	0.0	0.0	27.7	22.0	71.7
08/06	3.0	0.0	0.0	27.3	22.6	73.9
15/06	2.2	0.0	0.0	29.6	23.0	70.6
22/06	1.7	0.0	0.0	28.9	23.9	77.4
29/06	3.0	0.7	23.3	29.9	24.6	81.7
06/07/2013	3.3	0.9	27.3	28.9	24.7	77.4
13/07	4.7	0.7	14.9	28.7	24.7	78.4
20/07	7.7	0.3	3.9	29.4	24.6	82.4
27/07	6.7	2.0	29.9	30.3	24.9	84.1
03/08/2013	4.0	1.7	42.5	32.0	24.7	80.6
10/08	9.3	1.7	18.3	30.9	25.7	86.9
17/08	11.0	0.3	2.7	30.9	25.7	81.4
24/08	15.7	0.3	1.9	31.1	26.1	84.7
31/08	3.7	0.7	18.9	30.9	25.3	80.7
07/09/2013	7.3	0.0	0.0	30.6	24.9	82.6
14/09	10.0	0.7	7.0	29.6	25.0	77.9
21/09	7.3	1.0	13.7	29.9	25.1	78.6
28/09	3.0	0.3	10.0	27.9	23.4	71.7
05/10/2013	7.7	0.3	3.9	28.0	22.9	70.9
12/10	8.3	0.3	3.6	25.1	21.6	63.3
19/10	6.3	0.0	0.0	27.0	21.4	76.0
26/10	4.3	0.0	0.0	25.1	21.7	67.3
02/11/2013	3.3	0.0	0.0	25.1	22.0	78.0
09/11	1.3	0.0	0.0	25.0	20.7	80.9
16/11	0.3	0.0	0.0	24.6	21.1	83.1
23/11	1.0	0.0	0.0	22.7	18.0	79.1
30/11	0.0	0.0	0.0	24.3	18.9	74.1
07/12/2013	0.0	0.0	0.0	23.0	17.9	77.7
14/12/	0.0	0.0	0.0	16.1	11.3	81.0
21/12	0.0	0.0	0.0	16.4	9.1	84.0
28/12	0.0	0.0	0.0	19.1	13.3	74.9
04/01/2014	0.0	0.0	0.0	17.6	11.6	88.1
11/01	0.0	0.0	0.0	17.4	12.6	89.4
18/01	0.0	0.0	0.0	19.1	14.1	93.6
25/01	0.0	0.0	0.0	18.9	14.7	92.4
01/02/2014	0.0	0.0	0.0	19.9	13.1	79.3
08/02	0.0	0.0	0.0	17.9	13.9	78.6
15/02	0.0	0.0	0.0	19.0	14.0	82.4
22/02	0.0	0.0	0.0	18.9	14.4	89.7
01/03/2014	0.0	0.0	0.0	19.7	14.6	79.7

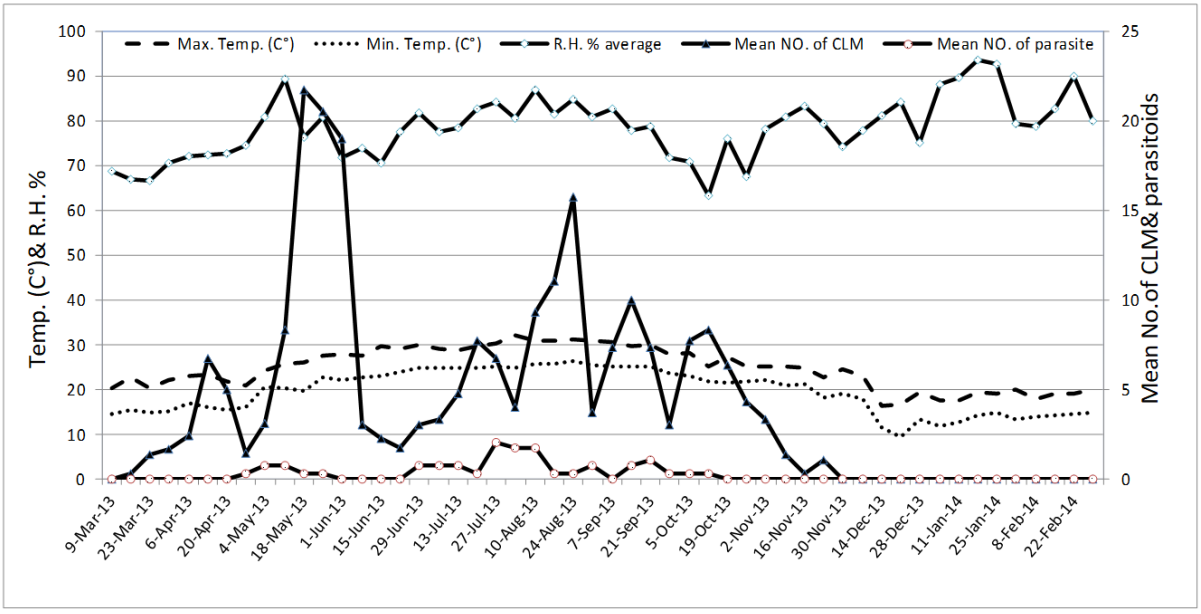

Fig.1: Weekly mean numbers of *Phyllocnistis citrella* larvae and its parasitoids per 50 mandarin leaves in relation to recorded temperature & relative humidity during 2013-14.

During 2014-15 those were noticed in late August and late September with numbers 13.2 and 17.0 larvae/sample (Table 2). The average registered temperature was about 28ºC and 76.8% R.H. during that period. This result indicated that there is a positive relationship between CLM population abundance and both temperature and R.H. This piece of the result is in agreement with that obtained previously (Patel *et al*., 1994; Smith, 1994; Pena *et al*., 1996; Katole *et al*., 1997; Batra *et al*., 1998; Hammad *et al*., 2000) For example; Patel *et al*. (1994) found that CLM larval population on lime was higher during August – September than any other time.

They mentioned that a minimum temperature of more than 18ºC had a positive association with the pest population. Smith (1994) found that CLM heavy infestation occurred during the hot – humid months of May and September. Pena *et al*. (1996) found that the high peaks of CLM population were observed during summer (June – July) and fall (Sept – October). Katole *et al*. (1997) stated that a temperature of 24-26ºC favored a CLM population increase. Batra *et al*. (1998) reported that two major peaks of CLM population were observed in April and September which coinciding with citrus new flushes. Hammad *et al*., (2000) found that CLM population had 6 – 8 peaks on mandarin trees at Sharkia Governorate.

On the contrary, Abdel-Rhman (2005) studied the population dynamics of CLM on mandarin trees in a citrus orchard located in El-Kanater El-Khairia, Qalyubiya Governorate during two successive years of 2000 & 2001. He found that CLM population had 5 peaks only in each year. For both years, the highest population peak was noticed by the end of July. In 2000, the highest peak was with 68 larvae/ 50 leaves when registered mean temperature was 31.6ºC and R.H was 59.9%. In 2001, He found that the highest peak was with 64 larvae/ 50 leaves and the average temperature was 27.6ºC and R.H was 61.9%. The discrepancy, in obtained results, between Abdel – Rhman study and the present work may be due to the different factors prevailing in the two studies such as climatic factors, age of mandarin trees, …..etc. Moreover, mandarin showed a considerably lower percentage of CLM infestation (Badawy, 1967; Shevale and Pokharkar, 1992; El-Saadany *et al*., 2002).

Data of Tables 1&2 are summarized and listed in Table (3) to show the fluctuation in the seasonal abundance of CLM during the studied years. Winter seasons of both 2013-14

and 2014-15 did not show any existence of CLM larvae. Huang *et al*. (1989) cited that water deficiency in leaves was the main mortality factor for winter and early spring CLM generations. However, Deng and Garrido (1999) reported that leaf water content had no significant effect on CLM larval mortality. They added that the low winter temperature and the no existence of new flushes were the key factors for the disappearance of CLM at that season.

Table (3) shows that the descending order of CLM abundance in the remaining seasons is: spring > summer ≥ autumn and that was true for the two studied years. Thus, regardless of the year of investigation, springtime is considered the most abundant season for *P. citrella* infestation followed by either summer or autumn seasons. This piece of the result is in accordance with that obtained previously. For example, Aly *et al.* (1999) reported that the high infestation with a maximum density of CLM larvae and mines occurred on summer shoots followed by autumn in Minia, Egypt. Zeb *et al*. (2011) found that the highest infestation of *P. citrella*, in Pakistan, was recorded in September and October. Chhetry *et al*. (2012) stated that, in India, three population peaks were observed for CLM, first in spring flush, the small second peak in July and third peak in September (autumn flush), and the highest CLM infestation level was noticed in spring.

From the above, the most likely reason for the increase and decrease in population was related to both the development of new shoots and an increase in favorable temperatures for the pest's development.

Regarding CLM parasitoids, *Semielacher petiolatus* (Girault) and *Cirrospilus ingenuus* (Gahan) are known to be solitary ecto parasitoids for CLM larvae and pupae. (Rizzo *et al*., 2006; Argov *et al*., 2012). They were selected as CLM main parasitoids, in the present work, for two reasons: (1) these parasitoids were more abundant on mandarin leaves as indicated during the preliminary field experiment of the present work. (2) Previous reports showed the importance of these two parasitoids as biological agents for CLM control (Ateyyat, 2002; Garcia – Mari, 2003; Elekcioglu and Uygun, 2006).

The seasonal abundance of CLM parasitoids is shown in Table (1) and Fig (1) for 2013-14 and Table (2) and Fig (2) for 2014-15. Two main periods were confirmed their appearance each year. In 2013-14, they were observed from 27th of April to 25th of May and from 29th of June to 12th of October, with five peaks of their abundance. These peaks were on 11th of May, 6^{th,} and 27th of July, 31st of August, 21st of September with 0.7, 0.9, 2.0, 0.7 and 1.0 parasitoids/sample (Table1).

In 2014-15, these parasitoids were noticed from 10th of May to 7th of June and from 23rd of August to 25th of October, with five peaks of abundance. These peaks were on 10th and 31st of May, 23rd of August, 20th of September, 11th of October with 0.7, 1.0, 0.9, 1.3 and 1.3 parasitoids/ sample (Table 2).

Accordingly, the highest parasitism was 42.5% on the 3rd of August in 2013-14 and 19.2% on 13th of Sept. in 2014-15. These results are in agreement with those obtained previously in which the minimum parasitism occurred in May and it is maximum between August and September (Alkhateeb *et al*., 1997; Ateyyat, 2002 and Garcia – Mari, 2003). Alkhateeb *et al*. (1997) mentioned that the highest ratio of parasitism on CLM was observed in August up to 73%. Five parasitoids were identified including *Semielacher petiolatus* and *Cirrospilus ingenuus*. Elekcioglu and Uygum (2006) added that these parasitoids play a significant role in reducing CLM population during late summer and autumn flushes. Several authors have reported low to high rates of parasitism due to their different parasitoid species complex of *P. Citrella* (Pena *et al*., 1996; Diez *et al*., 2006 and Xiao *et al*., 2007). In any way, Liotta *et al*. (1996) concluded that the total level of parasitism was not always sufficient to control the population of CLM.

Table 2: Weekly mean numbers of *Phyllocnistis citrella* larvae and its parasitoids per 50 leaves in mandarin orchard during 2014-15, in relation to climatic factors (temperature & relative humidity).

Date	Mean No. of CLM	Mean NO. of parasite	%parasite	Max. Temp. (C°)	Min. Temp. (C°)	R.H. % average
08/03/2014	0.0	0.0	0.0	21.0	16.3	79.3
15/03	0.0	0.0	0.0	19.4	14.0	80.4
22/03	0.0	0.0	0.0	20.4	15.4	80.9
29/03	0.0	0.0	0.0	21.1	16.4	91.7
05/04/2014	0.0	0.0	0.0	20.1	15.9	81.6
12/04	0.3	0.0	0.0	22.7	17.1	87.1
19/04	3.0	0.0	0.0	24.0	18.1	76.3
26/04	5.3	0.0	0.0	23.7	19.3	78.4
03/05/2014	12.3	0.0	0.0	24.6	19.6	73.0
10/05	5.0	0.7	14.0	28.7	21.4	64.7
17/05	13.0	0.3	2.3	24.9	20.1	68.1
24/05	25.7	0.0	0.0	25.0	21.0	70.0
31/05	16.0	1.0	6.3	27.7	21.7	69.1
07/06/2014	4.7	0.7	14.9	28.7	22.3	65.6
14/06	4.0	0.0	0.0	27.4	22.0	73.1
21/06	3.7	0.0	0.0	28.9	23.4	71.9
28/06	3.0	0.0	0.0	30.0	23.4	72.7
05/07/2014	2.7	0.0	0.0	30.0	25.0	75.0
12/07	1.4	0.0	0.0	30.7	25.0	74.0
19/07	8.6	0.0	0.0	29.7	25.0	74.3
26/07	2.4	0.0	0.0	30.4	25.1	72.1
02/08/2014	1.0	0.0	0.0	30.6	25.4	74.3
09/08	1.7	0.0	0.0	31.0	25.7	70.1
16/08	5.0	0.0	0.0	31.4	25.7	74.4
23/08	13.2	0.9	6.8	30.9	26.0	73.6
30/08	4.3	0.7	16.3	31.7	26.0	78.4
06/09/2014	10.0	0.3	3.0	30.4	25.6	72.4
13/09	5.2	1.0	19.2	30.1	25.6	68.6
20/09	10.3	1.3	12.6	30.0	25.0	70.1
27/09	17.0	0.3	1.8	31.0	24.9	71.0
04/10/2014	15.0	1.0	6.7	28.9	23.1	62.3
11/10	8.3	1.3	15.7	27.7	23.3	68.6
18/10	5.0	0.7	14.0	27.1	22.1	68.0
25/10	4.0	0.3	7.5	27.4	20.9	67.0
01/11/2014	2.3	0.0	0.0	26.6	21.9	69.0
08/11	0.3	0.0	0.0	24.7	19.6	66.9
15/11	0.0	0.0	0.0	24.7	19.6	73.4
22/11	0.3	0.0	0.0	24.1	19.3	71.7
29/11	0.7	0.0	0.0	20.3	15.3	72.6
06/12/2014	0.3	0.0	0.0	22.4	16.6	80.6
13/12	0.3	0.0	0.0	21.4	17.0	72.7
20/12	0.3	0.0	0.0	20.9	15.3	72.1
27/12	0.0	0.0	0.0	20.0	14.1	75.4
03/01/2015	0.0	0.0	0.0	19.4	11.7	64.6
10/01	0.0	0.0	0.0	15.4	9.4	69.1
17/01	0.0	0.0	0.0	16.9	10.1	72.1
24/01	0.0	0.0	0.0	19.9	12.0	77.0
31/01	0.0	0.0	0.0	18.9	14.4	74.6
07/02/2015	0.0	0.0	0.0	19.9	13.4	69.4
14/02	0.0	0.0	0.0	17.6	11.6	65.6
21/02	0.0	0.0	0.0	16.4	9.3	73.6
28/02	0.0	0.0	0.0	18.4	12.1	76.7

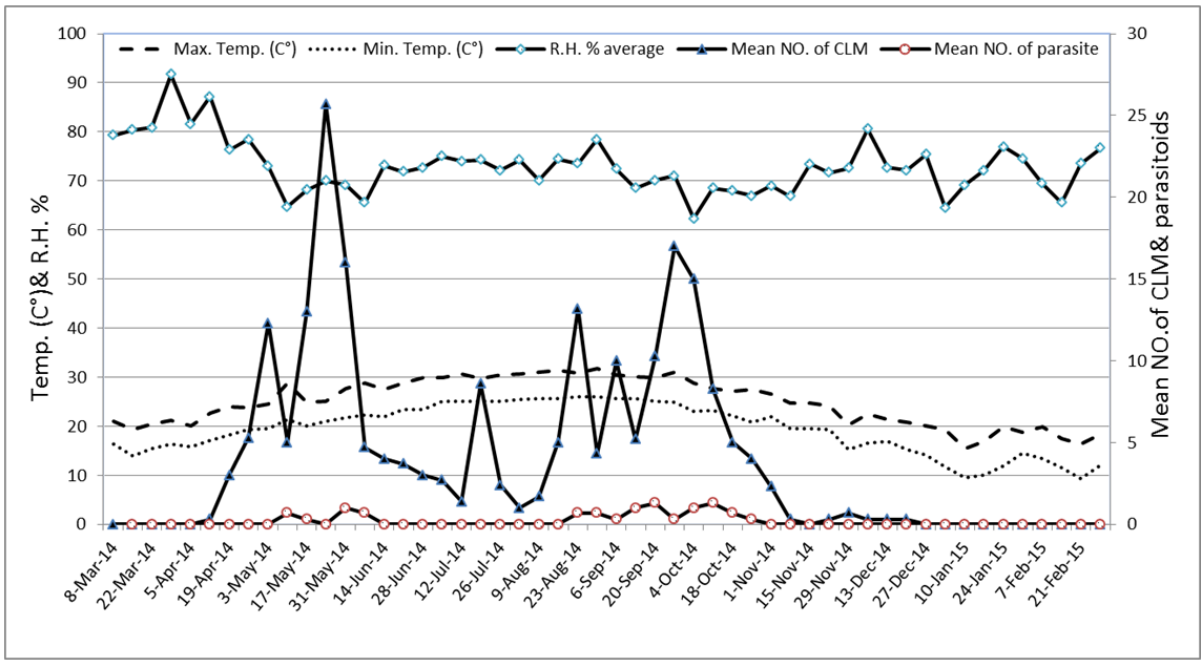

Fig.2: Weekly mean numbers of *Phyllocnistis citrella* larvae and its parasitoids per 50 mandarin leaves in relation to recorded temperature & relative humidity during 2014-15.

Table 3: Seasonal fluctuation of *Phyllocnistis citrella* (No. of larvae /50 leaves) during 2013-14 & 2014-15.

Seasons	2013-14	2014-15
Spring	7.4 a	6.9 a
Summer	6.7 ab	4.9 a
Autumn	3.3 bc	4.8 a
Mean years	5.8 a	5.5 a

*Means in each column followed by the same small letter (s) are no significant at P<0.05 according to Duncan's multiple range tests

Table (4) shows the statistical analyses of factors affecting the population density of CLM during the studied years (2013-14 & 2014-15).

Previous studies took in consideration many biotic factors (such as citrus species, plant age, presence of parasitoids and predators) and abiotic factors (such as temperature, relative humidity, vapour pressure, rainfall, direction, bright sunshine hours) that affect the population density of CLM (Patel 2001 and Diez *et al*., 2006)

In the present study, the effect of maximum and minimum daily temperature, daily mean percent relative humidity and the mean number of associated parasitoids were undertaken to neglect the effect of other climatic factors because the larvae and pupae of CLM are protected in the leaves.

As shown in Table (4) the effect of max. and min. temperatures had significant positive effects on the insect population during both studied years. The "r" values were 0.61, 0.38 and 0.58, 0.37 for the maximum and minimum temperatures in 2013-14 and 2014 -15, respectively.

For the effect of relative humidity, simple correlation showed significant positive effect in 2013-14 (r value = 0.35) and negative effect in 2014-15 (r value = -0.55).

For parasitoid numbers, statistical analysis proved that associated parasitoid numbers significantly had a positive effect in the first year, and had an insignificant positive effect in the 2nd year (Table 4).

The exact relation between the studied factors and CLM population density was determined by estimating the partial regression values. Table (4) shows that all values were insignificant except R.H. % in the 2nd year.

The effect of the combination of all studied factors on CLM population was presented as explained variance (E.V.) which was 36.9% in the first and 34.7% in the 2nd studied year (Table 4). These results are agreement with Abdel-Rhman (2005) and El-Afify *et al.*, (2018).

Table 4: Simple correlation and Partial regression values of one biotic and three abiotic factors on the variability of the population fluctuation of *Phyllocnistis citrella* larvae on mandarin trees during 2013-14 and 2014-15.

Year	Source of variation	Simple correlation		Partial regression		'F' value		E.V. %
		r	P	b	P	f	P	
First year 2013-14	Daily max. temp.	0.60672	0.0001	0.68448	0.1765	6.81	0.001	36.85
	Daily min. temp.	0.57763	0.0001	-0.04362	0.9265			
	Daily mean R.H.%	0.34755	0.0302	0.01336	0.8934			
	Parasitoids mean no.	0.36698	0.0216	0.52733	0.6155			
Second year 2014-15	Daily max. temp.	0.37602	0.0183	0.02105	0.9816	6.19	0.0017	34.68
	Daily min. temp.	0.36755	0.0213	0.27552	0.7664			
	Daily mean R.H.%	-0.54767	0.0003	-0.46608	0.0021			
	Parasitoids mean no.	0.24968	0.1253	-1.42838	0.3716			

In conclusion, the obtained results from studied population dynamic, parasitoids as well as climatic factors of citrus leafminer in mandarin orchard located in Sharkia Governorate can help build up an integrated control program for this insect.

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ARABIC SUMMARY

ديناميكية التعداد لحشرة صانعة أنفاق أوراق الموالح *Phyllocnistis citrella*
(حرشفية الأجنحة:Gracillariidae) وطفيلاتها على أشجار الموالح فى محافظة الشرقية، مصر.

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أجريت هذه الدراسة على حشرة صانعة أنفاق أوراق الموالح *Phyllocnistis citrella* لدراسة تذبذب تعداد هذه الحشرة على أشجارالبوسفي والطفيليات المرتبطة بها وتأثير العوامل المناخية وخاصة درجة الحرارة والرطوبة النسبية علي تعدادها خلال عامين متتاليين (٢٠١٣- ١٤ و٢٠١٤-١٥) فى محافظة الشرقية.

أظهرت نتائج تذبذب تعداد حشرة صانعة انفاق أوراق الموالح أن لها ٦ فترات يزداد فيها التعداد.حيث لوحظ أن أكبر تعداد يكون خلال فترتين رئيسيتين، الفترة الأولى في أواخر شهر مايو والفترة الثانية فى أواخرشهر أغسطس ومنتصف شهرسبتمبرلكل من عامى الدراسة. عموما، يعتبر فصل الربيع أكثر المواسم إصابة بهذه الحشرة يليه إما فصل الصيف أو الخريف، بينما كان هناك غياب كامل للأصابة بهذه الحشرة خلال فصل الشتاء.

لوحظ أن لهذين الطفيليين (*Semielacher petiolatus* (Girault)) و(*Cirrospilus ingenuus* (Gahan)) خمس فترات لزيادة أعدادهما في كل عام من الدراسة. كانت أعلى نسبة تطفل ٤٢,٥٪ في بداية شهر أغسطس عام ٢٠١٣-١٤ و ١٩,٢٪ في منتصف شهر سبتمبر عام ٢٠١٤-١٥. أظهر التحليل الأحصائى أن هناك علاقة إيجابية بين تعداد هذه الحشرة وكل من درجة الحرارة و٪ للرطوبة النسبية وأعداد الطفيليات المصاحبة لهذه الحشرة، كان التأثير المشترك لهذه العوامل مجتمعة بنسبة ٣٦,٩٪ فى العام الأول ، ٣٤,٧٪ فى العام الثانى من الدراسة.