



Article

## Population Dynamics of *Hemiberlesia lataniae* (Signoret) (Hemiptera: Diaspididae) and Associated Natural Enemies on Apple Trees *Malus domestica* (Boek), in Sadat, Menufia Governorate

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**Abstract:** Apple is one of the most important fruits in Egypt as far as its acreage, production and exportation potentials. This work is to study the population dynamics of *Hemiberlesia lataniae* (Signoret) (Hemiptera: Diaspididae) and associated natural enemies on apple trees *Malus domestica* (Boek), in Sadat, Menufia Governorate, Egypt. Total population of *H. latania* showed three peaks in both years of study the highest one was in August. Multiple regressions were conducted for weather factors and natural enemies (*Chrysoperla carnea* (Steph.) (Neuroptera: Chrysopidae) and *Encarsia citrine* (Craw) (Neuroptera : Chrysopidae)) combined as well as plant age as described. The explained variances (E.V) indicated the impact for weather factors on the total population of *H. latania* were (86.87% and 88.28%) in both years of study. While the effect of natural enemies (*E. citrine* and *C. carnea*) was (89.49% and 87.24%). The plant age had the value of (E.V) was (89.04% & 89.81%). To evaluate the common effect of biotic and abiotic factors was (96.75% & 96.79%) for nymphs population, (91.67% & 92.82%) for adult females population, (71.68% & 77.60%) for gravid females population and (96.51% & 96.54%) for total population of *H. latania*.

**Key words:** *Hemiberlesia lataniae*, *Chrysoperla carnea*, *Encarsia citrine*, apple *Malus domestica*.

### INTRODUCTION

Apple trees *Malus domestica* (Boek) (Rosaceae) is one of the most important fruits in Egypt as far as its acreage, production and exportation potentials are concerned (Moustafa and Abd-Rabou, 2011). The apple trees infesting by the major pests scale insects including *Hemiberlesia lataniae* in Egypt (Abd-Rabou, 2003). Also, *H. lataniae* is the most important diaspidid insects infested fruit and ornamental plants (Bayoumy et al., 2010). The latania scale infested all aerial parts. *H. lataniae* can be detected by abnormal coloring and some distortion of leaves, twigs and fruit, and as pitting of the bark of stems. Heavy infestation of latania scale can cause dieback of branches and twigs



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(Kosztarab, 1996). *H. latania* occurred on guava tree all the year round and has three overlapping generations a year in Qaliobiya governorate. The predators were five species, also there were three parasitoids associated with the scale insect, *H. lataniae*, *Aphytis* sp, *Comperiella bifasciata* Howard (primary parasitoids) and *Mariettja vensis* (Howard) (hyper parasitoid) (Attia *et al.*, 2017).

The aim of this work is to study the population dynamics of *Hemiberlesia lataniae* (Signoret) (Hemiptera: Diaspididae) and associated natural enemies on apple trees *Malus domestica* (Boek) (Rosaceae), in Sadat, Menufia Governorate, Egypt.

## MATERIALS AND METHODS

### Population dynamics of *Hemiberlesia lataniae* (Signoret) (Hemiptera: Diaspididae) infesting apple trees and associated natural enemies:

Population dynamics of the latania scale, *Hemiberlesia lataniae* (Signoret) (Hemiptera: Diaspididae) and associated natural enemies on apple trees *Malus domestica* (Boek), during 2020-2021 and 2021-2022 in Sadat, Menufia Governorate, Egypt.

The trees areas selected for these investigations no chemical control measures for several years. Thirty trees of apple almost similar in age, size, shape and growth condition were randomly chosen for sampling biweekly. On each sampling, 30 twigs of apple trees were chosen randomly. Thereafter, the twigs were kept in a closed paper bag and transferred to the laboratory for further examination and counting. Each sample was stored in a well-ventilated emergence glass tube and monitored daily for parasitoid emergence. Predators were counted in field and transferred to the laboratory for further examination.

### Effect of three ecological parameters on *Hemiberlesia lataniae* (Signoret) population dynamics:

Impact of the maximum temperature, minimum temperature and the average daily relative humidity over 2020-2021 and 2021-2022 were obtained from the Meteorological Central Laboratory, Agricultural Research Center, and Ministry of Agriculture. Effect of the predator, *Chrysoperla carnea* (Steph.) (Neuroptera: Chrysopidae) and the parasitoid, *Encarsia citrine* (Craw) (Hymenoptera: Aphelinidae).

Simple correlation and regression values were calculated to obtain information about the relationships between the three tested weather factors and the population of the latania scale and its natural enemies.

### Effect of biotic and abiotic factors on the Population dynamics of *H. latania*:

Plant phenology emulating plant nutritional value dynamics over the griming season was considered as plant age (X). This relation was presented by polymanial equation of third degree ( $Y = a + b_1X + b_2X^2 + b_3X^3$ ). Multiple regressions were conducted for weather factors and natural enemies (*E. citrine* and *C. carnea*) combined as well as plant age as described. The obtained determination factor ( $R^2$ ) of E.V. % was used to explain the effect of testing factors. Process Correlation and Regression were used in SAS to analysis the obtained data (SAS Instue, 1998).

## RESULTS AND DISCUSSION

### Population dynamics of *Hemiberlesia lataniae* (Signoret) (Hemiptera: Diaspididae) infesting apple trees:

The seasonal abundance of *H. latania* was studied for two successive years from September 2020 till August 2022 on apple trees in Sadat, Menufia Governorate.

The obtained results in figure (1) showed that the population of nymph stage of *H. latania* recorded three peaks were in 27<sup>th</sup> of October 2020 by 122 individuals /sample, 30<sup>th</sup> of March 2021 by 115 individuals /sample and 20<sup>th</sup> July 2021 by 200 individuals/ sample. Whereas, the adult females showed

three peaks in 10<sup>th</sup> of November 2020 by 71 individuals / sample, the end of March 2022 by 66 individuals / sample and the last on 3<sup>rd</sup> August 2022 by 167 individuals / samples. Gravid females had recorded three peaks the highest one was in 3<sup>rd</sup> August 2022 by 77 individuals / sample.

Total population of *H. latania* showed three peaks in first year of study the highest one was 3<sup>rd</sup> August 2021 by 420 individuals / sample.

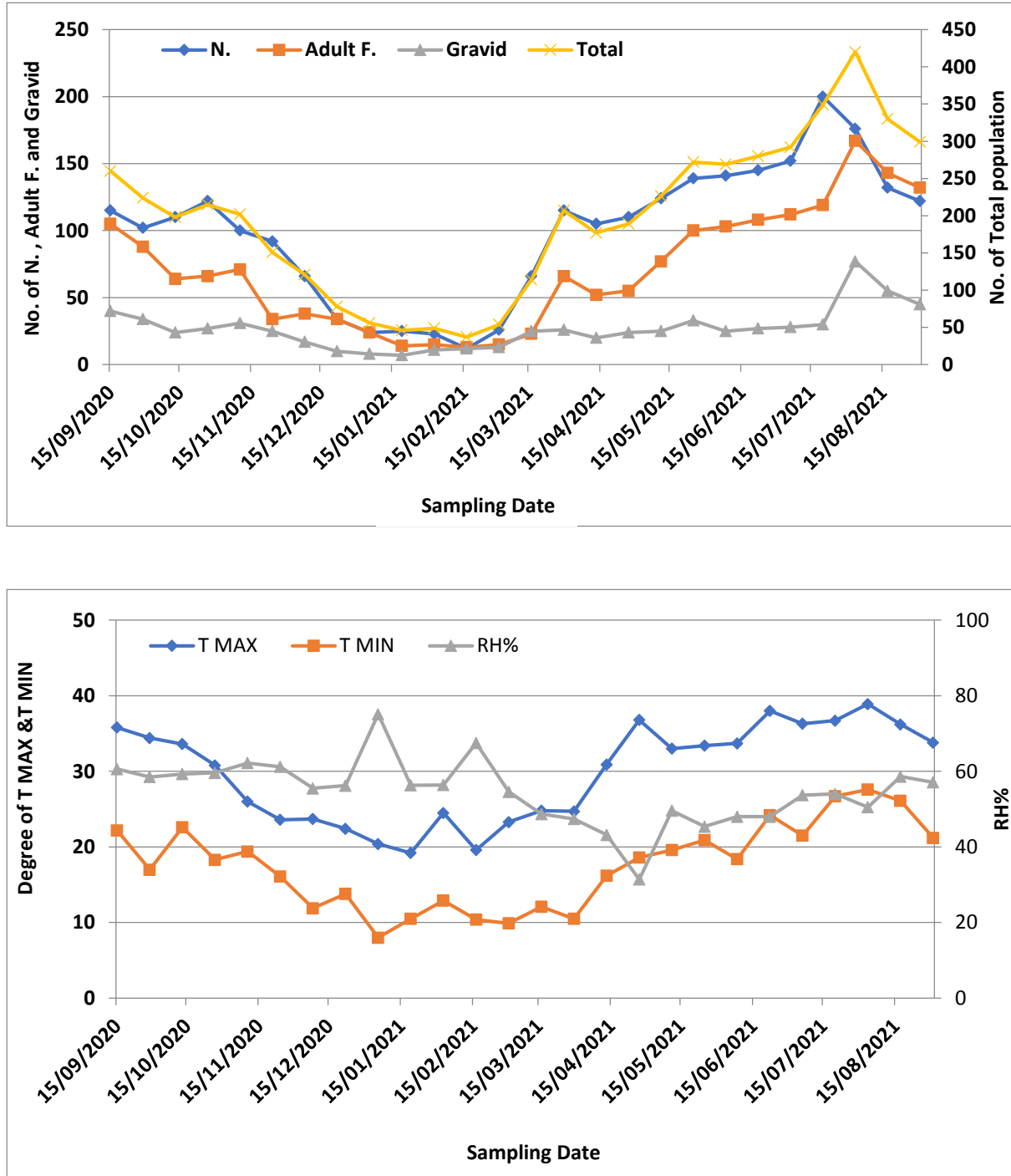


Figure 1. Population dynamics of nymphs, adult females, gravid females and total population of *Hemiberlesia lataniae* (Signoret) (Hemiptera: Diaspididae) on apple trees in Sadat, Menufia Governorate, during 2020/2021 season.

Second year of study (2021- 2022) appeared to be similar result. The nymph and adult stages of *H. latania* showed three peaks on fourth week of October 2021, end of March and third week of July 2022 by 116, 99 & 208 and 70, 74 & 127 individuals / sample, respectively. Also, gravid females had recorded three peaks the highest one was in first week of August 2022 by 80 individuals / sample. The total population had showed three peaks the highest one on 2<sup>nd</sup> August 2022 by 439 individuals / sample (figure, 2).

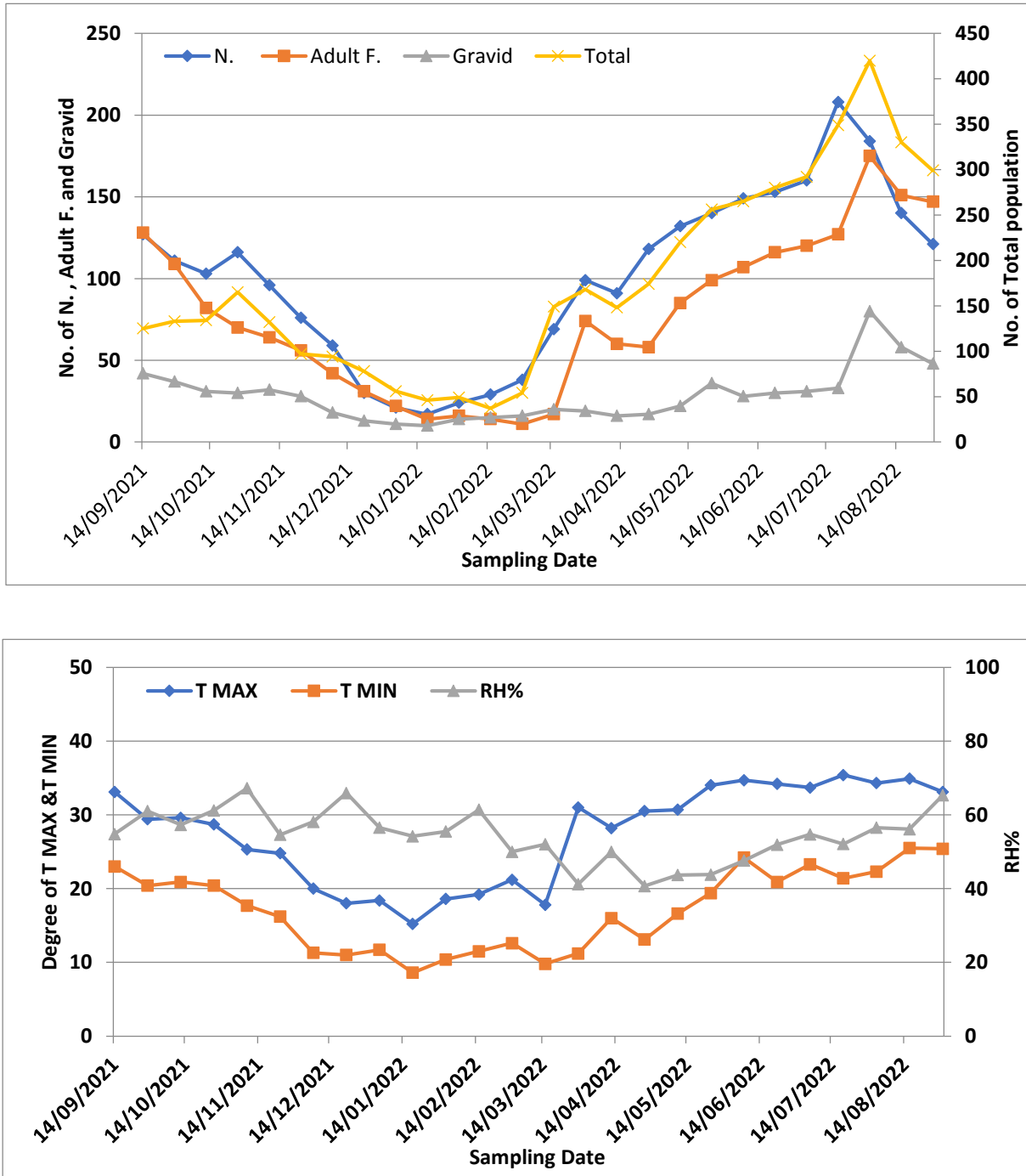


Figure 2. Population dynamics of nymphs, adult females, gravid females and total population of *Hemiberlesia lataniae* (Signoret) (Hemiptera: Diaspididae) on apple trees in Sadat, Menufia Governorate, during 2021/2022 season.

This result was agreement with that recorded by **Mohamed (1999)** who found that, *H. lataniae* had three peaks showed in first week of April, June and August on olive trees at Ismailia Governorate. Also, **Helmy (2014) and Radwan (2014)** found that the seasonal fluctuation of all stages of *H. lataniae* had three peaks. On guava at Shebeen El-Qanater, Qaliobya Governorate found that *H. latania* occurred all the year round and had three overlapping generations a year (**Attia *et al.*, 2017**).

#### **Effect of three ecological parameters on *Hemiberlesia lataniae* (Signoret) population dynamics:**

Impact of abiotic factors on the population of *H. latania* was investigated over the course of two years, from September 2020 to August 2021 and September 2021 to August 2022 in Menufia Governorate.

##### **Impact of the maximum temperature**

According to the findings of the statistical analysis of simple correlation, the value of the correlation coefficient ( $r$ ) for the nymphs stage was 0.89 and 0.91, was positive significant in both years of study. While the adult female, gravid females and the total population the value of correlation coefficient were (0.86, 0.87 & 0.71, 0.69 and 0.90, 0.91) respectively (Table 1).

##### **Impact of the minimum temperature**

The result of the statistical analysis of simple correlation showed that positive significant in both years of study by recorded (0.89, 0.89 & 0.88, 0.89 & 0.77, 0.79 and 0.92, 0.92) for nymphs, adult females, gravid females and total population of *H. latania*, respectively (Table 1).

##### **Effect of the average daily relative humidity**

The daily relative humidity for all stages of *H. latania* showed negative significant correlation over the two studied years, as shown in Table (1).

This results agreement with **EL-Minshawy *et al.* (1974)** who found that the impact of temperatures (20, 23, 25, and 30°C) on the population characteristics in low temperature the generation time is 146 days while in 27°C was 73 – 92 days.

#### **Effect of the associated predator, *Chrysoperla carnea* (Steph.) (Neuroptera: Chrysopidae)**

The data illustrated in figure (3 A) showed the number of the predator *C. carnea* had three peaks the highest one in 3<sup>rd</sup> August 2021 by 60 individuals /sample in first year. The rate of predatism was calculated showed the lowest 7.2% at the end of March and the highest rate was 15.8 % in 20<sup>th</sup> of July 2021.

In the second year of study the predator *C. carnea* showed the same trend in first year. The population of *C. carnea* had three peaks the highest one in 2<sup>nd</sup> August 2022 by 61 individuals/ sample. The rate of predatism showed the lowest 6.9% in the 15<sup>th</sup> of February 2022 (Figure 3B).

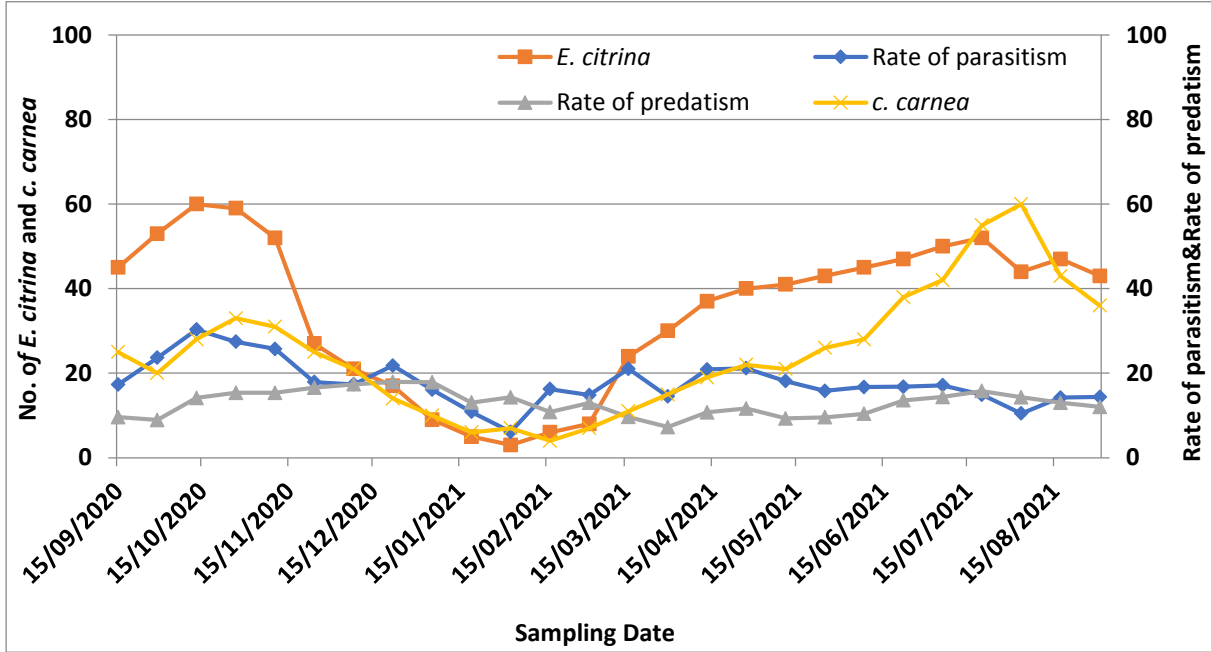
Statistical analysis showed a positive significant between the population of *C. carnea* and total population of the *H. latania* ( $r= 0.93$  & 0.91) in both years of study (Table. 1).

The results presented above were in line with those reported by **Helmy (2014)**, who noted that *C. carnea*, a predator to *H. lataniae*, was released in the field to manage this pest and provided a good reduction percentage. Additionally, *C. carnea* and *Coccinella* sp. were described as predators (natural enemies) of the pests that infest guava trees by **Al-Fwaer *et al.* (2013)**.

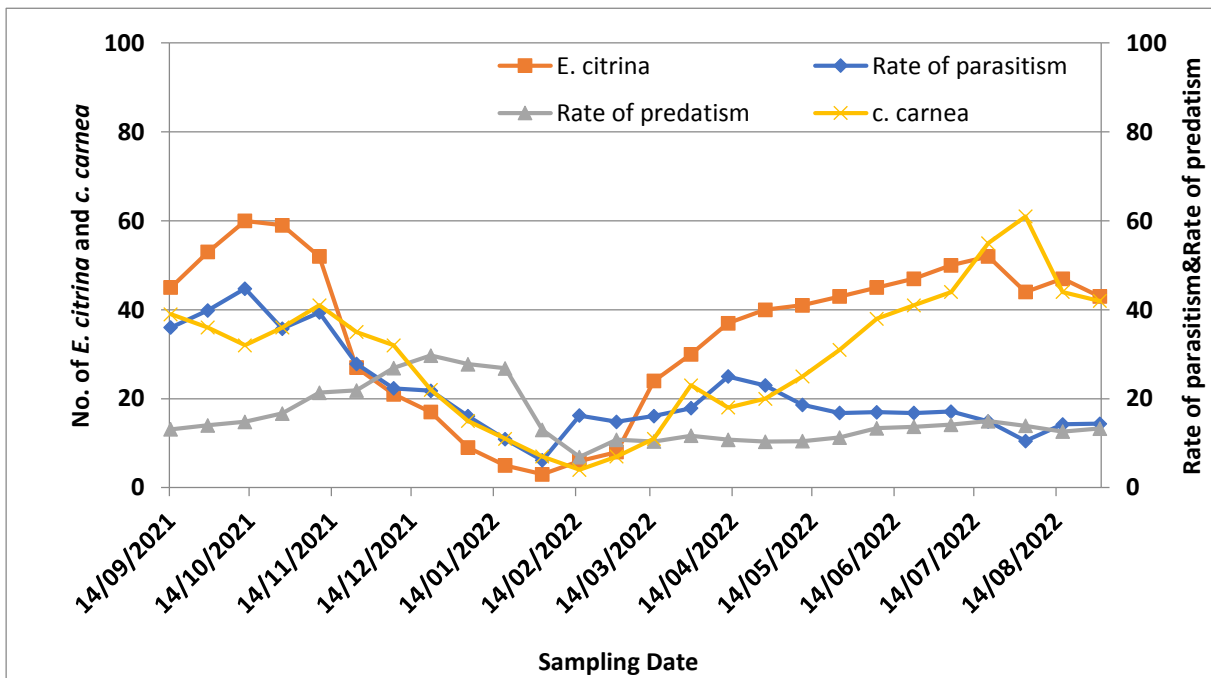
#### **Effect of the parasitoid, *Encarsia citrine* (Craw) (Hymenoptera: Aphelinidae)**

The data illustrated in figure (3 A) showed the number of the parasitoid *E. citrine* had two peaks the highest one in 13<sup>th</sup> October 2020 by 60 individuals /sample in first year. The rate of parasitism showed the lowest 6.1% at the 2<sup>nd</sup> of February and the highest was 30.3 % in 13<sup>th</sup> of October 2020.

In the second year of study the parasitoid *E. citrina* showed the same trend as in the first year. The population of *E. citrina* had two peaks the highest one in 12<sup>th</sup> October 2020 by 60 individuals /sample in second year. The rate of parasitism showed the lowest 5.6 % at the 1<sup>st</sup> of February and the highest was 27.8 % in 12<sup>th</sup> of October 2021 (Figure 3B).



(A)



(B)

Figure 3. Total population of *Encarsia citrina* (Craw) & *Crysoperla carnea* (Steph.) and the rate of parasitism & predatism during 2020/2021(A) and 2021/2022 (B) season.

**Effect of three ecological parameters on *Hemiberlesia lataniae* (Signoret) population dynamics:**

Statistical analysis showed a positive significant between the population of *E. citrine* and the total population of the *H. latania* ( $r=0.82$ ) in both years of study (Table. 1).

This result agreement with **EL-Amir *et al.* (2020)** who recoded the parasitoid *E. citrine* on apple in Gharbiya Governorate.

Multiple regressions were conducted for weather factors and natural enemies (*E. citrine* and *C. carnea*) combined as well as plant age as described. The explained variance (E.V) showed the impact for weather factor on the total population of *H. latania* with (86.87% and 88.28%) in both years of study. While the effect of natural enemies (*E. citrine* and *C. carnea*) were (89.49% and 87.24%). The plant age had the value of (E.V) were (89.04% & 89.81%). To evaluate the common effect of biotic and abiotic factors was (96.75% & 96.79%) for nymphs population, (91.67% & 92.82%) for adult females population, (71.68% & 77.60%) for gravid females population and (96.51% & 96.54%) for total population of *H. latania* (Table 1.)

On guava **Attia *et al.* (2017)** found that the outcomes of the statistical analysis revealed that the explained variances (E. V.) for the two years of study were 84.98 & 66.2 % respectively.

**Table (1). The simple correlation and regression coefficients and multiple regressions between the different stages of *Hemiberlesia lataniae* (Signoret) (Hemiptera: Diaspididae) on apple trees in Sadat, Menufia Governorate, during 2020/2021(A) and 2021/2022 (B) season**

Factor	Simple correlation and regression						Multiple regression		
	r		b		p		E.V.%		
	A	B	A	B	A	B	A	B	
Nymphs	T max.	0.89	0.91	2.672	4.124	0.0001	0.0001		
	T min.	0.89	0.89	4.997	3.919	0.0001	0.0001	84.30	85.80
	R.H.%	-0.40	-0.40	-0.654	-0.441	0.0455	0.447		
	<i>E. citrina</i>	0.86	0.84	1.212	2.113	0.0001	0.0001	89.32	85.41
	<i>c. carnea</i>	0.90	0.89	2.009	1.182	0.0001	0.0001		
	Age1-Age3							89.04	90.66
	All above							96.75	96.79
Adult females	T max.	0.86	0.87	3.585	4.856	0.0001	0.0001		
	T min.	0.88	0.89	3.516	3.0156	0.0001	0.0001	82.03	84.13
	R.H.%	-0.20	-0.17	0.728	1.154	0.3201	0.3974		
	<i>E. citrina</i>	0.75	0.77	0.474	0.702	0.0001	0.0001	80.62	78.97
	<i>c. carnea</i>	0.89	0.87	2.252	2.236	0.0001	0.0001		
	Age1-Age3							81.77	84.81
	All above							91.67	92.82
Gravid females	T max.	0.71	0.69	0.416	0.349	0.0001	0.0001		
	T min.	0.77	0.79	1.700	2.024	0.0001	0.0001	59.89	66.79
	R.H.%	-0.15	-0.01	0.140	0.424	0.4598	0.9622		
	<i>E. citrina</i>	0.61	0.60	0.035	-0.012	0.0010	0.0012	62.10	65.46
	<i>c. carnea</i>	0.79	0.81	0.788	0.890	0.0001	0.0001		
	Age1-Age3							58.98	61.47
	All above							71.68	77.60
Total population	T max.	0.90	0.91	6.673	9.329	0.0001	0.0001		
	T min.	0.92	0.92	10.212	8.958	0.0001	0.0001	86.87	88.28
	R.H.%	-0.30	-0.26	0.214	1.137	0.1379	0.1916		
	<i>E. citrina</i>	0.82	0.82	1.721	1.872	0.0001	0.0001	89.49	87.24
	<i>c. carnea</i>	0.93	0.91	5.050	5.239	0.0001	0.0001		
	Age1-Age3							89.04	89.81
	All above							96.51	96.54

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