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Effect of some climatic factors, natural enemies and Relation with the population of *Empoasca discipiens* Paoli and *Liriomyza trifolii* (Burgess) on *Calendula officinalis* L. plant under climate changes

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ABSTRACT

The aim of the study was to evaluate the effect of some climatic factors, natural enemies and their relation to the population density of *Empoasca discipiens* Paoli and *Liriomyza trifolii* (Burgess) on *Calendula officinalis* L. and its associated predators. The field experiments were conducted at Qaha city, Qalyubiya Governorate, during the winter 2021-2022 and 2022-2023 seasons. The *E. discipiens* recorded three peaks, the first peak of *E. discipiens* was on fourth week of November with decrease climatic factors during these two seasons. The second peak of *E. discipiens* population was on second week of January with very decrease climatic factors for these two seasons. Finely, the third peak of *E. discipiens* population on first week of April for 2021-2022 season, but, it the third peak of *E. discipiens* population on third week of March for 2022-2023 season, with suitable climatic factors. On the other side, the population of *L. trifolii* increased gradually to reached the highest population two peaks as follows: The first peak was on fourth week of November for 2021-2022 season, but, it was different the first peak of *L. trifolii* population on third week of November for 2022-2023 season, with decrease the climatic factors. Then the *L. trifolii* population recorded the second peak on third week of February during 2021-2022 season, but it recorded the second peak of *L. trifolii* population was on first week of March during 2022-2023, with very decrease climatic factors. The natural enemies were recorded in this study of *Coccinella undecimpunctata*, *Coccinella sptemunctata, Chrysoperla carnea,* and *Syrphus corolla* and record two peaks during 2021-2022and2022-2023 seasons. Also, parasite of *Diglyphus isaea* record two peaks for 2021-2022and2022-2023 seasons. Also, showed result the plant ages, natural enemies, temperature, R.H.% and wind had different effects (significant or unsignificant) on *E. discipiens* and *L. trifolii* on *Calendula officinalis* L. plant.

Keywords: Climatic factors, Natural enemies, *Empoasca discipiens, Liriomyza trifolii*

1. Introduction

The leafhopper *Empoasca decipiens* Paoli (Homoptera: Cicadellidae) is one of the most important insect pests that infest a wide variety of crops. The *E. discipiens* is insect causes significant damage to infested plants as it transmits phytoplasma diseases (Naseri *et al*.,2007; Demirel &Yildirim, 2008 and Awadalla *et al*.,2013). Both nymphs and adults of *E. decipiens* cause severe damage by directly transfer sap from vital cells and plant tissues, resulting in damage to leaves and stems, and thus a general weakening of the entire plant (Backus *et al.*, 2005). In addition, the *E. discipiens* causes indirect damage by transmitting pathogens such as viruses, mycoplasmas, spiroplasmas, and bacteria (Orenstein *et al*., 2003). Most known phytoplasma vectors belong to the family Cicadellidae, but many remain unknown. Within this family, several phytoplasmas from *Empoasca* sp. were positively transmitted, and their transmission was detected in *Empoasca decipiens* (Paoli), where it was secured as an experimental vector for Candidatus Phytoplasma asteris (Naseri *et al*., 2007; Galetto *et al*, 2011 and Ibrahim *el al*., 2023). Adults and nymphs feed on the leaves of the host plant. This jumping insect usually colonizes the underside of leaves, inserting its mouthparts into the plant tissues to extract plant

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sap. Females lay their eggs within the leaf vein tissues (Backus *et al.*, 2005). Also, the vegetable leafminer, *Liriomyza trifolii* (Burgess) (Diptera, Agromyzidae) is one of the most important insect pests attacking common bean plants in Egypt. It causes losses of up to about 50% of this crop. The larvae first burrow into the leaf layer where the chloroplasts are located and the adult females pierce both the upper and lower surfaces of the leaf to feed and lay eggs. The lower part of leaves of common bean plants showed higher infestation by the vegetable leafworm *L. trifolii* followed by the middle and upper parts (Omar and Faris 2000). In addition, the *L. trifolii*, also native to North, Central and South America, has spread to large parts of Europe, Africa, Asia and the Pacific, probably as a result of the trade in *Calendula officinalis* cuttings. It is a highly polytrophic plant and has been recorded from 25 plant families. The most economically important crops it attacks are beans, celery, chrysanthemums, cucumbers, gerberas, gypsophila, lettuce, onions, potatoes and tomatoes (CABI, 2013 and Nakamura *et al.*, 2013).

This research aimed to study the relation between *E. decipiens* and *L. trifolii* populations and their natural enemies with some climatic factors on *C. officinalis* plants at Qalyoubia Governorate during 2021-2022 and 2022-2023 seasons. Therefore, the environmental study of these two insects was conducted to identify the level of their damage under natural conditions, which is useful in preparing control program.

2. Material and Methods

Field experiments were conducted in Qaha city, Qalyoubia Governorate, during winter season 2021-2022 and 2022-2023 on *Calendula officinalis* L. plant. An area of 400 m^2 was divided into four replicates [Each replicate was 100 m^2, each sample was collected weekly and consisted of 40 plants/four replicate of Leafhopper *Empoasca discipiens* Paoli and the leafminer *Liriomyza trifolii* (Burgess) of 40 leaves/four replicate= 40 plants] used direct count was randomly technique. The pot marigold plant *C. officinalis* seeds of were sown on first week of September in plantation until transplanted to the field. Seedlings were transferred to the field after 45 days on 15 october during the winter seasons 2021-2022 and 2022-2023 with the relation between population each of leafhoppers *E. discipiens* (nymphs and adults) (Homoptera: Cicadellidae), the leafminer *L. trifolii* (larvae) (Diptera: Agromyzidae) and their associated natural enemies with effect some climatic factors. The whole plant technique was used for the examining of natural enemies count was taken from samples of 40 plants taken randomly from four replicate weekly. The predators (immature and adult) were the eleven-spotted ladybird beetle, *Coccinella undecimpunctata* L.; the seven-spotted ladybird, *Coccinella sptemunctata* L. (Coleoptera, Coccinellidae); the green lacewing *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae) and (Diptera: syrphidae) the hoverfly *Syrphus corolla* (Fabricius). The parasite of leafminer *Diglyphus isaea* (Walker,1838) (Hymenoptera: Eulophidae) record the total numbers of count was taken from samples of 40 leaves taken randomly from four replicate weekly for both seasons. Thus, put the leaves in plastic container covered with muslin gauze with rubber band, until the parasite emergence out from the leaves. Thereafter, treating the adults of parasite individuals with alcohol spray and record parasite numbers emergence by samples. Agricultural practices were implemented as recommended and not pesticides were used. The weather factors (daily mean maximum; minimum temperatures; daily mean wind speed (mph) and daily mean R.H.%) were obtained from central laboratory for agricultural climate, at Sheben El-Qanater Meteorological Station, Qalyoubia Governorate. Insects samples were identified in survey and classification research Department, Plant Protection Research Institute, Giza, Egypt. The crop yield was estimated as follows:

1- Average number of flowers/ plant x average weight of flowers /plant = weight kg/plant.

2- Weight kg/plant x number of plants /replicate= production /kg replicate. 3- Production /kg replicate x number replicate = production /kg. (Omran, *et al*. 2010; Rehab, *et al*. 2019 & Scientific names cited of Badr, 2007).

The statistical analysis (Simple correlation and partial regression) of the obtained data were performed by using SAS Institute (1997) program.

3. Results

3.1. Population fluctuation of leafhopper *Empoasca discipiens* Paoli.

The data in Table (1) and Fig. (2A) showed that the population of *E. discipiens*, appeared on the third week of October and was few numbers in the early stages from plant age. After that, the *E. discipiens* increased the population and recorded three peaks as follows: The first peak was in fourth week of November with decrease climatic factors, maximum and minimum temperatures, R.H% and winds recorded 21.95&22.75°C, 13.02&16.75°C, 63.71&54.35% and 5.91&7.09 mph during 2021-2022and2022-2023 seasons, respectively, show Fig. (1). The second peak of *E. discipiens* population was on second week of January with very decrease climatic factors, the climatic factors of Max., Min. temperatures, R.H.% and winds recorded 18.62&20.41℃, 10.71&14.32℃, 54.35&54.23% and 8.16&6.00 mph during 2021-2022and2022-2023 seasons, respectively. Finely, the third peak of *E. discipiens* population on first week of April with favourable climatic factors Max., Min. temperatures R.H.% and winds where recorded 26.76℃, 16.22℃, 48.47% and 8.81 mph during 2021-2022 season. However, the third peak of *E. discipiens* population on third week of March with favourable climatic factor recorded 23.65℃, 12.22℃, 50.47% and 8.81 mph for 2022-2023 season, this peak was the highest peaks from the perverse peaks. Accordingly, the climatic factors played an important role in controlling the leafhopper of *E. discipiens* population by affecting the development and it activity. The population was high until the end of the seasons 2021-2022and2022-2023. The overall general mean showed that the population of *E. discipiens* was the higher population in 2021-2022 than the 2022-2023 seasons.

3.2. Effect of different factors on leafhopper *Empoasca discipiens* population.

Data in Table (2) showed that the simple correlation values for the effect different factors on mean numbers of *E. discipiens* where the plant age[1] was positive and highly significant during 2021-2022 season, but, it show the effect was positive and significant at 2022-2023 season. While, the plant age[2] give the effect was positive and significant for 2021-2022 and 2022-2023 seasons. The plant age[3] show the effect was positive and significant during 2021-2022 season, but, it show the effect was positive and not significant during 2022-2023 season.

Data in Table (1) showed that the natural enemies (predatory) population of *C. undecimpunctata* and *C. sptemunctata* appeared on the first week of November after the *E. discipiens* infestation appearance and the population of *C. undecimpunctata* increased gradually to give two peaks for 2021-2022and2022-2023 seasons. The first peak of *C. undecimpunctata* recorded on third week of November and the *C. sptemunctata* the first peak recorded on first week of January during 2021-2022 season, moreover, the *C. undecimpunctata* reached the first peak on first week of December and the *C. sptemunctata* the first peak recorded on third week of December during 2022-2023 season. It is clear that this peak had impact on the population of *E. discipiens*, where the population was lower in week of this peak. Additionally, the second peak of *C. undecimpunctata* was on fourth week of March and give second peak of *C. Sptemunctata* was on third week of March during 2021-2022 season, while, the second peak of *C. undecimpunctata* reached on first week of March and the second peak of *C. sptemunctata* was on fourth week of February during 2022-2023 season. It is clear that this peak had impact on the population of *E. discipiens*, where the population was lower in the week of this peak. Finally, the results in Table (2) statistical analysis revealed that the simple correlation values for the effect the predatory of *C. undecimpunctata* on *E. discipiens* population showed the impact was positive and not significant at 2021-2022 season, as well as, it the effect was positive and highly significant during 2022-2023 season. The *C. sptemunctata* revealed that the effect was positive and highly significant at 2021-2022 season, while, it show the effect was positive and significant during 2022-2023 season. The *C. carnea* and *S. corolla* appeared on the first week of November at 2021-2022 season and appeared on the second week of November at 2022-2023 season after the *E. discipiens* infestation appearance.

The results in Table (1) revealed that the *C. carnea* and *S. corolla* population and increased gradually to give two peaks for 2021-2022 and 2022-2023 seasons. The first peak of *C. carnea* recorded on first week of January during 2021-2022 season, while, the first peak of *S. corolla* recorded on second week of December during 2021-2022 season. The first peak of *C. carnea* recorded on third week of December and the *S. corolla* the first peak recorded on fourth week of November during 2022-2023 season. The second peak of *C. carnea* was on first week of March and the second peak of *S. corolla* was

Table 1: Weekly mean numbers of *Empoasca discipiens* /40 plants and *Liriomyza trifolii* /40 leaves on *Calendula officinalis* plant and total weekly numbers for natural enemies at 2021-2022 and 2022-2023 seasons.

Data	*Empoasca discipiens*		*Liriomyza trifolii*		*Coccinella undecimpunctata*		*Coccinella Sptemunctata*		*Chrysopa carnea*		*Syrphus corolla*		*Diglyphus isaea*	
	2021-2022	2022-2023	2021-2022	2022-2023	2021-2022	2022-2023	2021-2022	2022-2023	2021-2022	2022-2023	2021-2022	2022-2023	2021-2022	2022-2023
Oct. 3rd week	6.95	8.95	1.90	2.80	0	0	0	0	0	0	0	0	0	0
4th week	8.00	9.40	2.32	3.40	0	0	0	0	0	0	0	0	4	3
Nov. 1st week	8.10	12.05	2.50	4.50	4	2	1	2	1	0	2	0	7	5
2nd week	10.00	13.25	5.95	6.90	7	5	3	4	4	3	2	6	7	5
3rd week	13.15	13.20	9.60	12.85	11	6	3	5	3	4	5	10	8	6
4th week	16.70	18.65	10.80	6.80	8	9	4	6	4	7	8	12	9	14
Dec. 1st week	13.25	17.35	8.95	5.75	8	14	6	7	5	9	11	10	11	16
2nd week	10.30	13.95	5.55	5.35	8	12	6	11	6	10	13	9	13	15
3rd week	11.50	11.95	4.80	5.05	7	11	7	14	7	12	9	6	14	12
4th week	15.85	14.10	3.98	4.75	5	10	9	13	8	4	8	5	16	11
Jan. 1stweek	21.75	17.70	3.65	4.65	7	10	11	11	9	8	6	6	17	9
2ndweek	28.75	22.15	2.15	4.45	9	11	8	9	8	9	5	6	14	9
3rdweek	21.80	16.20	2.10	4.00	10	11	8	11	7	10	4	5	9	10
4thweek	18.25	15.20	2.15	3.90	10	12	5	12	5	11	5	6	10	12
Feb. 1stweek	16.35	13.75	3.40	5.25	11	10	8	13	3	14	5	8	12	19
2ndweek	16.50	13.40	7.80	5.95	12	11	9	13	2	9	6	11	13	17
3rdweek	16.35	14.05	9.35	6.60	11	10	9	12	6	8	6	8	16	14
4thweek	14.30	17.35	6.95	7.30	11	14	8	18	9	6	14	7	18	11
Mar. 1stweek	18.60	21.18	5.40	8.85	12	19	9	11	15	6	9	4	14	10
2ndweek	23.15	26.45	4.85	7.55	13	16	8	10	13	4	8	3	12	11
3rdweek	26.70	31.12	2.55	5.35	14	13	16	9	10	3	7	2	11	10
4thweek	32.45	27.33	2.60	4.60	16	14	12	8	8	2	6	1	12	9
Apr. 1stweek	40.85	23.25	2.55	4.35	12	10	11	6	7	2	5	1	12	8
2ndweek	37.35	22.70	2.70	3.80	11	10	9	4	4	1	2	1	13	8
3rdweek	32.80	21.70	2.30	3.70	9	5	8	2	3	1	3	0	12	7
4thweek	30.15	20.60	2.40	3.11	7	4	7	1	3	0	3	0	8	6
May 1stweek	29.10	19.70	1.75	2.80	6	1	5	1	0	0	1	0	9	8
2ndweek	23.70	17.10	1.70	2.75	3	1	5	0	0	0	0	0	8	8
3rdweek	22.75	15.65	1.65	2.70	1	0	2	0	0	0	0	0	9	5
4thweek	19.40	15.75	1.40	2.65	0	0	0	0	0	0	0	0	8	6
General mean ±S.E	**20.16± 0.66**	**17.51± 0.36**	**4.19± 0.25**	**5.08± 0.22**	**8.10± 0.83**	**8.38± 0.90**	**6.57± 0.67**	**7.10± 0.70**	**5.01± 0.72**	**4.77± 0.71**	**5.10± 0.71**	**4.24± 0.69**	**10.87± 0.62**	**9.47± 0.78**

on fourth week of February during 2021-2022 season, while, the second peak of *C. carnea* reached on first week of February and the *S. corolla* was on second week of February during 2022-2023 season.

Statistical analysis in Table (2) showed that the simple correlation values for effect the predatory of *C. carnea* on mean number of *E. discipiens* was positive and not significant during 2021-2022 season, as well as, it give impact positive and significant at 2022-2023 season. While, the *S. corolla* showed effect positive and significant for 2021-2022and2022-2023 seasons. The overall general mean showed that the *C. undecimpunctata* had the highest population than each of *C. sptemunctata*, *C. carnea* and *S. corolla* for 2021-2022 and 2022-2023 seasons. The temp. max. recorded the effect on *E. discipiens* population was positive and highly significant at 2021-2022 and 2022-2023 seasons. The temp. min. recorded the effect on *E. discipiens* population was negative and highly significant for 2021-2022 and 2022-2023 seasons. The R.H.% recorded the effect was positive and not significant during 2021-2022 and 2022-2023 seasons. The winds give the effect was negative and not significant during 2021-2022, as well as, it recorded negative and significant during 2022-2023 seasons.

The Partial regression analysis in Table (2) showed that the effect on mean numbers of *E. discipiens* where gave the all plant ages and *C. undecimpunctata* had positive and significant during 2021-2022 and 2022-2023 seasons. While, the *C. sptemunctata* revealed positive and highly significant at 2021-2022, but, it give the impact was positive and significant at 2022-2023 season. From the other side, the *C. carnea*, *S. corolla*, temp. Min. and R.H.% gave the effect positive and not significant during 2021-2022 and 2022-2023 seasons. Whereas, the temp. Max. recorded positive and not significant during 2021-2022 season, as well as, it recorded the impact was positive and significant at 2022-2023 season. The winds give the effect was negative and not significant during 2021-2022 and 2022-2023 seasons.

The results in Table (2) showed that the combined effect of weather factors and all plant ages, the total numbers of natural enemies and the climatic factor the effect on mean numbers of *E. discipiens* population were highly significant at 2021-2022 and 2022-2023 seasons. The explained variance (E.V.%) showed that the 2021-2022 season was higher impact for these different factors compared to the 2022-2023 season. This due to the combined effect for these different factors on the *E. discipiens* population. The remaining percentage is due to other factors not included in this study.

3.3. Population fluctuation of leafminer *Liriomyza trifolii* (Burgess).

The data in Table (1) and (Fig. 2B) showed that the population of *L. trifolii* began to appear on the third week of October and few numbers in the early stages from plant age. After that, the population of *L. trifolii* increased gradually to give the highest population record two peaks as follows: The first peak was on fourth week of November with decrease the climatic factors recorded maximum, minimum temperatures, R.H% and winds recorded 23.54℃, 15.56℃ and 74.29% during 2021-2022 season, respectively [show Fig. (1)].

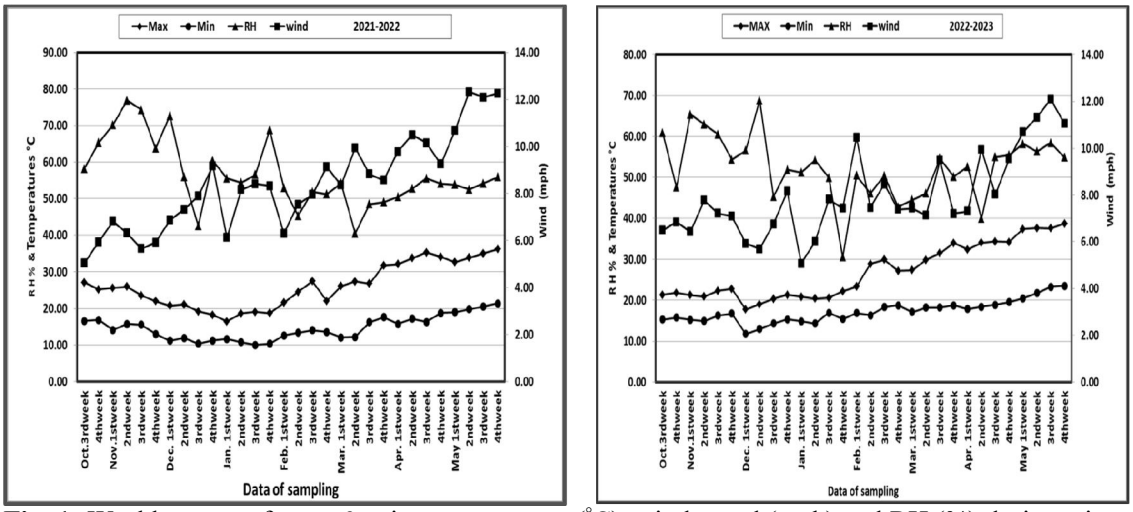

Fig. 1: Weekly mean of max. & min. temperatures (˚C), wind speed (mph) and RH (%) during winter 2021- 2022 and 2022-2023 seasons at Qalyoubia Governorate.

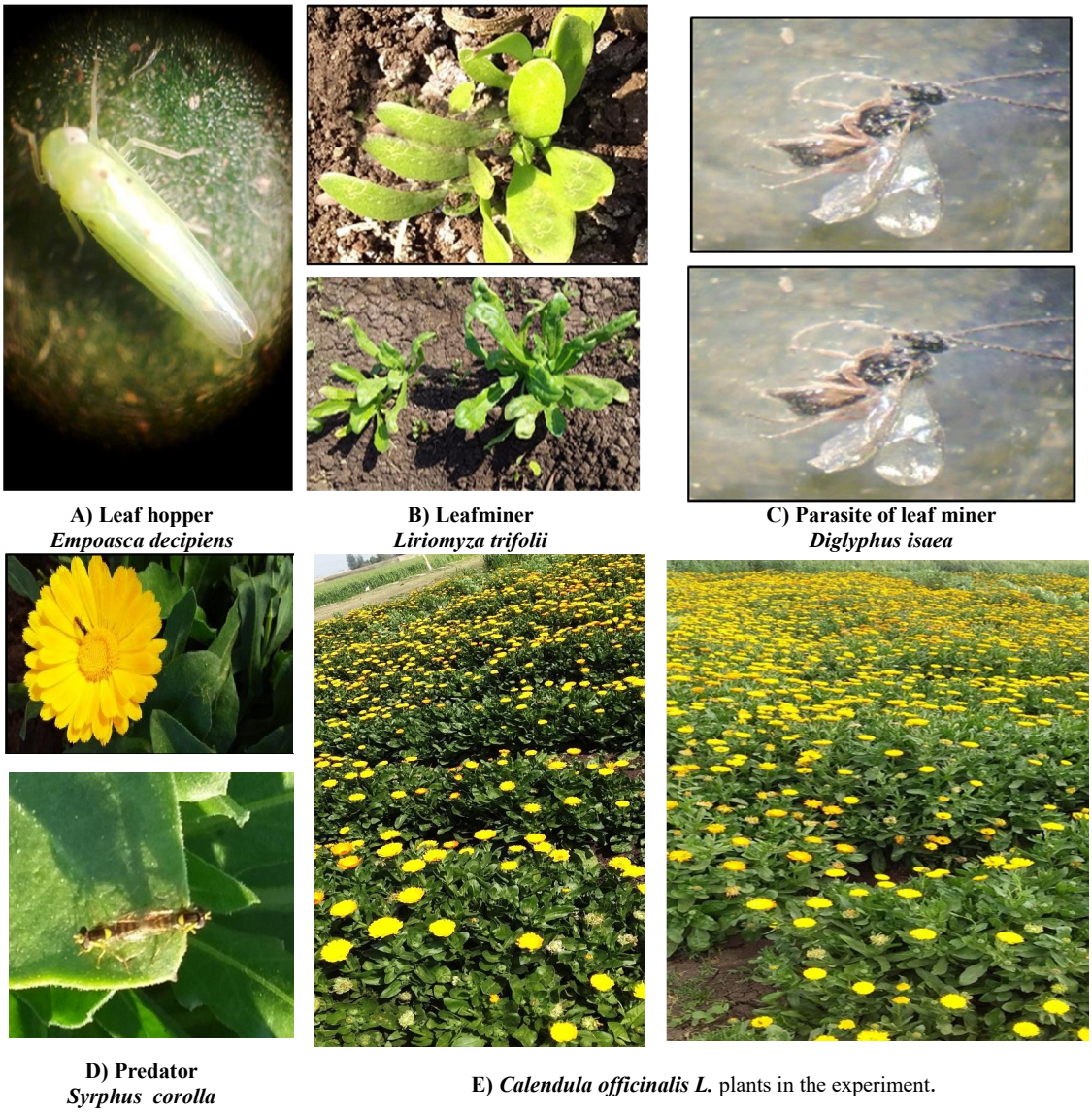

Fig. 2: Some different pictures from the study

However, the first peak of *L. trifolii* population on third week of November with decrease the climatic factors recorded maximum, minimum temperatures, R.H% and winds recorded 22.75°C, 16.75℃ and 54.35% at 2022-2023 season. Then the population decreased and increase the population of *L. trifolii* recorded second peak on third week of February with decrease climatic factors recorded maximum, minimum temperatures and R.H% recorded 27.43°C, 14.05°C and 51.87% during 2021-2022 season, respectively. Similarly, the second peak of *L. trifolii* population on first week of March with favourable weather factor recorded 23.65℃, 12.22℃ and 50.47% at 2022-2023 season, respectively. Moreover, the *L. trifolii* population decreased in the late of the plant age until the end of the seasons 2021-2022 and 2022-2023. For explanation, the first peak of *L. trifolii* is highest population than the second peak, due to the high nutrition value of the plant leaves and its decrease during the plant ages. The overall general mean showed that the population of *L. trifolii* was the higher population in 2022-2023 season than the 2021-2022 season.

Table 2: Simple correlation coefficient and Partial regression values for different factors on mean numbers of *Empoasca discipiens* and *Liriomyza trifolii* and productively for *Calendula officinalis* plant during winter seasons 2021-2022and2022-2023**.**

year	*Empoasca discipiens*								*Liriomyza trifolii*							
	Factors	Simple correlation		Partial regression		Analysis of variance			Factors	Simple correlation		Partial regression		Analysis of variance		
		r	P	b	P	F	P	E. V. %		r	P	b	P	F	P	E. V. %
2021-2022	Plant age[1]	0.199	0.010**	0.242	0.048*	3.08	0.016**	96.53%	Plant age[1]	0.509	0.004**	0.967	0.010**	2.81	0.0074**	95.72%
	Plant age[2]	0.319	0.055*	0.239	0.051*				Plant age[2]	0.471	0.008**	0.122	0.051*			
	Plant age[3]	0.363	0.048*	0.207	0.051*				Plant age[3]	0.385	0.006**	0.415	0.200			
	C. undecimpunctata	0.135	0.476	0.206	0.054*				*Diglyphus isaea*	0.609	0.006**	0.526	0.001**			
	C. sptemunctata	0.574	0.009**	0.155	0.013**				Temp. Max.	0.425	0.019**	0.737	0.057*			
	C. carnea	0.170	0.367	0.324	0.716				Temp. Min.	-0.433	0.016**	0.629	0.019*			
	S. corolla	0.404	0.026*	0.473	0.379				R. H. %	-0.715	0.635	0.407	0.207			
	Temp. Max.	0.455	0.011**	0.446	0.570											
	Temp. Min.	-0.546	0.001**	0.967	0.910											
	R. H. %	0.955	0.615	0.560	0.147											
	Winds(mph)	-0.305	0.100	-0.135	0.359											
	Productivity/kg/ cutting flowers at 2021-2022			**14.59±0.20**												
2022-2023	Plant age[1]	0.219	0.038*	0.199	0.047*	4.09	0.004**	91.41%	Plant age[1]	0.350	0.007**	0.712	0.013**	2.71	0.0015**	92.82%
	Plant age[2]	0.341	0.022*	0.424	0.035*				Plant age[2]	0.429	0.013**	0.195	0.012**			
	Plant age[3]	0.405	0.263	0.207	0.027*				Plant age[3]	0.566	0.009**	0.128	0.833			
	C. undecimpunctata	0.460	0.010**	0.356	0.035*				*Diglyphus isaea*	0.897	0.007**	0.819	0.001**			
	C. sptemunctata	0.542	0.001*	0.218	0.059*				Temp. Max.	0.635	0.016**	0.278	0.047*			
	C. carnea	0.417	0.021*	0.117	0.304				Temp. Min.	-0.521	0.002**	0.135	0.286			
	S. corolla	0.498	0.050*	0.403	0.015				R. H. %	-0.633	0.661	0.114	0.429			
	Temp. Max.	0.451	0.012**	0.292	0.027*											
	Temp. Min.	-0.533	0.002**	0.991	0.441											
	R. H. %	0.181	0.336	0.561	0.212											
	Winds(mph)	-0.373	0.042*	-0.324	0.298											
	Productivity/kg/ cutting flowers at 2022-2023			**15.46 ±0.17**												

Plant age[1] = Form date from planting to 45th days of plant age. Plant age[2] = Form 45th to 90 st days of plant age. Plant age[3] = Form 90st days of plant age to the end of season.
(r): correlation coefficient value. (b): Partial coefficient value (slope). (P): Probability value. (*): Significant at probability level 5%. (**): Highly significant at probability level 1%.
(+) = Positive correlation. (–) = Negative correlation.

3.4. Effect of different factors on leafminer *L. trifolii* population.

Data in Table (2) showed that the simple correlation values for the effect of different factors on mean numbers of *L. trifolii* for each of plant ages and temp. max. were positive and highly significant during 2021-2022 and 2022-2023 seasons.

While, the effect of temp. min. on *L. trifolii* population recorded negative and highly significant for 2021-2022 and 2022-2023 seasons. The R.H.% recorded the effect negative and not significant at 2021-2022 and 2022-2023 seasons.

Data in Table (1) the Parasite of *Diglyphus isaea* (Walker, 1838) appeared on the fourth week of October about seven days after the *L. trifolii* infestation appearance and the population of *D. isaea* increased gradually to give two peaks for 2021-2022 and 2022-2023 seasons. The *D. isaea* the first peak recorded on first week of January during 2021-2022 season, but it reached the first peak of *D. isaea* was on first week of December during 2022-2023 season. Thus, the second peak of *D. isaea* was on fourth week of February during 2021-2022 season, while, the second peak of *D. isaea* reached on first week of February during 2022-2023 season. Statistical analysis in Table (2) show that the simple correlation values for the effect of parasite *D. isaea* was positive and highly significant in 2021-2022 and 2022-2023 seasons. It is clear that these two peaks of *D. isaea* had impact on the population of *L. trifolii*, where the population was lower in the week of this peak.

The Partial regression analysis in Table (2) showed that the effect on mean numbers of *L. trifolii* where gave the plant age[1] the effect was positive and highly significant for 2021-2022 and 2022-2023 seasons. The plant age[2] gave effect of positive and significant for 2021-2022, while, it gave effect of positive and highly significant for 2022-2023 seasons. Whereas, the plant age[3] gave the effect of positive and not significant during 2021-2022 and 2022-2023 seasons. The parasite of *D. isaea* was positive and highly significant in 2021-2022 and 2022-2023 seasons.while, the temp. max. recorded the effect on *L. trifolii* population was positive and significant for 2021-2022 and 2022-2023 seasons. The temp. min. and recorded the effect on *L. trifolii* population was positive and significant for 2021-2022 season, as well as, it recorded positive and not significant for 2022-2023 season. The R.H.% recorded the effect was positive and not significant during 2021-2022 and 2022-2023 seasons.

The results in Table (2) showed that the combined effect of all plant ages, the total numbers of natural enemies and the climatic factor the effect on mean numbers of *L. trifolii* population were highly significant for 2021-2022 and 2022-2023 seasons. The explained variance (E.V.%) showed that the higher impact for these different factors in 2021-2022 and 2022-2023 seasons. This due to the combined effect for these different factors on the *L. trifolii* population. The remaining percentage is due to other factors not included in this study.

4. Discussion

The results of study showed that the leafhopper *Empoasca discipiens* Paoli gave three peaks of population and the leafminer *Liriomyza trifolii* (Burgess) gave two peaks of population. The effect of climatic factors was significant for some climatic factors and not significant for others climatic factors, as well as, the natural enemies during 2021-2022 and 2022-2023 seasons.

These results are similar with (Hashem, *et al*., 2009) on broccoli plant record two peaks of *E. decipiens* were obtained at end of November and February in the 2006-2007 and 2007-2008 seasons. In addition, the transmission of them was detected in *E. decipiens*, where it insured as experimental vector to Candidatus *Phytoplasma asteris*. The *E. decipiens* has been confirmed in several studies as a potential vector of phytoplasma in different crops. In Lebanon, it has been recorded of *E. decipiens* as potential vector of almond witches 'broom phytoplasma. As well as the reported of *E. decipiens* as potential vector of Chrysanthemum yellows phytoplasma in Italy (Galetto *et al*. 2011 and Atlihan *et al*. 2003). These results disagreed with the findings of El-Dessouki (2022), Beanland, *et al*. (2006) and Hegab, *et al*. (2007) who mentioned that the *E. decipiens* population density were record two peaks on pea and broad bean cultivations in Mansoura region. In addition, the results with agree El-Sarand *et al*., (2019) in Kafr El-Sheikh Governorate, revealed that the population densities of *E. decipiens* were higher in mid-October plantation than mid-November plantation in first and second during 2016-2017 and 2017-2018 seasons and recorded two peaks during both growing season.

On the other side, the results with agree El-Dessouki (2022) in Kafr El-Sheikh Governorate, where showed the impacts of certain weather and natural enemies on the population density of *Liriomyza trifolii*. The *L. trifolii* population density increased in January and March in 2021 and 2022.

Also, the Population densities of *L. trifolii* larval recorded two peaks on faba bean, *Vicia faba* at Kafr EL-Sheikh Governorate during 2016-2017 and 2017-2018 seasons, (El-Sarand *et al*., 2019, Nassef *et al*. 2008 and Scheffer *et al.* (2006). In addition, El-Dash and Abo-Shaeshae (2001) detected four peaks of *L. trifolii* larvae on broad bean and the highest numbers of larvae occurred during Jan. and Feb. at Shebin El kom region. Moreover, the *Diglyphus isaea* Walker was the most prevalent parasitic species against *L. trifolii* from the parasite complex that contains *Opius pallipes* Wesmeal and *Chrysocharis parksi* Crawford (Hymenoptera: Eulophidae) as endoparasites (El-Khouly, 2003 and Aamer and Hegazi, 2014). These results agree with the findings of Hawila (2016) who found that the *L. trifolii* population recorded three peaks of abundance on faba bean during January February and March. Three predatory insects were recorded: *Chrysoperla carnea*, *Coccinella undecimpunctata*, *Chrysopa carnea* and *syrphus corolla*. The total numbers of *C. undecimpunctata* and *C. carnea* beginning of December till the first week of April and the lowest total number of *C. undecimpunctata* was recorded during March.

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