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Enhanced activity of some insect parasitoid in tomato fields using some flowering plants

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Abstract
The present study evaluates the role of (*Callendula officinalis* L.) marigold, (*Coriandrum sativum* L.) coriander, and (*Matricaria chamomilla* L.) chamomile, as insectary plants that benefit parasitoids insect species. The insect parasitoids show preferences flowering plants species. Throughout the course of this research, six insect parasitoids were found in relatively large numbers on chamomile (*Matricaria chamomilla* L), including *Diglyphus isaea* (Wallker),*Opius* sp, *Kleidotoma* sp, *Sphegigaster* sp,*Ooensyrtus* sp. and *Trissolcus* sp. Similar results were obtained in coriander (*Coriandrum sativum* L, six insect parasitoid were recorded with relatively high numbers namely *Diglyphus* sp, *Kleidotoma* sp, *Sphegigaster* sp, *Opius* sp, *Dendrocerus* sp, and *Telenomus* sp. but Insect parasitoid were found in relatively high abundance on marigold plants (*Callendula officinalis* L.). *Trissolcus sp, Dendrocerus* sp., *Sphegigaster* sp., *Opius* sp., *Telenomus sp,* and *Diglyphus* sp. according to the findings Intercropping coriander, chamomile, and marigold plants with tomato fields increased the abundance of parasitoids insect species,. achating with leafminer, *Liriomyza trifolii* (Diptera: Agromyzidae), and *Aphid* sp when compared to those in untreated plots. Furthermore, when compared to a field with no forbs, floral resource plants resulted in a significant reduction in both Leaf miner and *Aphid* sp. populations. As a result, our findings indicate that chamomile, coriander, and marigold are beneficial insectary plants. And increase the efficiency of the insect parasitoid and could be used as control agents against Leaf miner, (*Liriomyza trifolii)* and Aphid species in tomato crops.

Keywords: *Liriomyza trifolii*; *aphid* species; tomato plant; flowering plants

Introduction

Tomato plants, *Lycopersicon esculentum* (Family: Solanaceae) are attacked by a variety of insect pests at various stages of development. The leaf miner *Liriomyza trifolii* (Agromyzidae, Diptera) is a major pest in many bower and vegetable crops, particularly tomatoes (Patra *et al*, 2016) [30]. Both larvae and adults cause damage: larvae primarily mine the palisade mesophyll (Parrella *et al*, 1984) [29], and adult females puncture both upper and lower leaf surfaces to feed and lay eggs. Adult pies have long been known to be resistant to several insecticides (Broadbent & Pree 1989 [7]; Keil and Parella, 1990 [21]; Mac- Donald 1991 [28]; Saito 1994 [36]; Civelek 1999 [10]). The addition of floral resources to crop fields has the potential to increase the effectiveness of natural enemy species (Poveda *et a*t, 2008 [31], Gurr & You, 2016 [13]). Thus, a good understanding of the interactions between herbivores, natural enemies, and crop management at the farm level is required to make habitat manipulation a viable practise. (Landis *et al*, 2000 [12, 23]; Fiedler *et al*, 2008 [12]). As a result, the addition of flowers could significantly increase the availability of resources for woolly apple. Aphid natural enemies may increase in number, improving biological control. Because of their semi-permanent features and relatively high levels of structural complexity, fruit orchards are particularly amenable to natural enemy conservation using flowers when compared to annual crops (Rollings & Goulson, 2019) [34]. Pollen or nectar can be used as a supplement to food (Landis *et al*, 2000) [12, 23]. Surprisingly few case studies have been published in which the addition of flowering plants has both increased natural enemy populations and improved pest suppression. (Heimpel and Jervis, 2005 [15], Campbell *et al* (2012 and 2017) [8, 9] discovered that the density of natural enemy were found to be higher in open-nectar plots than in other treatments in apple trees. According to Lu *et al* (2014) [27], the reduction of flowering crops in the habitats, and the extensive use of the insecticides, are all factors and lead to a sharp decline in biodiversity. As a result, the service provided by natural enemies has declined in the biological control ecosystem. Strategic use of flowering plants to increase plant biodiversity in a targeted manner can provide natural enemies with food and shelter, improving biological control and reducing reliance on chemical pesticides. This article examines the nutritional value of various plant-derived foods for natural enemies, potentially negative effects on pest management, and the practical application of flowering plants in orchards, vegetables, and field crops, the agricultural systems where the majority of research has been conducted. Possibilities for more effective use of flowering plants in biological control of insect pests. As a result, the current study aims to evaluate (*Coriandrum sativum* L., *Callendula officinalis* L.) and *Matricaria chamomilla* L. as plants that are beneficial to insect parasitoids, as well as the use of the flowering crops to boost the insect parasitoids efficiency. against to *Liriomyza trifolii*, a leafminer (Diptera: Agromyzidae). *Aphid* sp. on tomato.

Materials and Methods

An inventory of Insects parasitoid found on marigold, Chamomile, and coriander plants

Experiments in the field were carried out at the Faculty of Agriculture at Mansoura University in the Mansoura region. A total area of about 750 m^2 was prepared and divided into appropriate plots. (each plot approximately 60 m^2) for growing chamomile, *Matricaria chamomilla*, coriander, *Coriandrum sativum* L and Marigold, *Callendula officinalis*

were bought as seedlings from a nearby nursery and transplanted in (rows in each plot) on January (5th & 10th), (2019 and 2020), respectively. Normal agricultural practices were used in the cultivated area, and There were no chemical control applications used.

Techniques for Sampling

The sweep net technique was used to conduct parasitoid insect surveys in plantation of Marigold, Coriander and Chamomile, in the two seasons, (2019 & 2020). The sampling process began. in 10/2/2019 and 15/2/2020 (in the first and second season) respectively and will continue until the harvest. Borror and Delong (1981) described the use of a standard sweep net (diameter 0.35 m.). Every plot received fifteen double strokes (6 x 10 metre) once a week. The sample was transferred to the laboratory in a labelled collecting muslin bag; Chloroform was used to kill the specimens, which were then examined under a stereomicroscope. The number of individuals in each sample as well as the species composition were calculated, and the occurrence rate was calculated. Prof. Dr. Ahmed Samir Hendawi of the Plant Protection Institute, Ministry of Agriculture, identified the parasitoids species.

The effect of habitat management on tomato insect pests' natural enemies.

Field research was carried out in 2019/2020 within the Experimental Farm, Mansoura University, Faculty of Agriculture, To assess the effect of incorporating flowering plants (chamomile, coriander, and marigold plants) into landscapes on beneficial insects and herbivore population abundance. Coriander, marigold, and chamomile were bought as seedlings from a nearby nursery they were planted in rows around every plot. To determine whether a Parasitoids species associated with chamomile, coriander, and marigold plants would improve biological control of (aphid, Leaf miner) in adjacent (*Solanum lycopersicum*) fields, pest population densities were calculated in tomato plots surrounded by forbs (chamomile, coriander, and marigold) or in plots with no forbs. Each plot (60 m^2) of tomato and flowering plants was transferred to the experimental area as seedlings at 15 days old. On the 5th and 10th of January 2019, and 2020, respectively, A set of plots was surrounded by forbs (chamomile, coriander, and marigold), while another set was un-surrounded. Each set contained three plots. During the experimental period, no convertible control practices were used.

Program for sampling

Tomato leaves were collected biweekly from 10/2/2019 (in the first season) and 15/2/2020 (in the second season) until harvesting to estimate the density of pests populations on tomato plants surrounded and unsurrounded by flowering plants. Each sample contained 30 tomato leaves per treatment. The collected leaves were taken to the laboratory in polyethylene bags for investigation as previously mentioned. The number of individuals of each pest and species composition of every sample was determined; Aphid individuals were recorded as living, dead and parasitized with living parasitoids or emerged holes. To determine the parasitoid species, each sample was kept in a Petri dish (10 cm in diameter) with a piece of moistened cotton wool inside. The parasitoids that emerged were collected and identified. The percentage of parasitism was calculated. A sweep net (15 double strokes/plot) was used to collect insect Parasitoids in plots surrounded and non-surrounded by flowering plants. The collected Parasitoids were counted and identified.

Results

Table 1: The relative abundance and total number of Parasitoid insect species associated with chamomile plant) collected by using a sweep net during the seasons, (2019 & 2020).

Parasitoid species	2019 season		2020 season		Total	
	No.	%	No.	%	No	%
Diglyphus sp.	49	20.08	68	27.6	117	23.9
Opius sp.	39	15.98	35	14.2	74	15.1
Kleidotoma sp	37	15.16	36	14.6	73	14.9
Sphegigaster sp.	32	13.11	30	12.2	62	12.7
Ooensyrtus sp.	22	9.01	24	9.8	46	9.4
Trissolcus sp	24	9.83	11	4.5	35	7.1
Dendrocerus sp.	14	5.74	13	5.3	27	5.5
Cirrospilus sp.	15	6.15	10	4.1	25	5.1
Aphidius sp.	7	2.86	10	4.1	17	3.5
Telenomus sp	5	2.04	9	3.7	14	2.9
Total	244		246		490	

Insect parasites associated with the chamomile, coriander, and marigold Plants

Plants of Chamomile

Data on Table 1 displays the relative abundance and numbers of the insect Parasitoids found in the area was planting with chamomile at the growing seasons (2019 & 2020). Throughout the two seasons, ten insect Parasitoids species were observed on chamomile plants. Parasitoids insects, namely, *Diglyphus* sp., *Opius* sp., *Kleidotoma* sp, *Sphegigaster* sp., *Ooensyrtus* sp., and *Trissolcus* sp. were the highest abundance (Fig. 1 and Table 1), followed by (*Dendrocerus* sp., and *Cirrospilus* sp. were counted in a reasonable number. but. *Aphidius* sp. and *Telenomus* sp. were the least dominant parasitoids in both growing seasons 2019 and 2020, as shown in (Table 1). *Diglyphus* sp.,*Opius* sp.,K*leidotoma* sp, *Sphegigaster* sp., *Ooensyrtus* sp., and *Trissolcus* sp. showed the highest percentage of occurrence (23.9,15.1,14.9,12.7,9.4 and 7.1 %) of the total number of Parasitoids insects, followed by *Dendrocerus* sp., *Cirrospilus* sp., *Aphidius* sp and *Telenomus* sp. (5.5, 5.1, 3.5, and 2.9 %) respectively in the two seasons. (Fig. 1). In chamomile plant fields, insect Parasitoids are consistently a significant component of the total insect Parasitoids complex.

Table 2: The relative abundance and total number of Parasitoid insect species associated with coriander plant) collected by using a sweep net during the seasons, (2019 & 2020)

Parasitoid species	2019 season		2020 season		Total	
	No.	%	No.	%	No.	%
Diglyphus sp.	39	14.55	63	23.59	102	19.1
Kleidotoma sp	49	18.28	42	15.73	91	17
Sphegigaster sp.	37	13.8	34	12.73	71	13.3
Opius sp.	35	13.06	32	11.98	67	12.5
Dendrocerus sp.	28	10.44	23	8.61	51	9.5
Telenomus sp	18	6.72	21	7.86	39	7.3
Ooensyrtus sp.	18	6.72	15	5.61	33	6.2
Aphidius sp.	16	5.97	16	5.99	32	6
Trissolcus sp	18	6.72	12	4.49	30	5.6
Cirrospilus sp.	10	3.73	9	3.37	19	3.6
Total	268		267		535	

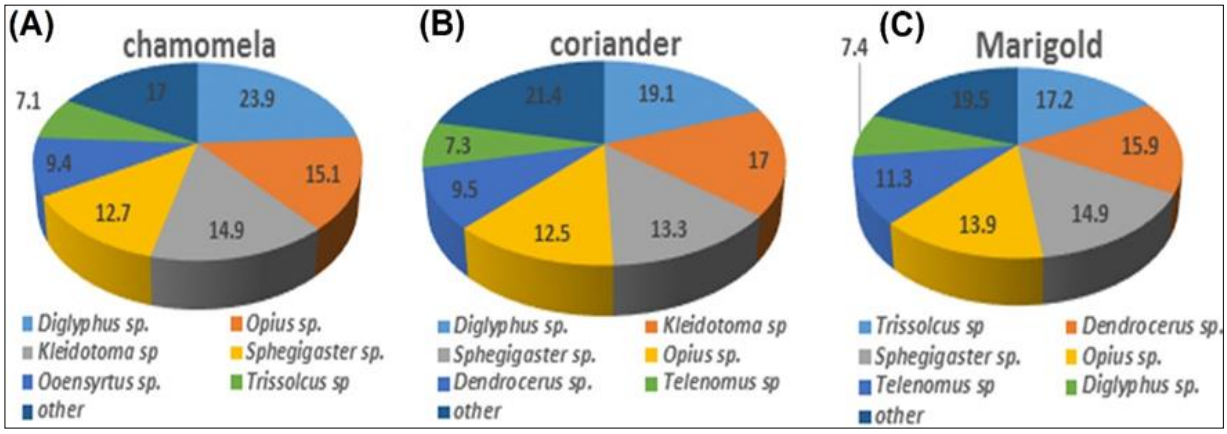

Fig 1: General dominance degree of collected insect Parasitoid by using sweep net on all cultivated plantations of chamomile Coriander and marigold

Plants of coriander

Data on Table 2 displays the total number and relative abundance of insect Parasitoids found in coriander plantations during the growing seasons (2019 & 2020). Ten insect parasitoids were discovered on coriander plants over the course of two seasons. Parasitoids insects, namely, *Diglyphus* sp., *Kleidotoma* sp, *Sphegigaster* sp., *Opius* sp., *Dendrocerus* sp, *Telenomus* sp *Ooensyrtus* sp., and *Aphidius* sp. were the highest abundance (Table 2 and Fig. 1), However, the least dominant Parasitoids were *Trissolcus* sp, and *Cirrospilus* sp.

As demonstrated in (Table 2) in the two seasons 2019 and 2020, *Diglyphus* sp., *Kleidotoma* sp, *Sphegigaster* sp., *Opius* sp., *Dendrocerus* sp, *Telenomus* sp *Ooensyrtus* sp., and *Aphidius* sp. showed the highest percent of occurrence (19.1, 17, 13.3, 12.5, 9.5, 7.3, 6.2 and 6%) of the total number of Parasitoids insects, followed by *Trissolcus* sp, and *Cirrospilus* sp. (5.6 and 3.6 %) respectively in the two seasons. (Fig. 1). In the field of coriander plants, parasitoids are consistently a significant component of the total insect Parasitoids complex.

Table 3: The relative abundance and total number of Parasitoid insect species associated with marigold plant) collected by using a sweep net during the seasons, (2019 & 2020)

Parasitoid species	2019 season		2020 season		Total	
	No.	%	No.	%	No.	%
Trissolcus sp	28	17.95	25	16.3	53	17.2
Dendrocerus sp.	27	17.3	22	14.4	49	15.9
Sphegigaster sp.	25	16.02	21	13.7	46	14.9
Opius sp.	23	14.74	20	13.1	43	13.9
Telenomus sp	17	10.89	18	11.8	35	11.3
Diglyphus sp.	11	7.05	12	7.8	23	7.4
Ooensyrtus sp.	10	6.41	11	7.2	21	6.8
Aphidius sp.	9	5.77	8	5.2	17	5.5
Kleidotoma sp	5	3.2	6	3.9	11	3.6
Cirrospilus sp.	1	0.64	10	6.5	11	3.6
Total	156		153		309	

Table 4: The mean number of parasitoid insect species and standard deviations on tomato crop surrounded by Chamomile, marigold Coriander, and control at the seasons, (2019 & 2020)

	Chamomile	Coriander	Marigold	(control)	LSD
2019 Season					
Diglyphus sp	4.900a ±3.381	3.900a ±2.726	1.400b ±1.776	0.200b±0.632	2.1474
Opius sp.	3.900a ±1.450	3.500a ±1.581	2.300b ±0.949	0000c±0000	1.0635
Kleidotoma sp	3.700a ±1.636	5.300a±3.199	0.500b±0.707	0.200b±.0.633	1.6853
Sphegigaster sp	3.200a ±1.814	3.700a ±2.111	2.500a ±1.581	0000b ±0000	1.4515
Trissolcus sp	2.400a ±2.633	1.700a ±0.949	1.700a± 1.337	0000b ±0000	1.4067
Telenomus sp	0.500bc±0.707	1.800ab±2.530	2.800a±2.741	0000c±0000	1.7216
Dendrocerus sp	1.400b±0.843	2.800a±1.398	2.700a±1.494	0000c±0000	1.0039
Ooencyrtuss sp	2.700a±1.636	1.700b±1.160	1.000b±0.816	0000c±0000	0.982
Cirrospilus sp	1.500a±1.269	1.000a±1.054	0.1000b±0.316	0000b±0000	0.7618
Aphidius sp.	0.800ab±1.033	1.600a ±1.350	0.900ab±1.595	0.100b±0.316	1.0668
2020 Season					
Diglyphus sp	8.333a±7.69	7.000a±5.000	1.444b±2.920	0.111b±0.333	4.6272
Opius sp	4.000a±2.345	3.556ab±2.242	2.222b±1.202	0000c±0000	1.6612
Kleidotoma sp	4.000a±2.646	4.667a±3.708	0.667b±0.707	0.222b±0.667	2.2362
Sphegigaster sp	3.333a±2.000	3.778a±2.774	2.333a±1.581	0000b±0000	1.8088
Trissolcus sp	1.222b±0.833	1.333ab±0.866	2.778a±2.949	0000b±0000	1.5287
Telenomus sp	1.000ab±0.707	2.333a±2.500	2.000a±1.658	0000b±0000	1.4798
Dendrocerus sp	1.444b±0.882	2.556a±1.509	2.444ab±1.509	0000c±0000	1.1088
Ooencyrtuss sp	2.667a±1.581	1.667ab±1.000	1.222b±0.972	0000c±0000	1.0122
Cirrospilus sp	1.778a±1.202	1.000ab±1.000	0.222bc±0.441	0000c±0000	0.7799
Aphidius sp.	1.111a±0.928	1.777a±1.202	0.889ab±1.0541	0.111b±0.333	0.9018

a,b,c = Means in each row with the same letter are not significantly different at p≤0.05.

Table 5: The mean number of Total *Aphid* sp. and *Liriomyza trifolii* on tomato crop surrounded by Chamomile, Coriander, and Marigold or no forbs during the growing seasons, (2019 & 2020)

Insect pest	Chamomile	Coriander	Marigold	No forbs (control)	L.S.D. (p=5%)
Aphid species					
2019	1.392b±1.343	1.647 b± 1.534	2.353 b ± 1.730	6.843 a±4.917	1.0928
2020	3.563b ±5.291	6.666 b ±9.295	7.333 b ±9.228	14.750 a±13.905	3.9908
Liriomyza trifolii					
2019	0.157b ±0.367	0.275 b ±0.603	0.314 b ±0.648	1.745 a ±2.965	0.6084
2020	0.708 b ±1.611	1.000 b±2.306	2.125 b±4.296	5.916 a ±6.010	1.5915

a,b = Means in each row with the same letter are not significantly different at p≤0.05.

Plants of Marigold

Data on Table 3 displays the relative abundance and the total number of insect Parasitoids found in Marigold plantations through the growing seasons (2019 & 2020). Throughout the two seasons, ten insect parasitoids were found on Marigold plants. Parasitoids insects, namely, *Trissolcus* sp, *Dendrocerus* sp, *Sphegigaster* sp., *Opius* sp., *Telenomus* sp, *Diglyphus* sp., *Ooensyrtus* sp. *Aphidius* sp., were the highest abundance (Table 3 and Fig. 1). However, the least dominant Parasitoids were *Kleidotoma* sp, and *Cirrospilus* sp as shown in (Table 3) in both growing seasons. *Trissolcus* sp, *Dendrocerus* sp, *Sphegigaster* sp., *Opius* sp., *Telenomus* sp, *Diglyphus* sp., *Ooensyrtus* sp. *Aphidius* sp. showed the highest percent of occurrence (17.2,15.9,14.9,13.9,11.3, 7.4,6.8 and 5.5 %) of the total number of Parasitoids insects, followed by *Kleidotoma* sp, and *Cirrospilus* sp. (3.6 and 3.6 %) respectively in the two seasons (Fig. 1). In Marigold plant fields, insect parasitoids are consistently a significant component of the total insect parasitoids complex.

Data on Table 4 displays standard deviations and the mean number of parasitoid species are found in tomato crop surrounded by Chamomile, Coriander, marigold and control / 15 double strokes at the growing seasons (2019 & 2020). Statistical analysis indicated that: The reactions of parasitoid species *Diglyphus* sp, *Opius* sp, *Kleidotoma* sp., *Sphegigaster* sp,*Trissolcus sp*, *Ooensyrtus* sp, *Cirrospilus* sp., *Dendrocerus* sp., *Aphiduis* sp *Telenomus* sp., were observed in response to the tested plants (chamomile, coriander, and marigold).

The plant species were discovered to be highly appealing to *Diglyphus* sp,in comparison to no forbs. The mean and SD of responders were (4.900^{a}±3.381, 3.900^{a}±2.726, 1.400^{b}±1.776, and 0.200^{b}±0.632) for chamomile, coriander, marigold and no forbs (control), and (8.333^{a}±7.69, 7.000^{a}±5,000, 1.444^{b}±2.920, and 0.111^{b}±0.333), respectively. In the first and second seasons and L.s.d, (2.1474, 4.6272) respectively. In the first and second seasons while, *Opius* sp, (3.900^{a}±1.450, 3.500^{a}±1.581, 2.300^{b}±0.949, and 0.000^{c}±0.000), (4.000^{a}±2.345, 3.556^{ab} ±2.242, 2.222^{b} ±1.202, and 0.000^{c} ±0.000), respectively. In the two seasons, and, The L.s.d, (1.0635, 1.6612,) respectively. in the first and second seasons, *Kleidotoma* sp.,(5.300^{a}±3.199, 3.700^{a}±1.636, 0.500^{b}±0.707 and 0.200 ^{b}±0.633),and (4.667^{a}±3.708, 4.000^{a}±2.646, 0.667^{b}±0.707 and 0.222 ^{b}±0.667) for, coriander, chamomile, Marigold and no forbs (control),The L.s.d, (1.6853, 2.2362) respectively, in two seasons, while, *Sphegigaster* sp,(3.700^{a}±2.111, 3.200^{a}±1.814, 2.500^{a}±1.581, 0.000^{b}±0.000),(3.778^{a}±2.774, 3.333^{a}±2.000, 2.333^{a}±1.581, 0.000^{b}±0.000 for coriander, chamomile, Marigold and no forbs (control), respectively in two seasons, while, The L.s.d, (1.4515,1.8088) respectively in two seasons, while, marigold plant, was shown to be high significant attractive to the *Trissolcus* sp**,** followed by coriander, and,chamomile, compared to no forbs (control), the mean and S.D of responders were, (2.778^{a}±2.949, 1.333^{ab}±0.866, 1.222^{b}± 0.833and 0.000^{b}±0.000,) respectively The L.s.d, 1.5287, in the second season, while, in the first season, (1.700^{a}±1.337, 1.700^{a}±0.949, 2.400^{a}± 2.633,and 0.000^{b}±0.000,) and The L.s.d, 1.4067, respectively. Also, marigold plant, were discovered to be highly appealing to the *Telenomus* sp., followed by coriander, and, chamomile, comparison to no forbs.The mean and S.D of responders were, (2.800^{a}±2.741, 1.800^{ab}±2.530, 0.500^{bc}± 0.707 and 0.000^{c}±0.000,) respectively The L.s.d, 1.7216, in the first season, while, in the second season, (2.000^{a}±1.658, 2.333^{a}±2.500, 1.000^{ab}± 0.707, and 0.000^{b}±0.000,) and The L.s.d, 1.4798, respectively. The plant species were discovered to be highly appealing to *Dendrocerus* sp., comparison to no forbs, the mean and S.D of responders were (2.800^{a}±1.3988, 2.700^{a}±1.494, 1.400^{b}± 0.843 and 0.000^{c}±0.000,), and (2.556^{a}±1.509, 2.444^{ab}±1.509, 1.444^{b}± 0.882 and 0.000^{c}±0.000,), for coriander, marigol, chamomile, compared to no forbs (control), During the two seasons, The, L s.d., 1.0039, 1.1088, in the two season respectively. The plant species were discovered to be highly appealing to *Ooensyrtus* sp, comparison to no forbs, the mean and S.D of responders were (2.700^{a}±1.636, 1.700^{b}±1.160, 1.000^{b}±0.816, and 0.000^{c}±0.000) and (2.667^{a}±1.581, 1.667^{ab}±1, 000, 1.222^{b}±0.972, and 0.000^{c}±0.000), for chamomile, coriander, marigold and no forbs (control), respectively. In the first and second seasons and L.s.d, (0.982, 1.0122) respectively. In the first and second seasons. Also, *Cirrospilus* sp., (1.500^{a}±1.269, 1.000^{a}±1.054, 0.1000^{b}±0.316, and 0.000^{b}±0.000), (1.778^{a}±1.202, 1.000^{ab} ±1.000, 0.222^{bc} ±0.441, and 0.000^{c} ±0.000), respectively. In the first and second seasons, and, The L.s.d, (0.7618, 0.7799,) respectively. In the first and second seasons,while *Aphiduis* sp, (1.600^{a}±1.350, 0.800^{ab}±1.033, 0.900^{ab}±1.595 and 0.100 ^{b}±0.316), and (1.777^{a}±1.202, 1.111^{a}±0.928, 0.889^{ab}±1.0541 and 0.111^{b}±0.333,) for, coriander, chamomile, Marigold and no forbs (control), The L.s.d, (1.0668,0.9018) respectively. In the first and second seasons.

The data on Fig. (2) show the degree of dominance of the total number of Parasitoids insects using a sweep net (in the two seasons).

Sex insect Parasitoid species were recorded throughout the two seasons. Parasitoids insects, namely, *Diglyphus sp., Opius sp, Kleidotoma sp., Sphegigaster sp., Dendrocerus sp.,* and *Aphidius sp.*, on tomato plants surrounded with Chamomile. The dominance degree of the total number of Parasitoids insects as shown in Fig (2A), The highest abundance was 31.6, 20, 19.7, 16.8,7.3 and 4.6 % for *Diglyphus sp., Opius sp, Kleidotoma sp., Sphegigaster sp., Dendrocerus sp., and Aphidius sp.* respectively. However on tomato plants surrounded with Coriander. The dominance degree of the total number of Parasitoids insects as shown in Fig (2B), The highest abundance was 24.6, 22, 17.2,16.2,12.3 and 7.7 % for *Diglyphus sp., Kleidotoma sp., Sphegigaster sp., Opius sp, Dendrocerus sp,* and *Aphidius sp.* respectively. but on tomato plants surrounded with marigold The highest abundance was 25.9, 24.3, 22.8, 12.2, 9 and 5.8 % for *Dendrocerus sp, Sphegigaster sp., Opius sp, Diglyphus sp., Aphidius sp., and Kleidotoma sp.* respectively (Fig. 2C).

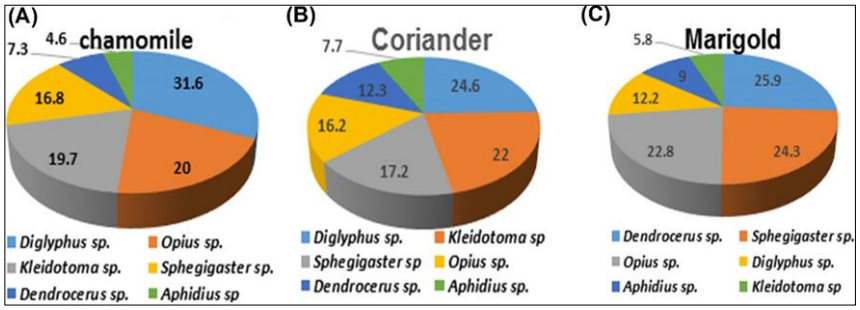

Fig 2: General dominance degree of collected insect Parasitoid by using sweep net on tomato plants sarounded with Chamomile (A), Coriander (B) and marigold (C) during 2019 and 2020

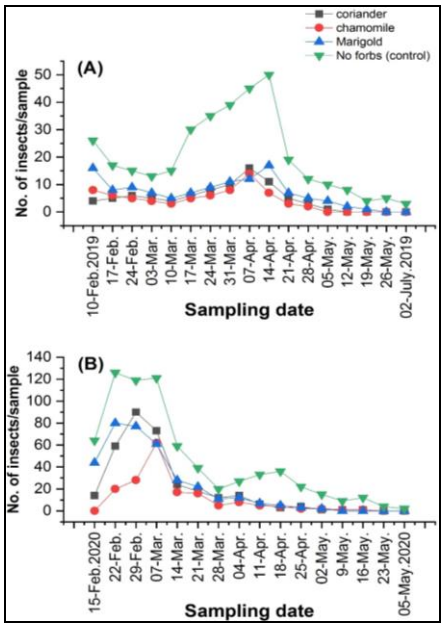

Fig 3: Number of Total aphid species on Tomato plants (*Solanum lycopersicum*) surrounded by either chamomile, coriander, Marigold (treatments) or no forbs (check), during season2018/ 2019 (A) and 2019/2020 (B)

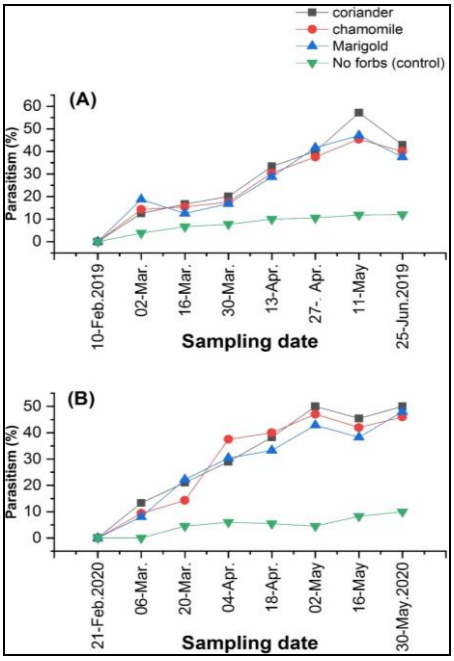

Fig 4: Seasonal abundance of Leaf miners on Tomato plants (*Solanum lycopersicum*) surrounded by either chamomile, coriander, Marigold (treatments) or no forbs (check), during season2018/ 2019 (A) and2019/ 2020 (B)

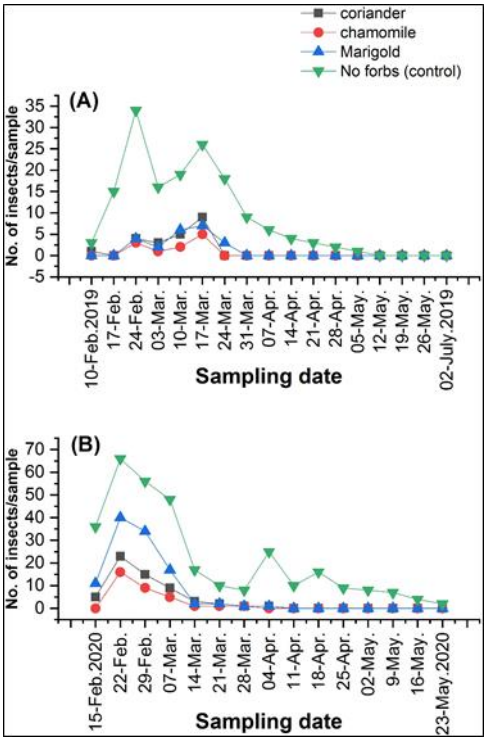

Fig 5: Percentage of aphid parasitism by hymenopterous parasitoids on Tomato plants (*Solanum lycopersicum*) surrounding or non-surrounded with chamomile, coriander, and Marigold), during the first 2019 (A) and second 2020 (B) seasons

Influence of adding floral resource plants on prey population (aphids)

As shown in (Fig. 3 A and B), the number of aphids in plots surrounded either by chamomile, coriander, or Marigold plants was initially low and then increased gradually. After that, the aphid population declined steadily until the end of the season. During the same period, the number of aphids increased dramatically in the check plots in both season 2018 /2019 and 2019/ 2020. In the first season (2018 /2019): the obtained data are summarized and illustrated in (Fig. 3A) the changes in the population of aphid species on Tomato plants (*Solanum lycopersicum*) surrounded by either chamomile, coriander, or Marigold plants aphid population showed one slight peak of abundance in plots surrounded with chamomile, Marigol plants. The peak occurred on the 7th and 14th of Apr. with a total number of 14 and 12 individualis / sample. While in plots surrounded with coriander aphid population showed two slight peak of abundance the peak occurred on the 24th Feb. and 7th of Apr. with a total number of 6 and 16 individualis / sample. On the contrary, in check plots, aphid population was high on Tomato plants and exhibited one peak of abundance. The peak was recorded on the 14th Apr., represented by 50 individuals. While, in the second season aphid population

showed one and two slights peaks of seasonal abundance on Tomato plants surrounded with Marigold, (the 4th of April. With a total number of 12 individualis / sample) coriander, (29th Feb. and 4th Apr. with a total number of 90 and 14 individualis / sample) and chamomile, (7th Mar. and 4th Apr. with a total number of 62 and 8 individualis / sample) In check plots, aphid population exhibited one peak of activity (on the 18th Apr. With a total number of 36 individualis / sample). Respectively The data in Table (5) show the mean number and standard deviations of total *Aphid* sp. and *Liriomyza trifolii* on tomato plants surrounded by (Chamomile, Coriander, and marigold) or no forbs during the 2019 and 2020 seasons. Statistical analysis indicated that the reactions of total *Aphid* sp. and leafminer *Liriomyza trifolii* population were observed in response to the tested plants (chamomile coriander, and Marigold). The floral resource plant caused considerable reduction of total *Aphid* sp. and *Liriomyza trifolii* population in both treated compared to no forbs (control). The mean and SD of responders of total *Aphid* sp. population were (1.392b±1.343, 1.647 b± 1.534, 2.353 b ± 1.730, 6.843 a±4.917) for chamomile, coriander, Marigold, and No forbs (control) and L.s.d, 1.0928 in the first respectively. And 3.563b±5.291, 6.666 b ±9.295, 7.333 b ±9.228, 14.750 a±13.905) for chamomile, coriander, Marigold, and No forbs (control) and L.s.d 3.9908 in the second seasons respectively. The mean and SD of responders of *Liriomyza trifolii* population were (0.157b±0.367&0.708b±1.611), (0.275b±0.603&1.000b±2.306), (0.314b±0.648&2.125b±4.296),(1.745a±2.965&5.916a±6.010) for chamomile, coriander, Marigold, and control respectively and LSD, (0.6084 &1.5915) in the first and second seasons respectively.

Influence on prey population leaf miner, (Liriomyza trifolii)

As shown in (Figs. 4 A and B) leaf miner, (*Liriomyza trifolii*) population in plots surrounded either by chamomile, coriander, or Marigold plants was initially low and then slightly increased. Following that, the population declined steadily until the end of the season. During the same time (seasons 2018/2019 and 2019/2020), the number of leaf miners increased dramatically in the control plots. The leaf miner population on tomato plants exhibited a single peak of abundance in the first and second seasons, as shown in (Figs. 4 A and B). The peak in the first season occurred on 17th of March respectively. In plots surrounded with, coriander, chamomile, Marigold, and two Peaks no forbs (control) on the 24th, Apr. and 17th of March represented by 9, 5, 7, and 34, 26 individuals, respectively. While In the second season peaks occurred on the 22th February respectively in plots surrounded with coriander, and chamomile, Marigold, and Three Peaks no forbs (control) on the 22nd February and 4th, 18th Apr. represented by 23, 16, 40, and 66,25,16 individuals, respectively.

Table 6: The mean number and standard deviation of parasitism on tomato crop surrounded by Marigold, Chamomile, Coriander, and (control) at the two seasons, (2019 & 2020)

Parasitism %	Chamomile	Coriander	Marigold	(control)	L S D. (P=5%)
2019	30.895a ±18.362	29.525a±18.362	27.881a±16.810	4.8488 b±3.535	16.012
2020	27.8025a± 18.746	25.060a ±15.652	25.369 a±16.118	7.801b±4.2009	15.138

a,b = Means in each row with the same letter are not significantly different at p≤0.05.

Influence on aphid parasitoid activity (parasitism %)

The change in the percentage of parasitism with hymenopterous parasitoids on aphid population on Tomato plants was estimated every two weeks. The obtained results were illustrated in (Table 6 and Figs. 5 A and B), the average percentage of parasitism on check plant was considerably low in comparison with those in treated plots (in the first and second seasons). The average percentage of parasitism was, (30.895 a±18.362&27.8025a±18.746) (29.525a±18.362&25.060a±15.652) and (27.881a±16.810&25.369 a±16.118) in the first and second seasons in surrounded plots with chamomile, coriander, and Marigold plants. Meanwhile, in check plots (with no forbs) the percentage of parasitism were (4.8488 b±3.535&7.801b±4.2009) and LSD. (16.012 & 15.138) respectively. In the first and second seasons, (Table 6).

Discussion

According to the finding, intercropping flowering plants (coriander, chamomile, and marigold) in tomato crops increased the number of the insect parasitoids species as chatting with leaf miner, *Liriomyza trifolii* (Diptera: Agromyzidae), and *aphid* sp in comparison with those in check plots. Among the early research directions were a focus on aphid natural enemies and their potential use in biological control (Heimpel *et al*, 1997) [16]. Furthermore, when compared to a field with no forbs, floral resource plants significantly reduced the populations of both Leaf miner and aphid sp.

According to Shrewsbury *et al* (2004) [37], increasing the number of flowering plants in crop fields reduces insect pest outbreaks and increases the population of natural enemies. The development of alternative hosts may increase aphid parasitoid abundance, putting more pressure on the aphid population. Furthermore, parasitism rates by hymenopterous parasitoids were higher in shrubs surrounded by flowering forbs than in shrubs without flowering forbs (Ellis *et al*, 2005 [11]; Bell *et al*, 2006 [4]; Irvin *et al*, 2006 [4]; Rebek *et al*, 2006) [33]. Tested host plants influenced aphid and Leaf miners on Tomato plants (*Solanum lycopersicum*) surrounded by either chamomile, coriander, Marigold (treatments), or no forbs (check). Aphid and Leaf miner populations, on the other hand, were significantly lower in study plots with floral resource plants and significantly higher in plots without floral plants

.According to Jervis *et al* (1996) [20], Irvin *et al* (2000) [18], flowers increase parasitoid efficiency by improving their fitness. These findings support the hypothesis that aphid populations can be reduced by planting floral resources plants adjacent to host plants of the pest. (Hogg *et al*, 2011) [17].

Natural enemies' longevity and fecundity can be increased by nectar and pollen availability, which improve natural enemies' survival. Rebek *et al* (2006) [33], Abd El- Kareim *et al* (2011) [1], Lu *et al* (2014) [27], Ambrosino *et al* (2006) [3], Russell (2015), van Rijn and Wäckers (2016), He and Sigsgaard (2019) [14]. According to Abd El-Kareim *et al* (2007) [2] Fiedler *et al* (2008) [12], and Rannbacck (2008), plant that are beneficial to insects are preferred by natural enemies and are not preferred by pest insects. Furthermore,

the tested plant species' nectar attraction was discovered to be both accessible and attractive to parasitoids. As a result, according to current study, flowers differ in terms of both attractiveness and accessibility Similar, conclusion was recorded by (Rannbacck (2008), (Kopta & Psota,2012) [22] This study evaluated the attractiveness of some medicinal plants to insect parasitoids by using sweep n*et al*so, to estimate the influence of adding floral resource plants on some pests in tomato fields. Increased plant diversity within and around crop fields, on the other hand, has a positive effect on the abundance of arthropod natural enemies while having a negative effect on herbivore populations (Letourneau *et al*, 2009, 2010) [25, 26], flowering plants and non-cropped areas Insect parasitoids are more abundant in *Solanum lycopersicum* plots with flowers. Otherwise, the pest population was reduced.

The current findings are consistent with those obtained by Abd El-Kareim, *et al*, 2011 [1], who discovered that flowering plant increases the abundance of insect parasitoids. Otherwise, the pest population was reduced. (Landis *et al*, (2000) [12, 23]; Ellis *et al* (2005) [11]; Bell *et al* (2006) [4]; Irvin *et al* (2006) [19]; Rebek *et al* (2006) [33]. Shrewsbury *et al* (2004) [37]. Mentioned that conservation of natural enemies through habitat management has been shown to have the potential to increase biological control. According to (Jervis *et al*, 1996 [20]; Abd El- Kareim, *et al*, 2011 [1]).

According to (Abd El- Kareim, *et al*, 2011) [1] Obtaining success in the provision of floral resources in the field can be viewed as a hierarchy of research outcomes that are progressively more different in order to obtain, natural enemies aggregate at or near the flowers, parasitism rate increases, and host population is reduced. Therefore, our results suggest that chamomile, coriander, and marigold can be used in habitat management to increase natural enemy activity As a result of the current study, flowers differ in both accessibility and attractiveness. Similar, conclusion was recorded by Rannbacck (2008), Abd El- Kareim, *et al*, 2011 [1], Bhagat *et al* 2018 [5]).

According to Shrewsbury *et al (*2004) [37]. Adding flowering plants in crop fields reduce insect pest outbreaks and increases natural Enemies populations. The development of alternative hosts may increase aphid parasitoid abundance, putting more pressure on the aphid population. Furthermore, parasitism rates by hymenopterous parasitoids were higher in shrubs surrounded by flowering forbs than in shrubs without flowering forbs.

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