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Some ecological aspects of main pests and predators incidence on sweet basil in Assiut governorate, Egypt

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Abstract

Incidence of arthropod pests and predators on sweet basil, *Osimum basilicum* L. have been studied during 2017 and 2018 growing seasons in a semi-arid newly reclaimed land (Arab El-Awamer, Abnob, Assiut governorate, Egypt). Results recorded thirty eight arthropod species belong to 27 families and 10 orders incidence on sweet basil. Destructive pest species comprised 20 species belongto 14 families and 7 orders, predaceous species composed 13 species of 10 families and 6 order and five visitor species belong to 5 families and 3 orders. In addition. results showed that *Empoasca decipiens* (Paoli), *Bemisia tabaci* (Genn.), *Aphis gossypii* (Glover), *Tetranychus urtica* (Koch) and *Thrips tabaci* (Lind.) were the main pests recorded on sweet basil, and the dominant predaceous species were *Coccinella undecimpunctata* (L.), *Chrysopa carnea* (Steph.), *Scymnus interruptus* (Goeze), *Stethorus punctillum* (Weise), *Orius albidipennis* (Rossi) and *Scolothrips longicornis* (Priesnes) on sweet basil. Results indicated that a heavey infestation with *E. decipiens, B. tabaci, T. urticae* and *T. tabaci* to the sweet basil occurred in July, while *A. gossypii* was found in August during the two seasons. A heavey incidence of predaceous species, *S. longicornis*, *S. punctillum*, *O. albidipennis* and *S. interruptus* were recorded in July, where *C. undecimpunctata* and *C. carnea* were observed in August on sweet basil during the two seasons. Results also cleared that the correlation between the previous pests and predators was highly significant positive or a significant positive. It could be concluded that there are great numbers of predators that they can play an important role in biological control of the main pests attacking sweet basil to avoid hazardous to environment with chemical pesticides.

Keywords: Piercing sucking pests, predaceous species, sweet basil, survey.

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Introduction

During the last few years, medicinal and aromatic plants are considered important crops in Egypt for human and exporting; they are used as food and for industry to produce drugs, cosmetics and others. Nowadays, the area cultivated with these plants are increased, especially in the newly reclaimed lands to cope the increasing needs for local consumption as well for export purpose through the government encourages the expansion in cultivation of medicinal and aromatic plants in Egypt, such as sweet basil, *O. basilicum* . Many destructive pest species, e.g. piercing sucking pests, cause a reduction in crop quantity and quality of sweet basil. Therefore, it is necessary and valuable to study those pests that cause an economic damage. The available literature revealed that there is a little known knowledge about the pests infesting sweet basil (Osman et al., 2017; Abou El-Nour, 2016; Amaar, 2010; Banjo et al., 2006). Also, beneficial insects such as predators and visitors can play an important role that affect productivity of sweet basil. Number of investigators has surveyed the predators on different medicinal and aromatic plants (Lubiarz et al., 2013; Abd El-Megid, 2007; Abdel-Moniem & Abd El-Wahab, 2006; Hammad & Mohsen, 2000; El-Kordy et al., 1998). Therefore, the current study aims to survey the main pests, predators and visitors species incidence on sweet basil and to study their average numbers as well as the relationship between them.

Materials and methods

Field experiments: Field ecological experiments were carried out at Arab El-Awamer (semi-arid newly reclaimed land) Abnob, Assiut Governorate, Egypt during 2017 and 2018 growing seasons to survey the pests, predators and visitors species that found on sweet basil. An area of about 525 m^2 was prepared and divided into suitable plots for growing sweet basil, *Osimum basilicum* L. and was sown on the 1st of April in both growing seasons. The area received normal practices and was not subjected to any chemical control application during the period of investigation.

Sampling techniques: Two sampling techniques were used, namely plant samples and sweeping net. The experimental area was divided into three replications (each 175 m^2). Samples of 20 leaves were weekly collected at random from each replicate, starting from the beginning of June till the end of August during the two seasons. The samples were placed in polyethylene bags and transferred to the laboratory, where they were carefully examined using a binocular microscope. The stages of pests and predators were counted and recorded. The sweeping net was 30 cm in diameter and 60 cm in depth. Each week, 15-double strokes were taken by walking diagonally across the experimental area from one corner to the opposite one. The catches were killed using a jar containing calcium cyanide. Samples were examined in the laboratory by the aid of a binocular microscope and the number of main pests and predators were recorded.

Statistical analysis: Obtained data were statistically analyzed according to the analysis of variance (ANOVA) procedure and the L.S.D. were used to determine the significance between

weekly average mean numbers of main pests from one side and predators from other side, and the correlation (r) and regression (b) coefficients were calculated using SAS program (SAS Institute, 1994).

Results and Discussion

Faunistic composition of arthropod pests, predators and visitors on sweet basil: Thirty eight arthropod species belongs to 27 families and 10 orders found on sweet basil were recorded as indicated in Table (1). Destructive pest species comprised 20 species belong to 14 families and 7 orders. Order Hemiptera (Homoptera and Heteroptera) ranked first in the number of species (5 sp.) per each recorded on sweet basil, followed by Orthoptera and Lepidoptera (3 sp. for each) then Diptera (2 sp.), whereas Thysanoptera and Acari (1 sp. for each). Predaceous species compiled 13 species of 10 families and 6 orders. Order Coleoptera ranked the first in number of species (4 sp.) recorded on sweet basil, followed by Hemiptera-Heteroptera and Acari (3 sp. for each), whereas Thysanoptera and Hymenoptera (1 sp. for each). Five visitor species belongs to 5 families and 3 orders. Order Lepidoptera and Hymenoptera ranked the first in the numbers of species (2 sp. for each), whereas Diptera had a one species .These insect visitors may play a role in cross pollination. The previous obtained results are in agreement with the findings of the following investigators; Osman et al. (2017) recorded that 29 insect species belongs to 25 families and 10 orders associated with three studied medicinal and aromatic plants (roselle, thyme and sweet basil) and 7 predaceous insect species belongs to 5 families and 5 orders were found on previous plants. Similar trends were recorded by Metwally et al. (2005), Abd El-Moneim and Abd El-Wahab (2006), Ismail et al. (2010) and Ismail et al. (2016).

Seasonal abundance of the main pests found on sweet basil: Average numbers of the main pests found on sweet basil were presented in Tables (2 and 3) during the two successive growing seasons 2017 and 2018.

Seasonal abundance of *Tetranychus urticae* found on sweet basil: As shown in Tables (2 and 3), the average numbers of the individuals (moving stages) appeared during the first week of June were 1.00 and 1.33 during 2017 and 2018 seasons, respectively. Thereafter, the population increased gradually in the fourth and third week of July recording 16.33 and 21.67 during 2017 and 2018 seasons, respectively, then decreased until the end of the two seasons. Also, the highest percent of monthly averages for *T. urticae* individuals were 72.54 and 72.41% through 2017 and 2018 seasons, respectively and was recorded during July which considered the most favorable month for the mite activity; meanwhile in June the lowest percent of monthly averages for *T. urticae* individuals were 7.49 and 7.39% during 2017 and 2018 seasons, respectively. The present findings are in quite proportional with those obtained by El-Doksh (2006) who revealed that the population density of *T. urticae* on soybean reached its maximum during July through the two seasons of the study. Abou El-Saad (2008) indicated

that, the monthly average numbers of the two-spotted spider were noticed in July and August during the two successive seasons of 2006 and 2007 on peanut. Hagrass et al. (2008) revealed that the peak of *T. urticae* recorded during July on cotton and eggplant. Safar (2010) noticed the high population of *T. urticae* during July on spearmint and peppermint. Abou El-Saad (2015**)** indicated that the average number of the two-spotted spider mite, *T. urticae* ranked the highest abundant during the second week of July in the two seasons of 2013 and 2014 seasons on watermelon.

Table 1: Taxonomic list of arthropod pests, predators and visitors recovered by plant sample and sweeping net from sweet basil plantations during 2017 and 2018 season in Assiut governorate, Egypt.

Order	Family	Common name	Species	Status
Orthoptera	Acrididae	Grosshopper	*Aiolopus strepens* (Latr.)	Pest
		The migratory locust	*Locusta migratoria* L.	Pest
	Gryllotalpidae	European male cricket	*Gryllotalpa gryllotalpa* L.	Pest
Thysanoptera	Thripidae	Onion thrips	*Thrips tabaci* (Lindeman)	Pest
		Predatory thrips	*Scolothrips longicornis* Priesnes	Predator
Hemiptera-homoptera	Aphididae	Melon or cotton aphid	*Aphis gossypii* (Glover)	Pest
		Green peach aphid	*Myzus persicae* (Sulzer)	Pest
	Aleyrodidae	Sweet potato whitefly	*Bemisia taaci* (Genn.)	Pest
	Cicadellidae	Green leaf hopper	*Empoasca decipiens* (Paoli)	Pest
		Cotton jassid	*Empoasca lybica* (de Berg)	Pest
Hemiptera-heteroptera	Anthocoridae	Predatory bug	*Orius albidipennis* (Rossi)	Predator
	Lygaeidae	Pentatomomorpha	*Geocoris megacephalus* (Rossi)	Predator
		False chinch bug	*Nysius cymoides* Spinola	Pest
		Cotton seed bug	*Oxycarenus hyalinipennis* (Costa)	Pest
	Nabidae	Pale damsel bug	*Nabis capsiformis* (Grmer)	Predator
	Miridae	Plant or leaf bug	*Campylomma impicta* (Wagner)	Pest
		British bug	*Phytocoris ulmi* (L.)	Pest
	Pentatomidae	Stink bug	*Nezara viridula* (L.)	Pest
Neuropteran	Chrysopidae	Green lacewings	*Chrysopa carnea* (Steph.)	Predator
Lepidoptera	Noctuidae	Black cutworm	*Agrotis ipsilon* (Huf.)	Pest
	Pieridae	Cabbage white butterfly	*Pieris rapae* L.	Visitor
	Nymphalidae	Painted lady butterfly	*Vanessa cardui* L.	Visitor
	Pyraustidae	The European corn borer	*Ostrinia nubilalis* Hbn.	Pest
	Lycaenidae	Blue butterfly	*Cosmolyce baeticus* L.	Pest
Coleopteran	Coccinellidae	Ladybird beetle	*Coccinella undecimpunctata* (L.)	Predator
		Lady beetle	*Scymnus interruptus* Goeze	Predator
		Blck lady beetle	*Stethorus punctillum* Weise	Predator
	Styphylinidae	Rove beetle	*Paederus alfierii* (Koch)	Predator
Hymenoptera	Syrphidae	The syrphid fly	*Syrphus corolla* (F.)	Predator
	Apidae	Honey bee	*Apis mellifera* L.	Visitor
	Vespidae	Oriental hornet	*Vespa orientalis* L.	Visitor
Diptea	Muscidae	House fly	*Musca domestica* L.	Visitor
	Agromyzidae	American serpentine leaf miner	*Liriomyza trifolii* Burges	Pest
		Broad bean leafminer	*Liriomyza congesta* Becker	Pest
Acari	Tetranychidae	Two spotted spider mite	*Tetranychus urticae* Koch	Pest
	Phytoseiidae	Predaceous mite	*Phytoseiulus persimilis* (A.-H.)	Predator
		The predatory mite	*Neoseiulus californicus* (Mc Gregor)	Predator
	Stigmaeidae	Predaceous mite	*Agistemus exsertus* Gonzalez	Predator

Table 2: Average numbers of main pests on sweet basil plant during 2017 season in Assiut governorate, Egypt.

Date	*Tetranychus urticae*		*Bemisia tabaci*		*Aphis gossypii*		*Empoasca decipiens*		*Thrips tabaci*	
	Moving stage	Monthly average (%)	Immature & adult	Monthly average (%)	Nymph & adult	Monthly average (%)	Nymph & adult	Monthly average (%)	Larvae & adult	Monthly average (%)
4/6/2017	1.00		3.33		0.67		4.33		1.33	
11	1.67		3.00		1.00		5.00		1.33	
18	1.33		4.67		0.67		5.33		1.00	
25	2.00		9.67		1.67		11.33		1.33	
Average	1.50	7.49	5.17	12.77	1.00	3.96	6.50	11.26	1.25	7.06
2/7	15.67		15.67		3.00		20.00		3.00	
9	14.00		19.67		4.33		21.67		11.67	
16	15.00		22.00		6.00		29.00		13.67	
23	16.33		22.67		6.33		41.33		15.00	
30	11.67		25.33		7.67		35.67		11.00	
Average	14.53	72.54	21.07	52.04	5.47	21.69	29.53	51.18	10.87	61.41
6/8	6.67		20.00		21.00		28.67		10.00	
13	2.33		17.00		22.33		23.00		6.00	
20	5.00		14.00		19.00		19.00		4.00	
27	2.00		6.00		12.67		16.00		2.33	
Average	4.00	19.97	14.25	35.19	18.75	74.35	21.67	37.56	5.58	
G. average	20.03DE		40.49B		25.22C		57.70A		17.70E	31.53

$L.S.D._{0.05}$ = 2.48

Table 3: Average numbers of main pests on sweet basil plant during 2018 season in Assiut governorate, Egypt.

Date	*Tetranychus urticae*		*Bemisia tabaci*		*Aphis gossypii*		*Empoasca decipiens*		*Thrips tabaci*	
	Moving stage	Monthly average (%)	Immature & adult	Monthly average (%)	Nymph & adult	Monthly average (%)	Nymph & adult	Monthly average (%)	Larvae & adult	Monthly average (%)
6/6/2018	1.33		4.33		1.33		6.67		1.67	
13	1.67		6.33		1.67		9.67		1.67	
20	2.00		7.67		1.33		7.67		1.33	
27	2.33		12.00		2.33		13.67		1.67	
Average	1.83	7.39	7.58	14.03	1.66	6.08	9.42	15.15	1.58	7.60
4/7	15.00		25.00		7.00		28.67		11.00	
11	19.67		29.00		7.00		34.00		14.67	
18	21.67		30.00		7.00		43.67		19.00	
25	15.33		31.67		8.00		34.44		15.67	
Average	17.92	72.41	28.92	53.53	7.25	26.55	35.17	56.55	15.08	72.53
1/8	7.67		21.00		21.67		23.67		7.67	
8	6.00		21.00		23.67		22.67		4.00	
15	5.00		15.33		17.00		24.67		4.33	
22	4.00		15.67		15.33		19.67		1.67	
29	2.33		14.67		14.33		21.00		3.00	
Average	5.00	20.20	17.53	32.44	18.40	67.37	17.60	28.30	4.13	19.87
G. Average	24.75D		54.03B		27.31CD		62.19A		20.79E	

$L.S.D._{0.05}$ = 3.27

Seasonal abundance of *Bemisia tabaci* found on sweet basil: Data in Tables (2 and 3) showed the weekly changes in the population of *B. tabaci* (immature & adult) on sweet basil through 2017 and 2018 seasons. Individuals of *B. tabaci* appeared generally in a few average numbers of individuals (3.33 and 4.33) during 2017 and 2018 seasons, respectively, and then the population increased gradually inthe last week of July recording 25.33 and 31.67 during 2017 and 2018 seasons, respectively, after that decreased to the end of the two

seasons. On the other hand, the highest percent of monthly averages for *B. tabaci* individuals were 52.04 and 53.53% during 2017 and 2018 seasons, respectively which recorded in July, then 35.19 and 32.44% in August and 12.77 and 14.03% in June during 2017 and 2018 seasons, respectively. These results are in partial agreement with those obtained by Salman et al. (2002) who indicated that the abundance of *B. tabaci* on soybean plants reached its peak during August. Sourial et al. (2002) reported that *B. tabaci* had one peak in the end of July, two peaks in late July and mid-August and one peak in the end of August on the first, second and third sowing dates of soybean, respectively. Abou El-Saad (2015) indicated that the average numbers of *B. tabaci* ranked the highest abundant during the third week of July through the two seasons, 2013 and 2014.

Seasonal abundance of *Aphis gossypii* found on sweet basil: The average numbers of nymph and adult stages of *A. gossypii* on sweet basil during 2017 and 2018 seasons were presented in Tables (2 and 3). The individuals of *A. gossypii* appeared during first week of June in a few average numbers of individuals (0.67 and 1.33) through 2017 and 2018 seasons, respectively. Thereafter, the population increased gradually in the second week of August recording 22.33 and 23.67 during the two seasons of 2017 and 2018, respectively, also the highest percent of monthly averages for *A. gossypii* individuals were 74.35 and 67.37% during the two seasons, 2017 and 2018, respectively which were recorded during August that considered the most favorable month for aphid activity; meanwhile the lowest percent of monthly averages for *A. gossypii* individuals (3.96 and 6.08%) were recorded in Jun during 2017 and 2018 seasons, respectively. Similar results were obtained by Hammad & Mohsen (2000) revealed that the highest average numbers of *A. gossypii* recorded during August on roselle plants.Sourial et al. (2002) indicated that the highest peak of *A. gossypii* on the three sowing dates of soybean was in mid-August. Mousa & El-Sisi (2005) recorded that the highest average numbers of *A. gossypii* was in August on coriander, dill, and parsley. El-Samahy and Saad (2010) stated that the high population density of *A. gossypii* on soybean plants was recorded during August.

Seasonal abundance of *Empoasca decipiens* found on sweet basil: The data compiled in Tables (2 and 3) obviously showed that the average numbers of individuals of *E. decipiens* (nymph and adult) during the first week of June were 4.33 and 6.67 during 2017 and 2018 seasons, respectively, then the population increased gradually in fourth and third week of July recording 41.33 and 43.67 during 2017 and 2018 seasons, respectively, then decreased till the end of the two seasons. Also the highest percent of monthly averages for *E. decipiens* individuals were 51.18 and 56.55% through the two seasons of 2017 and 2018, respectively which were recorded during July, while the lowest percent of monthly average for *E. decipiens* individuals (11.26 and 15.15%) was recorded in June during 2017 and 2018 growing seasons, respectively. The present results are in harmony with those obtained by Ba-Angood et al. (2000) in Yemen who found that the high numbers

of jassids occurred on sesame plants at early sowing in August and September. Hegab et al. (2005) indicated the average numbers of *E. decipiens* recorded two peaks at second week of both July and August on bean and cowpea. El-Samahy & Saad (2010) revealed that the population density of *E. decipiens* on soybean reached its maximum in the fourth week of July. Abd-Elsamad et al. (2011) revealed that the leafhopper *E. decipiens* recorded two peaks on soybean plants, the first peak was noticed at the 4th week of July for the two seasons and the second peak was recorded in 2nd week of August.

Seasonal abundance of *Thrips tabaci* found on sweet basil: The average numbers of immature and adult stages of *T. tabaci* found on sweet basil during 2017 and 2018 growing seasons were presented in Tables (2 and 3). The individuals of *T. tabaci* appeared during first week of June in a few average numbers of individuals (1.33 and 1.67) during 2017 and 2018 seasons, respectively, after that the population increased gradually in fourth and third week of July recording 15.00 and 19.00 during 2017 and 2018 seasons, respectively. On the other hand, the highest percent of monthly averages for *T. tabaci* individuals were 61.41 and 72.53% during the two seasons of 2017 and 2018, respectively; these were recorded through July which considered the most favorable month for *T. tabaci* activity, followed by 31.53 and 19.87% in August and 7.06 and 7.60% in June during 2017 and 2018 growing seasons, respectively. Confirmed results were reported by some investigators such as Metwally et al. (2005) revealed that the numbers of *T. tabaci* on guar plants were highly significant which ranged between 0.06-0.98 and 0.00-0.29 individuals per sample during the first and second seasons, respectively. It was found that the highest numbers of thrips occurred during March and May in the two successive seasons. Hammad (2006) reported that, the population of *T. tabaci* infests chamomile plants appeared two peaks during the infestation season with the highest ones, 1.73 and 1.52 insects per leaf, occurring on 27th and 26th of April during the two respective seasons. Generally, in the two seasons of study, the highest infestations with *E. decipiens, B. tabaci*, *T. urticae* and *T. tabaci* for sweet basil were in July, while *A. gossypii* in August. Also *E. decipiens* had the highest population density on sweet basil, followed by *B. tabaci*, *A. gossypii, T. urticae* and *T. tabaci* in the same month. In general population density of previous main pests found on sweet basil was higher in 2018 season than in 2017 season, may be due to the changes in the climatic factors.

Seasonal abundance of the main predators found on sweet basil: Average numbers of the main predators found on sweet basil were presented in Tables (4 and 5) during the two growing seasons, 2017 and 2018.

Table 4: Average numbers of predators on sweet basil plant during 2017 season in Assiut governorate, Egypt.

Date	*Scolothrips longicornis*		*Orius albidipennis*		*Chrysopa carnea*		*Scymnus interruptus*		*Stethorus punctillum*		*Coccinella undecimpunctata*	
	Larvae & adult	Monthly average (%)	Nymph & adult	Monthly average (%)	Larvae & adult	Monthly average (%)	Adult	Monthly average (%)	Adult	Monthly average (%)	Larvae & adult	Monthly average (%)
4/6/2017	0.00		0.33		0.00		0.00		0.00		0.00	
11	0.33		0.67		0.00		0.33		0.00		0.67	
18	0.00		0.67		0.00		0.67		0.00		1.00	
25	0.67		1.00		1.33		0.67		1.33		1.67	
Average	0.25	4.61	0.67	10.45	0.33	3.93	0.42	6.04	0.33	5.08	0.83	7.22
2/7	4.00		4.33		2.33		2.33		4.33		2.33	
9	2.67		3.00		3.00		3.67		3.33		3.33	
16	4.00		4.33		3.67		4.33		4.33		5.33	
23	5.00		5.67		4.00		5.00		6.00		6.00	
30	2.67		3.00		4.33		5.67		3.33		6.33	
Average	3.67	67.71	4.07	63.49	3.47	41.36	4.20	60.43	4.6	65.54	4.66	40.56
6/8	2.33		3.00		6.67		4.33		3.00		7.33	
13	1.67		1.67		6.67		3.33		2.33		8.33	
20	2.00		2.00		3.67		1.67		2.33		6.67	
27	0.00		0.00		1.33		0.00		0.00		1.67	
Average	1.50	27.68	1.67	26.06	4.59	54.71	2.33	33.53	1.91	29.38	6.00	52.22
G. Average	5.42D		6.41C		8.39B		6.95C		6.50C		11.49A	

$L.S.D._{0.05}$ = 0.550

Table 5: Average numbers of predators on sweet basil plant during 2018 season in Assiut governorate, Egypt.

Date	*Scolothrips longicornis*		*Orius albidipennis*		*Chrysopa carnea*		*Scymnus interruptus*		*Stethorus punctillum*		*Coccinella undecimpunctata*	
	Larvae & adult	Monthly average (%)	Nymph & adult	Monthly average (%)	Larvae & adult	Monthly average (%)	Adult	Monthly average (%)	Adult	Monthly average (%)	Larvae & adult	Monthly average (%)
6/6/2018	0.00		0.67		0.00		0.33		0.00		0.33	
13	0.67		1.00		0.33		0.67		0.00		1.00	
20	0.33		0.33		0.67		1.00		0.67		1.33	
27	1.00		1.33		1.67		1.33		1.00		2.00	
Average	0.50	7.90	0.83	10.69	0.67	6.95	0.83	9.67	0.42	5.11	1.16	9.30
4/7	4.67		5.00		2.67		2.67		4.33		2.67	
11	3.00		3.33		3.67		4.33		5.00		3.67	
18	4.67		5.67		4.33		4.33		5.67		5.33	
25	5.67		6.00		6.00		5.00		6.33		6.67	
Average	4.50	71.09	5.00	64.43	4.17	43.26	4.08	47.55	5.33	64.84	4.58	36.73
1/8	2.67		3.33		6.00		5.67		5.00		7.67	
8	2.00		3.00		6.00		5.67		3.00		9.00	
15	2.00		2.00		7.00		4.33		2.33		7.33	
22	0.00		1.33		3.33		2.33		1.67		7.00	
29	0.00		0.00		1.67		0.33		0.33		2.67	
Average	1.33	21.01	1.93	24.88	4.80	49.79	3.67	42.78	2.47	30.05	6.73	53.97
G. Average	6.33D		7.76C		9.64B		8.58C		8.22C		12.47A	

$L.S.D._{0.05}$ = 0.875

Seasonal abundance of *Scolothrips longicornis* found on sweet basil: Data in Tables (4 and 5) showed the weekly changes in the population of *S. longicornis* (larvae & adult) on sweet basil during 2017 and 2018 growing seasons. The individuals of *S. longicornis* appeared generally in a less average numbers of individuals (0.33 and 0.67) during 2017 and 2018 seasons, respectively, then the population increased gradually in the fourth week of July recording 5.00 and 5.67 during 2017 and 2018 seasons, respectively, after that decreased till the end of the two seasons. On the other hand, the highest percent of monthly averages for *S. longicornis* individuals were 67.71 and 71.09% during 2017 and 2018 seasons, respectively, recorded during July,

followed by 27.68 and 21.01% in August and 4.61 and 7.90% in June during 2017 and 2018 seasons, respectively.

Seasonal abundance of *Orius albidipennis* found on sweet basil: As shown in Tables (4 and 5) the average numbers of individuals of *O. albidipennis* (nymph & adult) on sweet basil during the two seasons 2017 and 2018. The individuals of *O. albidipennis* appeared during the first week of June in small average numbers (0.33 and 0.67) during 2017 and 2018 seasons, respectively. Thereafter, the population increased gradually in the fourth week of July recording 5.67 and 6.00 during 2017 and 2018 growing seasons, respectively, then decreased until the end of the two seasons. The highest percent of monthly averages for *O. albidipennis* individuals were 63.49 and 64.43% during the two seasons 2017 and 2018, respectively recorded during July; while the lowest percent of monthly averages for *O. albidipennis* individuals were recorded during June (10.45 and 10.69%) in 2017 and 2018 seasons, respectively.

Seasonal abundance of *Chrysopa carnea* found on sweet basil: The average numbers of larva and adult stages of *C. carnea* on sweet basil during 2017 and 2018 growing seasons were presented in Tables (4 and 5). The individuals of *C. carnea* appeared during the fourth and the second week of June in a few average numbers of individuals (1.33 and 0.33) during 2017 and 2018 seasons, respectively. Thereafter, the population increased gradually in the second and the third week of August recording 6.67 and 7.00 during the two seasons of 2017 and 2018, respectively. Also the highest percent of monthly averages for *C. carnea* individuals were 54.71 and 49.79% recorded during August, followed by July (41.36 and 43.26%) and June (3.93 and 6.95%) during the two seasons of 2017 and 2018, respectively.

Seasonal abundance of *Scymnus interruptus* found on sweet basil: The data compiled in Tables (4 and 5) obviously showed the average numbers of individuals of *S. interruptus* (adult) on sweet basil during the two seasons of 2017 and 2018. The individuals appeared during the first and the second week of June in small average numbers of individuals (0.33 and 0.33) during the two seasons of 2017 and 2018, respectively; then the population increased gradually during the fifth week of July and the first week of August recording 5.67 and 5.67 during 2017 and 2018 seasons, respectively, then decreased till the end of the two seasons. Also the highest percent of monthly averages for *S. interruptus* individuals were 60.43 and 47.55% through the two seasons of 2017 and 2018, respectively recorded during July, while the lowest percent of monthly averages for *S. interruptus* individuals (6.04 and 9.67%) were recorded during June of 2017 and 2018 seasons, respectively.

Seasonal abundance of *Stethorus punctillum* found on sweet basil: The average numbers of adult stages of *S. punctillum* found on sweet basil during 2017 and 2018 growing seasons were presented in Tables (4 and 5). The individuals of *S. punctillum* appeared during the fourth and the third week of June in a few average numbers of

individuals (1.33 and 0.67) during 2017 and 2018 season, respectively. After that the population increased gradually in the fourth week of July recording 6.00 and 6.33 during 2017 and 2018 seasons, respectively. On the other hand, the highest percent of monthly averages for *S. punctillum* individuals (65.54 and 64.84%) were recorded in July, followed by (29.38 and 30.05%) August and (5.08 and 5.11%) June during the two seasons of 2017 and 2018, respectively.

Seasonal abundance of *Coccinella undecimpunctata* found on sweet basil: Data in Tables (4 and 5) showed the weekly changes in the population of *C. undecimpunctata* (larvae & adult) found on sweet basil during 2017 and 2018 growing seasons. The individuals of *C. undecimpunctata* appeared in a few average numbers of individuals (0.67 and 0.33) during the first and the second week of June of 2017 and 2018 seasons, respectively. Thereafter, the population increased gradually in the second week of August recording 8.33 and 9.00 during the two seasons of 2017 and 2018, respectively. Also, the highest percent of monthly averages for *C. undecim-punctata* individuals were 52.22 and 53.97% during August followed by 40.56 and 36.73% in July and 7.22 and 9.30% in June during the two seasons of 2017 and 2018, respectively. The previous obtained results are in agreement with the findings of the following investigators; Hammad and Mohsen (2000) who reported that the *C. undecimpunctata*, *S. interruptus, O. albidipennis* and *C. carnea* as predatory insects found on roselle during July and August in the two respective seasons. Rott and Ponsonby (2000) studied the predatory behaviour of *S. punctillum* on the two-spotted spider mite, *T. urticae*. His results showed that the activity of *S. punctillum* on pepper, tomato and ubergine throught July and August months. Afsah (2005) found that *C. carnea* was the main insect predator associated with the insect pests infesting roselle plants during July and August in the seasons of study. Hammad (2006) recorded *O. albidipennis, C. undecimpunctata, S. interruptus* and *C. carnea* as predatory insects on chamomile plants, whereas the main insect pests were *A. gossypii* and *T. tabaci*. Afsah (2009) recorded two natural enemies, *Coccinella* sp. and *Orius* sp. associated with *T. tabaci, Liriomyza* sp. and aphid species on fenugreek plants. Generally, from the abovementioned results in our study, results showed that, *C. undecimpunctata* was the higher population density on sweet basil, followed by *C. carnea, S. interruptus, S. punctillum, O. albidipennis* and *S. longicornis* during the two growing seasons.

The relationship between main pests and predators found on sweet basil: Data in Tables (6 and 7) showed the simple correlation (r) and partial regression (b) values for the effect of the predators; *S. longicornis, O. albidipennis, C. carnea, S. interruptus, S. punctillum* and *C. undecimpunctata* on the population of main pests; *T. urticae, B. tabaci, A. gyossypii, E. decipiens* and *T. tabaci* found on sweet basil during the two growing seasons 2017 and 2018.

Table 6: Simple correlation (r) and regression (b) between the main pests and predators on sweet basil plant during 2017 season in Assiut governorate, Egypt.

Pests \ Predators	*Scolothrips longicornis*		*Orius albidipennis*		*Chrysopa carnea*		*Scymnus interruptus*		*Stethorus punctillum*		*Coccinella undecimpunctata*	
	r	b	r	b	r	b	r	b	r	b	r	b
Tetranychus urticae	0.975**	0.263	0.965**	0.294	0.754*	0.288	0.904**	0.301	0.648*	0.206	0.762*	0.385
Bemisia tabaci	0.935**	0.148	0.945**	0.168	0.928**	0.208	0.976**	0.192	0.950**	0.178	0.937**	0.279
Aphis gossypii	0.609*	0.138	0.608*	0.154	0.912**	0.293	0.699*	0.189	0.637*	0.171	0.910**	0.388
Empoasca decipiens	0.932**	0.103	0.941**	0.116	0.919**	0.144	0.965**	0.132	0.947**	0.123	0.933**	0.193
Thrips tabaci	0.921**	0.291	0.929**	0.329	0.865**	0.387	0.969**	0.378	0.932**	0.348	0.874**	0.518

* = Significant, ** = Highly significant

Table 7: Simple correlation (r) and regression (b) between the main pests and predators on sweet basil plant during 2018 season in Assiut governorate, Egypt.

Pests \ Predators	*Scolothrips longicornis*		*Orius albidipennis*		*Chrysopa carnea*		*Scymnus interruptus*		*Stethorus punctillum*		*Coccinella undecimpunctata*	
	r	b	r	b	r	b	r	b	r	b	r	b
Tetranychus urticae	0.941**	0.247	0.949**	0.285	0.781*	0.297	0.844**	0.279	0.953**	0.314	0.728*	0.355
Bemisia tabaci	0.923**	0.128	0.952**	0.152	0.882**	0.178	0.933**	0.164	0.960**	0.168	0.886**	0.229
Aphis gossypii	0.612*	0.138	0.680*	0.176	0.913**	0.299	0.877**	0.250	0.725*	0.205	0.952**	0.400
Empoasca decipiens	0.906**	0.102	0.944**	0.122	0.909**	0.149	0.923**	0.132	0.946**	0.134	0.887**	0.187
Thrips tabaci	0.956**	0.295	0.956**	0.339	0.787**	0.354	0.843**	0.329	0.960**	0.373	0.727*	0.418

* = Significant, ** = Highly significant

Data revealed highly significant positive correlation values for *B. tabaci, E. decipiens* and *T. tabaci* from one hand and all predators from other hand during the two seasons, except in the second season the correlation value was significantly positive (r= 0.727) between *C. undecimpunctata* and *T. tabaci*. Also (r) value was highly significant positive for *T. urticae* from one hand and *S. longicornis, O. albidipennis* and *S. interruptus* from other hand during the two seasons. In addition to *S. punctillum* in second season, the correlatio was (r= 0.953) significantly positive for *T. urticae* from one hand and *C. carnea* and *C. undecimpunctata* from other hand during the two seasons, Also the correlation of *S. punctillum* in first season was 0.648. The correlation value was significantly positive for *A. gossypii* from one hand and *S. longicornis, O. albidipennis, S. interruptus* and *S. punctillum* from other hand, and highly significant positive for *C. carnea* (r= 0.912) and *C. undecimpunctata* (r= 0.910) during the first season, while the correlation value during the second season was significantly positive for *A. gyossypii* from one hand and *S. longicornis, O. albidipennis* and *S. punctillum* from other hand, and was highly signficiantly positive for *A. gossypii* from one hand and *C. carnea* (r= 0.913), *S. interruptus* (r= 0.877) and *C. undecimpunctata* (r= 0.952) from other hand. Similar results were obtained by Abou El-Saad (1998) who showed that the simple correlation coefficient (r) between the population density of each predators; *S. interruptus, C. undecimpunctata, O. albidipennis, C. carnea* and *P. alfierii, T. urticae, B. tabaci, E. decipiens* and *Aphis creccivora* found on cowpea plantation was highly significantly positive in the two seasons of 1995 and 1996, and Abou El-Saad (2015) who stated that the correlation coefficient values were highly significantly positive and

significantly between *S. longicornis*, *Orius* sp. and *C. undecimpunctata* from one hand and the piercing sucking pests; *T. urticae*, *B. tabaci*, *A. gossypii* and *E. decipiens* on other hand on watermelon plantation during 2013 and 2014 seasons. It could be concluded from the obtained results that the predators play a role in sweet basil plantation against main pests attacking it. Accordingly, this role must be encouraged and developed continuously.

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