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BIOCONTROL OF CERTAIN PIERCING SUCKING PESTS INFESTING CUCUMBER PLANTS IN EGYPT

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Abstract

The present study was conducted to study certain piercing sucking pests and their natural enemies on cucumber plants during two successive seasons 2018 and 2019. The dominant insect pests were aphids, *Aphis gossypii* Glover, *Myzus persicae* (Sulzer),whitefly, *Bemisia tabaci* (Genn.), *Thrips tabaci* (Lind.) and a few numbers of Jassid as well as *Nezara viridula* F. Whereas, the prevailing associated predators were *Orius* spp., *Metasyrphus corollae* F., *Chrysoperla carnea* (Steph.), *Coccinella undecimpunctata* L., *C. septempunctata* and a few number of *Paederus alfierii* (Koch) and true spiders. The infestation of *B. tabaci* was much higher in autumn plantations than in summer plantations in both seasons of study, while, *T. tabaci* could be detected in few number on cucumber plants during autumn plantation in both seasons. In autumn plantation, *Orius* spp. had two peaks of activity in both years. The two peaks of activity were recorded in the second week of November and first week of December (19 and 20 individuals/40 leaves) in 2018 season and (15 and 16 individuals/40 leaves)in 2019, respectively. In the same regards, during autumn plantation, *Coccinella septumpunctata* had two peaks of activity in both years. The two peaks of activity in the first week of November with values (8 and 12 individuals /40 leaves) and (10 and 15 individuals /40 leaves), in the 4th week of November, during 2018and 2019 season, respectively in autumn plantation. Two primary parasitoids *Diaeretiella rapae* (M¼Intosh), *Aphidius colemani* (Viereck) and a hyperparasitoid, *Aphidencertus* sp.were recorded. The primary parasitoid *Diaeretiella rapae* was the most dominant species with mean relative densities (54.63 and 52.01%) during the two seasons, respectively, Meanwhile, the mean relative densities of *Aphidius colemani* were (32.41 and 32.17%) respectively, but the hyperparasitoids *Aphidencertus sp.* Recorded (12.96 and 15.82%) respectively in two years. The percentage of parasitism ranged from 1.6% to 23.21% in the first season 2018, while the percentage of parasitism started by 2.08% to 33.33% in season 2019. The mortality percentage of the fungus *V. lecanii* on *Aphis gossypii* recorded after 7 days of application with spore concentration 1×10^7 with 98.66% percentage and LC_{50} are obtained at concentration 5.95×10^4.Statistical analysis showed that temperature and relative humidity were significant with some insects and insignificant with the others.

Key words : *Aphis gossypii, Bemisia tabaci, Thrips tabaci,* predators,Aphid parasitoid and *Verticillium lecanii.*

Introduction

Cucumber plants, *Cucumis sativus* L. is an important cucurbitaceous crop in many parts of the world, are subjected to attack by numerous insects through the growing season (El-Maghraby *et al.,* 1989). Among these insect pests certain homopterous such as aphids, whitefly and thrips are of great economic importance which cause serious damage either directly by sucking plant juice or indirectly as vectors of plant pathogenic virus (Yokomi *et al.,* 1990 and Abdulsalam *et al.,* 1998). Parasitoids and predators are considered one of the most important factors that regulate the populations of such pests and may be the best solution to solve such problems (Ali 1996; El-Baz 2007; El –Maghraby *et al.,* 2008; Saljoqi 2009; Khan *et al.,* 2012; Ali 2014 and Abd El- Qader Rehab 2017). The hymenopteran parasitoid, *Aphidius matricariae, Ephedrus cerasicola,Lysiphlebus testacipes, A. colemani* and *Trioxys auctus* are well known as potential bio agent for *A. gossypii* on cucumber (Ohata, 2003and Saleh *et al.,* 2017a). The entomopathogenic fungi *Verticillium lecanii* was used as the effective biopesticide to managed the insects by the presence of Chitosan. (Vinodhini *et al.,*2017). Entomopathogenic fungi such as *Beauveria bassiana, Verticillium lecanii, Metarhizium anisopliae, Isaria fumosorosea* are appearing to be effective, environment-friendly and target-specific

biocontrol tools against many sucking insect pest species. They are being utilized to induce fast mortality of target pests by inhibiting enzymatic detoxification mechanisms that successively dispose the target pest insects for fungal infection. (Majeed *et al.*, 2017 and Ambethgar 2018). Today, biological control is an increasingly important component of integrated pest management (IPM) program for agriculture as well as for urban environment. Therefore, the mass production techniques of some predators may be relatively help in solving the problems of insect pests on cucumber and environment in the world and Egypt (Jin *et al.*, 2014 and Saleh *et al.*, 2017b). Therefore, the objective of the current study was to:

1. Survey and seasonal abundance of certain piercing – sucking pests and their associated (predators and aphid parasitoids) infesting cucumber plants.

2. Study the effect of certain weather factors on the seasonal abundance of these pests and their associated (predators and aphid parasitoids).

3. The efficacy of *verticilium lecanii* as biocontrol agent on *A. gossypii* .

Materials and Methods

The present investigation was carried out at field in (El-Salhia district) district Sharkia Governorate during 2018and 2019seasons**.** An area of about half feddan was cultivated with cucumber. In all cases the field of each experimental host plant was left without pesticide application enhancing the natural enemies to play its role in competing different insect pests.

1. Survey and seasonal abundance of piercing sucking pests and their predators on Cucumber plants:

Surveying of major piercing sucking pests and their predators and aphid parasitoids took place during two successive growing seasons 2018 and 2019 on cucumber (summer and autumn) plantations. The cultivated area was one feddan in both seasons. The sowing date was in the 4th of October in the first season, while it was 6th of October in the second one. Sampling started after about two weeks from planting and continued to the harvesting time, the sample size was 40 leaves from 10 cucumber plants and chosen randomly from plants early in morning before the whitefly adults tend to be more active. Direct count of adults of injurious insects and predators on cucumber plant was undertaken. Since the natural enemies under investigation differed in their living habits, activities, and distributions on the host plants infested with different prey and host insects it was necessary to use one sampling method for all groups such as leaves sampling plant method in order to explain the relationship between pests and their associated predators. Samples were placed in paper bags to be examined carefully under stereoscopic binocular microscope. The number of insect pests and predators (immature stages and adults) in most cases were directly counted.

In case of aphid parasitoids aphis were supplied with fresh host leaves and kept in Petri dishes (50 aphids / Petri dish) until formation of mummies. The mummies of the aphids was isolated and separated in small glass tubes until the emergence of adult parasitoids. The emerged parasitoids were primarily classified, counted and preserved in 70 % ethyl alcohol. Parasitoid specimens were mounting, confirmation and identification was completed by aid of Prof. Ahmed El-Heneidy, biological control laboratory, Ministry of Agriculture, Egypt. The percentage of parasitism was calculated according to Farrell and Stufkens (1990).

$$\text{Percentage of parasitism} = \frac{A+B}{A+B+C} \times 100$$

Where:

A:Number of mummified aphids counted at the date of inspection.

B:Number of mummified host appeared during the laboratory rearing.

C:Number of unparasitized aphids.

2. Study the effect of certain weather factors on the population density of the piercing sucking pests and their (predators “ aphid parasitoids) on cucumber:

To study the effect of certain weather conditions on the population density of the pests and their associated natural enemies daily minimum, maximum, mean temperature and mean relative humidity were obtained from the Meteorological central laboratory for Agricultural Climate, Agricultural Research Center during the whole period of study. The correlation coefficient between weather parameters and the number of pests and their associated predators were studied. Also, the numerical relation among these variables was calculated for the key weather factors, using regression coefficient (Costat Statistical Software (1995).

3. Laboratory evaluation of *V.lecanii* spores suspension on *Aphis gossypii*

Fungi: *V. lecanii* strain NRRL 11003 was cultured on Dox Agar media and maintained in growth chamber at 25±1C°, 16L:8D photoperiod. Conidia collected from 12 days old cultures diluted at 0 (control, 10^5, 10^6 and 10^7 conidia/ml).

Mass rearing of insect

Aphis gossypii was collected from cucumber plant in greenhouse and laboratory culture established on broad bean. Colony of aphids was maintained at 25±1C°, 65 ± 5% RH and 16L:8D photoperiod

Results

1. Survey and population density of certain piercing sucking insects and their associated (predators and parasitoids) in cucumber plants.

The seasonal abundance of the dominant insect pests infesting cucumber plants were aphids *Myzus persicae* (Sulzer) and *Aphis gossypii* (Glover); white fly *Bemisia tabaci* (Genn.), *Thrips tabaci* (Lind.) and few of jassids *and Nezara virdula* F. the prevailing associated predators were:

Anthocorids : *Orius leavigatus* Fieb. and *O. albidipennis* Reut (Hemiptera, Anthocoridae).

Coccinellids : *Coccinella septempunctata* L., *C. undecimpunctata* L. and *Paederus alfierii* (Koch) (Coleoptera, Coccinellidae).

Chrysopid: *Chrysoperla carnea* Steph. (Neuroptera, Chrysopidae).

Syrphids: *Metasyrphus corollae* F. (Diptera, Syrphidae).

The following is a list of hymenopterous primary and hyper parasitoid species that emerged from *A. gossypii* and *M. persicae* on cucumber plants :

Primary parasitoids: *Diaeretiella rapae* (M¼Intosh), *Aphidius colemani* (Viereck).

Hyperparasitoids: *Aphidencertus* sp.

Result in table 1 showed that the infestation of *T. tabaci* was the highest, which represented 53.96 and 54.31% of the total number of insect pests followed by aphids (*A. gossypii* and *M. persicae*) 38.69 and 35.44% of the total number of insect pests followed by white fly *B. tabaci*, 7.35 and 10.25 % of the total number of insect pests infesting cucumber plants during summer plantation of 2018 and 2019 seasons, respectively. While in the autumn plantation white fly was the highest infestation, which represented 66.94 and 75.22% of the total number of insect pests followed by aphids 30.43 and 22.26% then thrips 2.63 and 2.52% from the total number of insect pests infesting cucumber plants during autumn plantation of 2018 and 2019 seasons, respectively. The number of *Orius spp*. was the highest and represented by 34.18 and 29.49% followed by *C. undecimpunctata* (21.66 and 28.90%) then *M.corollae* (18.68 and 17.17%) and (14.01 and 14.95%) for *C. septumpunctata* while *Ch. carnae* represented by (11.47 and 9.49%) from the total number of insect predators during the summer plantations of 2018 and 2019, respectively. While in the autumn plantation the number of *C. undecimpunctata* was the highest and represented by 29.47 and 28.99% followed by *Ch. Carnae* (27.02 and 23.08%), then *Orius spp*. (23.51 and 18.94%) and (11.93 and 15.68%) for *C. septempunctata* while *M. corollae* represented by (8.07 and 13.31%) from the total number of insect predators during the autumn plantation of 2018 and 2019seasons, respectively (Table 1).

Seasonal abundance of predators associated with pests infesting cucumber.

Autumn plantation.

a) *Orius* spp. Data presented in table 2, showed that *Orius* spp. were appeared on cucumber plants in the fourth week of October (3 individuals/40 leaves), two peaks of activity were recorded in the second week of November and first week of December (19 and 20 individuals/40 leaves), respectively during the first season 2018. While in the second autumn season 2019, table 3, obtained that *Orius* spp. begun to appear in the end of October (2indibiduals/40 leaves). Two peaks of activity were recorded in the second week of November and first week of December (15 and 16 individuals/40 leaves), respectively.

b) *Metasyrphus corollae*. Data presented in tables 2&3 showed that *M. corolla*e was appeared in the first week of November by (3 and 4 individuals/40 leaves) and recorded one peak of activity with values (8 and 12 individuals / 40 leaves) in the 3rd and 4th week of November during 2018 and 2019 seasons, respectively.

c) *Coccinella septempunctata*. Tables 2 & 3 showed that this predators was recorded two peaks of activity in the first week of November with values (8 and 12 individuals /40 leaves) and (10 and 15 individuals /40 leaves), in the 4th week of November, during 2018 and 2019 season, respectively.

d) *Coccinella undecimpunctata*. Data presented in tables (2&3) showed that *C. undecimpunctata* was appeared in the 4th week of October during two seasons, and recorded one peak of activity (28 and 30 individuals /40 leaves), in the first week of December and 4th week of November, during 2018 and 2019 seasons, respectively.

e) *Chrysoperla carnea*. Data presented in tables (2&3) showed that *Ch. carnea* was recorded only one peak of population activity (18 individuals /40 leaves) for everyone in the 3rd and 4th week of November during 2018 and 2019 seasons,

Summer plantation

a) *Orius* spp. Two peaks of activity were recorded

Table 1: Mean numbers of different pests and the associated predators with cucumber cultivated in autumn and summer plantation of 2018and 2019.

Year season / Variable	2018				2019			
	Summer		Autumn		Summer		Autumn	
	Total	%	Total	%	Total	%	Total	%
Insect pests:								
1- Aphids	5853	38.69	3755	30.43	5465	35.44	2570	22.26
2-Bemisia tabaci	1112	7.35	8260	66.94	1580	10.25	8685	75.22
3- Thrips tabaci	8164	53.96	325	2.63	8375	54.31	291	2.52
Total	15129	100	12340	100	15420	100	11546	100
Insect predators:								
1-*Orius leavigatus &O. albidipennis*	161	34.18	67	23.51	140	29.49	64	18.94
2-Metasyrphus corollae	88	18.68	23	8.07	85	17.17	45	13.31
3-Coccinella septempunctata	66	14.01	34	11.93	74	14.95	53	15.68
4-*C. undecimpunctata*	102	21.66	84	29.47	143	28.90	98	28.99
5-Chrysoperla carnea	54	11.47	77	27.02	47	9.49	78	23.08
Total	471	100	285	100	495	100	338	100

Table 2: Seasonal abundance of certain insects and their associated predators on cucumber plants in autumn 2018.

Date of insspection	*A.gossypii & M.persicae*		*B.tabaci*		*T.tabaci*		*Orius .spp*	*M.corallae*	*C.septem punctata*	*C.undecim punctata*	*Ch. carnea*	Mean	
	No.	Mean	No.	Mean	No.	Mean						C°	R.H.
October 3rd	0	0	120	3.0	0	0.5	0	0	0	0	0	24.4	61
4th	15	0.38	840	21.0	20	0.63	3	0	3	5	4	23.7	55
November 1st	130	3.25	1360	34.0	25	1.0	10	3	8	8	8	21.0	60.7
2nd	720	18.0	1280	32.0	40	1.5	19	5	4	10	14	19.8	61.6
3rd	840	21.0	1250	31.25	60	1.88	4	8	5	12	18	20.8	70
4th	1160	29.0	1210	30.25	75	28.3	6	4	10	16	15	19.0	67
December 1st	720	18.0	1320	33.0	50	1.25	20	3	4	28	12	18.6	70
2nd	170	4.25	760	19.0	35	0.88	5	0	0	5	6	17.4	69
3rd	0	0	120	3.0	20	0.5	0	0	0	0	0	19.7	70
Total	3755		8260		325	0.90±	67	23	34	84	77		
		10.43		22.94±									
Mean		±3.7		4.15		0.19							

in the first week of both May and June (30 and 32 individuals/40 leaves), in 2018 season table 4. In the second season 2019, the number of *Orius* spp. Took place in the 2nd week of April (3individuals/40 leaves) its increased to record two peaks of activity (25 and 36 individuals/40 leaves) in the first week of both May and June, respectively, table 5.

b) *Metasyrphus corollae*. Table (4 & 5) showed that *M. corollae* were appeared on cucumber plants in the 2nd and 3rd week of April by (12 and 10 individuals/40 leaves) during summer plantation 2018 and 2019, respectively and recorded one peak of activity during every season with values (20 and 23 individuals/40 leaves), in the first week of May, respectively.

c) Coccinella septempunctata. (Table 4) showed that *C. septempunctata* individuals were appeared in the 2nd week of April and recorded two peaks of activity (12 and 13 individuals/40 leaves) in the first week of both May and June, respectively, during 2018 season. In 2019 season was appeared in 3rd week of April (3 individuals. /40 leaves), recorded two peaks of activity (12 and 18 individuals /40 leaves) in the first and 4th week of May, respectively, table 5.

d) *Coccinella undecimpunctata*. Data tabulated in table (4), showed that *C. undecimpunctata* was recorded two peaks of activity (18 and 20 individuals /40 leaves) in the first and 4th week of May, respectively in summer season 2018. In the summer season 2019, two peaks of

Table 3: Seasonal abundance of certain insects and their associated predators on cucumber plants in autumn 2019.

Date of insspection		*A.gossypii & M.persicae*		*B.tabaci*		*T.tabaci*		*Orius .spp*	*M.corallae*	*C.septem punctata*	*punctata*	*Ch. carnea*	Mean	
		No.	Mean	No.	Mean	No.	Mean						C°	R.H.
October	3rd	0	0	150	3.75	0	0	0	0	0	0	0	24.0	71.4
	4th	30	0.75	860	21.5	10	0.25	2	0	3	5	8	24.04	61.1
November	1st	145	3.63	1380	34.5	30	0.75	8	4	12	10	10	21.15	74.8
	2nd	560	14.0	1290	32.25	42	1.05	15	8	8	15	13	21.05	82
	3rd	675	16.88	1275	31.88	70	1.75	10	10	6	22	14	21.25	85
	4th	840	21.0	1420	35.5	65	1.63	7	12	15	30	18	21.55	81
December	1st	180	4.5	1310	32.75	44	1.10	16	6	9	10	10	17.0	78.3
	2nd	140	3.5	820	20.5	30	0.75	6	5	0	6	5	16.55	78.4
	3rd	0	0	180	4.5	0	0	0	0	0	0	0	16.5	48.4
Total		2570		8685		291	0.81±	64	45	53	98	78		
			7.14±		24.13									
Mean			2.66		±4.18		0.22							

Table 4: Seasonal abundances of certain insects and their associated predators on cucumber plants during summer plantation season of 2018.

Date of insspection		*A.gossypii & M.persicae*		*B.tabaci*		*T.tabaci*		*Orius .spp*	*M.corallae*	*C.septem punctata*	*punctata*	*Ch. carnea*	Mean	
		No.	Mean	No.	Mean	No.	Mean						C°	R.H.
April	1st	85	2.13	3	0.08	10	0.25	0	0	0	2	0	21.6	56.6
	2nd	130	3.25	8	0.2	110	2.75	3	12	3	8	0	22.7	57.4
	3rd	217	5.43	120	3.0	720	18.0	5	14	6	12	3	23.0	51.0
	4th	260	6.5	128	3.2	1125	28.13	10	18	7	15	5	24.5	52
May	1st	1255	31.38	130	3.25	1160	29.0	30	20	12	18	6	21.75	68.3
	2nd	1160	29.0	120	3.0	1245	31.13	22	16	8	10	9	24.1	59
	3rd	1138	28.45	260	6.5	1132	28.3	20	5	6	12	12	24.1	60.7
	4th	1270	31.75	118	2.95	1130	28.25	24	3	9	20	15	24.2	58
June	1st	148	3.7	115	2.88	762	19.05	32	0	13	5	4	25.7	58.5
	2nd	125	1.13	110	2.75	650	16.25	10	0	2	0	0	26.25	61.3
	3rd	65	1.63	0	0	120	3.0	5	0	0	0	0	26.4	60.1
Total		5853		1112		8164		161	88	66	102	54		
			13.30±		2.53±		18.56±							
Mean			4.06		0.57		3.54							

activity were recorded also in the first and 4th week of May with value (28 and 35 individuals/40 leaves), respectively, table 5.

e) *Chrysoperla carnea*. Tables (4 & 5) clearly that *Ch. carnea* was recorded one peak of population activity (15 and 14 individuals / 40 leaves) in the 4th week of May during 2018 and 2019 seasons, respectively.

3. Population density of (*Aphis gossypii* " and *Myzus persicae*) and its common parasitoids on **cucumber** plants.

As shown in (Tables 6, 7), two peaks for *A. gossypii* and *M. persicae* were recorded on cucumber plant in the two seasons 2018 and 2019. These peaks occurred in the first and fourth week of May (340 and 320 individuals) in 2018 season and (320 and 310 individuals); in the second season 2019. The maximum number mummified aphids were (70 and 95 mummies) recorded in the fourth week of May in two seasons, respectively when the temperature and relative humidity were (24.2" 26.5°C) and (58.0%"59.0%) (Tables 6, 7). The data also cleared that The primary parasitoid *D. rapa* was the most dominant species with mean relative densities (54.63 and 52.01% R.H) during the two seasons respectively. Meanwhile, the mean relative densities of *A. colemani*

Table 5: Seasonal abundances of certain insects and their associated predators on cucumber plants during summer plantation season of 2019.

Date of insspection		*A.gossypii & M.persicae*		*B.tabaci*		*T.tabaci*		*Orius .spp*	*M.corallae*	*C.septem punctata*	*punctata*	*Ch. carnea*	Mean	
		No.	Mean	No.	Mean	No.	Mean						C°	R.H.
April	2nd	120	3.0	25	0.63	80	2.0	3	0	0	0	0	22.35	57.5
	3rd	170	4.25	130	3.25	185	4.63	5	10	3	4	0	30.1	52
	4th	630	15.75	142	3.55	720	18.0	8	15	6	10	5	24.55	53
May	1st	870	21.57	260	6.5	1570	39.25	25	23	12	28	7	25.6	58.9
	2nd	655	16.38	370	9.25	1270	31.75	20	16	8	22	8	24.5	59.9
	3rd	510	12.75	210	5.25	1215	30.38	15	10	9	23	10	25.4	62
	4th	1460	36.5	190	4.75	1125	28.13	12	8	18	35	14	26.5	59
June	1st	480	12.0	130	3.25	980	24.5	36	3	16	18	3	27.75	65.1
	2nd	350	8.75	120	3.0	820	20.5	15	0	2	3	0	27.65	60.8
	3rd	220	5.5	0	0	410	10.25	7	0	0	0	0	27.65	57
Total		5465		1580		8375		146	85	74	143	47		
			13.66±3				20.94±3							
Mean			.15		3.94±0.85		.88							

Table 6: Population density of *Aphis gossypii* and *Myzus persicae* aphid and number of parasitoid aphids in cucumber field during 2018 season.

Sampling date (weeks)		No. of aphid	No .of parasitized aphid (mummies)			Total parasitism%	Primary parasitoids				Hyper parasitoids		Total	Corresponding means of	
							D.rapae		*A.colemani*						
			A	B	Total		No.	R.D.%	No.	R.D.%	No.	R.D.%		Temp	R.H%
April	1st	230	0	0	0	0	0	0	0	0	0	0	0	21.6	56.6
	2nd	250	0	4	4	1.6	2	100	0	0	0	0	2	22.7	57.4
	3rd	285	10	13	23	8.07	12	63.16	7	36.84	0	0	19	23.0	51.0
	4th	290	18	25	43	14.83	23	58.97	12	30.77	4	10.26	39	24.5	52.0
May	1st	340	20	32	52	15.29	28	58.33	14	29.17	6	12.5	48	21.75	68.3
	2nd	260	24	26	50	19.23	20	45.46	16	36.36	8	18.18	44	24.1	60.7
	3rd	280	27	38	65	23.21	29	49.15	18	30.51	12	20.34	59	24.1	60.7
	4th	320	40	30	70	21.88	35	55.56	22	34.92	6	9.52	63	24.2	58.0
June	1st	260	18	22	40	15.38	18	50.0	12	33.33	6	16.67	36	25.7	58.5
	2nd	210	8	12	20	9.52	10	71.43	4	28.57	0	0	14	26.25	61.3
	3rd	195	0	4	4	2.05	0	0	0	0	0	0	0	26.4	60.1
Total			165	205											
		2920			371		177		105		42		324		
Mean		265±			33.73±	2.5	16.09±		9.55±		3.82±		29.45±		
		13.3			7.52		3.70		2.36		1.25		7.09		

were (32.41 and 32.17%) respectively, but *Aphidencertus sp*. Record (12.96 and 15.82%) respectively table 8.

Percentage of parasitism

The percentage of parasitism ranged from 1.6% to 23.21% in the first season 2018, while the percentage of parasitism started by 2.08% in the second week of April and increased until reached the peak of 33.33% in the 3rd week of May and decreased until the end of season 2019, (Table 6, 7).

Effect of temperature and relative humidity on the population density of certain piercing sucking pests and its (predators "parasitoids) on cucumber plants.

The results in tables 9, 10 show the values of correlation coefficient of the relation between temperature, relative humidity and certain piercing

Table 7: Population density of *Aphis gossypii* and *Myzus persicae* aphid and number of parasitoid aphids in cucumber field during 2019 season.

Sampling date (weeks)		No. of aphid	No .of parasitized aphid (mummies)			Total parasitism%	Primary parasitoids				Hyper parasitoids		Total	Corresponding means of	
							D.rapae		*A.colemani*						
			A	B	Total		No.	R.D.%	No.	R.D.%	No.	R.D.%		Temp	R.H%
April	2nd	210	0	0	0	0	0	0	0	0	0	0	0	22.35	57.5
	3rd	240	0	5	5	2.08	3	100	0	0	0	0	3	30.1	52
	4th	275	14	20	34	12.36	15	50.0	12	40.0	3	100	30	24.55	53
May	1st	320	28	32	60	18.75	25	45.46	15	27.27	15	27.27	55	25.6	58.9
	2nd	260	25	28	53	20.38	28	56.0	12	24.0	10	20.0	50	24.5	59.9
	3rd	270	28	31	59	21.85	22	40.74	16	29.63	16	29.63	54	25.4	62
	4th	310	42	53	95	30.65	43	51.81	30	36.14	10	12.05	83	26.5	59
June	1st	240	40	40	80	33.33	40	57.14	25	35.71	5	7.15	70	27.75	65.1
	2nd	205	10	20	30	30.64	15	60.0	10	40.0	0	0	25	27.65	60.8
	3rd	120	0	5	5	4.17	3	100	0	0	0	0	3	27.65	57.0
Total		2450	187	234	421				120		59		373		
						17.42	194								
Mean		245±			42.1±1	±3.91	19.4±4.8		12		5.9		37.3±		
		18.29			0.38				±3.26		±2.02		9.34		

Table 8: Survey and relative densities of *Aphis gossypii and Myzus persicae* Parasitoids on cucumber plants, during two successive seasons.

Species	Family	2018		2019	
		Number	%	Number	%
Primary parasitoids:		177	54.63	194	52.01
1-*Diaeretiella rapae*	Aphidiidae	105	32.41	120	32.17
2- Aphidius colemani					
3- Aphidencertus sp.	Encyrtidae	42	12.96	59	15.82
Total		324	100	373	100

Table 9: Simple correlation between the total number of insect pests and their natural enemies and temperature and relative humidity on cucumber during two autumn seasons.

	Simple correlation						Explained variance	
	2018			2019			2018	2019
	Max. Temp.	Min. Temp.	Mean R.H.	Max. Temp.	Min. Temp.	Mean R.H.	%	%
A.gossypii & M. persicae	-0.452	-0.449	0.408	0.187	0.054	0.686*	21.96	51.86
Bemisia tabaci	-0.335	-0.401	0.022	0.109	-0.070	0.722**	28.70	58.27
Thrips tabaci	-0.590*	-0.640*	0.516*	-0.117	-0.235	0.521*	44.50	36.78
Orius spp.	-0.464	-0.364	0.060	-0.203	-0.309	0.713**	57.82	63.41
M.corollae	-0.201	-0.214	0.280	-0.022	-0.148	0.804**	19.29	70.08
C.septempunctata	-0.081	-0.243	-0.066	0.213	-0.037	0.533*	38.15	43.21
C.undecimpunctata	-0.482*	-0.425	0.364	0.196	0.069	0.688*	25.35	51.73
Chrysoperla carnea	-0.403	-0.424	0.305	0.225	0.101	0.699*	18.11	57.65

sucking pests and its (predators "parasitoids) on cucumber plants. The maximum temperature cleared significant negative correlation on the population density of *Thrips tabaci* during autumn plantation in 2018 (-0.590*) and showed positive significant on the population density of *Orius* spp. during summer plantation in 2019(0.492*). The minimum temperature cleared significant negative correlation on the population density of (*A. gossypii* " *M. persicae*), *C. undecimpunctata* and *M. corolla* during during summer plantation in 2018(-0.502*,-0.567* and -0.667*) and showed positive significant on the population density of *Orius* spp. in 2019(0.518*). Meanwhile, the minimum temperature cleared significant negative correlation on the population density of *T. tabaci* during autumn plantation in 2018 (-0.640*). On the other hand, the mean relative humidity parameters indicated highly positive significant effect on the population density *B. tabaci*,

Table 10: Simple correlation between the total number of pests and their natural enemies and temperature and relative humidity on cucumber during two summer seasons.

	Simple correlation						Explained variance	
	2018			2019			2018	2019
	Max. Temp.	Min. Temp.	Mean R.H.	Max. Temp.	Min. Temp.	Mean R.H.	%	%
A.gossypii & M. persicae	-0.0123				0.184			
Bemisia tabaci	0.212	-0.502*	0.477	0.291	-0.203	0.186	58.00	10.57
Thrips tabaci	0.315	-0.0955	0.134	0.009	0.294	0.236	13.38	29.38
Insect predators:		-0.303	0.129	0.441		0.550*	47.25	37.50
Orius spp.	0.343				0.518*			
M.corollae	-0.255	-0.202	0.525*	0.492*	-0.335	0.766**	62.34	60.42
C.septempunctata	0.182	-0.667*	-0.045	-0.237	0.272	-0.21	47.81	12.78
C.undecimpunctata	-0.222	-0.384	0.222	0.367	0.089	0.496*	44.02	27.49
Chrysoperla carnea	0.166	-0.567*	0.010	0.248	-0.066	0.408	33.91	25.27
Primary parasitoids:		-0.298	0.125	0.200		0.269	27.71	33.42
D.rapae	0.260	-0.278	0.222	0.511*	0.376	0.629*	28.77	46.07
A.colemani	-0.305	0.166	0.520*		0.586*	40.74	43.01	

Table 11 : Efficiency of *Verticillium lecanii* spores suspension under laboratory conditions of 25 ± 1°C, 65% ± 5 RH%.

Concentration (spore / ml)	Mortality percentages of *Aphis gossypii* per 75 individuals											
	After 1 day			After 3 days			After 5 days			After 7 days		
	Life	Dead	Mortality	Life	Dead	Mortality	Life	Dead	Mortality	Life	Dead	Mortality
1×10^5	75	0	0	62	13	17.33	25	50	66.66	12	63	84
1×10^6	75	0	0	63	12	16	28	47	62	8	67	89.33
1×10^7	75	0	0	38	37	49.33	15	60	80	1	74	98.66

Orius spp. and *M. corollae*

(0.722**, 0.713** and 0.804**) and significant positive effect on the population density of (*A. gossypii* and *M. persicae*), *T. tabaci*, *C. septempunctata*, *C. undecimpunctata* and *Ch. carnea* during autumn plantation in 2019(0.686*, 0.521*, 0.533*, 0.688* and 0.699*) respectively, also positive significant effect on the population density of *T. tabaci* (0.516*) in 2018. The obtained results indicated that the mean relative humidity parameters showed positive significant effect on the population density *T. tabaci*, *C. septumpunctata*, *D.rapae* and *A.colemani* during summer plantation in 2019(0.550*, 0.496*, 0.629 and 0.586*) respectively. Meanwhile, the mean relative humidity showed highly significant positive effect (0.766**) on the population density of *Orius* spp. in 2019 and positive significant effect in 2018 (0.525*) in the same plantation.

Combined effects

The combined effects (Estimated Variance, E.V.%) for three weather factors on aphids infested cucumber plants recorded 58 and 10.57%| during summer season while in autumn seasons recorded 21.96 and 51.86 % during 2018 and 2019, respectively. *B. tabaci* recorded 13.38 and 29.38% during summer seasons of 2018 and 2019, while in autumn were 28.7 and 58.27 % during both seasons . *T. tabaci* recorded 47.25 and 37.50 % during summer seasons and in autumn seasons recorded 44.5 and 36.78 % during 2018 and 2019, respectively. *Orius spp.* recorded 62.34 and 60.42 % during summer seasons while in autumn seasons recorded 57.82 and 63.41% during 2018 and 2019. *M.corollae* recorded 47.81 and 12.78% during summer seasons and in autumn seasons recorded 19.29 and 70.08 % during two seasons. *Coccinella septempunctata* recorded 44.02 and 27.49 % during summer seasons, while in autumn seasons 2018 and 2019 recorded 38.15 and 43.21 %, respectively. *Coccinella undecimpunctata* recorded 33.91 and 25.27% during summer, while in autumn recorded 25.35 and 51.73 % during 2018 and 2019, respectively. *Chrysoperla carnea* recorded 27.71 and 33.42% during summer season and in autumn season were 18.11 and 57.65 % during 2018 and 2019, respectively.

Diaeretiella rapa recorded 28.77 and 46.07% during summer seasons of 2018 and 2019, respectively. *Aphidius colemani* recorded 40.74 and 43.01% during summer seasons of 2018 and 2019, respectively.

3. Laboratory evaluation of *V.lecanii* spores suspension on *Aphis gossypii*

Data given in table 11 show the efficacy of *V. lecanii* spores suspension on *Aphis gossypii*, after application with different concentrations of *V. lecanni* spores under laboratory conditions of 25 ± 1°C, 65 ± 5 RH% and 12 hr photoperiod. The concentrations were adjusted to 10^5, 10^6 and 10^7 spores/mL. Mortality percentages after 1, 3,5, 7 days of application were obtained. the result at the seventh day for each concentration 84.00, 89.33 and 98.66%, respectively. The LC_{50} values of *V.lecani* spores/ml after 7 days of application on *Aphis gossypii* were obtained as following LC_{50} was 5.95×10^4 spores/mL.

Discussion

In the present study was carried out to survey the most sucking and piercing pests and their associated natural enemies. The seasonal abundance of the dominant insect pests infesting cucumber plants were two aphid species *A. gossypii* and *Myzus persicae*, whitefly *Bemisia Tabaci* and *Thrips tabaci*.. However, Hafez *et al.,* (1996) in Egypt, studied the seasonal fluctuation of *A. gossypii* and associated predators and parasitoids in Egypt. According to Attia and El-Hamaky *et al.,* (1985) Aphids were the most injurious insectpests to cucumber. These results were in agreement with Ali (1996), Adam *et al.,* (1997) and El-Lakwah *et al.,* (2011), they found that the population of *B.tabaci* which occurred in autumn on cucumber was higher than signed in spring season.

The obtained data revealed that predators recorded as following, *Orius leavigatus*, *O. albidipennis*, *Coccinella septumpunctata*, *C. undecimpunctata*, *Chrysoperla carnea*, *Metasyrphus corollae*, primary parasitoids *Diaeretiella rapae Aphidius colemani* and hyperparasitoids (*Aphidencertus* sp.).

The results agrees with that of Kamal and Hamouda (1993). They found *that D.rapae* parasitized on *A.gossypii* Glover. on cucumber in Tunisia. Also, Steenis and El-Khawas (1995), recorded the parasitoid, *Aphidius colemani* Viereck. emerged from mummified aphid *A.gossypii* Glover. on cucumber. Meanwhile, Albert (1995) was detected in Germany found that *Aphidius matricariae* (Haliday) parasitoid on *A. gossypii* Glover. on cucumber plants. Also, Ohta (2003) found that the host acceptance and host suitability of *A.gossypii* Glover. for *Aphis colemani.*

Thrips tabaci was the highest infestation, which represented 53.96 and 54.31 % of the total number of insect pests followed by aphids 38.69 and 35.44 % from the total number of insect pests followed by *B. tabaci* Genn. 7.35 and 10.25 % from the total number of insect pests infesting cucumber plants during summer plantation of 2018 and 2019 seasons, respectively. While in the autumn plantation *B. tabaci* was the highest infestation, represented by 66.94 and 75.22 % of the total number of insect pests followed by Aphids with 30.43 and 22.26 % then *T. tabaci* Lind. with 2.63 and 2.52 % from the total number of insect pests infesting cucumber plants during autumn plantation of 2017 and 2018 seasons, respectively.

These results are in agreement with the findings of El-Lakwah *et al.,* (2011), Mohamed (2016), Ibrahim *et al.,* (2017), Alasady (2018) and Eid *et al.,* (2018), who stated that Aphids were the most injurious insect pests to cucumber. The population of *B.tabaci*. which occurred in autumn on cucumber was higher than signed in the spring season, meanwhile, they mentioned that cucumber plants were infested by few numbers of thrips during summer and autumn plantation.

In the present study insect predators associated with insect pests recorded as following**:** *Orius* spp. was the highest and represented by 34.18 and 29.49 % followed by *C. undecimpunctata* L. represented by 21.66 and 28.90 % then *M. corollae* F. represented by 18.68 and 17.17 % and 14.01 and 14.95 % for *C. septempunctata* while *Ch. Carnea* represented by 11.47 and 9.49 % from the total number of insect predators during the summer plantations of 2018 and 2019, respectively. While, in the autumn plantation the number of *C. undecimpunctata* L. was the highest, represented by 29.47 and 28.99 % followed by *Ch. carnea* Steph. represented by 27.02 and 23.08 %, then *Orius* spp. represented by 23.51 and 18.94 % and 11.93 and 15.68 % for *C. septempunctata* while *M. corollae* which represented by 8.07 and 13.31% from the total number of insect predators during the autumn plantation of 2018 and 2019 seasons, respectively.

These results are in accordance with Nicoli *et al. (*1994) and Abdel-Salam (1995) results, who found that the most abundant coccinellid on watermelon, accounting for 61.2% of the total number of aphidophagous coccinellids in 1992 and 87.5% in 1993. However, El-Magraby *et al.,* (1989) and Ali (1996) reported that *A. gossypii* and *M. persicae* by *D. rapae* on cucumber plants. Moreover, Abd El-Qader (2017) the result is given in these study show clearly that the primary parasitoid *Diaeretiella rapae* was the most dominant species with mean relative densities (54.63 and 52.01%) during the two seasons, respectively, Meanwhile, the mean relative densities of *Aphidius colemani* were (32.41 and 32.17%) respectively, but the hyperparasitoids *Aphidencertus* sp. Recorded (12.96 and 15.82%) respectively. On the other hand, Steenis and El-Khawass (1995) recorded that *L. testaceipes* and *Ephedrus cerasicola* parasitized 26%

to 23 % of *A. gossypii, A. colemani* parasitized 72.80 %of aphid while *Aphidius matricariae* parasitized less than 6% of *A. gossypii*. Our results agreed with that obtained by El- Magraby *et al.,* (1989), Ali (1996), Burgio *et al*., (1997), Martin *et al., (*1998), Pierre *et al., (*2006). Statistical analysis showed that temperature and relative humidity were significant with some insects and insignificant with the others.

However, Abdel- Fattah *et al.,* (2000) showed that partial negative correlation between aphid population density and each of temperature; wind velocity, photo period and rainfall in summer and nail plantation in both years. In Egypt, the change in the environmental factors from year to year, such as the maximum and minimum daily temperature, relative humidity, direction and speed of wind, rain fall,…etc affects the population density and dynamics of insect pests and the occurrence of their natural enemies (Aldyhim and Khalil, 1993 and Saleh *et al.,* 2017).

Our results indicated the efficacy of different concentrations of The fungus *V. lecanii* spores suspension on *Aphis gossypii*. The maximum mortality percentage recorded after 7 days of application with spore concentration 1×10^7 with 98.66% percentage. These results are agreed with (Ashour *et al.,* 2003 and Akram *et al.,*2018) whose found that the fungus *V. lecanii* induces mortality of the green peach aphid *M. persicae*. and *A. gossypii* the mortality was closely related to fungal inoculum concentration and Inoculums concentration is an important factor in the pathogenicity of entomopathogenic fungi (Panyasiri *et al.,* 2007, Demirci *et al.,* 2011and Talha *et al.,*).

Conclusion

The obtained results revealed that the aphid parasitoids *Diaeretiella rapae* and *Aphidius coleman*, the predators as *Orius spp., C. undecimpunctata, M. corollae, C. septempunctata, Ch. Carnea* and the entomopathogenic fungus *V. lecanii* could be recommended as biocontrol agents against piercing sucking pests under Egyptian conditions.

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