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Population Fluctuation of Cotton Aphid (*Aphis gossypii* Glover) on Roselle Plants in Relation with Certain Biotic and Abiotic Factors

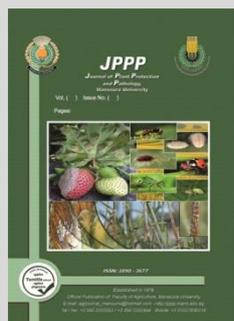
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ABSTRACT

This research work was conducted to describe the relationship between the population density of the cotton aphid on roselle plants and its accompanied predators, some quantities characters of roselle plants and the main weather factors at Awlad – Sakr district, Shakira Governorate, Egypt in 2018 and 2019 growing seasons. Aphids were collected by using plant sample technique. Results indicated that *A. gossypii* showed seven peaks of activity, the highest one (1453 individuals /sample) was on the 8th of August in the first season. In the second season *A. gossypii* recorded five distinct activity peaks the highest of them took place on the 23rd of July with 5068 individuals /sample. Simple correlation, partial regression and coefficient of determination between aphid population and the aforementioned factor were evaluated. Statistical analysis results showed that these factors played a conspicuous role in detecting the activity of cotton aphid during the two investigated seasons of the study.

Keywords: roselle, cotton aphid, biotic and abiotic factors.

INTRODUCTION

Roselle, *Hibiscus sabdariffa* L. (Fam. Malvaceae) is a medicinal plant which occupied an important position in Egypt as an exporting crop beside its local consumption. Its extracts are considered as a basic material in medicinal cure, nutritions and cosmetics due to the world's return to natural remedies (Shalan *et al.* 2001).

Roselle is a summer crop and lasts about six months in the field, that makes it susceptible to be afflicted by arthropod pests (Abdel-Moniem *et al.* 2005). Out of these species come the piercing sucking insects such as the cotton aphid (*Aphis gossypii* Glover) which is known as one of the most wide spread species of aphids and shows a large range of host plants, belonging to various families and that made it a main insect pest of numerous crops (Hooks and Ferrer 2006; Fuchsberg *et al.*, 2007). Aphids causing economic yield losses not only by sucking sap from the host plant and secreting honeydew which provides a medium for the growth of black sooty mold that covers the leaves and deprives the photosynthesis, but also by vectoring viral diseases. (Ahmad *et al.*, 2002; Asi *et al.*, 2008 and Amin *et al.*, 2017).

Thus, the objective of this research is to explain the changes in the population dynamics of cotton aphid insects infesting roselle plants and their relation with the mean numbers of its associated predators, some morphological characters of roselle plants and the prevailing weather factors.

MATERIALS AND METHODS

The investigation was executed at Awlad - Sakr district, Sharkia Governorate, Egypt during the two summer growing seasons 2018 and 2019. The experimental area for both seasons (about 1/12 feddan) was prepared and divided into three replicates each about (58 m²). This area was

designed according to the complete randomized blocks design and was sown by roselle seeds on the 1st of April in both growing seasons. All recommended agricultural practices were regularly done without any pesticidal treatments.

Weekly plant samples of 20 leaves were collected at random from each replicate when the plants were about one month old. After fruit formation, 20 fruits / plot were picked up randomly and continued till the end of the two seasons of the study. These samples were transferred to the laboratory in tightly closed paper bags for inspection and counting the number of cotton aphid and its accompanied predators using binocular microscope.

To study the relationship between aphid infestation and its associated predators, some morphological characters of roselle plant and the main climatic factors, the weekly numbers of aphid's predators were recorded as previously mentioned, and 20 plants were taken every week till the harvest time to estimate the plant height (cm), number of branches per plant, number of roselle fruits per plant and weight of roselle leaves or fruits (g). Also, the daily mean records temperature and relative humidity were obtained from the Meteorological Department of Agricultural Research center at Qassasin Ismailia Governorate during the two summer growing seasons 2018 and 2019.

Statistical analysis

Values of simple correlation (r), partial regression (b) and coefficient determination (CD %) were calculated and used for describing the relationship between the population fluctuation of the cotton aphid insects from one side and each of its accompanied predators ,the roselle's morphological characters and the main weather factors in natural conditions from the other side according to Costat Software Microcomputer Program Analysis (1990).

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RESULTS AND DISCUSSION

Population fluctuation of the cotton aphid *Aphis gossypii* (Glover) on roselle plants.

Data presented in Table (1) indicated that the first presence of *A. gossypii* was on the 25th of April with 13 individuals/ sample. Then the insect population fluctuated and showed seven peaks on the 2nd of May, 6th of June, 11th of July, 8th of August, 29th of August, 12th of September and 10th of October which recorded 59, 324, 136, 1453, 255, 56 and 51 individuals/ sample at means of 22.14, 25.00, 28.00, 32.00, 29.33, 30.57 and 27.00°C and 53.86, 48.71, 57.43, 46.57, 55.67, 62.29 and 59.43% RH in the first season, respectively.

As shown in Table (2), the cotton aphid started to attack roselle plants on the 7th of May with 8 individuals/ sample. Five peaks were occurred on the 21st of May, 23rd of July, 13th of August, 17th of September and 8th of October with total numbers of 228, 5068, 376, 651 and 87 individuals/ sample at means of 28.14, 30.00, 30.14, 27.71 and 26.24°C and 42.43, 56.71, 60.71, 72.57 and 75.00 % RH in the second season, consecutively.

Generally, it was observed that the cotton aphid individuals were more active on roselle plants during the second season (500.52 insects /sample) three times than the first season (147.67 insects/sample).

These results are supported by the findings of Hammad and Mohsen (2000) who stated that the maximum numbers of the cotton aphid on roselle plants were recorded in July and August during the two summer growing seasons of 1997 and 1998. The obtained data are also partially agree with those of Ismail (2018) who studied the incidence of the major sucking insect pests on okra plants during 2015 and 2016 seasons and reported that the main activity period of cotton aphid was in July and August in both seasons of the study, And Pathon *et al.* (2018) who found that *A. gossypii* showed a high level of infestation on okra plants in August during 2015 and 2016 growing seasons.

Effects of some biotic and abiotic factors the mean number of the cotton aphid, *A gossypii*

The results illustrated in Table (3) clear the relationship between the population of *A gossypis* on roselle plants and its accompanied predators, some morphological characters of roselle plants and the main ecological weather factors.

Insect predators

The cotton aphid had a positive and insignificant correlation with its associated predators (*Coccinella undecimpunctata* L. and *Metasyrphus corollae* (Fabr.) were recorded), where $r = 0.3089$ and 0.0772 in the two seasons of the study, respectively. The partial regression between *A. gossypii* population and its predators were 0.2444 and 0.7609 in both seasons, successively.

Table 1. Weekly records of *Aphis gossypii* and its associated predators, some quantities characters of roselle plants and the main weather factors in 2018 growing season.

Sampling date	Total numbers of		Morphological characters of plants				Corresponding means of		
	<i>A. gossypii</i>	*predator s	Plant height (cm)	No. of branches/ plant	No. of fruits/ plant	Weight of		Temp. °C	RH %
						Leaf (g)	Fruit (g)		
Apr., 25	13	0	-	-	-	-	-	25.00	44.00
May, 2	59	0	-	-	-	-	-	22.14	53.68
9	16	0	-	-	-	-	-	24.29	46.86
16	11	0	-	-	-	-	-	25.43	48.29
23	5	0	10.23	8.12	0.00	0.47	0.00	29.14	33.43
30	171	0	18.83	12.05	0.00	0.55	0.00	23.33	47.33
June, 6	324	0	20.89	14.6	0.00	1.22	0.00	25.00	48.71
13	126	1	28.41	21.8	0.00	2.20	0.00	26.43	54.00
20	56	2	35.78	22.72	0.00	2.38	0.00	28.29	47.57
27	29	1	44.77	25.45	0.00	2.88	0.00	27.29	48.29
July, 4	87	3	65.02	27.27	0.00	3.48	0.00	27.00	56.57
11	136	2	77.35	28.00	0.00	4.03	0.00	28.00	57.43
18	49	2	94.05	31.88	0.00	3.77	0.00	28.86	51.71
25	114	3	111.22	31.93	0.00	3.90	0.00	30.14	46.43
Aug., 1	181	3	128.38	31.98	0.00	4.05	0.00	32.29	50.71
8	1453	4	152.95	33.88	0.00	4.33	0.00	32.00	46.57
15	495	5	168.97	26.32	5.50	0.00	4.45	31.00	52.14
22	193	9	176.83	27.38	10.63	0.00	3.75	29.86	57.57
29	255	7	187.97	28.72	7.77	0.00	3.62	29.33	55.67
Sep., 5	1	3	199.60	29.55	34.61	0.00	3.83	29.26	54.00
12	56	2	219.32	31.07	58.63	0.00	4.22	30.57	62.29
19	26	1	235.00	34.08	67.92	0.00	4.02	29.86	31.02
26	18	1	248.48	32.22	88.58	0.00	6.22	30.29	41.00
Oct., 3	19	0	246.08	18.72	98.93	0.00	6.07	26.86	56.86
10	51	0	253.18	17.02	119.00	0.00	6.40	27.00	59.43
17	21	0	259.40	20.90	147.28	0.00	6.47	26.14	63.29
24	22	0	264.52	20.90	153.68	0.00	6.07	25.71	55.29
Total	3987								
Mean	147.67								

*Total number of both cotta aphid predators : *Coccinella undecimpunctata* L. and *Metasyrphus corollae* (Fabr.).

Table 2. Weekly records of *Aphis gossypii* and its associated predators, some quantities characters of roselle plants and the main weather factors in 2019 growing season.

Sampling date	Total numbers of		Morphological characters of plants				Corresponding means of		
	<i>A. gossypii</i>	*Predators	Plant height (cm)	No. of branches/plant	No. of fruits/plant	Weight of		Temp. °C	RH %
						Leaf (g)	Fruit (g)		
Apr., 23	0	0	-	-	-	-	-	27.29	37.86
30	0	0	-	-	-	-	-	25.50	40.00
May, 7	8	0	-	-	-	-	-	25.71	44.71
14	14	0	-	-	-	-	-	28.00	39.14
21	228	0	14.85	12.07	0.00	0.85	0.00	28.14	42.43
28	3	0	19.22	13.57	0.00	1.22	0.00	29.00	41.43
June, 4	1	1	25.00	16.77	0.00	1.55	0.00	32.71	27.14
11	7	2	30.73	18.83	0.00	1.83	0.00	29.00	44.43
18	37	4	35.23	23.20	0.00	1.97	0.00	30.00	46.29
25	50	4	41.90	24.10	0.00	2.07	0.00	30.71	57.00
July, 2	94	5	52.67	29.63	0.00	2.1	0.00	29.86	58.71
9	280	5	58.83	31.70	0.00	2.27	0.00	30.43	54.29
16	2673	5	71.10	31.53	0.00	2.85	0.00	30.00	50.71
23	5068	6	82.70	29.93	0.00	2.88	0.00	30.00	56.71
30	2094	10	96.30	28.40	0.00	3.02	0.00	29.67	59.67
Aug., 6	143	21	107.97	26.63	0.00	3.17	0.00	31.29	54.00
13	376	16	117.60	25.93	0.00	3.27	0.00	30.14	60.71
20	166	9	146.50	30.03	0.00	3.50	0.00	28.00	73.57
27	273	5	139.67	31.50	23.23	0.00	2.02	28.14	74.57
Sep., 3	409	3	159.03	27.40	57.40	0.00	3.23	28.00	70.57
10	537	3	197.77	24.33	92.17	0.00	4.08	27.86	75.71
17	651	1	180.77	20.27	93.20	0.00	4.53	27.71	72.57
24	175	1	183.23	28.57	83.70	0.00	5.58	26.43	63.14
Oct., 1	73	0	186.67	28.23	91.67	0.00	5.55	26.86	73.14
8	87	0	188.00	22.13	114.40	0.00	5.93	26.24	75.00
15	58	0	191.63	17.73	146.90	0.00	6.28	24.57	72.14
22	9	0	192.77	17.20	152.13	0.00	6.35	23.71	74.14
Total	13514								
Mean	500.52								

*Total number of both cotton aphid predators :*Coccinella undecimpunctata* L. and *Metasyrphus corollae* (Fabr.).

Table 3. Simple correlation, partial regression and coefficient of determination between certain biotic and abiotic factors and weekly numbers of *Aphis gossypii* on roselle plants at Awlad-sakr district, Sharkia Governorate during 2018 and 2019 growing seasons.

Factor	Simple correlation(r)		Partial regression (b)		Coefficient of determination (CD %)	
	2018	2019	2018	2019	2018	2019
Insect predators	0.3089	0.0772	0.2444	0.7609	9.54	5.75
Plant height(cm)	-0.0586	0.0885	0.7907	0.6879	3.43	7.84
No. of branches/plant	0.2366	0.3772	0.2772	0.0760	5.60	14.23
No. of fruits/plant	-0.6691	-0.4636	0.0244*	0.2088	44.77	21.49
Weight of leaf (g)	0.3157	0.3801	0.3175	0.1800	9.97	14.45
Weight of fruit (g)	-0.4224	-0.6025	0.1956	-0.0859	17.84	36.31
Main temperature	0.3798	0.2601	0.0507	0.1900	12.77	9.58
Relative humidity %	-0.0375	0.5150	0.8525	0.71870	12.77	9.58

*. Correlation is significant at the 0.05

Plant height

The correlation between the aphid mean number and the roselle plant height was insignificantly and negative (r= - 0.0586) in 2018 season, while in 2019 it was insignificantly and positive (r=0.0885) The partial regression values were 0.7907 and 0.6879 in the two growing seasons, alternatively.

Number of branches / plants

The correlation coefficient between *A. gossypii* population was positive and insignificant (r = 0.2366 and 0.3772) in the first and the second seasons, respectively. The partial regression between the mean aphid number and the number of branches per plant were 0.2772 and 0.0760 in the two seasons, alternatively.

Number of fruits /plants

The mean number of *A gossypii* had negative insignificant correlation with number of fruits per plant (r= -

0.6691 and - 0.4636) in both seasons, respectively. The values of partial regression were 0.0244 and 0.2088 during the two growing seasons, subsequently.

Weight of leaves (g)

The relationship between *A gossypii* population and the weight of roselle leaves was positive and insignificant (r= 0.3157 and 0.3801) during 2018 and 2019 growing seasons, respectively. The partial regression between weekly number of the cotton aphid and the weight of leaves were 0.3175 and 0.1800 during the two mentioned seasons, consecutively.

Weight of fruits (g)

There were negative and insignificant correlation relationships between the population density of the cotton aphid insects and the weight of reselle fruits in both seasons, whereas r valued (-0.4117 and - 0.2770), successively. The partial regression values were 0.1956 and -0.0859 in the first and the second seasons, respectively.

Mean temperature

A *gossypii* population had positive and insignificant correlation with the mean temperature, where (r) values were 0.3798 and 0.2601 during the two experimental seasons, consecutively. The partial regression values were 0.0507 and 0.1900 for the two growing seasons, respectively.

Relative humidity

Relative humidity showed a negative and insignificant effect with (r) value of - 0.0375 in the first season, while in the second one it was positive and insignificant with (r) value of 0.5150. The values of partial regression between the mean number of aphids and relative humidity were 0.8525 and on 0.7987 during 2018 and 2019 growing seasons, successively.

The percentages of coefficient of determination for the previously mentioned biotic and abiotic factors cleared that these factors had an important role in regulating the cotton aphid activity on roselle plants during the two investigated seasons.

The obtained results are relatively agree with these of Bale et al. (2002) who reported that the most effective abiotic factor in insect population variation is temperature. And Ottai et al. (2004) who studied the effect of infestation with spiny bollworm on the growth quantitative character of roselle plants and found a positive correlation between the insect population and the number of branches and dry sepal weight. Also Abdel Moniem and Abd El- Wahab (2006) who mentioned the importance of predators as a biological control agent in detecting the population of insect pests infesting some medicinal plants. And Ismail (2018) who stated that the meteorological parameters are the main variable factors that affect population fluctuation of sucking insect pests.

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تقلبات التعداد لمن القطن علي نباتات الكركديه وعلاقته ببعض العوامل الحيويه والغير حيويه

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تم اجراء هذا العمل البحثي لتوضيح العلاقة بين الكثافة العددية لمن القطن على الكركديه بالمقترسات المصاحبه لها وكذلك ببعض الصفات الكمييه لنبات الكركديه، وأيضاً بالعوامل الجويه السائده في منطقة أولاد صقر - محافظة الشرقية - مصر خلال موسمي ٢٠١٨ و ٢٠١٩ باستخدام طريقة العينات النباتيه. وقد أظهرت النتائج وجود سبع قمم نشاط لمن القطن ، كانت أعلاها (١٥٤٣ / فرد / عينه) قد سجلت في اليوم الثامن من أغسطس خلال الموسم الأول للدراسه .وفي الموسم الثاني تم تسجيل خمس قمم نشاط لمن القطن .و قد كانت القمه الأعلى في اليوم الثالث والعشرون لشهر يوليو باعداد ٥٠٦٨ فرد / عينه .تم تقدير معامل الارتباط البسيط ، و الانحدار الجزئي ، و معامل التحديد بين تعداد المن والعوامل السابق الاشاره اليها .و أظهرت نتائج التحليل الإحصائي أن هذه العوامل قد لعبت دورا في الحد من تعداد من القطن خلال موسمي الدراسه.