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GENERATIONS, PREFERABLE LEAF SURFACE AND HORIZONTAL DISTRIBUTION OF *AONIDIELLA AURANTII* (MASKELL) ON NAVEL ORANGE TREES AND ITS ASSOCIATED PARASITOID, *APHYTIS LINGNANENSIS* COMPERE IN ISMAILIA GOVERNORATE, EGYPT

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ABSTRACT: *Field experiments along two successive years from June 2011 to May 2013 were conducted on California red scale insect, Aonidiella aurantii (Maskell) (Hemiptera: Diaspididae) and its associated parasitoid, Aphytis lingnanensis Compere (Hymenoptera: Aphelinidae) on navel orange trees at El-Qasaseen Research Station farm, El-Qasaseen district, Ismailia Governorate, Egypt. The annual number of generations, their durations, preferable leaf surface and horizontal distribution of the insect and its associated parasitoid were considered. The obtained results revealed that A. aurantii had two to three annual generations on navel orange trees, the generation period were varied from three to five months. California red scale insect, A. aurantii and the parasitoid, A. lingnanensis preferred the upper leaf surface than the lower one. Mathematical calculation showed that A. aurantii and its associated parasitoid were concentrated on the northern east and southern directions of the examined trees.*

Key words: *Aonidiella aurantii, annual generations, preferable leaf surface, horizontal distribution*

INTRODUCTION

Navel orange, *Citrus sinensis* (L.) is represented as one of the most economically crops in Egypt. A great attention has been done to increase the production and improve the quality and quantity of this crop. Now, the policy strategy in Egypt is to increase the quality level of exported crops to certain European countries.

Scale insects, especially armored scale insects (Hemiptera: Diaspididae) are usually considered as the most important pests infesting horticultural trees and ornamental plants all over the world causing serious damages to the infested trees. The greatest damage can be done by the scale insects by sucking the plant sap that give low photosynthesis and respiration which leads to distortion of foliage, discoloration of flowers, galls and tumors formation, distorted blossoms, reduction in the general vigor of the trees and decreasing fruit production (quality and quantity) (Moffit, 1999). California red scale insect, *Aonidiella aurantii* (Maskell) is considered one of the serious pests of citrus. Many researches have recorded *A. aurantii* attacking citrus trees in Egypt (Habib *et al.,* 1971; El-Rahman *et al.,* 1979; El-Nabawi and Ammar, 1987 and Tawfeek, 2012). Abul-Nasr *et al.* (1975), Rizk, *et al.* (1978), Abou-Setta (1981), Mahmoud (1981), Garcia (1992), Hassan (1992) and Selim (2014) reported that *A. aurantii* had 3-5 annual generations. Therefore, the present investigation was planned with the aim of studying the number of the insect generations and their durations on navel orange trees under field conditions, the preferable leaf surface of navel orange leaves for the pest and its associated parasitoids. In addition to the distribution of the pest and its parasitoids in different directions (east, west, north and south) of navel orange trees.

Such study may help in determination of the proper time and direction of chemical control against *A. aurantii* without any objections with natural biological control activity.

MATERIALS AND METHODS

The field experiments were carried out at El-Qasaseen Research Station farm, Agricultural Research Center in El-Qasaseen district, Ismailia Governorate. The farm received normal agricultural practices and no chemical control was applied. The study was continued for two successive years, starting from June 2011 until May 2013. An area of about one feddan cultivated with navel orange trees, *Citrus sinensis* (L.) was chosen to conduct the experiment. Ten navel orange trees were nearly similar in size, age and vegetation were selected. Each one was divided into main directions (east, west, north and south).

Sampling technique:

For sampling, ten leaves were picked up at random once a month from each direction, *i.e.* 400 leaves per sample (10 trees × 4 directions × 10 leaves). The samples were put in polyethylene bags and transferred to the laboratory for carefully inspection. These samples were examined in the same day using a stereomicroscope, where the different stages of *A. aurantii* and the parasitized ones on the upper and lower surface of the leaves in each direction were counted and recorded.

To study the parasitism ratios of California red scale insect, *A. aurantii*, the insects on each sample were separated into healthy alive insects and parasitized ones which bearing emerging holes of parasitoid adults or including parasitoid larvae or pupae. Each healthy alive insect or parasitized ones were counted and recorded. Parasitized insects were preserved in glass jars, covered with muslin cloth by the aid of rubber bands and kept under laboratory conditions until parasitoids emergence. The total parasitism percentage for each sample was estimated. Emerging parasitoid was mounted in canda balsam and identified with helping of Prof. Dr. S. Abd-Rabou, Chief Researcher, Scale Insects and Mealy bugs Department, Plant Protection Research Institute, Agricultural Research Center, Giza, Egypt.

Generations estimate:

For estimating the number of *A. aurantii* generations and their durations, the method proposed by Audemard and Milaire (1975) and Jacob (1977) was used. Results of monthly counts of nymphal stage were indicated on millimeter papers.

The preferable direction for insect and its parasitoid:

To detect the effect of the cardinal directions on the distribution of scale insects and its associated parasitoid mathematically, the following formula was used:

$$H = \sqrt{F_1^2 + F_2^2 + 2\,F_1\,F_2\,\mathrm{Cos}\ Q}$$

This angle was calculated by dividing F_2 / F_1, Mahmoud (1981), Hassan (1998) and Nabil (2003).

H = Powers summation

F_1 = The population on the east minus the population on the west if the first is higher and reversed it if the later is higher.

F_2 = The population on the north minus the population on the south if the first is higher and the reverse is applied if the population on the south is higher.

The obtained figure represents the tangent, the corresponding values of which was obtained form the mathematical.

$F_1 = E - W$ $F_2 = N - S$ $\mathrm{Tan}\ Q = F_2 / F_1$

RESULTS AND DISCUSSION

1-Number of generations:

As *A. aurantii* is known to have overlapping generations, it was necessary to utilize the formula proposed by Audemard and Milaire (1975) and emended by Jacob (1977) for estimating the number of generations and their annual durations. Data

of monthly counts of nymphal stage were indicated on millimeter paper.

Data given in Table (1) and Figs. (1 and 2) indicated that *A. aurantii* had two annual generations during the first year (2011-2012). The first generation was during the period extended from the beginning of June till the end of November. The second one occurred from the beginning of December till the end of May. While, during the second year (2012-2013) three annual generations were recorded. The first one was occupied the period extended from the beginning of June till the end of August, the second generation recorded from the period extended from the beginning of September till the end of December. While, the third one was appeared during the period extended from the beginning of January till the end of May.

These results were conformable with those of Garcia (1992), Hassan (1992) and Selim (2014) who reported that *A. aurantii* had 3-5 annual generations.

2-Preferable leaf surface:

Data presented in Table (2) indicated that in the first and second years, the total number of alive stages, total number of parasitoid, *Aphytis lingnanensis* Compere (Hymenoptera: Aphelinidae) and mean percentage of parasitism were higher on the upper leaf surface than the lower one with values of (1762, 305 individuals and 9.82%) in upper surface compared with (902, 109 individuals and 6.87%) in lower one during the first year, respectively. And (2945, 1338 individuals and 15.86%) in upper surface compared with (1284, 488 individuals and 15.53%) in lower one during the second one, consecutively.

3. Preferable direction for the insect and its associated parasitoid

Results illustrated in Tables (3 and 4) and Fig. (3) showed that during the first year (2011-2012) the insect occurred in north western direction of the trees making an angle 49° 21′ 25″, while during the second year (2012-2013) the insect preferred the north eastern side of the trees making an angle 74° 31′ 31″.

Data presented in Tables (3 and 4) and Fig. (3) showed that during the first and second years (2011-2012 and 2012-2013) the parasitoid *A. lingnanensis* occurred in south eastern and north eastern sides of the trees making angles 84° 5′ 38″ and 47° 46′ 27″, successively.

These results were agreement with those of Habib *et al.* (1971) who mentioned that the highest population of scale insects infesting citrus trees in Egypt occurred on eastern aspect of the trees. And Nabil (2010) who revealed that the armored scale insect, *Aulacaspis tubercularis* (Newstead) and its associated parasitoids concentrated in the quarter north eastern direction or south eastern direction of the trees.

Table 1

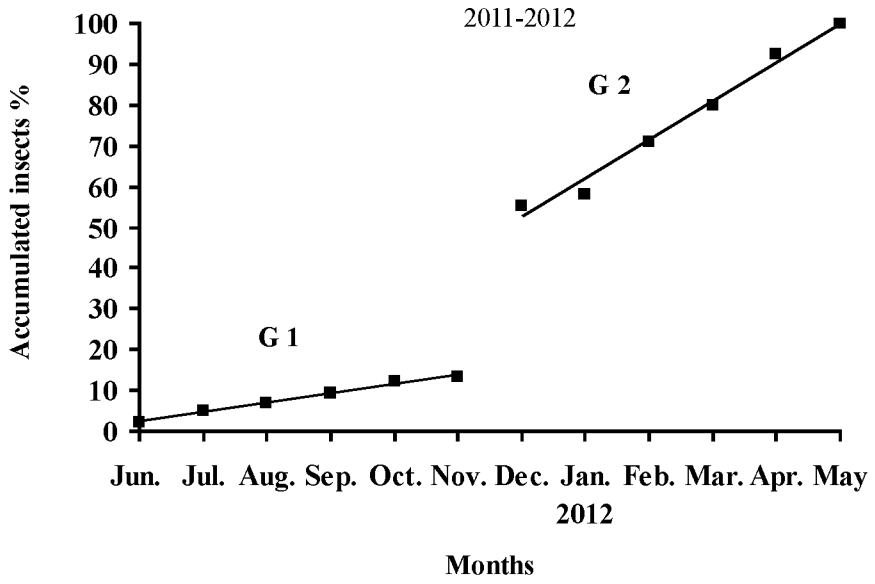

Fig.(1): Annual generations and durations of *Aonidiella aurantii* (Maskell) on navel orange trees, in El-Qasaseen district, Ismailia Governorate during the first year (2011-2012)

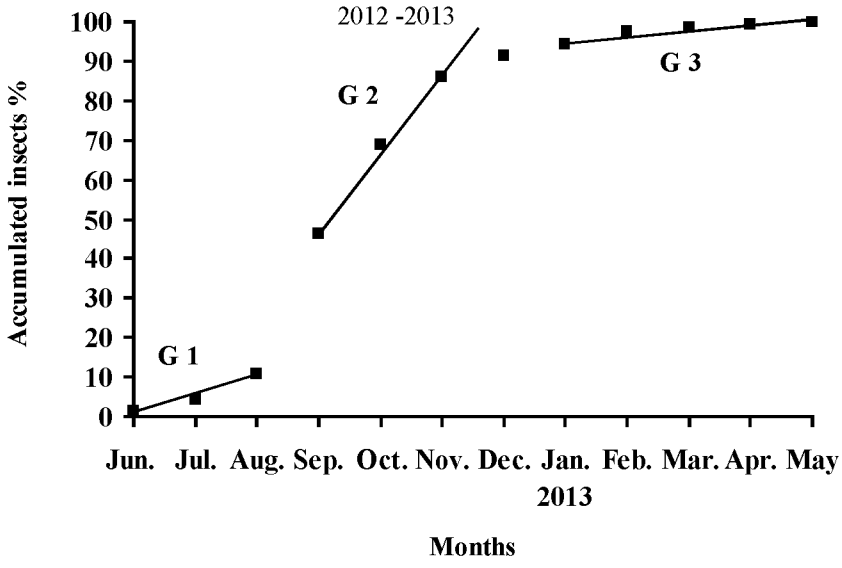

Fig.(2): Annual generations and durations of *Aonidiella aurantii* (Maskell) on navel orange trees, in El-Qasaseen district, Ismailia Governorate during the second year (2012-2013)

Table 2

Table 3

Table 4

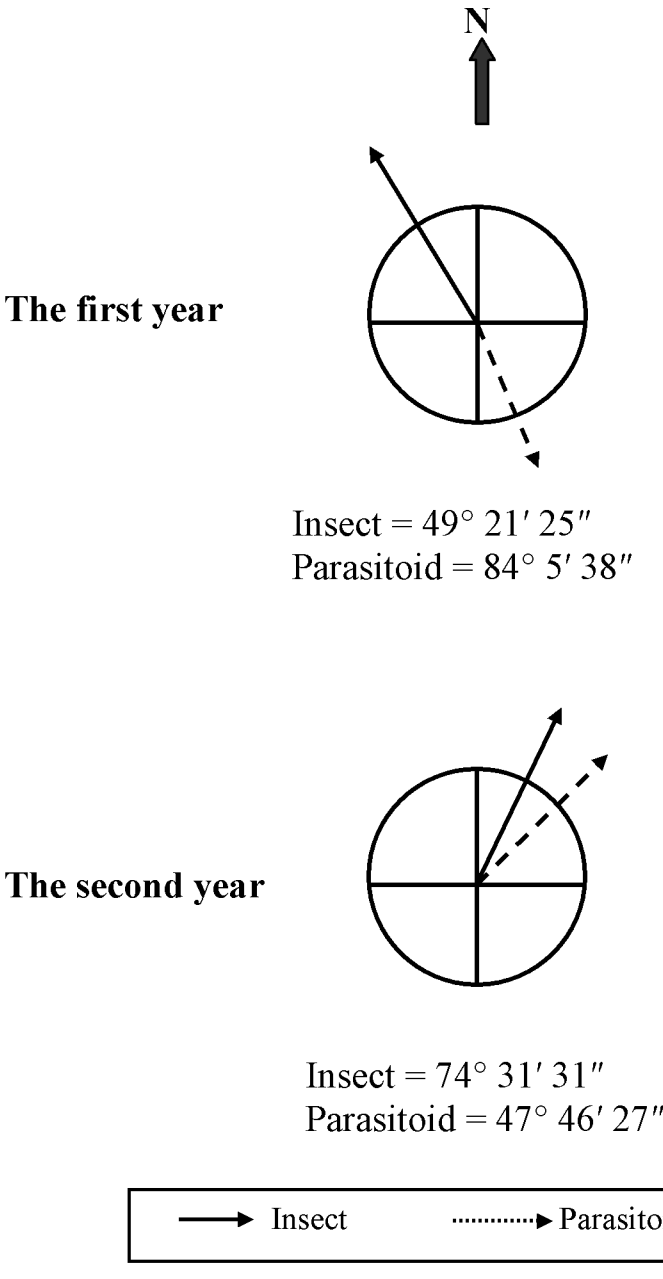

Fig.(3): The calculated directions of *Aonidiella aurantii* (Maskell) and its associated parasitoid on navel orange trees, in El-Qasaseen district, Ismailia Governorate during the two successive years (2011-2012 and 2012-2013)

REFERENCES

Abou-Setta, M.M. (1981). The influence of certain spray parameters on the efficiency of insecticides for controlling scale insects on citrus trees. M.Sc. Thesis, Fac. of Agric., Ain Shams Univ., Egypt.

Abul-Nasr, S., S. Swailem and N.M. Ahmed (1975). Seasonal fluctuations of the citrus red scale insect, *Aonidiella aurantii* (Maskell) in certain regions of lower Egypt (Hemiptera : Homop. : Diaspididae). Agric. Res. Rev., 33 (1): 149-159.

Audemard, H. and H.G. Milaire (1975). Le pieeage carpocapse (*Laspeyresia pomonella* L.) avec une phéromone sexuelle de synthese: premiers resultats utilisables pour 1 estimation des populations et laconduite de la lutte. Ann. Zoll. Ecol. Anim.,: 7 – 61.

El- Nabawi, A. and I.M. Ammar (1987). Population studies on the red scale, *Aonidiella aurantii* (Mask.) on different citrus hosts in Shebin El-Kom. Bull. Soc. Entomol. Egypt, 67:13-21.

El-Rahman, A.I., S.M. Metwally and F.M. El-Agamy (1979). Population density and sex ratio of certain scale insects on different citrus host at Kafr El-Sheikh region. J. Agric. Res., Tanta Unive., Egypt, 52: 101-110.

Garcia, M.F. (1992). Biología y control del "poll roig" de California en los cítricos valencianos. Phytoma España, 153: 120-123.

Habib, A., H.S. Salama and A.H. Amin (1971). Population studies on scale insects infesting citrus trees in Egypt. Zeitschrift für Angewandte Entomologie, 69 (3): 318-330.

Hassan, A.SH. (1992). Studies on certain species of scale insects infesting citrus and guava trees in Sharkia region. M.Sc. Thesis, Fac. of Agric., Zagazig Univ.

Hassan, A.SH. (1998). Studies on some scale insects and mealybugs infesting certain horticulture crops in newly reclaimed areas. Ph.D. Thesis, Fac. of Agric., Zagazig Univ., Egypt.

Jacob, N. (1977). Un model matematic pentru stabilirea. Limitelor economice de toloranta a atacului molilor. Fructelor in lupte integrate. Analele I. C. P. P., Romania, 15: 179.

Mahmoud, S.F. (1981). Ecological studies on the California red scale and the purple scale insects on citrus trees and the effect of some recent insecticides on them and their parasites. M.Sc. Thesis, Fac. of Agric., Cairo Univ., Egypt.

Moffit, L.J. (1999). Economic risk to United States agriculture of pink hibiscus, European and Mediterranean Plant Protection Organization, 2005. http.//www. eppo. org / Quarantine / insects/ Ds_Maconellicoccus_hirsutus.

Nabil, H.A. (2003). Studies on some species of mealybugs and scale insects infesting guava trees in Sharkia Governorate. M.Sc. Thesis, Fac. of Agric., Zagazig Univ.

Nabil, H.A. (2010). Ecological studies on some species of scale insects, mealybugs and their associated parasitoids infesting mango trees in Sharkia Governorate. Ph.D. Thesis, Fac. of Agric., Zagazig Univ.

Rizk, G.A., I.B. Sheta and S.M. Hussein (1978). Some aspects of the population activity of *Aonidiella aurantii* (Mask.) in relation to weather factors in Middle Egypt. 4th Conf. Pest Control. NRC. Cairo.

Selim, A.A. (2014). Ecological studies on California red scale insect, *Aonidiella aurantii* (Mask.) on some orange varieties in relation to biotic and abiotic factors. International Journal of Plant & Soil Science, 3 (6): 659-670.

Tawfeek, M.E. (2012). Distribution of armoured scale insects infesting citrus trees in different localities in Egypt. Journal of Entomology, 9(6): 429-434.

الأجيال وسطح الورقة المفضل والتوزيع الأفقى لحشرة *Aonidiella aurantii* (Maskell) التى تصيب أشجار البرتقال أبوسرة والطفيل *Aphytis lingnanensis* Compere المصاحب لها بمحافظة الإسماعيلية – مصر

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الملخص العربى

أُجريت هذة الدراسة بمزرعة محطة بحوث القصاصين – مركز البحوث الزراعية بالإسماعيلية على الحشرة القشرية الحمراء(Maskell) *Aonidiella aurantii* والطفيل *Aphytis lingnanensis* Compere المصاحب لها على أشجار البرتقال أبوسرة خلال الفترة من يونيو ٢٠١١ وحتى مايو ٢٠١٣ لدراسة عدد الأجيال وسطح الورقة المفضل وتأثير الإتجاهات المختلفة لأشجار البرتقال أبوسرة على إنتشار الحشرة والطفيل المصاحب لها وكانت النتائج المتحصل عليها كما يلى:

١- وجد أن للحشرة من جيلين إلى ثلاثة أجيال فى العام تراوحت مدة الجيل من ٣- ٥ شهور.

٢- وجد أن الحشرة والطفيل المرتبط بها خلال عامى الدراسة يفضلا السطح العلوى لأوراق البرتقال أبوسرة مقارنة بالسطح السفلى للأوراق.

٣- أوضح التقدير الرياضى أن الحشرة والطفيل المرتبط بها تواجدا بأعداد كبيرة فى النصف الشمالى الشرقى الجنوبى من الأشجار مقارنة بالنصف الآخر.

Table (1): Annual generations and durations of *Aonidiella aurantii* on navel orange trees, in El-Qasaseen district, Ismailia Governorate during the two successive years (2011-2012 and 2012-2013)

months	Number of insects / 400 leaves during the first year (2011-2012)				Number of insects / 400 leaves during the second year (2012-2013)				
	Accumulated days of investigation	Monthly counts of nymphs	Accumulated monthly counts	Accumulated insects %	Months	Accumulated days of investigation	Monthly counts of nymphs	Accumulated monthly counts	Accumulated insects %
Jun.	30	6	6	2.03	Jun.	30	14	14	1.38
Jul.	61	9	15	5.08	Jul.	61	30	44	4.33
Aug.	92	5	20	6.78	Aug.	92	66	110	10.84
Sep.	122	7	27	9.15	Sep.	122	361	471	46.40
Oct.	153	9	36	12.20	Oct.	153	226	697	68.67
Nov.	183	3	39	13.22	Nov.	183	176	873	86.01
Dec.	214	124	163	55.25	Dec.	214	55	928	91.43
Jan. 2012	245	8	171	57.97	Jan. 2013	245	27	955	94.09
Feb.	274	38	209	70.85	Feb.	273	33	988	97.34
Mar.	305	27	236	80.00	Mar.	304	14	1002	98.71
Apr.	335	37	273	92.54	Apr.	334	7	1009	99.41
May	366	22	295	100.00	May	365	6	1015	100.00

Table (2): Monthly numbers of *Aonidiella aurantii* and *Aphytis lingnanensis* on navel orange trees, in El-Qasaseen district, Ismailia Governorate during the two successive years (2011-2012 and 2012-2013)

Months	Number of insects / 400 leaves during the first year (2011-2012)								Number of insects / 400 leaves during the second year (2012-2013)							
	Upper leaf surface				Lower leaf surface				Upper leaf surface				Lower leaf surface			
	Alive stage no.	Dead stage no.	Para-sitoid no.	Parasi-tism %	Alive stage no.	Dead stage no.	Para-sitoid no.	Parasi-tism %	Alive stage no.	Dead stage no.	Para-sitoid no.	Parasi-tism %	Alive stage no.	Dead stage no.	Para-sitoid no.	Parasi-tism %
Jun.	9	0	1	11.11	8	7	1	6.67	20	8	1	3.57	7	6	0	0.00
Jul.	14	5	0	0.00	10	0	0	0.00	87	30	1	0.85	30	8	0	0.00
Aug.	15	14	0	0.00	18	17	0	0.00	229	111	21	6.18	43	25	1	1.47
Sept.	152	83	0	0.00	22	29	0	0.00	799	238	70	6.75	193	75	16	5.97
Oct.	91	68	5	3.14	33	28	5	8.20	556	469	145	14.15	187	143	44	13.33
Nov.	161	147	18	5.84	106	75	4	2.21	404	953	251	18.50	280	252	75	14.10
Dec.	267	120	15	3.88	192	46	6	2.52	300	863	253	21.75	134	234	59	16.03
Jan.	317	153	34	7.23	106	136	3	1.24	247	869	116	10.39	102	189	52	17.87
Feb.	294	366	74	11.21	138	148	20	6.99	152	1251	313	22.31	187	587	129	16.67
Mar.	223	195	66	15.79	141	112	34	13.44	97	498	128	21.51	84	193	72	25.99
Apr.	171	165	79	23.51	112	80	36	18.75	44	189	37	15.88	26	131	39	24.84
May	48	29	13	16.88	16	6	0	0.00	10	10	2	10.00	11	15	1	3.85
Total	1762	1345	305		902	684	109		2945	5489	1338		1284	1858	488	
mean				9.82				6.87				15.86				15.53

Table (3): Monthly numbers of *Aonidiella aurantii* and *Aphytis lingnanensis* on navel orange trees, in El-Qasaseen district, Ismailia Governorate during the first year (2011-2012)

Months	Number of insects / 100 leaves during the first year (2011-2012)							
	East		West		North		South	
	Alive stages	Parasitoid Number	Alive stages	Parasitoid Number	Alive stages	Parasitoid Number	Alive stages	Parasitoid Number
Jun. 2011	2	0	2	0	2	0	11	2
Jul.	3	0	3	0	11	0	7	0
Aug.	5	0	6	0	6	0	16	0
Sept.	46	0	36	0	46	0	46	0
Oct.	21	3	32	2	38	2	33	3
Nov.	40	5	94	5	68	5	65	7
Dec.	87	8	137	3	136	6	99	4
Jan. 2012	87	11	107	9	136	9	93	8
Feb.	78	15	112	32	139	18	103	29
Mar.	111	19	89	24	90	30	74	27
Apr.	93	38	59	24	60	18	71	35
May	24	5	17	2	11	2	12	4
Total	597	104	694	101	743	90	630	119

Table (4): Monthly numbers of *Aonidiella aurantii* and *Aphytis lingnanensis* on navel orange trees, in El-Qasaseen district, Ismailia Governorate during the second year (2012-2013)

Months	Number of insects / 100 leaves during the second year (2012-2013)							
	East		West		North		South	
	Alive stages	Parasitoid Number	Alive stages	Parasitoid Number	Alive stages	Parasitoid Number	Alive stages	Parasitoid Number
Jun. 2012	4	1	8	0	8	0	7	0
Jul.	8	0	14	0	80	1	15	0
Aug.	34	0	26	0	169	22	43	0
Sept.	190	20	222	16	370	35	210	15
Oct.	187	36	172	18	225	109	159	26
Nov.	194	97	150	58	154	74	186	97
Dec.	115	95	89	54	131	114	99	49
Jan. 2013	114	82	76	19	96	49	63	18
Feb.	103	133	77	103	85	115	74	91
Mar.	37	51	37	48	42	45	65	56
Apr.	16	36	13	18	12	9	29	13
May	2	0	4	1	6	1	9	1
Total	1004	551	888	335	1378	574	959	366