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POPULATION DYNAMIC OF THE BROWN SOFT SCALE, *Coccus hesperidum* L. (HEMIPTERA: COCCIDAE) INFESTING THE ORNAMENTAL PLANT, *Nerium oleander* UNDER ASSIUT GOVERNORATE CONDITIONS.

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ABSTRACT

The ornamental plant *Nerium oleander* L. was inspected as a host of the brown soft scale, *Coccus hesperidum* L. The present study was carried out in the Farm of Faculty of Agriculture, Assiut University, during two successive seasons of 2012/2013 and 2013/2014. Data from both seasons revealed that the highest numbers of nymphs and the total number of the pest were recorded during the 1st week of August. The highest percentages of the total monthly mean count (out of the total year count) were found to be 21.11 and 19.45 %, in July during the 1st and 2nd years. In addition, it has four generations per year under field conditions. *Metaphycus luteolus* Timberlake was the only wasp species found to parasitize on *C. hesperidum*. Parasitism rate reached 5.31% during the first year of the study. The brown soft scale was able to resist parasitization by encapsulating the parasitoid's eggs. Maximum encapsulation rate was estimated up to 2.19% of adult scales. Predation rate reached 3% and it was attributed to the coccinellid, *Chilocorus bipustulatu*s (L). The effects of weather elements on the pest population were also possible. This aforementioned information can be taken into consideration when developing a plan for sustainable control strategy for this pest in Egypt.

INTRODUCTION

Oleander plant, *Nerium oleander* L. is an ornamental plant belonging to the family Apocynoideae. The plant grows well in worm subtropical regions, where it is extensively used as ornamental plant in landscape, parks, and along roadsides.

Scale insects are notorious pests of ornamental plants, particularly perennials. They cause damage by feeding on plant sap, reducing vigour and producing chlorotic areas at feeding locations, premature leaf drop, and distorting stems and bark. Large population of scale insects can kill branches and heavily infestations may kill trees. The sugar-rich honeydew produced by the Coccoidea pests provides a medium for the growth of sooty mould. This mould covers the leaves with a black infected coating of mycelia, which interferes with photosynthesis, causing the plants to decline in vigour and to lose their aesthetic value (Selma and Hasan, 2004). Also, indirect damage represents in the injection of toxins into the host and some insects serve as viral vectors. As far as its biology is concerned, females are reproducing parthenogentically (Ben-Dov 1993). Males may occur in the population at a low proportion. Its entire life cycle is spent on the lower leaf surface (Gill 1988). The population fluctuation of the brown soft scale, *Coccus hesperidum* L was studied by many authors in different locations (e.g. Ben-Dov and Hodgoson, 1997 and Malais and Ravensberg, 2003) on fruit plants, however, such studies on ornamental plants are very limited especially in Egypt.

Many parasitoids mainly encyrtids, *Metaphycus* sp., (Blumberg and DeBach, 1981; Guerierri and Noyes, 2000 and Kapranas, 2002) and a few coccinellid predators (Elmer and Brawner, 1975 and Abd-Rabou and Badary, 2005) have been reported to act against *C. hesperidum*. Variable encapsulation rates of many parasitoid eggs by *C. hesperidum* have been demonstrated in other studies (Blumberg and DeBach, 1981 and Bernal et al., 1999). The encapsulation frequency depends on several factors, such as the host plant, the temperature, the age or the species of the scale insect pest and supperparasitism. The encapsulation rates of two parasitoids (*Metaphycus swirskii* and *Encyrtus lecanorium*) by *C. hesperidum* were lower in young female scales than in mature ones (Blumberg 1982, Blumberg and Goldenburg 1991). Superparasitism reduces the encapsulation frequency due to the weakness of the parasitized scale. The *C. hesperidum* which had been weakened by *Coccophagus* sp. parasitism was not able to encapsulate eggs of *M. swirskii* (Blumberg 1982). This resistance to parasitization which occurred by encapsulation has been regarded as the main cause of the inability of many parasitoids to prevent outbreaks of the pest (Blumberg 1991).

The present work aims to study some ecological aspects of *C. hesperidum* under Assiut governorate conditions concerning the predators and parasitoids of the scale insect pest as well as their activity, the possibility of the scale to control the development of parasitoids by encapsulation, the frequency and seasonal fluctuation of encapsulation and the age of the scale and the parasitoid in which encapsulation occurs.

MATERIALS AND METHODS

The present study was carried out in the Farm of the Faculty of Agriculture, Assiut University during two successive seasons of 2012/2013 and 2013/2014. The normal agricultural practices were performed and no insecticides were used during the period from July, 2012 to June, 2014. Five plants of *N. oleander* were randomly chosen on successive weeks. Five leaves of each tree were picked up randomly forming 25 leaves as a sample kept in a polyethylene bag, then transferred into the laboratory for examination. The lower surfaces of leaves were examined under a stereomicroscope of 10-60 magnification power. The numbers of all scales of each instar as well the numbers of predated and parasitized scales were recorded. As predated scales were recorded only the partially destroyed ones (the half-eaten scales) because the totally consumed individuals (such as crawlers) obviously could not be estimated. The meaning of "Percent

Parasitism" (% PA) in studies of insect parasitoids was described by **Van Driesche (1983)** and calculated as follows:

$$\% \, PA = \frac{EMP + L\,P}{EMP \; + \; LP \; + \; UMH}$$

Where EMP = emerged parasitoids, LP = all live parasitoids and UMH = unparasitized brown soft scale hosts. To simplify the formula EMP + LP= total parasitized hosts, EMP + LP + UMH= total brown soft scale hosts.

Females containing one or more encapsulated (melanized) parasitoid eggs were also noted. Dark encapsulated eggs were easily distinguished inside the transparent yellowish scale body. Encapsulation frequency was assessed as follow:

1. Scales containing encapsulated eggs as percentage (%) of live adult scales;

2. Percentage parasitized scales wherein encapsulation completely prevented parasitoid development, which reflects the rate of efficient encapsulation (Ee): (Blumberg 1991)

$$Ee = \frac{\text{Scales with encapsulated egg only}}{\text{Total number of parasitized scales}} \times 100$$

To identify the pest parasitoid, each plant sample (10 leaves from each plant (5 plants)), after the examination of plant leaves in the laboratory for counting the nymphs and adults of the pest, were stored in a one pound glass Jar (10 glass jars weekly). The jar was furnished with a suitable disc of filter paper on its bottom to absorb condensed humidity. Jars were covered with a piece of polyethylene with minute holes held by means of rubber band. A piece of cotton-wool soaked in 10% sucrose solution was placed in a small plastic container and placed inside the jar for feeding the emerged parasitoids. The emerged parasitoids were then collected and kept in a well-ventilated small tubes containing alcohol 70% and transferred into the Biological Control Research Department, Plant Protection Institute, Ministry of Agriculture, Egypt, for identification by Dr. A. Raouf.

Insect generation is defined, as the time needed to complete its life cycle. The number and duration of the annual generations of the pest, which were estimated depending on the adult numbers of the insect weekly count, were worked out according to Audemard and Milaire (1975) formula.

RESULTS AND DISCUSSION

Seasonal density monitoring. Data (Tables (1 and 4) show the weekly population counts and the monthly incidence of the brown soft scale (nymphs and adults) on *N. oleander* leaves during both seasons of 2012/2013 and 2013/2014.

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Season 2012/2013: Data presented in Table (1) indicated that the brown soft scale population started the season with a very high population and quickly reached its high population. The highest numbers of brown soft scale nymphs and the total population (nymphs and adults) were recorded during the first week of August (383 and 482 individuals/25 leaves) while the highest number of adults was recorded during the third week of November (127 individuals/25 leaves). The population decreased after December till May when no single nymph was recorded during the second week of February. However, both nymphs and adults were recorded again during the last week of March. Results in Table (2) showed that the highest percentage of brown soft scale (nymphs and adults) was recorded during July (21.11 % of the total count of the year), while the lowest one was reported during April (0.40%). It is clear that the brown soft scale populations were recorded at their high rates from July till December, then, decreased sharply to reach its low percentage during February (0.51% of the total year count). The population of *C. hesperidum* (nymphs and adult) started to increase on June (4.66% of the total year count).

Table (2): The monthly incidence of *C. hesperidum* stages and their percentages out of the year total during 2012/2013.

Month	Insect count/25 leaves			
	Nymphs	Adults	Total	% out of year total
July, 2012	1622	379	2001	21.11
August	1229	286	1515	15.98
September	981	251	1232	13.00
October	1005	263	1268	13.38
November	886	455	1341	14.15
December	707	300	1007	10.62
January, 2013	106	358	464	4.90
February	7	42	49	0.51
March	15	53	68	0.72
April	23	16	39	0.40
May	38	15	53	0.56
June	353	89	442	4.66
Total	6972	2507	9479	100

Season 2013/2014: Data in Table (3) indicated that the same trend of the insect seasonal population occurred during the first season was approximately repeated during the second one. The highest numbers of nymphs and the total ones (nymphs and adults) were occurred during the first week of August (386 and 499 individuals/25 leaves). The brown soft scale population decreased after December and did not record during the first week of March and the third week of April. A slight increase was occurred again during June.

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Results in Table (4) showed that the highest percentages of both nymphs and adults were occurred during July and August (19.45 and 18.42% of the total year count) and the lowest one was occurred during April (0.33). The population of the brown soft scale started the season on July with its high incidence percentage (19.45% of the total year count), then the population fluctuated around this percentage till December. After December, the population decreased to reach its low percentage during April (0.33% of the total year count), and then a very slight increase was occurred on June, to follow a sequence growth.

Results of both seasons clearly indicated that the population of brown soft scale was in its high population during July. Its population stayed in high level till December. The population decreased after December to reach its low level during April. The population achieved its increase during May and June. These results are in full agreement with those obtained by Annecke (1966) who reported that there is a peak of infestation with *C. hesperidum* from the beginning of July until autumn. Also, Hart and Ingle (1971) stated that *C. hesperidum* population was high during July-November and low from December-June

Table (4): The monthly incidence of *C. hesperidum* stages and their percentages out of the year total during 2013/2014.

Month	Insect count/25 leaves			
	Nymphs	Adults	Total	% out of year total
July, 2013	1301	326	1627	19.45
August	1228	312	1540	18.42
September	966	260	1226	14.66
October	782	226	1008	12.05
November	852	427	1279	15.29
December	645	302	947	11.32
January, 2014	107	347	454	5.44
February	11	52	63	0.75
March	15	49	64	0.77
April	17	11	28	0.33
May	33	21	54	0.65
June	58	15	73	0.87
Total	6015	2348	8363	100

The numbers of brown soft scale adults on *N. oleander* leaves during 2012/2013 and 2013/2014 seasons were used to determine the number of their generations according to Audemard and Milaire (1975) this method was used to determine the number of field generations either for coccoideae pests or others by many investigators. Abd-Rabou and Mostafa (2010) used this method to determine the number of field generations of the oyster shell olive scale, *Leucaspis riccae*. Hassanein and Salman (2009) determined the number of field generations of the pubescent rose chafer, *Tropinota squalida* (Scop.). The number of generations is shown in Figure (1). Illustration in Figure (1, A) revealed the occurrence of four generations. Adults of the 1st

generation were appeared in the field during the period from July, 2 to August, 27. This generation lasted 56 days. The 2nd generation started from September, 3 to November, 19 and lasted 77 days. The third generation was observed from November, 26 to February, 4 and lasted 70 days. The last generation lasted 139 days and appeared from February, 11 to June, 30; whereas illustration in Figure (1, B) showed also four generations for *C. hesperidum* during this season. The 1st generation was observed from July, 7 to August, 18 and lasted 42 days. The 2nd generation began from August, 25 to November, 10 and lasted 77 days. The 3rd generation was observed in the field from November, 17 to January, 26 and lasted 71 days. The last one occupied the period from February, 9 to June, 29 and lasted 140 days.

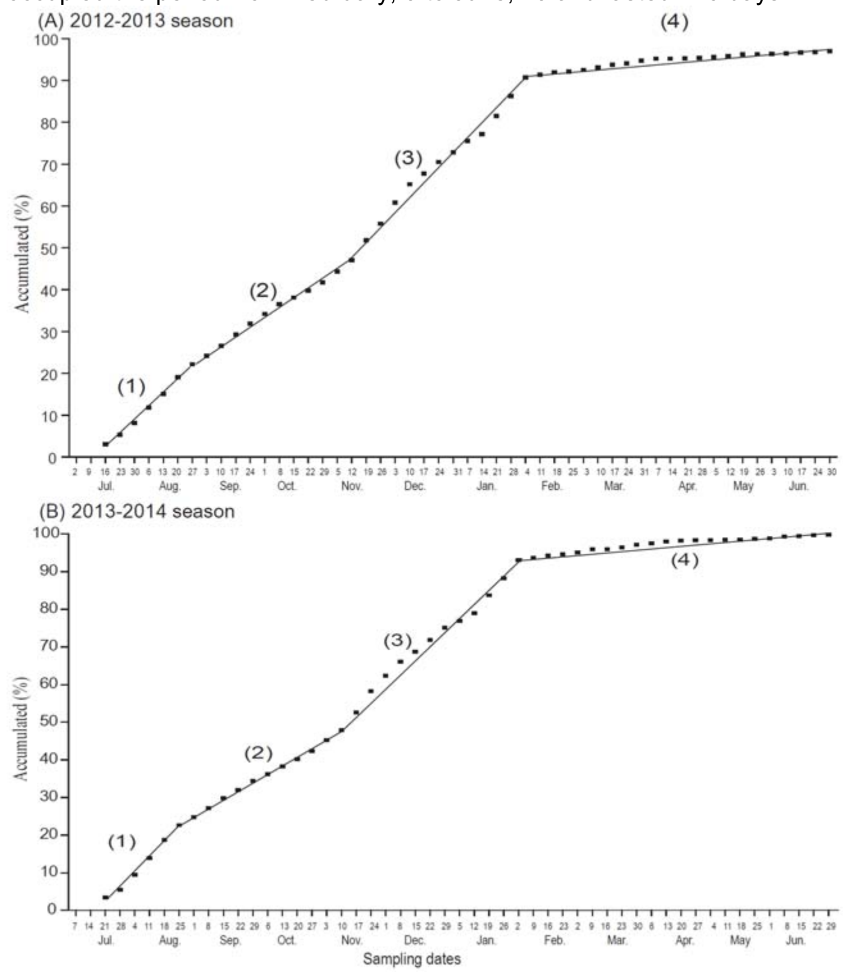

Fig. (1):Number of *Coccus hesperidum* adults field generations, arranged according to Audemard and Milaire (1975) method during 2012/2013 and 2013/2014 seasons, at Assiut governorate.

Results of both seasons revealed that there is four generations for *C. hesperidum* on *N. oleander* leaves at Assiut region. The shortest generation was the 1st one where the temperature was in its high levels during the period of this generation. Many authors (e.g. Nakahara, 1976 and Malais and Ravensberg, 2003) arrived to the same result in which the brown scale insect has four yearly generations. In additions, some other authors (e. g. Gill, 1988; Kosztarab, 1996 and Johnson, 2002) revealed that the pest has 3-5 generations a year. The conflict in the results may be due to the differences in the regions and consequently differences in climatic elements, the differences in host plants and cultural practices.

Data of the two seasons in Table (5) revealed that the most effective weather variables were minimum temperature and relative humidity during the first season, and the relative humidity and minimum temperature during the second one. Johnson (2002) found that the most important factor affecting the population numbers of *C. hesperidum* was temperature especially if combined with low humidity.

Table (5): Multiple regression analysis between the total number of the brown soft scale insect, *C. hesperidum* and some weather factors prevailing at Assiut region during 2012/2013 and 2013/2014 seasons.

Growing season	Weather factors	r	R	R^2x100	Decrease in R^2x100	Efficiency
2012/2013	Non	-	0.8023	64.38	-	-
	Max. temp. (X_1)	+0.2307	0.7878	62.07	2.31	2.7979
	Min. temp. (X_2)	+0.5601**	0.4555	20.74	43.64	52.8321
	Avg. R.H. % (X_3)	-0.0091	0.7560	57.15	7.23	8.7512
2013/2014	Non	-	0.6624	43.88	-	-
	Max. temp. (X_1)	+0.3780**	0.6296	39.64	4.24	4.9477
	Min. temp. (X_2)	+0.4320**	0.5941	35.30	8.58	10.0108
	Avg. R.H. % (X_3)	-0.1383	0.4368	19.08	24.80	23.926

r = Simple correlation.
R = Multiple regression.
R^2 = Coefficient of determination.
**** = Highly significant at 0.01 level of probability.**

Parasitized scales are presented in Tables (1 and 3). Parasitism was recorded only in adult scale and it was attributed to *Metaphycus luteolus* Timberlake (Hymenoptera: Encyrtidae), since this was the only parasitoid that emerged from parasitized scale. Parasitism rate was maximized during July 2012 (5.31%), and July 2013 (3.96%). Among the parasitoids which are referred as natural enemies of the brown soft scale in bibliographies, three species only are reported in several areas in Egypt, and they are *Metaphycus luteolus*, *M .helvolus* and *M. flavus* (Abd-Rabou, 2006).*Metaphycus luteolus* have been collected from infested black scale *Saissetia oleae* (Oliver)

(Kennett, 1986). The former species was the sole wasp recorded during the present study causing notable parasitism to the coccid demonstrating two peaks in July 2012 (5.31%), and in July 2013 (3.96%). This regarded as quite an increased parasitism rate when compared with the respective rates by *M. stanleyi* (10 - 12%) (Blumberg and Blumberg, 1991) and the parasitoid complex of *Metaphycus* sp., *Coccophagus* sp. (Hymenoptera: Aphelinidae) and *Tetrastichus* sp. (Hymenoptera: Eulophidae) (25.2%) (Toit *et al.* 1991). Results showed that the numbers of this parasitoid was low and in the same line with Kapranas *et al*. (2007) and Mohamed *et al*. (2013) where they reported that although this parasitoid was common, its numbers peaked only sporadically, and never abundant in relation to *C. hesperidum* densities. Also, the percentages of parasitism were low which ranged from 7 to 11 % during both seasons. This means that this parasitoid species is not established yet at Assiut Governorate because it worked well in established regions, although it discovered latterly in some of these regions because of the suitability of temperature and relative humidity. Where the parasitoid is the predominant agent in biological control of *C. hesperidum*, the percentages of parasitism were high which ranged from 60 to 83.5% during both seasons in Israel (Blumberg and Goldenburg, 1991). Nectar from plants has often proved to be a good adult food source, as indicated by improved parasitoid lifespan and fecundity (Saakyan, 1964 and Davoodi, 2004).

The brown soft scale was able to resist parasitization by encapsulating the parasitoid's eggs. It reacted to *Metaphycus luteolus* parasitism by encapsulating the parasitoid egg. The highest levels of encapsulation were recorded during summer (July 2012 and August 2013) reaching 2.19% and 1.93% of adult scales (Table 1 and 3). Encapsulation was observed only at the egg of the parasitoid, which means that parasitoid development was entirely prevented. Encapsulation rate reached 2.19 –1.93 % of adult scales. It is evident that encapsulation by scales infesting *Nerium oleander* at Assiut region is significantly less intense compared to that by scales infesting other ornamental plants (28–65%) and avocado trees (49-62%) (kapranas and Luck, 2008 and kapranas *et al.,* 2009), in USA. Taking into consideration that encapsulation is significantly influenced not only by ambient temperature, but also by parasitoid species (Salt, 1963) the differences among those studies and the current one may be explained. The abovementioned studies were conducted in USA, an area with colder climate than Assiut, Egypt, and dealt with various parasitoids species other than *M. luteolus*, such as its conspecifics *M. helvolus, M. swirskii* and *M. galbus*. Although, it is very probable that most encapsulated eggs observed during the present study belong to *M. luteolus*, the author cannot exclude the possibility that other parasitoids failed to complete development inside *C. hesperidum* due to the encapsulation of their eggs. This difference in the numbers of encapsulated eggs could be attributed to differences in host scale insects, parasitoid species and host plants. The fact that encapsulation rate was high during summer is in agreement with the results of other studies in which encapsulation was more frequent in summer than in other seasons (Blumberg, 1997).

The presence of predated individuals of *C. hesperidum* is attributed to the action of *Chilocorus bipustulatu*s which proved to be the sole predatory insect observed during the present study. However, these data refer only to partially destroyed scales and do not include totally consumed individuals such as crawlers that obviously cannot be estimated. Predated scales are reached to the highest during July 2012 and July 2013 and reached to 3% and 2.61% of total scales (Tables 1 and 2). The presence of *C. bipustulatu*s has also been noted on infested by *C. hesperidum* citrus trees in Turkey (Elecioglu and Derya, 2007). Other coccinellids such as *Hyperaspis* sp. and *C. angolensis* (Robertson *et al*. 1986), *C. nigrita* (Fabricius) and *Exochomus quadripustulatus* (L.)(Dixon, 2000) and Chrysoperla *carnea* (Stephens) (Swirski *et al*. 1997) have also been reported to feed upon *C. hesperidum.*

The data of the present study give some information concerning the phenology and ecology of *C. hesperidum* which is considered a new pest in Assiut area. Although the scale is found at present only on oleander shrubs, it could be considered as a potential serious pest, as it referred as important pest of fruit tree and ornamental plants in many parts of the world (Ben-Dov, 1993). The data of phenology show that the scale insect is active throughout the year completing several overlapping generations. The predator C*. bipustulatu*s could not result in any significant reduction of the pest. In addition, the action of the parasitoid *M. luteolus* was higher than that of the predator even thought it could not be able to control the pest where the infestation levels were found similar in both years. The study on encapsulation is giving important information on the ecology of this pest, as it is known that a high rate of encapsulation of *Metaphycus* spp. eggs by *C. hesperidum* during the summer that may interfere with the efficient biological control of the pest (Blumberg, 1997).

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دراسة ديناميكية مجموع الحشرة القشرية البنية الرخوة التى تصيب نبات التفلة تحت ظروف محافظة أسيوط

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تم إجراء هذه الدراسة فى المزرعة البحثية التابعة لكلية الزراعة بجامعة اسيوط خلال موسمى ٢٠١٣/٢٠١٢ و٢٠١٤/٢٠١٣ .

أوضحت النتائج خلال موسمى الدراسة أن أكبر عدد من الحوريات ومجموع الآفة يظهر خلال الأسبوع الأول من شهر أغسطس . كما تظهر أعلى نسبة مئوية من التعداد الكلى السنوى في شهر يوليو (٢١,١١ ، ١٩,٤٥٪) خلال سنتى الدراسة . وجد ان لهذه الحشرة ٤ أجيال فى السنة وقد تم تحديد ميعاد بداية ونهاية كل جيل وبالتالى فترة بقاء الحشرة .

وقد تم دراسة تأثير العوامل الحيوية وغير الحيوية على تعداد هذه الآفة. كما تم تصنيف نوع واحد من الطفيليات وهو *Metaphycus luteolus*. وقد بلغت أعلى نسبة للتطفل ٥,٣١٪ خلال العام الأول من الدراسة. كما أظهرت الدراسة أيضا أن الحشرة القشرية البنية الرخوة لها القدرة على مقاومة هذا الطفيل عن طريق ظاهرة التحوصل لبيض هذا الطفيل وكانت أعلى نسبة للتحوصل هى ٢,١٩٪ خلال العام الأول من الدراسة.كما سجل للحشرة القشرية البنية الرخوة خلال موسمى الدراسة مفترس واحد هو *Chilocorus bipustulatus* وكانت أعلى نسبة للإفتراس ٣٪ . كما أمكن ايضا دراسة تأثير العوامل الجوية على تعداد هذه الحشرة.

Table (1): Population fluctuations of the brown soft scale, *Coccus hesperidum* its parasitoid, *M. luteolus*, encapsulated eggs, and its predator, *Chilocorus bipustulatus* on ornamental plant during 2012/2013 seasons, at Assiut governorate.

Month and year	Date	Weakly insect count/ 25 leaves						% parasitism	% Efficient encapsulation	% predates	Meteorological records		
		Nymphs	Adults	Total	parasitized (No. of adults)	Efficient encapsulation	predated (No. of adults)				Temperature (°C)		R.H
											Max.	Min.	%
July, 2012	2	312	76	388	25	2	62				40.4	22.4	40.5
	9	275	57	332	13	3	54				42.4	22.8	40.5
	16	329	72	401	33	3	51	5.31	2.19	3.00	37.4	21.6	42.79
	23	330	91	421	35	2	51				41	20.2	43.43
	30	376	83	459	27	1	66				38.8	22	45.64
Total		1622	379	2001	133	11	284						
August	6	383	99	482	33	2	15				41.2	21.8	46.29
	13	331	78	409	25	1	11	3.35	1.20	0.55	39	23	51.5
	20	254	50	304	13	2	12				38.4	21.4	52
	27	261	59	320	13	1	14				40	21.2	46.57
Total		1229	286	1515	84	6	52						
September	3	265	68	333	12	2	15				40.2	21.2	47.57
	10	247	67	314	14	1	10	1.83	1.00	0.47	40.6	20.2	51.07
	17	238	58	296	9	0	9				41.4	20.6	46.07
	24	231	58	289	11	2	11				43.2	18.8	46.43
Total		981	251	1232	46	5	45						
October	1	172	39	211	8	1	17				35.8	17.8	51.64
	8	191	42	233	6	0	22				36	18	51.86
	15	186	49	235	9	2	27	1.68	0.80	1.11	37.4	15	52.07
	22	225	67	292	9	0	22				39.6	16	47.43
	29	231	66	297	10	1	17				42.2	17.8	39.43
Total		1005	263	1268	42	4	105						
November	5	204	121	325	16	2	18				38.6	14.2	50.43
	12	225	98	323	14	1	20	2.39	1.00	1.00	33.8	11.2	53
	19	239	127	366	17	1	33				29.8	11.2	53.43
	26	218	109	327	13	1	24				29.4	10.2	59.71
Total		886	455	1341	60	5	95						
December	3	152	64	216	9	0	22				26.2	8.8	57.36
	10	165	70	235	10	1	26				26.4	5.4	62.14
	17	143	58	201	13	1	22	1.95	0.40	1.11	29	8	58.93
	24	151	68	219	9	0	19				25	2.6	61.29
	31	96	40	136	8	0	16				22	0.2	61.93
Total		707	300	1007	49	2	105						

Table (1):Cont.

January, 2013	7	21	109	130	18	1	13	2.03	0.40	0.49	24.4	3.4	57
	14	22	119	141	11	0	12				21.6	3.6	58.07
	21	62	112	174	18	1	18				24.6	5.4	61.14
	28	1	18	19	4	0	3				21.2	4.2	55.14
Total		106	358	464	51	2	46						
February	4	1	13	14	3	0	1	0.28	0.00	0.01	25.8	4.6	56.21
	11	0	5	5	0	0	0				27.8	5.2	63.93
	18	2	9	11	2	0	0				24.4	2.2	64.79
	25	4	15	19	2	0	0				29.4	4.4	57
Total		7	42	49	7	0	1						
March	3	3	16	19	3	1	2	0.28	0.20	0.06	36.4	10	49.86
	10	3	9	12	0	0	0				34.2	7.2	50.79
	17	5	15	20	2	0	3				28.6	7.6	50.79
	24	4	13	17	2	0	1				30.2	7	55.5
	31	0	0	0	0	0	0				34.4	11.2	54
Total		15	53	68	7	1	6						
April	7	6	2	8	0	0	0	0.08	0.00	0.01	35.4	10	49.71
	14	11	3	14	0	0	1				34.4	7	47.21
	21	5	4	9	1	0	0				38	12.6	41.93
	28	1	7	8	1	0	0				37.2	11.8	42.86
Total		23	16	39	2	0	1						
May	5	3	10	13	2	0	1	0.08	0.00	0.05	37.4	15.6	43.71
	12	6	1	7	0	0	0				46.6	15	31.64
	19	2	1	3	0	0	0				46	16.8	37.14
	26	27	3	30	0	0	4				40.4	12.4	37.64
Total		38	15	53	2	0	5						
June	3	34	6	40	1	0	6	0.76	0.60	0.36	43.6	18.6	35.71
	10	19	3	22	0	0	4				44.4	18.8	36.29
	17	29	5	34	1	0	5				40.4	19	38.36
	24	110	46	156	10	2	9				43.4	20	38.86
	30	161	29	190	7	1	10				38.4	20	40.42
Total		353	89	442	19	3	34						
Total		6972	2507	9479	502	39	779						

Table (3): Population fluctuations of the brown soft scale, *Coccus hesperidum* its parasitoid, *M. luteolus*, encapsulated eggs, and its predator *Chilocorus bipustulatus* on ornamental plant during 2013/2014 seasons, at Assiut governorate.

Month and year	Date	Weakly insect count/25 leaves						% parasitism	% Efficient encapsulation	% predates	Meteorological records		
		Nymphs	Adults	Total	parasitized (No. of adults)	Efficient encapsulation	Predated (No. of adults)				Temperature (°C)		R.H
											Max.	Min.	%
July, 2013	7	326	81	407	18	2	53	3.96	1.72	2.61	40.8	20	42.42
	14	255	48	303	10	0	48				42.8	21.6	37.43
	21	337	94	431	25	3	66				44.6	22.4	41.71
	28	383	103	486	40	3	51				42.2	20	43.21
Total		1301	326	1627	93	8	218						
August	4	386	113	499	27	3	38	2.94	1.93	1.39	45.4	23.2	45.21
	11	314	93	407	21	4	28				41.6	22.2	44.5
	18	255	50	305	11	2	22				40.2	21.8	45
	25	273	56	329	10	0	28				38.2	19.8	49.71
Total		1228	312	1540	69	9	116						
September	1	213	62	275	11	2	16	2.21	1.07	1.10	38.6	20.6	56.64
	8	206	51	257	9	0	23				37.4	20.6	55.21
	15	223	56	279	10	2	19				35.8	18.8	55.29
	22	143	43	186	11	0	14				37	16.4	54
	29	181	48	229	11	1	20				41.6	18	45.93
Total		966	260	1226	52	5	92						
October	6	168	44	212	9	0	18	1.87	0.86	0.91	44.2	18.6	45.21
	13	188	53	241	10	1	22				35.4	15.4	51.64
	20	204	67	271	13	2	17				40.6	15.4	52.57
	27	222	62	284	12	1	19				37.8	16	47.86
Total		782	226	1008	44	4	76						
November	3	203	112	315	22	2	23	3.71	1.72	0.91	35.4	15.8	52.93
	10	236	133	369	30	3	26				35.2	12.6	56.64
	17	226	96	322	21	2	18				36.4	13	51.79
	24	187	86	273	14	1	9				27.4	8.8	61
Total		852	427	1279	87	8	76						
December	1	148	62	210	11	0	14	2.77	1.07	0.84	23.8	5.6	62.57
	8	155	74	229	20	1	22				26.4	6.4	59.64
	15	160	78	238	18	2	13				25.8	6.6	61.93
	22	95	42	137	7	0	11				23.8	5.6	65.14
	29	87	46	133	9	2	10				23.8	4.6	66.5
Total		645	302	947	65	5	70						

Table (3):Cont.

January, 2014	5	54	113	167	9	1	13	1.41	0.86	0.45	29.2	5.2	63.71
	12	32	106	138	11	2	11				20.8	4.8	68.36
	19	18	112	130	13	1	12				22.8	4.2	67.5
	26	3	16	19	0	0	2				23.6	4	66.64
Total		107	347	454	33	4	38						
February	2	3	14	17	2	0	2	0.30	0.21	0.06	27.4	5.4	59.93
	9	4	8	12	0	0	0				23.8	4.2	59.57
	16	1	13	14	2	0	1				22.2	3	63.64
	23	3	17	20	3	1	2				32.4	8.6	61.5
Total		11	52	63	7	1	5						
March	2	0	0	0	0	0	0	2.73	0.00	0.04	31	7.6	57.5
	9	3	13	16	2	0	1				33.8	8.4	52.93
	16	6	17	23	2	0	2				24.4	6	61.29
	23	4	9	13	0	0	0				28.6	7.8	57.57
	30	2	10	12	1	0	0				31.4	9	57.93
Total		15	49	64	5	0	3						
April	6	11	6	17	1	0	1	0.09	0.00	0.01	28.43	11.97	52.5
	13	4	2	6	0	0	0				31.8	13.74	53.57
	20	0	0	0	0	0	0				33.66	15	46.43
	27	2	3	5	1	0	0				35.71	19.26	45.14
Total		17	11	28	2	0	1						
May	4	8	2	10	0	0	0	0.26	0.00	0.02	36.6	14.8	42.64
	11	10	4	14	1	0	0				37.4	12.8	44.36
	18	7	4	11	0	0	0				38.4	15.4	42.29
	25	8	11	19	5	0	2				42.2	18.6	38.86
Total		33	21	54	6	0	2						
June	1	6	2	8	0	0	0	3.11	0.00	0.06	39.4	16.8	42.43
	8	13	5	18	1	0	1				40.6	20.4	42.93
	15	18	3	21	1	0	1				43.8	20.8	36.64
	22	8	1	9	0	0	0				43.8	19	41.14
	29	13	4	17	1	0	3				37.4	20.2	43.93
Total		58	15	73	3	0	5						
Total		6015	2348	8363	466	44	702						

1110 1111 1112 1113 1114 1115 1116 1117 1118 1119 1120 1121 1122 1123 1124 1125 1126 1127

1110 1111 1112 1113 1114 1115 1116 1117 1118 1119 1120 1121 1122 1123 1124 1125 1126 1127