SEASONAL ABUNDANCE AND GENERATION NUMBERS OF THE CALIFORNIA RED SCALE INSECT, *AONIDIELLA AURANTII* (MASK.) INFESTING MANGO TREES IN SOUTH EGYPT

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Abstract

The California red scale insect, *Aonidiella aurantii* (Mask.) is a serious pest of mango trees. As a basic study for developing future management of this scale species, seasonal abundance of different stages of this insect was investigated through two successive years (2005/2006 and 2006/2007) at Armant district, Qena governorate. The obtained results showed that, *A. aurantii* had four annual overlapping generations occurred in mid-April, mid -June, end-September and mid-December in first year. While, it was in mid-May, mid-July, mid-October and beginning-January for the second year. Moreover, the percentages of explained variance (E.V.) indicate that all tested variables (maximum temperature, minimum temperature and relative humidity) were together responsible for (22.2, 21.2, 38.8 and 4.7%) and (75.5, 54.3, 31.4 and 29.8%) 1st, 2nd, 3rd and 4th generations, during the two years of study, respectively.

INTRODUCTION

Mango, (*Mangifera indica* L.) is one of the most popular and economic fruit trees in Egypt. Mango trees are subjected to infestation by different pests. Among these pests, *Aonidiella aurantii* (Mask.) which is responsible for production descending of the crop (El-Deeb *et al.* (1992)) and Rodrigo *et al.* (2004). Also, Salah (2005), stated that insect attacks all the aerial parts. The presence of this insect weakens the infested plant itself by sucking the sap with the piercing sucking mouth parts causing thereafter deformations by the action of the toxic saliva. Severe infestations caused the drying out of the branches and cortical lesions form, yellow and dropping of the foliage.

Therefore, this work was carried out for two successive years (2005/2006 & 2006/2007) in mango orchard at Armant district, Qena Governorate, south Egypt. However, the following points were studied, the seasonal abundance, rate of monthly variation, number and duration of generations under field conditions. Also, the effect of temperature and relative humidity on the population density of this insect was determined.

MATERIALS AND METHODS

Four mango trees (*M. indica*) similar in size, age, shape, height (6-7m) vegetative growth and receive the same horticultural practices were selected for carrying out the study. Samples were taken at 14-days intervals. The sample size (40 leaves) was selected randomly from orchard mango at Armant district, Qena governorate. Samples were immediately collected and transferred to the laboratory in polyethylene bags for inspection by the aid of stereomicroscope binocular. The insect red scale stages on upper and lower surfaces of leaves individually sorted into alive preadults, adult females and (adult + crawlers) were counted and recorded. The abundance degrees of total population were calculated according to (Ahmed, 2004). Also, the monthly variation rate (MVR) in population density was calculated according to (Serag-El-Din, 1998).

On other hand, the simultaneous effect of three main weather factors namely the maximum temperature, minimum temperature and mean % relative humidity (R.H.). on this insect activity was adopted by using the simple correlation, regression coefficient and the partial regression. (Fisher, 1950). All of these statistical analysis in this present work were carried out by computer (MSTATC Program).

RESULTS AND DISCUSSION

1- Seasonal abundance of the California red scale insect *A. aurantii*

The seasonal abundance of *A. aurantii* infesting mango trees at Armant district, Qena governorate was recorded through two successive years of 2005-2007 in (Figs. 1 & 2).

In the first year of study (2005/2006) it was observed that, the total number of this insect increased continuously until reached the first peak in the beginning of April, when 652 individuals/40 leaves were recorded at means of 21.8°C and 43.5% R.H. Thereafter, the insect population decreased gradually until end-May. Then, the population increased to reach the second peak in beginning-July when 3310 individuals/40 leaves were recorded at mean of 31°C and 20 % R.H. Moreover, the population decreased until mid-August. Afterthat, the insect population increased gradually and the environmental conditions were suitable for the insect activity and the newly hatched crawlers of this insect increased to reach the third peak in end-September, when 4240 individuals were recorded under the mean field conditions of 31.8°C and 36% R.H. Again, the population decreased in beginning-November when 1830 individuals/40 leaves. Subsequently, the population increased to reach the fourth peak in mid-December when 6812 individuals/40 leaves were recorded at mean of 16.2°C and 56% R.H., Fig. (1).

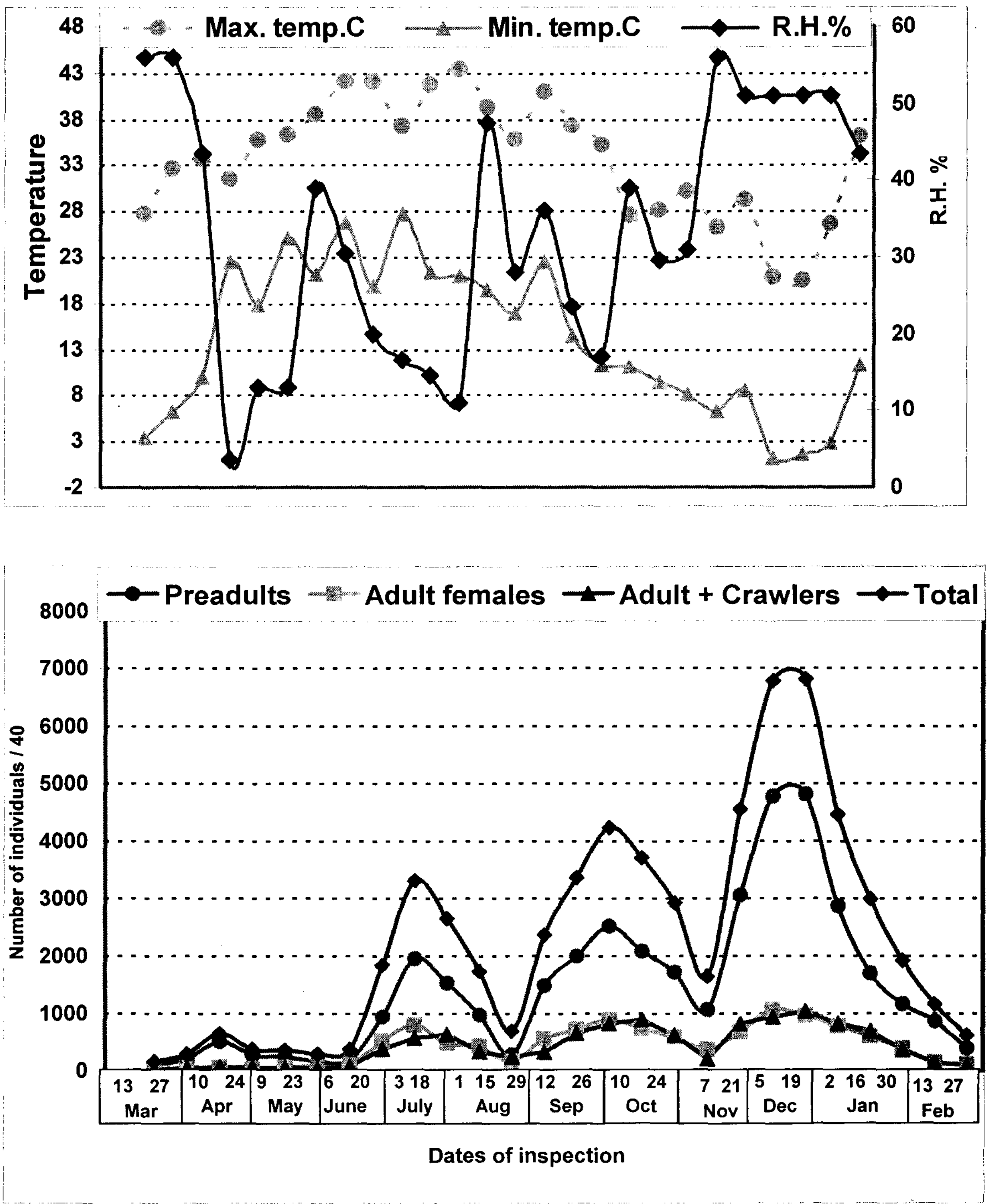

Fig. 1. Means of 14-days counts of different stages of *A. aurantii* (Mask.) during the first season (2005/2006), at Armant district, Qena governorate, with their corresponding records of climatic factors.

A similar trend in the seasonal abundance of preadults was observed. However, it had four peaks in the beginning of April, beginning-July, end-September and mid-December when the population density was 510, 1950, 2520 and 4812 individuals/40 leaves, respectively. Also, the adult females had four peaks, recorded in the beginning of April, beginning-July, end-September and beginning-December when the population density was 66, 792, 896 and 1066 individuals/40 leaves, respectively. In the same trend, the (adult + crawlers) had four peaks in the beginning of April, mid-July, beginning-October and mid-December, when the population density was 76, 634, 890 and 1038 individuals/40 leaves, respectively.

Results of the second year of study (2006/2007) Fig. (2) indicated that the total population of this insect was higher in comparison to the first year of investigation. Thus due to the influence of favourable factors (such as environmental conditions, ... etc.). Moreover, the obtained results showed that in the second year (2006/2007) the highest population density of *A. aurantii* preadults (2336.3 individuals), adult females (704 individuals), adult + crawlers (756.3 individuals) and total population (3796.3 individuals) /40 leaves in average were recorded in autumn. While, the least population density of *A. aurantii* preadults (845.7 individuals), adult females (236.7 individuals), (adult + crawlers 261.5 individuals) and total population 1343.8 individuals) /40 leaves in average were recorded in spring.

Careful view to the annual fluctuations of these physical factors, it appeared that the annual fluctuation in the population density for the insect activity during the two years was affected by the variability in these physical factors in the both years of investigation. Results agreed with Salah (2005) and Rodrigo *et al.* (2004) who mentioned that the population density of *A. aurantii* reached its peak in winter and decreased considerably during spring, but the population was lower in summer.

It could be concluded that the total population of this insect had four peaks which was recorded in mid-April, mid-June, end-September and mid-December in first year. While, it was in mid-May, mid-July, mid-October and beginning-January for the second year. These data were agreeable with Rodrigo *et al.*, (2004), Salah (2005) and Subhankar (2007).

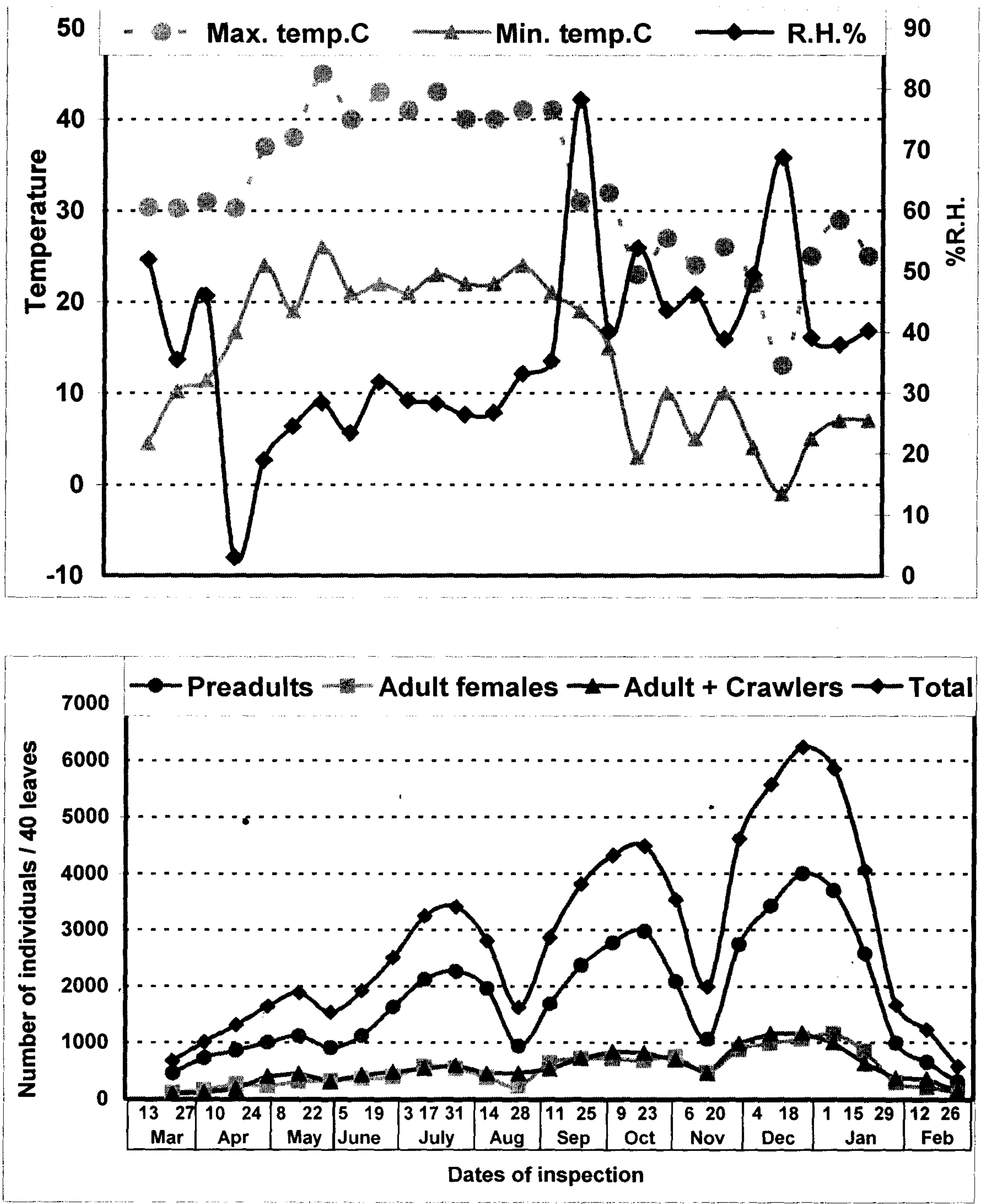

Fig. 2. Means of 14-days counts of different stages of *A. aurantii* (Mask.) during the second season (2006/2007), at Armant district, Qena governorate, with their corresponding records of climatic factors.

2- Rate of monthly variation of the California red scale insect, *A. aurantii* **population**:

Concerning the rates of monthly variation (M.V.R.) for the total population, it could be concluded that the favourable times for the annual increased appeared to be in April, June, September and December during the first season, (2005/2006), when the rates of monthly variation were 2.24, 3.33, 2.38 and 2.19, respectively. While, it took place in April, July, September and December during the second growing season (2006/2007), when the rates of monthly variation were 1.76, 1.42, 1.81 and 1.79, respectively.

These results were coincided with the finding of El-Deeb *et al.* (1992), and El-Agamy *et al.* (1994).

3- Number and duration of the annual generations:

The number of generations in the two seasons was four overlapping generations per year (Fig.3). The individuals of the first generation appeared during the first half of March and continued until the end-May (about 84 days) with average total population of (539 individuals/10 leaves) for the first year of investigation. While, in the second year, the first generation lasted about 112 days, extended from early March and continued until the mid-June with average total size of 3125 individuals/10 leaves. The second generation occurred during a period extended from the first half of May to end of August (126 days) with total size of 3410 individuals/10 leaves for the first year. But, in the second year, the second generation lasted about 140 days extended from early of May and continued until the first half of September with average total size of 6408 individuals/10 leaves. The third generation was occurred during from beginning-August to beginning-December with duration of 140 days with average total size of 8004 individuals/10 leaves in the fist year of study. While, this generation appeared at end-July to mid-December about (154 days) with average total size of 10472 individuals/10 leaves in the second year. In addition, the fourth generation occurred during October and continued until the end of February (154 days) with the generation size of 9394 and 9960 individuals per 10 leaves for first and second years, respectively. On the other hand, the population density in the first year was lower (in size) than in the second year. The above mentioned results are in agreement with results by Selim (2002) and Salah (2005) who stated that the California red scale, *A. aurantii* had four generations per year.

4- Effect of certain climatic factors on the total population density of *A. aurantii*:

A- Effect of maximum temperature:

In the first year of study, the correlation coefficient (r) between maximum temperature and total population through 1st, 2nd, 3rd and 4th generations, was positively insignificant relation (+0.41 and +0.37), for the

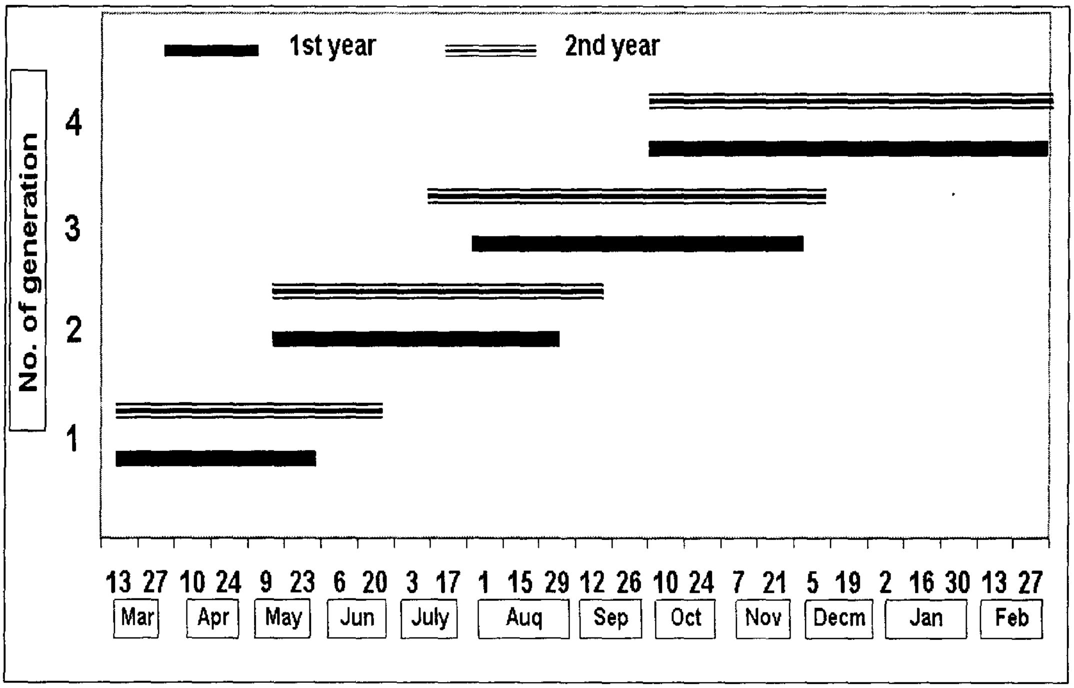

Fig. 3. Duration of the four successive annual generations of *A. aurantii* on mango trees at Armant, Qena governorate during (2005/2006 & 2006/2007).

first and second generations, while it was negatively insignificant (r value was -0.5 and -0.03) for the third and fourth generations. As well as, the unit effect (regression coefficient) indicates that an increased of 1°C in the maximum temperature increased the population by 5.24 and 37.15 individuals per 10 leaves for the 1st and 2nd generations and decreased by 35.9 and 2.6 per 10 leaves for the 3rd and 4th generations, respectively.

Also, the partial regression values emphasized a positive and insignificant relation (+8.1, +37.4 and +56.5) for the first, second and third generations, respectively. But, it was negatively insignificant (P.reg = -41.2) for the fourth generation. A similar trend in the second year was occurred (Table, 1).

B- Effect of minimum temperature:

Concerning the first year of study, the results of simple coefficient (r), showed a positive insignificant correlation between the minimum temperature and the insect population (r values were +0.13, +0.16 and +0.1) for 1^{st}, 2^{nd} and 4^{th} generations, respectively. While, it was negatively insignificant correlation (r value was -0.5) for 3^{rd} generation, (Table, 1). As well as, the unit effect (regression coefficient) indicates that an increased of 1°C in the minimum temperature increased the population by 0.6, 12.8 and 7.9 individuals per 10 leaves for the first, second and fourth generations, respectively. But, decreased by 43.25 individuals per 10 leaves, for the third generations. The precise effect of the minimum temperature on the insect population, showed that it was negatively insignificant (P.reg values were -3.7 and -93.5) for the first and third generations, while, it was positively insignificant (+16.1 and +44.4) for the second and fourth generations, respectively (Table, 1).

During the second year of study, the results showed that the correlation coefficient (r) between minimum temperature and the total population of this insect was highly positive significant (+0.86) and positively insignificant (+0.1 and +0.15) for 1^{st}, 2^{nd} and 4^{th} generations, respectively. While, it was negative insignificant (-0.33) for the third generation. As well as, the calculated regression coefficient (b) for the effect this factor indicated that for every 1°C increased in the minimum temperature, the population density increased by 16.7, 8.1 and 13.2 and decreased by 15.5 individuals per 10 leaves for 1^{st}, 2^{nd}, 3^{rd} and 4^{th} generations, respectively. The real effect of this factor appeared from the partial regression (P.reg) value that it had insignificant positive effect (P.reg values was 9.1, 10.7, 70.6 and 127.04) during 1^{st}, 2^{nd}, 3^{rd} and 4^{th} generations (Table, 1).

C- Effect of relative humidity:

The effect of relative humidity on the insect activity during the first year of investigation had insignificant negative effect (the correlation coefficient (r) was -0.13 and -0.1) for 1^{st} and 4^{th} generations, respectively. While, it was positively insignificant (+0.20 and +0.28) for the 2^{nd} and 3^{rd} generations, (Table, 1). Also, the calculated regression coefficient (b) for the effect this factor indicated that for every 1% R.H. increased in the relative humidity, the population density increased by 4.37 and 10.75 individuals per 10 leaves for 2^{nd} and 3^{rd} generations and decreased by 0.21 and 3.4 individuals per 10 leaves for 1^{st} and 4^{th} generations, respectively.

As regarding the second year of study, the correlation coefficient (r) was negatively insignificant (-0.63) for the 1^{st} generation and positive significant (+0.7) for the 2^{nd} generation. But, positively insignificant (+0.29 and +0.24) for the third and fourth generations, respectively. A similar trend the regression coefficient (b) was observed. The unit effect decreased by (5.79) the population in the first generation and increased the population by (33.9, 7 and 8.82 individuals per 10 leaves), for the second, third and fourth generations, respectively. To determine the real effect of the relative humidity, partial regression was carried out. The obtained results showed that this factor had insignificant negative effect (P.reg value was-2.36, -7.4 and -12.5) for the first, third and fourth generations, respectively. While, it was significantly positive (+45.9) for the second generation (Table, 1).

D- The combined effects of the three climatic factors (maximum temperature, minimum temperature and percentage of relative humidity) on the total population activity:

The calculated partial regression values indicated the presence of a simultaneous effect of these factors on the population of insect in both years. The obtained results revealed that the combined effect of these tested weather factors (Table, 1) was insignificant during 1st, 2nd, 3rd and 4th generations, where the calculated "F" values were (0.19, 0.45, 1.27 and 0.11) and (4.12, 2.38, 1.07 and 0.99) throughout the two successive years of study, respectively. The influence of these combined climatic factors was expressed in Table (1) as percentages of explained variance (E.V.) for 1st, 2nd, 3rd and 4th generations, it being (22.2, 21.2, 38.8 and 4.7%) and (75.5, 54.3, 31.4 and 29.8%) during the two years of study respectively. The remaining unexplained variances are assumed to be due to the influences of other unconsidered factors (Environmental, ... etc.) in addition, of course, to the experimental error. The previous results indicated that the activity of this insect was mostly related to the simultaneous effect of these selected weather factors rather than the single effect of each factor separately of *A. aurantii.* These results were agreed with that obtained by Selim (2002), Salah (2005) and Willard (2007).

Table 1. Effect of both temperature and relative humidity on the total population of *A. aurantii* on mango trees at Armant district, Qena governorate through the two successive years of investigation (2005-2007).

Year	Generation	Weather factors	Simple correlation and regression values		Partial regression values	Analysis variance			
			r	b	P.reg	F values	MR	R^2	E.V%
2005/2006	First	Max. temp	0.41	5.24	8.08	0.19	0.47	0.22	22.2
		Min. temp	0.13	0.60	-3.73				
		%R.H.	-0.13	-0.21	-0.97				
	Second	Max. temp	0.37	37.15	37.4	0.45	0.46	0.21	21.2
		Min. temp	0.16	12.77	16.1				
		%R.H.	0.20	4.37	4.60				
	Third	Max. temp	-0.5	-35.86	56.51	1.27	0.62	0.38	38.8
		Min. temp	-0.5	-43.25	-93.5				
		%R.H.	0.28	10.75	15.58				
	Fourth	Max. temp	-0.03	-2.55	-41.2	0.11	0.22	0.05	4.7
		Min. temp	0.1	7.88	44.4				
		%R.H.	-0.1	-3.41	-4.83				
2006/2007	First	Max. temp	0.72*	18.55*	6.84	4.12	0.87	0.76	75.5
		Min. temp	0.86**	16.66**	9.1				
		%R.H.	-0.63	-5.79	-2.36				
	Second	Max. temp	0.34	27.98	-31.4	2.38	0.74	0.54	54.3
		Min. temp	0.1	8.1	10.7				
		%R.H.	0.70*	33.94*	45.9*				
	Third	Max. temp	-0.44	-20.29	-95.5	1.07	0.56	0.31	31.4
		Min. temp	-0.33	-15.46	70.6				
		%R.H.	0.29	6.99	-7.4				
	Fourth	Max. temp	-0.1	-10.5	-141	0.99	0.55	0.29	29.8
		Min. temp	0.151	13.20	127				
		%R.H.	0.24	8.82	-12.5				

r = Simple correlation

b = Simple regression

P.reg = Partial regression

MR = Multiple correlation

R^2 = Coefficient of determination

E.V% = Explained variance

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الوفرة الموسمية وعدد الأجيال للحشرة القشرية الحمراء التى تصيب أشجار المانجو فى جنوب مصر

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تعتبر الحشرة القشرية الحمراء من الآفات الخطيرة التى تصيب أشجار المانجو فى جنوب مصر ولتصميم برنامج مكافحة متكامل لهذه الآفة فقد تم دراسة التغيرات الموسمية التى تطرأ على كثافة أفراد هذه الحشرة على أشجار المانجو فى مدينة أرمنت محافظة قنا خلال عامين متتابعين من مارس ٢٠٠٥ حتى فبراير ٢٠٠٧. وقد أظهرت النتائج أن هناك أربعة أجيال سنوية متداخلة ظهرت فى العام الأول من الدراسة فى النصف الأول من أبريل بينما كانت قمة الجيل الثانى فى النصف الأول من يونيه وكانت قمة الجيل الثالث فى نهاية سبتمبر وكانت قمة الجيل الرابع فى النصف الثانى من ديسمبر. بينما فى العام الثانى من الدراسة كانت قمم النشاط فى النصف الأول من مايو وفى النصف الثانى من يوليو وفى النصف الأول من أكتوبر وفى بداية يناير على الترتيب. حيث كانت الظروف البيئية فى الخريف والشتاء أكثر ملائمة لنشاط الحشرة. وكان تأثير العوامل الجوية على تعداد الحشرة واضحا. حيث أظهر التحليل الاحصائى باستخدام طريقة الانحدار المتعدد أن تأثير العوامل الثلاثة تحت الدراسة كانت مجتمعة وأن نسبة الاختلاف التى يمكن أعزاؤها إحصائياً إلى التغير فى عوامل الطقس (E.V%) كانت عالية فى الجيل الثالث (٣٨,٨%) وأقلها فى الجيل الرابع (٤,٧%) فى العام الأول. بينما كان معامل التباين عالياً فى الجيل الأول (٧٥,٥%) ومنخفضاً فى الجيل الرابع (٢٩,٨%) فى العام الثانى من الدراسة.