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Some ecological aspects of *Kilifia acuminata* (Hemiptera : Coccidae) and its parasitoids on mango trees at Sharkia Governorate, Egypt.

Hassan, A.S.[1]; Nabil, H. A.[1]; Shahein, A. A.[2] and Hammad, K.A.A.[2]
1- Plant Protection Research Institute , Agricultural Research Center,, Zagazig , Egypt.
2- Plant Protection Department, Faculty of Agriculture, Zagazig Univ., Egypt.

ABSTRACT

Studies on some ecological aspects of *Kilifia acuminata* (Signoret) (Hemiptera: Coccidae) and its parasitoids on mango trees were carried out in Inshas El- Raml district, Sharkia Governorate, Egypt during two successive years (2007-2008 and 2008-2009). The obtained results revealed that total alive stages had two to three peaks of activity yearly in both top and bottom levels of the trees. *Metaphycus* sp. and *Coccophagus* sp. were recorded as parasitoids of *K. acuminata*. The pest activity appeared three generations annually either in the top and bottom levels of mango trees. Each generation was lasted about 4 months. They periods were from March to June, July to October and November to February, respectively. The total effects of a biotic factors (Temp.ºC, RH% and Light intensity Lux) under this study on the total numbers of alive stages during the two years were 84.17 and 38.30 % in the top level and 85.87 and 43.76 % in the bottom one, successively. Preferable level and preferable leaf surface of *K. acuminata* and its associated parasitoids were studied.

Keywords: Ecological aspects, *Kilifia acuminata* ,parasitoids, mango trees , Egypt.

INTRODUCTION

Mango fruits, *Mangifera indica* Linnaeus (Anacardiaceae) are one of the most popular fruits in Egypt. It contains a high percent of sugar, protein, fats, salts, vitamins and it plays an important role in food industrialization such as juices, which wanted with large amounts to export according to good reputation of Egyptian varieties.

Now, the Egyptian agricultural strategy is to increase the quality level of exported crops to certain European countries, for this reason many efforts has been done to increase the total cultivated areas of mango in Egypt, as a favorable fruits in many countries. The total cultivated areas in Egypt has been rapidly increased and reached about 129073 feddans in 2007, producing a yield of approximately 497771 tons. In Sharkia Governorate, cultivated areas were 20873 feddans producing a yield of approximately 95428 tons. (Economic Agricultural Report (2007), from Central Administration for Economic Agriculture, Ministry of Agriculture, Egypt, 2007).Scale insects are usually considered as one of the most important pests which infesting mango trees in many countries of the world.

Kilifia acuminata (Signoret) (Homoptera : Coccidae) is one of the most important soft scale insects in Egypt. It attacks mango, *Mangifera indica* L., *Psidium guajava* L., *Pyrus communis* L., *Citrus* spp., other hosts of fruit trees and ornamental plants (Ezzat and Hussein, 1969; Hamon and Williams, 1984; El-Dash, 1997; El-Dash *et al.*, 2002 and Soliman *et al.*, 2007). According to its economic importance in Egypt especially on mango trees, the present work was carried out to study the seasonal fluctuations of this pest, its parasitoids, and the effects of biotic factors (temper-

ature ºC, relative humidity RH% and light intensity Lux) on both insect and its parasitoids. Such study may help in determination the proper time of chemical application against this pest without any objection with natural biological control activity.

MATERIALS AND METHODS

Field experiments were carried out in mango farm located in Inshas El-Raml district, Sharkia Governorate, Egypt. The study was continued for two successive years, from March 2007 until February 2009. The farm received normal agricultural practices and no chemical control was applied. The study was conducted in an area of about one feddan for mango, *Mangifera indica* L. variety Balady. Five trees were selected and labeled. These trees were nearly similar in size, age and vegetation. Each tree was divided into top and the bottom levels and every level was divided into four main directions (east, west, north and south).

For sampling, five leaves were picked up at random once a month from each direction, *i.e.* 200 leaves per sample (5 trees × 4 directions × 5 leaves × 2 levels of the tree). The samples were put in polyethylene bags and transferred into the laboratory for carefully inspection. These samples were examined in the same day using a stereomicroscope whereas the different stages of *Kilifia acuminata* (Signoret) were counted and recorded. The formula proposed by Audemard and Milaire (1975) and emended by Jacob (1977) was applied for estimating the number of *K. acuminatum* annual generations and their durations. Data of monthly counts of nymphal stage were indicated on millimeter papers.

To study the parasitism ratios of *K. acuminata*, the insects on each sample were separated into healthy alive insects and parasitized ones which bearing emerging holes of parasitoid adults or including parasitoids larvae or pupae. Each healthy alive insects 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. All emerging parasitoids were mounted in canada balsam and identified with helping of Dr. A.R. Hamed, Chief Researcher, Biological Control Department, Plant Protection Research Institute, Agricultural Research Center, Giza, Egypt.

The prevailing means of air temperature (ºC) and relative humidity (RH%) in the experimental area during the periods of the present study were obtained from the Central Laboratory for Agricultural Meteorology, Agricultural Research Center, Ministry of Agriculture. Light intensity (Lux) in outer zone of the trees was measured at the sampling days using Luxmeter at mid-day (12 *a.m.*), when the sunlight was perpendicular with the earth to obtain the highest light intensity. The relationships between the tested climatic factors and each insect populations and parasitism ratios were studied. Simple correlation, partial regression values and explained variance were calculated using COSTAT Computer Program (2005).

RESULTS AND DISCUSSION

1. Seasonal abundance

1.1. Total number of alive stages

As shown from obtained data in Tables (1 and 2) the total numbers of alive stages in the top level of mango trees showed three peaks of activity during the first year. They were in June, August and December with values of 177, 547 and 2046 individu-

als respectively. During the second year, two peaks of activity were recorded in July (1889 individuals) and December (665 individuals). In general, the population of alive stages during the second year (9562 individuals) was relatively higher in comparison with that during the first one (8672 individuals).

Table 1: Seasonal abundance of *Kilifia acuminata* and its parasitoids in the top level of mango trees, variety Balady, in Inshas El-Raml district, Sharkia Governorate during the first year (2007-2008).

Month	Number of insects / 100 leaves							Monthly average of climatic factors		
	Alive stages			Dead stages	Mortality %	Parasitoids		Temp. (ºC)	RH (%)	Light intensity (Lux)
	Females	*Nymphs*	Total			No.	%			
Mar., 2007	20	553	573	146	20.31	0	0.00	24.7	60.7	74000
Apr.	8	302	310	79	20.31	0	0.00	22.6	57.6	85000
May	6	128	134	29	17.79	0	0.00	27.9	56.9	87000
Jun.	6	171	177	31	14.90	0	0.00	30.6	58.9	90000
Jul.	4	152	156	55	26.07	2	0.95	31.8	65.6	86000
Aug.	3	544	547	102	15.72	2	0.31	31.9	67.1	85000
Sep.	6	376	382	47	10.96	1	0.23	30.2	65.4	84000
Oct.	9	308	317	78	19.75	2	0.51	29.0	62.2	73000
Nov.	25	778	803	93	10.38	0	0.00	24.2	62.6	55000
Dec.	12	2034	2046	147	6.70	1	0.05	19.2	63.2	60000
Jan., 2008	12	1906	1918	164	7.88	1	0.05	15.6	65.2	50000
Feb.	6	1303	1309	212	13.94	1	0.07	17.3	65.5	60000
Total	117	8555	8672	1183		10				
Mean					12.00		0.10			

Table 2: Seasonal abundance of *Kilifia acuminata* and its parasitoids in the top level of mango trees, variety Balady, in Inshas El-Raml district, Sharkia Governorate during the second year (2008-2009).

Month	Number of insects / 100 leaves							Monthly average of climatic factors		
	Alive stages			Dead stages	Mortality %	Parasitoids		Temp. (ºC)	RH (%)	Light intensity (Lux)
	Females	*Nymphs*	Total			No.	%			
Mar., 2008	5	989	994	206	17.17	0	0.00	22.9	62.2	70000
Apr.	2	457	459	128	21.81	0	0.00	27.8	56.8	87000
May	4	237	241	31	11.40	0	0.00	27.9	65.6	86000
Jun.	3	1013	1016	52	4.87	0	0.00	32.0	58.9	90000
Jul.	13	1876	1889	166	8.08	0	0.00	32.7	66.1	91000
Aug.	27	1314	1341	321	19.31	0	0.00	33.5	67.7	85000
Sep.	18	811	829	317	27.66	0	0.00	31.8	63.3	80000
Oct.	12	534	546	222	28.91	2	0.26	27.7	63.3	72000
Nov.	10	553	563	208	26.98	2	0.26	25.0	60.0	75000
Dec.	7	658	665	156	19.00	4	0.49	20.0	61.7	70000
Jan., 2009	1	565	566	175	23.62	0	0.00	17.7	60.3	65000
Feb.	5	448	453	104	18.67	1	0.18	18.9	60.8	55000
Total	107	9455	9562	2086		9				
Mean					17.91		0.08			

Data given in Tables (3 and 4) revealed that the total number of alive stages in the bottom level of mango trees indicated two and three peaks of activity during the first and second years, respectively. they took place in September and January, and in August, November and January with counts of 719, 2129, 1979, 922 and 1016 individuals, respectively. Generally, the total number of alive stages during the second year (12091 individuals) was clearly higher as compared with recorded during the first one (10308 individuals).

These finding are in agreement with those of following workers Habib *et al.* (1971) who noticed that the highest insect population tended to occur in the middle and upper zones of the tree in August. Salama and Saleh (1971) who mentioned that

the coccid reaches its peak of seasonal abundance in October-November. Shahein (1974) who reported that *K. acuminata* had three periods of activity, the 1st one occupied at October and lasted for February, while the 2nd period was found from April to May and the last period occurred from July to September. El-Dash (1997) who revealed that the total average of total monthly count indicated three peaks of abundance in May, July and October- November.

Table 3: Seasonal abundance of *Kilifia acuminata* and its parasitoids in the bottom level of mango trees, variety Balady, in Inshas El-Raml district, Sharkia Governorate during the first year (2007-2008).

Month	Number of insects / 100 leaves							Monthly average of climatic factors		
	Alive stages			Dead stages	Mortality %	Parasitoids		Temp. (ºC)	RH (%)	Light intensity (Lux)
	Females	*Nymphs*	Total			No.	%			
Mar., 2007	79	1013	1092	234	17.65	0	0.00	24.7	60.7	74000
Apr.	67	595	662	160	19.46	0	0.00	22.6	57.6	85000
May	31	267	298	86	22.40	0	0.00	27.9	56.9	87000
Jun.	31	254	285	24	7.77	1	0.32	30.6	58.9	90000
Jul.	78	270	348	61	14.91	3	0.73	31.8	65.6	86000
Aug.	136	410	546	119	17.89	1	0.15	31.9	67.1	85000
Sep.	117	602	719	145	16.78	1	0.12	30.2	65.4	84000
Oct.	70	439	509	91	15.17	1	0.17	29.0	62.2	73000
Nov.	136	792	928	81	8.03	1	0.10	24.2	62.6	55000
Dec.	145	1467	1612	154	8.72	0	0.00	19.2	63.2	60000
Jan., 2008	107	2022	2129	210	8.98	0	0.00	15.6	65.2	50000
Feb.	34	1146	1180	264	18.28	0	0.00	17.3	65.5	60000
Total	1031	9277	10308	1629		8				
Mean					13.65		0.07			

Table 4: Seasonal abundance of *Kilifia acuminata* and its parasitoids in the bottom level of mango trees, variety Balady, in Inshas El-Raml district, Sharkia Governorate during the second year (2008-2009).

Month	Number of insects / 100 leaves							Monthly average of climatic factors		
	Alive stages			Dead stages	Mortality %	Parasitoids		Temp. (ºC)	RH (%)	Light intensity (Lux)
	Females	*Nymphs*	Total			No.	%			
Mar., 2008	67	957	1024	235	18.67	0	0.00	22.9	62.2	70000
Apr.	64	516	580	122	17.38	0	0.00	27.8	56.8	87000
May	32	355	387	84	17.83	0	0.00	27.9	65.6	86000
Jun.	98	635	733	35	4.56	0	0.00	32.0	58.9	90000
Jul.	318	1489	1807	203	10.10	0	0.00	32.7	66.1	91000
Aug.	293	1686	1979	419	17.47	0	0.00	33.5	67.7	85000
Sep.	111	979	1090	314	22.36	0	0.00	31.8	63.3	80000
Oct.	75	751	826	374	31.17	1	0.08	27.7	63.3	72000
Nov.	49	873	922	336	26.71	0	0.00	25.0	60.0	75000
Dec.	22	695	717	158	18.06	0	0.00	20.0	61.7	70000
Jan., 2009	14	1002	1016	166	14.04	2	0.17	17.7	60.3	65000
Feb.	14	996	1010	121	10.70	2	0.18	18.9	60.8	55000
Total	1157	10934	12091	2567		5				
Mean					17.51		0.03			

1.2. Percentages of total mortality

As shown from obtained data in Tables (1 and 2) in the top level of mango trees during the first year, the percentages of total mortality indicated two peaks. There were in July (26.07%) and October (19.75%). While, during the second year, three peaks were recorded in April, October and January with values of 21.81, 28.91 and 23.62% mortalities, consecutively. The mean percentage of total mortality during the second year (17.91%) was relatively higher as compared with that during the first one (12.00%).

Data presented in Tables (3 and 4) show the percentages of total mortality in the bottom level of mango trees. Two peaks of mortality were recorded during the two

respective years. They took place in May and August during the first year and in March and October during the second one, with values of 22.40, 17.89, 18.67 and 31.17%, successively. The mean percentage of mortality during the second year (17.51%) was relatively higher as compared with that noticed during the first one (13.65%).

1.3. Percentages of parasitism

Data presented in Tables (1,2,3 and 4) showed that parasitism was very rare in the top and bottom levels of mango trees during the two successive years. The percentages of parasitism indicated one peak in July in the top and bottom levels of mango trees during the first year, with values of 0.95 and 0.73% parasitism, respectively.

This finding are in agreement with those of Salem (1994) who reported that hymenopterous parasite belonging to family Encyrtidae was more associated with *K. acuminata* in Egypt. The percentages of parasitism on this insect were low during the two seasons. The parasite had one to four periods of activity.

2. Effects of some climatic factors

2.1. Total number of alive stages

Data in Table (5) showed that in the top level of mango trees only during the first year, there were negative highly significant effects between the total number of alive stages and each of temperature and light intensity whereas r= -0.838** and -0.847**, consecutively. Statistical analysis showed that E.v. % affected this stage by 84.17 and 38.30%, respectively.

Data given in Table (5) revealed that in the bottom level of mango trees during the first year, there were negative highly significant effects between total number of alive stages and each of temperature and light intensity whereas r= -0.868** and -0.856**, successively. During the second year, there was a positive significant effect between total number of alive stages and relative humidity whereas r= 0.606*. E.v. % influenced the total number of alive stages by 85.87 and 43.76% during the first and second years, consecutively.

Table 5: Statistical analysis based on correlation coefficient (r) indicating the effects of climatic factors on different stages of *Kilifia acuminata* and its parasitoids on mango trees, variety Balady, in Inshas El-Raml district, Sharkia Governorate during the two successive years (2007-2008 and 2008-2009).

	Temp. (ºC)		RH (%)		Light intensity (Lux)		Explained variance (E.v. %)		Combined effect	
	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom		
1st year (2007-2008)										
Number of females	-0.373	-0.080	-0.148	0.546	-0.604*	-0.391	68.48	40.69		
Number of nymphs	-0.837**	-0.888**	0.400	0.316	-0.843**	-0.852**	84.00	87.15	RH(%)	Light intensity (Lux)
Total number of alive stages	-0.838**	-0.868**	0.398	0.347	-0.847**	-0.856**	84.17	85.87	Temp.(ºC) -0.048	0.817**
Total number of dead stages	-0.807**	-0.730**	0.431	0.260	-0.764**	-0.516	80.57	67.73	RH(%)	-0.347
Total mortality %	0.539	0.232	-0.258	-0.186	0.638*	0.502	41.18	36.59		
Parasitism %	0.529	0.618*	0.467	0.246	0.301	0.434	52.48	45.89		
2nd year (2008-2009)										
Number of females	0.596*	0.743**	0.707*	0.644*	0.259	0.600*	75.50	68.32		
Number of nymphs	0.548	0.267	0.477	0.568	0.458	0.023	37.46	40.28	RH(%)	Light intensity (Lux)
Total number of alive stages	0.553	0.383	0.484	0.606*	0.458	0.152	38.30	43.76	Temp.(ºC) 0.428	0.868**
Total number of dead stages	0.242	0.271	0.37	0.469	-0.065	-0.054	38.40	46.24	RH(%)	0.235
Total mortality %	-0.289	-0.032	-0.152	0.125	-0.477	-0.183	32.31	10.27		
Parasitism %	-0.463	-0.496	-0.144	-0.192	-0.473	-0.344	23.51	28.29		

2.2. Percentages of total mortality

Data presented in Table (5) showed that in the top level of mango trees during the first year, there was a positive significant effect between the percentages of total mortality and light intensity whereas (r) value was 0.638*. Statistical analysis showed that E.v.% affected percentages of total mortality in the top level by 41.18 and 32.31% during the first and second years, respectively. While, in the bottom level E.v.% influenced the percentages of total mortality by 36.59 and 10.27% during the first and second years, consecutively.

2.3. Percentages of parasitism

As shown from obtained data in Table (5) in the bottom level of mango trees during the first year, temperature had positive significant effect on percentages of parasitism whereas (r) value was 0.618*. In the top level of mango trees E.v.% affected percentages of parasitism by 52.48 and 23.51% during the first and second years, respectively. In bottom level E.v. % influenced percentages of parasitism by 45.89 and 28.29% during the first and second years, successively.

3. Number of generations

As *K. acuminata* 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.

As shown from the obtained data in Figs. (1 and 2), *K. acuminata* had three generations annually in the top and bottom levels of mango trees during the two successive years. In General, every generation took about four months. The first generation was during the period extended from the beginning of March till the end of June. The second one occurred from the beginning of July till the end of October. The third generation occupied the period from the beginning of November till the end of February.

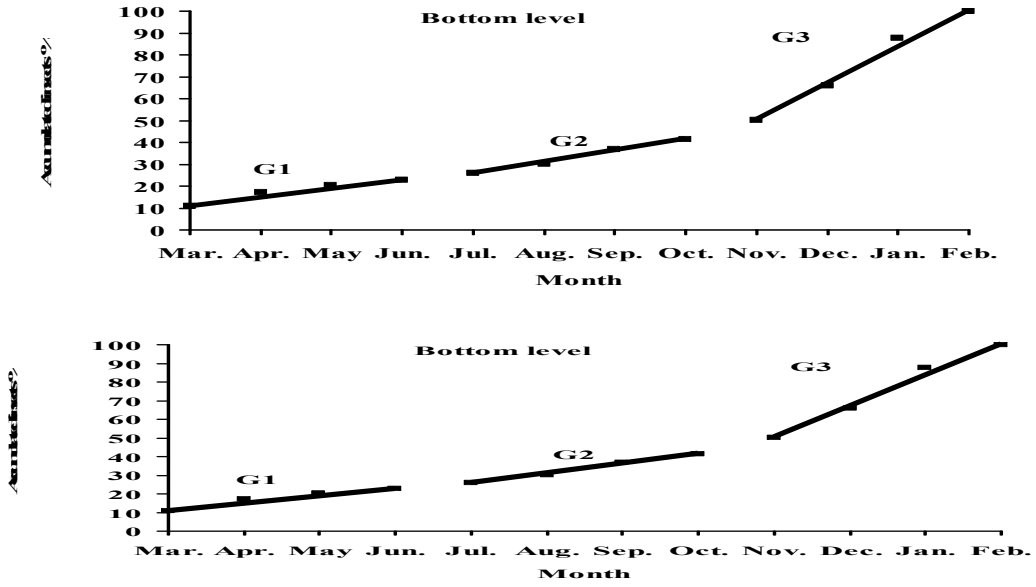

Fig.1: Annual generations and their durations of *Kilifia acuminata* in the top and bottom levels of mango trees, variety Balady, in Inshas El-Raml district, Sharkia Governorate, Egypt during the first year (2007-2008).

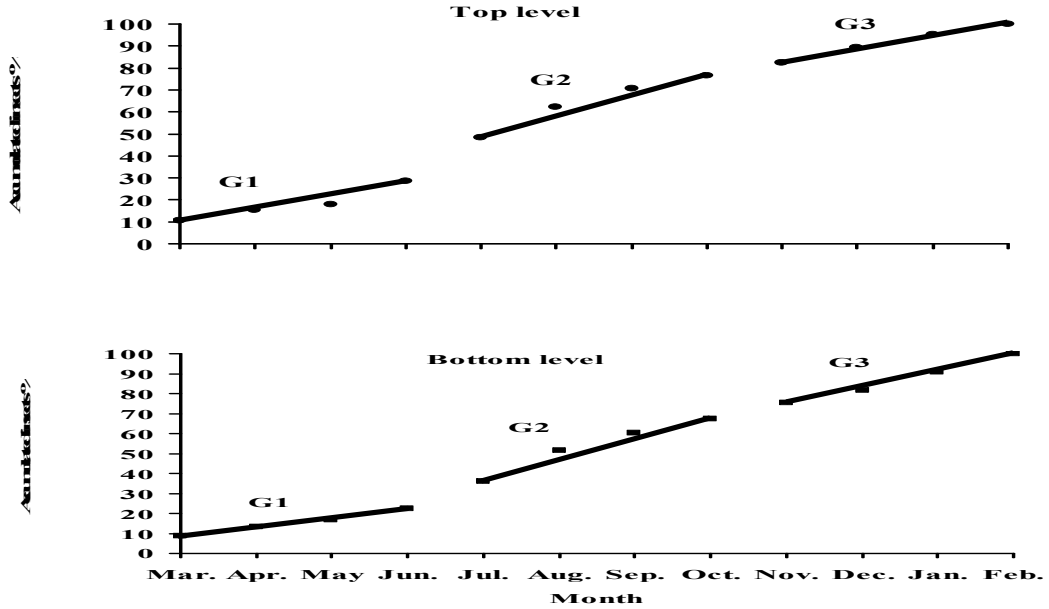

Fig.2: Annual generations and their durations of *Kilifia acuminata* in the top and bottom levels of mango trees, variety Balady, in Inshas El-Raml district, Sharkia Governorate, egypt during the second year (2008-2009).

4. Preferable level and preferable leaf surface

Data given in Table (6) showed that during the two successive years, all stages did not infest the upper surface of the leaves. The total number of alive stages was relatively higher (10308 and 12091 individuals) than those in the top level (8672 and 9562 individuals) during the first and second years, consecutively. While, the mean percentage of parasitism in the top level of mango trees was higher (0.10 and 0.08%) as compared with that in the bottom one (0.07 and 0.03%), during the first and second years, respectively.

Table 6: Monthly numbers of *Kilifia acuminata* and its parasitoids on lower surface of mango trees, variety Balady, in Inshas El-Raml district, Sharkia Governorate during the two successive years (2007-2008 and 2008-2009).

Month	First year (2007-2008)								Second year (2008-2009)							
	Top				Bottom				Top				Bottom			
	Alive stages	Dead stages	Parasitoids		Alive stages	Dead stages	Parasitoids		Alive stages	Dead stages	Parasitoids		Alive stages	Dead stages	Parasitoids	
			No.	%			No.	%			No.	%			No.	%
Mar., 2007	* 573	146	0	0.00	1092	234	0	0.00	994	206	0	0.00	1024	235	0	0.00
Apr.	310	79	0	0.00	662	160	0	0.00	459	128	0	0.00	580	122	0	0.00
May	134	29	0	0.00	298	86	0	0.00	241	31	0	0.00	387	84	0	0.00
Jun.	177	31	0	0.00	285	24	1	0.32	1016	52	0	0.00	733	35	0	0.00
Jul.	156	55	2	0.95	348	61	3	0.73	1889	166	0	0.00	1807	203	0	0.00
Aug.	547	102	2	0.31	546	119	1	0.15	1341	321	0	0.00	1979	419	0	0.00
Sep.	382	47	1	0.23	719	145	1	0.12	829	317	0	0.00	1090	314	0	0.00
Oct.	317	78	2	0.50	509	91	1	0.17	546	222	2	0.26	826	374	1	0.08
Nov.	803	93	0	0.00	928	81	1	0.10	563	208	2	0.26	922	336	0	0.00
Dec.	2046	147	1	0.04	1612	154	0	0.00	665	156	4	0.49	717	158	0	0.00
Jan., 2008	1918	164	1	0.05	2129	210	0	0.00	566	175	0	0.00	1016	166	2	0.17
Feb.	1309	212	1	0.07	1180	264	0	0.00	453	104	1	0.18	1010	121	2	0.18
Total	8672	1183	10		10308	1629	8		9562	2086	9		12091	2567	5	
Mean				0.10				0.07				0.08				0.03

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ARABIC SUMMARY

بعض الظواهر الايكولوجية لحشرة المانجو القشرية الرخوة *Kilifia acuminata* والطفيليات المصاحبة لها على أشجار المانجو بمحافظة الشرقية - مصر

عبد المنعم شوقي حسن[1] و حسن أحمد نبيل[1] و على عبد الحميد شاهين [2]و كامل عبد اللطيف حماد[2]
1- معهد بحوث وقاية النباتات – مركز البحوث الزراعية – الزقازيق -مصر
2- قسم وقاية النبات - كلية الزراعة – جامعة الزقازيق

أجريت هذه الدراسة بمنطقة أنشاص الرمل بمحافظة الشرقية بحدائق المانجو التابعة لوزارة الأوقاف على الصنف بلدى بداية من مارس 2007م وحتى فبراير 2009م وذلك لدراسة التقلبات الموسمية لتعداد حشرة المانجو القشرية الرخوة والطفيليات المصاحبة لها وكذلك النسبة المئوية للتطفل على أطوارها المختلفة بالمستويين العلوي والسفلى للأشجار وتأثير العوامل البيئية المحيطة من حرارة ورطوبة نسبية وكثافة ضوئية وكانت النتائج المتحصل عليها كما يلي:

1- أظهرت نتائج الدراسة ان لإجمالي تعداد الأطوار الحية خلال عامي الدراسة من اثنين الى ثلاث ذروات في كلا المستويين.
2- وجد أن الأنواع *Coccophagus* sp. and *Metaphycus* sp. تتطفل على الحشرة.
3- أوضح نشاط الآفة أن لها ثلاثة أجيال سنوياً في المستويين العلوي والسفلى للأشجار. يبدأ الجيل الأول من شهر مارس وينتهي في شهر يونيو ويبدأ الجيل الثاني في شهر يوليو وينتهي في شهر أكتوبر، أما الجيل الثالث والأخير فيبدأ في نوفمبر وينتهي في شهر فبراير. ووجد أن الجيلين الثاني والثالث هما أقوى الأجيال خلال عامي الدراسة.
4- وجد أن العوامل المناخية تؤثر في العدد الكلى للأطوار الحية للآفة في المستوى العلوي بنسب 84.17 و 38.30% خلال عامي الدراسة على التوالي. وفى المستوى السفلى كانت نسب التأثير 85.87 و 43.76% خلال عامي الدراسة على التوالي.