RELATIONSHIP BETWEEN THE RATES OF INFESTATION WITH THE CALIFORNIA RED SCALE INSECT, *AONIDIELLA AURANTII* (MASK.) (HEMIPTERA: DIASPIDIDAE) AND THE YIELD LOSS OF MANGO TREES AT LUXOR GOVERNORATE, EGYPT

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Abstract

The main objective of the present work is to evaluate the relationship between the rates of infestation by *Aonidiella aurantii* (Mask.) (Hemiptera: Diaspididae) during four peaks of insect activity in October, December, April and July and the yield loss of grafted Balady mango trees at Esna district, Luxor Governorate through the two connective seasons of (2010/2011 and 2011/2012). The obtained results revealed that the increase in population density in four peaks of insect population decreased the yield gradually (inverted relation) by (1.37, 1.47, 4.25 and 1.77 kg/tree) and (1.45, 1.53, 4.66 and 1.85 kg/tree) during two successive seasons, respectively and increased the percentage of the yield loss (positive relationship) by (0.55, 0.59, 1.70 and 0.71 %) and (0.60, 0.63, 1.90 and 0.76 %), when the yield data were correlated with the peaks of insect population in October, December, April and July through the two successive seasons, 2010-2011 and 2011-2012 respectively. The insect infestation during April was more effective causing the greatest loss in mango yield during the two seasons. The reduction in mango yield was a summation of many factors including level and time of infestation and the ability of variety to infestation.

Key words: *Aonidiella aurantii*, infestation, mango variety, yield and percentage of reduction.

INTRODUCTION

Mango (*Mangifera indica* L.) is one of the most important fruits in the tropics and subtropics. In Egypt, mango is occupies the third place in the acreage after citrus and grapes. The area of mango orchards reached 71009 ha producing about 598084 tons of fruits annually (FAOSTAT, 2011). Mango is considered the most popular fruit due to its good flavour, delicious taste, nutritive value and other fruit attractive features. They are rich in vitamins C & B complex, Beta carotene precursor of vitamin A, minerals and fatty acids. Mango trees are subjected to infestation by different pests. Among these pests, the California red scale insect, *Aonidiella aurantii* (Mask.) (Hemiptera: Diaspididae) is considered as a severe pest of mango trees in different parts in Egypt. This pest attacks tender shoots, twigs, leaves, branches and fruits. Adults and nymphs of this insect feed on leave sap with their long, sucking great amount of nitrogen and macro- and micro-elements. At high level of infestation with this insect species, remarkable damage occurs, resulting in early leave drop and yield reduction (Salah, 2005). The leaves develop a characteristic yellow spot under and around each female scale. Great damage can be done by the scale insect not only by sucking the plant sap resulting in low photosynthesis and respiration which ultimately leads to wilting, dropping to leaves, malformations, drop, dieback of twigs and limbs, dwarfing, decrease in fruit production (quality and quantity), and even plant death (Badary and Abd-Rabou, 2010). In addition, insect secretion of the toxic saliva results in malformed leaves and poor shoot growth (Dreistadt *et al.*, 1994). Maturing fruit can become completely encrusted with scales; developing scales form prominent pits on young fruit which are still evident when the fruit matures. Such fruit tend to dry out and fall off. Even the trunk can become heavily infested (Bedford, 1998). Infested leaves affect the quantity and quality of fruits because parenchyma cells in the leaves loses their capacity for chlorophyll a, b production and carotenoids as well as some element (Bakry, 2014).

The objective of this investigation is to estimate the relationship between the rate of infestation by *A. aurantii* during four peaks of insect activity and the percentage of loss in yield of mango during the two successive seasons of (2010/2011 and 2011/2012).

MATERIALS AND METHODS

This investigation was carried out on mango trees at Esna district, Luxor Governorate during the period from September, 2010 to October, 2012, to clarify the effect of the levels of infestation by *A. aurantii* on the yield of mango. Grafted Balady mango variety has been chosen to conduct this study.

Grafted Balady mango trees were almost similar and as uniform as possible in size, age (10 years), shape, height (6-7m), vegetative growth and received the normal agricultural practices without application any chemical control measures before and during the period of investigation were selected for carrying out this study.

Regular bimonthly samples consisted of 20 leaves from each tree, were randomly chosen from all directions. Samples were collected and immediately transferred to the laboratory in polyethylene bags for inspection by the aid of stereo-microscope. The stages of this insect on upper and lower surfaces of leaves individually sorted into alive nymphs and adult females were counted and recorded the numbers of this insect to express the total population of pest. The yield of each tree was assessed.

The objective of the work was to determine the loss of yield of mango trees in relation to the population density of *A. aurantii* during four peaks of insect activity. The data obtained were statistically analyzed by using simple correlation which the independent variable (X) representing the number of insects per one mango leaf and the dependent variable (y) represented the yield per tree.

The simple regression was used to show the variability in the yield that could be caused by infestation during the whole season. Partial regression formula which was adopted to find out the simultaneous effects of four peaks of insect activity in October, December, April and July on the yield of mango. According to Fisher (1950) and Hosny *et al.* (1972). The equation of linear regression was calculated according to the following formula:

$$\mathbf{Y = a \pm bx}$$

Where:

Y = Prediction value (Dependent variable) **a** = Constant (y - intercept)

b = Regression coefficient **x** = Independent variable

This method was helpful in obtaining basic information about the amount of variability in the yield that could be attributed to these infestations, together, which was calculated as percentage of explained variance (%E.V.). The partial regression values indicate the average rate of change in yield due to a unit change in any of the four peaks of insect activity. Statistical analysis in this present work was carried out by computer **(MSTATC Program software, 1980).**

The amount of damage and losses of yield due to scale insect were calculated according to the following equation:

$$\textbf{\%Yield loss} = \frac{\textbf{A-B}}{\textbf{A}} \textbf{x 100}$$

Which:

A = Yield for uninfested trees. **B** = Yield for infested trees.

* Average yield of mango for uninfested trees were 250 and 245 kg/tree during the first and second seasons of study, respectively.

RESULTS AND DISCUSSION

Data represented in Table (1) and illustrated in Figs (1 and 2) revealed that the yield decreased gradually with increasing the population density of *A. aurantii* during the first and second seasons of (2010/2011 and 2011/2102), respectively.

Table (1): Effect of infestation by *Aonidiella aurantii* during four peaks of population on the yield of mango trees (grafted Balady variety) through the two seasons (2010/2011 and 2011/2012).

Season	Inspected trees	Yield (kg)	% Yield reduction	Peaks of *A. aurantii*				
				October infestation insect/leaf	December infestation insect/leaf	April infestation insect/leaf	July infestation insect/leaf	Average infestation/leaf
2010 / 2011	1	240	4.0	28.0	35.3	10.0	16.0	22.3
	2	238	4.8	31.8	39.8	11.2	17.0	24.9
	3	235	6.0	40.5	48.0	12.0	24.0	31.1
	4	228	8.8	43.0	52.0	13.2	25.9	33.5
	5	222	11.2	45.3	56.0	14.0	28.8	36.0
	6	215	14.0	46.5	60.8	16.6	32.0	39.0
	7	210	16.0	58.0	63.0	18.7	35.5	43.8
	8	200	20.0	62.0	66.0	20.6	42.0	47.7
	9	185	26.0	65.6	70.4	22.0	46.0	51.0
2011 / 2012	1	235	4.08	25.8	32.4	8.8	14.6	20.4
	2	230	6.12	29.3	36.6	9.9	15.4	22.8
	3	228	6.94	37.3	44.2	10.6	21.8	28.5
	4	222	9.39	39.5	47.8	11.6	23.5	30.6
	5	218	11.02	41.7	51.5	14.0	26.2	33.4
	6	210	14.29	42.8	55.9	14.6	29.1	35.6
	7	200	18.37	53.4	58.0	16.5	32.3	40.0
	8	192	21.63	57.0	60.7	18.1	38.2	43.5
	9	185	24.49	60.3	64.8	19.4	41.9	46.6

These results confirmed the inverted relation between the yield of mango and population density in four peaks of insect activity during both seasons.

Results of statistical analysis of data in Table (2) revealed that strongly highly significant negative correlation between the yield of mango and the peaks of insect population (r = -0.958, -0.942, -0.984 and -0.982) and (r = -0.978, -0.950, -0.991 and -0.984) in October, December, April and July during the 1st and 2nd seasons, respectively.

It could be concluded that the total population of this insect had four peaks, which were recorded in the October, December, April and July.

Table (2): Simple correlation, regression values and linear regression equation when the counts of *Aonidiella aurantii* were plotted versus the yield of mango in the two seasons (2010/2011 and 2011/2012).

Season	Tested counts	Simple correlation and regression values					Regression curve formula
		r	b	s.e	t	p	Y= a ± bx
2010 / 2011	Average no. of individuals/ leaf (October)	-0.958	-1.374	0.155	-8.86	0.000	-1.374 x + 283.43
	Average no. of individuals/ leaf (December)	-0.942	-1.468	0.198	-7.41	0.000	-1.468x + 299.36
	Average no. of individuals/ leaf (April)	-0.984	-4.249	0.291	-14.6	0.000	-4.249 x + 284.5
	Average no. of individuals/ leaf (July)	-0.982	-1.765	0.130	-13.6	0.000	-1.765 x + 271.6
	General average	-0.971	-1.842	0.173	-10.7	0.000	-1.842 x + 286.6
2011 / 2012	Average no. of individuals/ leaf (October)	-0.9777	-1.452	0.118	-12.4	0.000	-1.452 x + 275.8
	Average no. of individuals/ leaf (December)	-0.9504	-1.534	0.190	-8.10	0.000	-1.534 x + 290.4
	Average no. of individuals/ leaf (April)	-0.9908	-4.663	0.241	-19.3	0.000	-4.663 x +277.3
	Average no. of individuals/ leaf (July)	-0.9839	-1.852	0.127	-14.6	0.000	-1.852 x +263.4
	General average	-0.9804	-1.941	0.147	-13.2	0.000	-1.941x + 278.3

r = Simple correlation b = Simple regression

s.e = Standard error t = Paired t-test

These data were agreeable with Fouad *et al.* (2009) stated that the California red scale insect, *A. aurantii* on mango trees had four generations per year. Salah (2005) in Egypt, however with different host, who reported that this pest had four peaks per year.

To determine the real effect of the population density of insect on yield of mango, the partial regression, multiple correlation and coefficient of determination values were carried out in Table (3).

The obtained results showed that the peaks of activity of insect during the first season (2010/ 2011) was insignificant positive effect (P.reg value was +0.75 and +0.34) and (t value = +1.27 and +0.72) in October, December, respectively. While, was insignificant negative (P.reg. value = -2.70 and -1.97) and (t value = -1.70 and -1.97) through during April and July, Table (3).

Table (3): Partial regression, multiple correlation, coefficient of determination values and explained variance when the counts of *Aonidiella aurantii*, were plotted versus the yield of mango in the two seasons (2010/2011 and 2011/2012).

Season	Tested counts	Partial regression values				Analysis variance			
		P.reg	s.e	t	p	F values	MR	R^2	E.V%
2010 / 2011	Average no. of individuals /leaf (October)	0.75	0.593	1.27	0.27	62.06**	0.992	0.984	98.41
	Average no. of individuals /leaf (December)	0.34	0.469	0.72	0.51				
	Average no. of individuals /leaf (April)	-2.70	1.591	-1.70	0.16				
	Average no. of individuals /leaf (July)	-1.97	1.000	-1.97	0.12				
2011 / 2012	Average no. of individuals /leaf (October)	-0.30	0.503	-0.60	0.58	89.78**	0.994	0.989	98.90
	Average no. of individuals /leaf (December)	0.55	0.402	1.38	0.24				
	Average no. of individuals /leaf (April)	-3.69	1.517	-2.44	0.07				
	Average no. of individuals /leaf (July)	-0.65	0.842	-0.77	0.49				

MR = Multiple correlation P.reg = Partial regression
R^2 = Coefficient of determination E.V% = Explained variance
s.e = Standard error t = Paired t-test

However, through the two season (2011/2012), the partial regression values (P.reg) emphasized insignificant negative relation that was (-0.30, -3.69 and -0.65) and the "t value" were (-0.60, -2.44 and -0.77) during October, April and July. While, was insignificant positive (P.reg. value = +0.55) and (t value = +1.38) through during December, Table (3).

Hernandez *et al.* (2002) studied the relationship between the population density of *A. aurantii* and the yield of citrus trees. They found that positive correlation was found between fruit infestation and yield loss at harvest between consecutive years.

The estimated partial regression values indicated the presence of a simultaneous effect of the four peaks of insect population on the yield of mango in two successive years of 2010/2011 and 2011/2012.

The results showed that the combined effect of these peaks of insect activity on yield of mango during the 1st and 2nd years of study was highly significant where the «F» value, was 62.06 and 89.78 respectively for the two seasons of study (Table, 3).

In the same table, the influence of these combined all peaks of insect was expressed as percentages of explained variance (% E.V.) that was 98.4 and 98.9 % for two successive years, respectively. The previous results indicated that the yield was mostly related to the simultaneous effect of these peaks of insect rather than the single effect of each peak of insect infestation.

Results in Table (4) and illustrated in Fig. (1) indicated that the maximum yield (240 and 235 kg) was recorded with the lowest level of population density through the four peaks during the first and second seasons, respectively. While, the minimum yield (185 kg) was estimated with the highest value of population density in the four peaks during the two seasons, respectively.

The calculated yield decreased gradually with increasing the population density of *A. aurantii* (inverted relation) in all peaks of insect during the two seasons, Table (4).

The slope of the regression lines, revealed that a unit change of *A. aurantii* (one insect/leaf) reduced on the yield by (1.37, 1.47, 4.25 and 1.77 kg/tree) and (1.45, 1.53, 4.66 and 1.85 kg/tree) when the yield data were correlated with the infestations in October, December, April and July during the two successive seasons, respectively are illustrated in Fig. (1).

However, when the yield were correlated with the general average of infestation for the four peaks, the yield decreased by 1.84 and 1.94 kg/tree during two seasons are illustrated in Figs (1).

Data of both seasons also indicated that the quantity of yield on the first season (2010/2011) was higher than that on the 2nd one (2011/2012). The differences may be attributed to many reasons, such as the reduction of yield resulting from the infestation by pest and fruits depression due to natural causes such as exchange of pregnancy and deficiency of fertilizers.

These results are similar to those obtained by Mohamed and Asfoor (2004), in Egypt, however with different host, they studied the effect of the red scale, *A. aurantii* infestation and the yield loss on citrus trees, the reduction in Valencia orange was higher than that of Navel. As well as, the damage was estimated as % reduction in the yield per tree by 31.14 and 27.15%, respectively.

Data presented in Table (5) and illustrated in Fig. (2), showed that the least loss percentage in yield (4.0 and 4.1%) was recorded with the lowest level of population density (positive relation) through the four peaks during the first and second seasons, respectively.

Table (4): Gradual decrease in yield with increase the rates of infestation by *Aonidiella aurantii* during four peaks during the two seasons (2010/2011 and 2011/2012).

Inspected trees		Yield (kg)	October infestation		December infestation		April infestation		July infestation		General average	
			No. of insects / leaf	Calculated yield	No. of insects / leaf	Calculated yield	No. of insects / leaf	Calculated yield	No. of insects / leaf	Calculated yield	No. of insects / leaf	Calculated yield
2010 / 2011	1	240	28	244.96	35	247.60	10	242.03	16	243.37	22.3	245.51
	2	238	32	239.74	40	240.99	11	236.93	17	241.70	24.9	240.70
	3	235	41	227.79	48	228.88	12	233.53	24	229.25	31.1	229.28
	4	228	43	224.39	52	223.00	13	228.43	26	225.94	33.5	224.89
	5	222	45	221.19	56	217.13	14	225.03	29	220.78	36.0	220.26
	6	215	47	219.54	61	210.15	17	213.98	32	215.13	39.0	214.85
	7	210	58	203.74	63	206.85	19	205.06	35	208.99	43.8	205.95
	8	200	62	198.25	66	202.45	21	196.98	42	197.47	47.7	198.85
	9	185	66	193.37	70	195.95	22	191.04	46	190.41	51.0	192.69
2011 / 2012	1	235	26	238.36	32	240.61	9	236.23	15	236.39	20.4	238.75
	2	230	29	233.28	37	234.26	10	231.30	15	234.79	22.8	234.11
	3	228	37	221.66	44	222.61	11	228.02	22	222.91	28.5	223.09
	4	222	40	218.36	48	216.96	12	223.10	24	219.75	30.6	218.86
	5	218	42	215.25	52	211.32	14	211.98	26	214.81	33.4	213.58
	6	210	43	213.65	56	204.61	15	209.15	29	209.42	35.6	209.22
	7	200	53	198.29	58	201.44	16	200.53	32	203.56	40.0	200.65
	8	192	57	192.95	61	197.20	18	192.73	38	192.57	43.5	193.83
	9	185	60	188.21	65	190.95	19	186.99	42	185.82	46.6	187.90

While, the highest loss percentage in yield (26.0 and 24.5%) was estimated with the highest value of population density (inverted relation) in the four peaks during the two seasons, respectively, Table (5) and illustrated in Fig. (2).

Also, the calculated reduction of yield increased with increasing the population density of *A. aurantii* (positive relation) in all peaks of insect during the two seasons, Table (5).

The slope of the regression line, revealed that a unit change of *A. aurantii* (one insect/leaf) increased the percentage loss in the yield by (0.55, 0.59, 1.70 and 0.71 %) and (0.59, 0.63, 1.90 and 0.76 %), when the percentage loss in yield were correlated with the infestations in October, December, April and July during the two successive seasons, respectively are illustrated in Fig. (2).

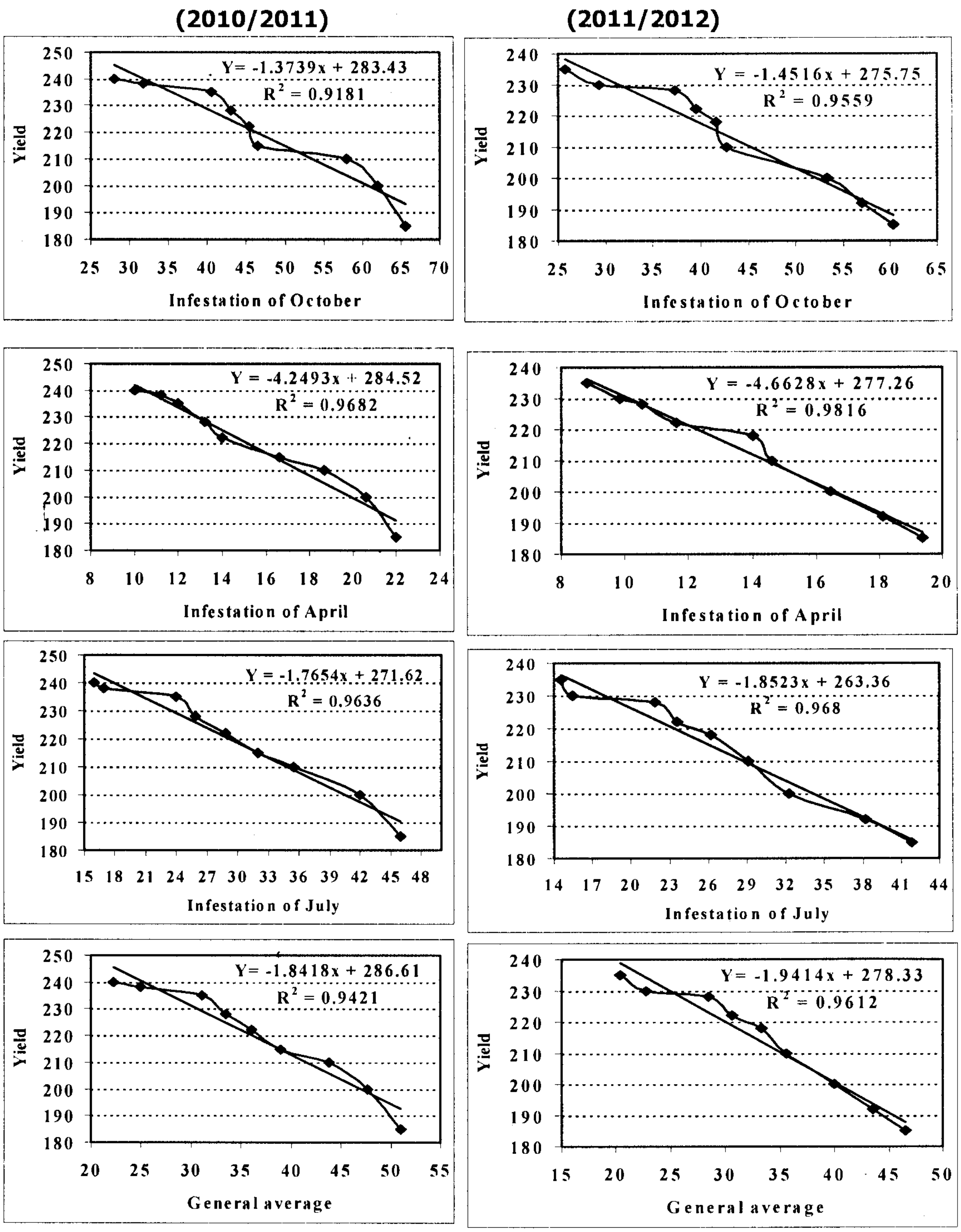


Fig. (1): Relationship between population density of *Aonidiella aurantii* and mango yields of the grafted Balady variety during the two seasons (2010/2011 and 2011/2012).

Table (5): Gradual increase in yield loss with increasing the infestation rate of *Aonidiella aurantii* during four peaks of population densities (2010/2011 and 2011/2012) seasons at Esna, Luxor Governorate.

Inspected trees		% Yield reduction	October infestation		December infestation		April infestation		July infestation		General average	
			No. of insects / leaf	Calculated reduction	No. of insects / leaf	Calculated reduction	No. of insects / leaf	Calculated reduction	No. of insects / leaf	Calculated reduction	No. of insects / leaf	Calculated reduction
2010/2011	1	4.0	28.0	2.0	35.3	1.0	10.0	3.2	16.0	2.7	22.3	1.8
	2	4.8	31.8	4.1	39.8	3.6	11.2	5.2	17.0	3.3	24.9	3.7
	3	6.0	40.5	8.9	48.0	8.5	12.0	6.6	24.0	8.3	31.1	8.3
	4	8.8	43.0	10.2	52.0	10.8	13.2	8.6	25.9	9.6	33.5	10.0
	5	11.2	45.3	11.5	56.0	13.2	14.0	10.0	28.8	11.7	36.0	11.9
	6	14.0	46.5	12.2	60.8	15.9	16.6	14.4	32.0	14.0	39.0	14.1
	7	16.0	58.0	18.5	63.0	17.3	18.7	18.0	35.5	16.4	43.8	17.6
	8	20.0	62.0	20.7	66.0	19.0	20.6	21.2	42.0	21.0	47.7	20.5
	9	26.0	65.6	22.7	70.4	21.6	22.0	23.6	46.0	23.8	51.0	22.9
2011/2102	1	4.1	25.8	2.71	32.4	1.79	8.8	3.58	14.6	3.52	20.4	2.55
	2	6.1	29.3	4.78	36.6	4.38	9.9	5.59	15.4	4.17	22.8	4.44
	3	6.9	37.3	9.53	44.2	9.14	10.6	6.93	21.8	9.02	28.5	8.94
	4	9.4	39.5	10.87	47.8	11.44	11.6	8.94	23.5	10.31	30.6	10.67
	5	11.0	41.7	12.14	51.5	13.75	14.0	13.48	26.2	12.32	33.4	12.82
	6	14.3	42.8	12.80	55.9	16.48	14.6	14.64	29.1	14.52	35.6	14.60
	7	18.4	53.4	19.06	58.0	17.78	16.5	18.15	32.3	16.92	40.0	18.10
	8	21.6	57.0	21.25	60.7	19.51	18.1	21.34	38.2	21.40	43.5	20.89
	9	24.5	60.3	23.18	64.8	22.06	19.4	23.68	41.9	24.16	46.6	23.30

However, when the percentage loss in yield were correlated with the general average of infestation for the four peaks, the yield decreased by 0.74 % and 0.79 % during two seasons in illustrated in Fig. (2).

These results were coincided with those obtained by Salman and Bakry (2012) in Egypt, however with different insect species and different host, they reported that the increase in population density of the mealybug, *Icerya seychellarum* (Westwood) (Hemiptera: Margarodidae) in three peaks of population decreased the yield gradually (inverted relation) by (3.6, 6.5 and 4.3 kg/tree) and (2.5, 4.1 and 2.3 kg/tree) during two successive, respectively and increased the percentage of the yield loss by (1.47, 2.64 and 1.77 %) and (1.47, 1.97 and 1.08 %), when the yield data were correlated with the peaks of insect population in October, May and August through the two successive seasons, respectively.

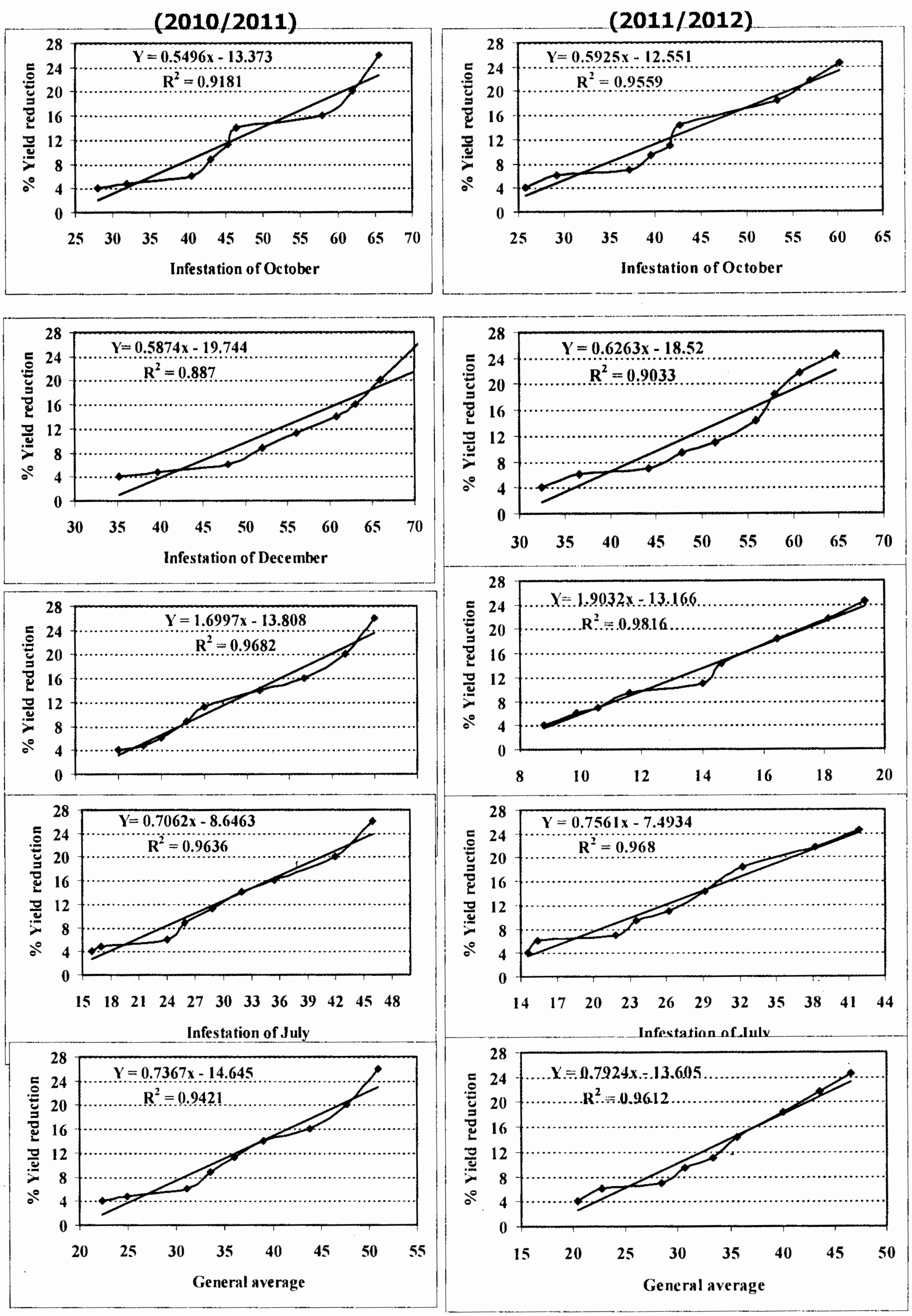


Fig. (2): Relationship between population density of *Aonidiella aurantii* and mango yields of the grafted Balady variety in the two seasons (2010/2011 and 2011/2012).

Concerning, the comparison between population peaks of *A. aurantii* and their effect on the yield of mango during the two successive seasons (2010/2011 and 2011/2012) in Table (6) and illustrated in Fig. (3), were depended on the number of insects per leaf for all peaks of population and applying the straight line equation for each peak.

The results revealed that the infestation during April was more effective causing the least expected values in mango yield with an average of 114.5 and 90.71 kg/tree through the two successive seasons, respectively. While, the infestation during December was least effective causing the highest expected values in mango yield with an average of 240.6 and 229.0 kg/tree during the two successive seasons respectively, Table (6) and illustrated in Fig. (3).

As regarding, the prospective values with (increase or decrease) in the percentage of the loss in yield with increasing the rates of infestation by *A. aurantii* during the two successive seasons (2010/2011 and 2011/2012) in Table (7) and illustrated in Fig. (4).

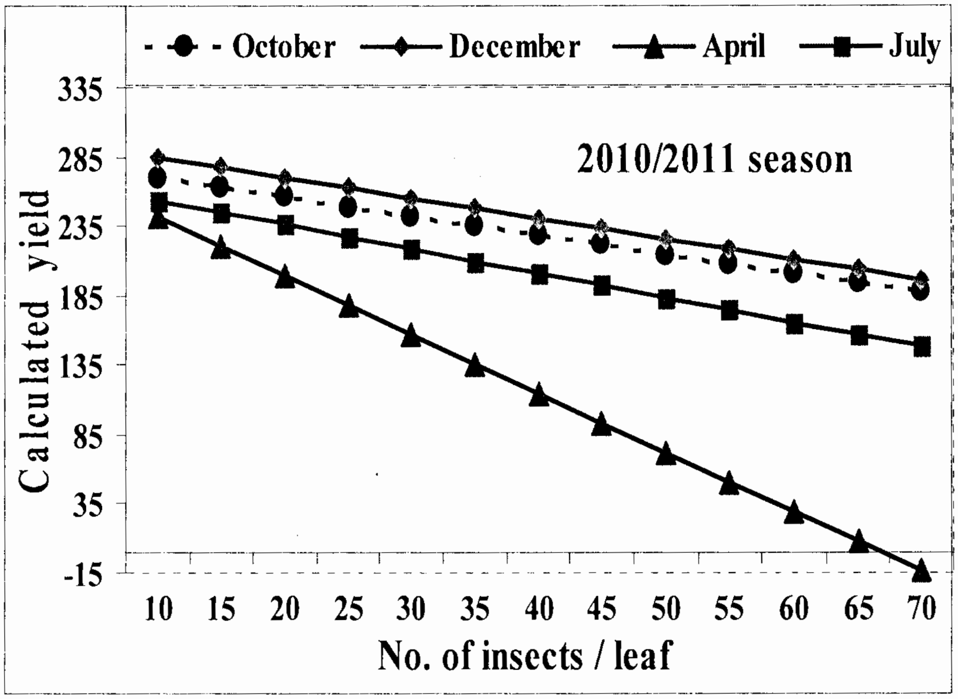
The results showed that the infestation during December was least effective causing the least reduction in mango yield with an average of 3.75 and 6.53% during the two successive seasons, respectively. But, the insect infestation during April was more effective causing the greatest loss in mango yield with an average of 54.18 and 62.96% during the two successive seasons, respectively in Table (7) and illustrated in Fig. (4).

Generally, it seems that the infestation during April was more effective causing the greatest loss in mango yield during the two seasons. These results were confirmed by the findings of El-Said (2006) found that the high infestation levels, the feeding of *I. seychellarum* causes serious damage resulting in early leaves drop and yield reduction. Bakry (2009) reported that the early season infestation with the Maskell scale insect, *Insulaspis pallidula* (Green) (Hemiptera: Diaspididae) during May was more effective causing the greatest loss in mango yield.

Also, Salman and Bakry (2012) stated that the early infestation with the mealybug, *I. seychellarum* during May was more effective causing the greatest loss in mango yield during the two seasons.

Table (6): Expected values with (increase or decrease) in the yield with increase the rates of infestation by *Aonidiella aurantii* during four peaks in the two seasons (2010/2011 and 2011/2012).

Inspected trees	No. of insects / leaf	Calculated yield			
		October	December	April	July
2010/2011	10	269.69	284.68	242.03	253.97
	15	262.82	277.33	220.78	245.14
	20	255.95	269.99	199.53	236.31
	25	249.08	262.65	178.29	227.49
	30	242.21	255.31	157.04	218.66
	35	235.34	247.97	135.79	209.83
	40	228.47	240.62	114.55	201.00
	45	221.60	233.28	93.30	192.18
	50	214.74	225.94	72.06	183.35
	55	207.87	218.60	50.81	174.52
	60	201.00	211.26	29.56	165.70
	65	194.13	203.91	8.32	156.87
	70	187.26	196.57	-12.93	148.04
Average	40	228.474	240.624	114.548	201.004
2011/2012	10	261.23	275.03	230.62	244.84
	15	253.98	267.35	207.30	235.58
	20	246.72	259.68	183.98	226.31
	25	239.46	252.01	160.67	217.05
	30	232.20	244.34	137.35	207.79
	35	224.94	236.67	114.03	198.53
	40	217.69	228.99	90.71	189.27
	45	210.43	221.32	67.39	180.01
	50	203.17	213.65	44.07	170.75
	55	195.91	205.98	20.75	161.48
	60	188.65	198.31	-2.57	152.22
	65	181.40	190.63	-25.89	142.96
	70	174.14	182.96	-49.21	133.70
Average	40	217.686	228.994	90.708	189.268



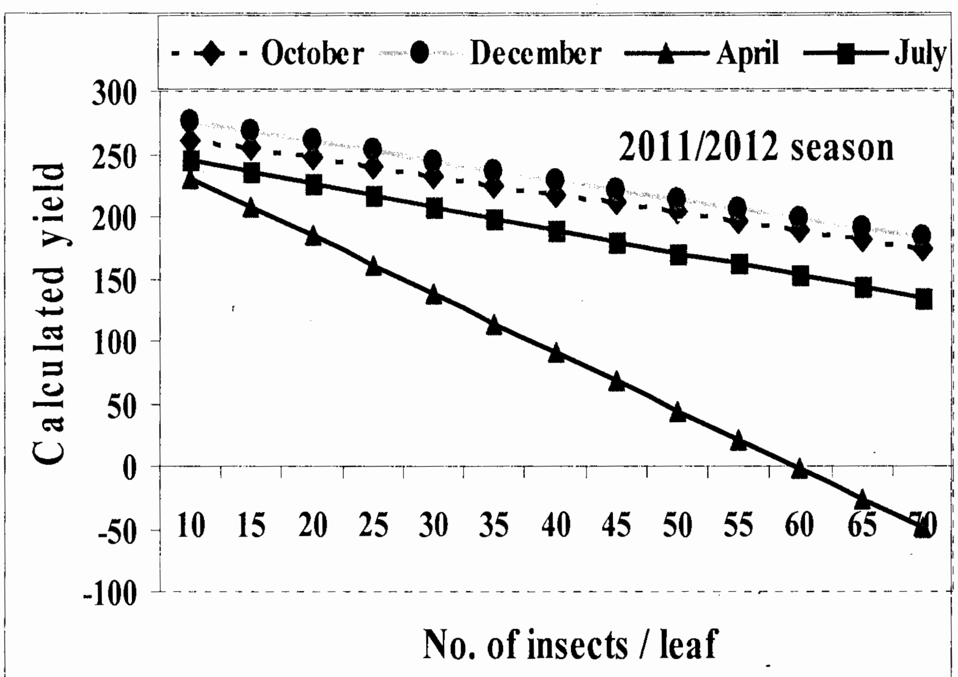
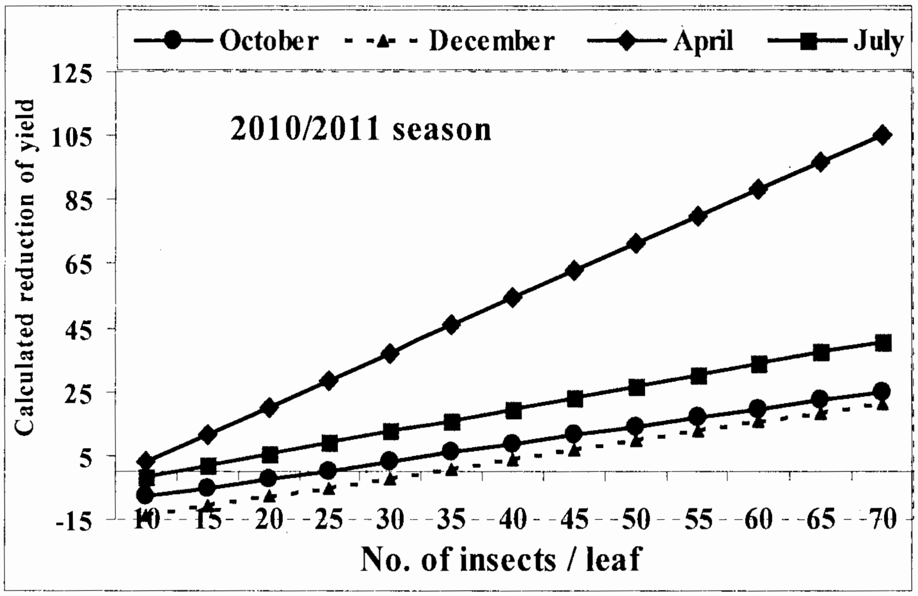


Fig. (3): Expected values with (increase or decrease) in the yield with increase the rates of infestation by *Aonidiella aurantii* during four peaks in the two seasons (2010/2011 and 2011/2012).

Table (7): Expected values (increase or decrease) in the percentage of the loss in yield with increase the rates of infestation by *Aonidiella aurantii* during four peaks population in the two seasons (2010/2011 and 2011/2012).

Inspected trees	No. of insects / leaf	% Yield reduction in peaks of *A. aurantii*			
		October	December	April	July
2010/2011	10	-7.877	-13.870	3.189	-1.584
	15	-5.129	-10.933	11.688	1.947
	20	-2.381	-7.996	20.186	5.478
	25	0.367	-5.059	28.685	9.009
	30	3.115	-2.122	37.183	12.540
	35	5.863	0.815	45.682	16.071
	40	8.611	3.752	54.180	19.602
	45	11.359	6.689	62.679	23.133
	50	14.107	9.626	71.177	26.664
	55	16.855	12.563	79.676	30.195
	60	19.603	15.500	88.174	33.726
	65	22.351	18.437	96.673	37.257
	70	25.099	21.374	105.171	40.788
Average	40	8.611	3.752	54.180	19.602
2011/2012	10	-6.626	-12.257	5.866	0.068
	15	-3.664	-9.126	15.382	3.848
	20	-0.701	-5.994	24.898	7.629
	25	2.262	-2.863	34.414	11.409
	30	5.224	0.269	43.930	15.190
	35	8.187	3.401	53.446	18.970
	40	11.149	6.532	62.962	22.751
	45	14.112	9.664	72.478	26.531
	50	17.074	12.795	81.994	30.312
	55	20.037	15.927	91.510	34.092
	60	22.999	19.058	101.026	37.873
	65	25.962	22.190	110.542	41.653
	70	28.924	25.321	120.058	45.434
Average	40	11.149	6.532	62.962	22.751



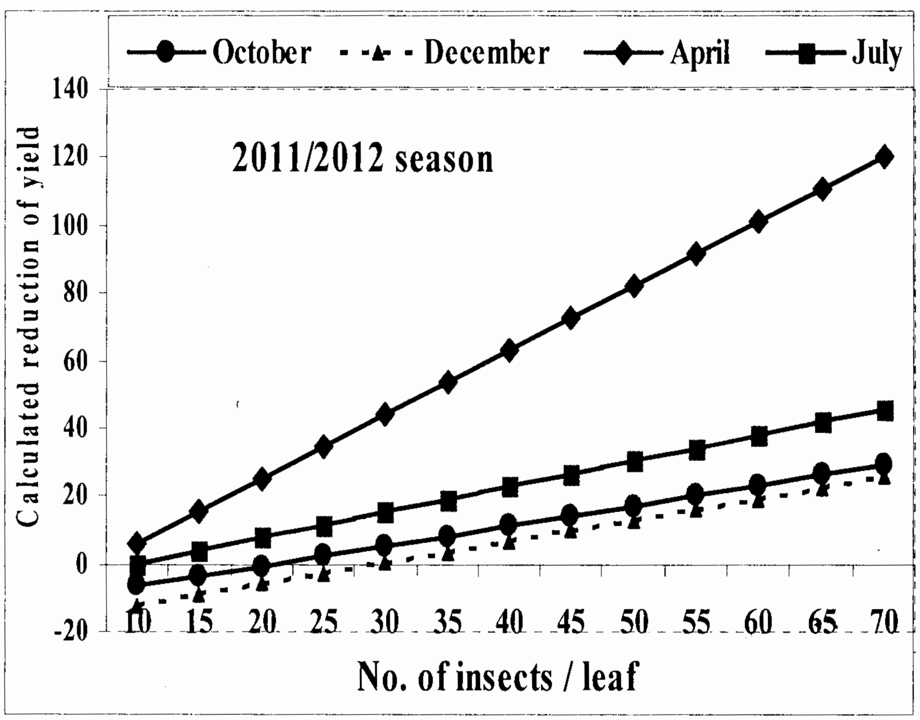


Fig. (4): Expected values (increase or decrease) the percentage of the loss in yield with increase the rates of infestation by *Aonidiella aurantii* during four peaks population during in the two seasons (2010/2011 and 2011/2012).

Generally, it could be concluded that the reduction in mango yield was a summation of many factors including level and time of infestation and the ability of variety to infestation.

These results are similar to those obtained by Reddy-Seshu (1992) who found a linear relationship between infestation and yield loss, and more increasing in yield loss as a result of the earlier infestation. Selim (2002) studied the effect of Maskell scale insect, *I. pallidula* (Green) infestation on the yield of mango trees. He stated that the yield decreased gradually with increasing the population density of this pest. He added that the yield decreased gradually with increasing the population density of *I. pallidula* (Green) in four peaks (September, April, July and August).

REFERENCES

1. Badary, H. and S. Abd-Rabou (2010): Biological studies of the California red scale, *Aonidiella aurantii* (Maskell) (Hemiptera: Diaspididae) bunder different host plants and temperatures with an annotated list of natural enemies of this pest in Egypt. Egypt. Acad. J. biolog. Sci., 3 (1): 235 – 242 pp.
2. Bakry, M.M.S. (2009): Studies on some scale insects and mealybugs infesting mango trees in Qena Governorate. M.Sc. Thesis, Fac. Agric. Minia, Univ., 204 pp.
3. Bakry, M.M.S. (2014): Negative impacts of scale insects and mealybugs infestation on mango leaf growth (leaf area) and pigments content at Luxor Governorate, Egypt. 2nd International Conference on Agricultural & Horticultural Sciences, Hyderabad, India. Feb., 03-05, 2014.
http://www.omicsgroup.com/conferences/agricultural-horticultural-2014/scientific-programme.php?day=1&sid=241&date=2014-02-03.
4. Bedford, E.C.G. (1998): Red scale *Aonidiella auranii* (Maskell). In: E.C.G. Bedford, M.A. Van den Berg and E.A. De Villiers (eds.), Citrus pests in the Republic of South Africa. Dynamic Ad., Nelspruit, South Africa: 132-134 pp.
5. Dreistadt, S.H.; J.K. Clark and M.L. Flint (1994): Pests of landscape trees and shrubs: An integrated pest management guide. Oakland: Univ. Calif. Div. Agric. Nat. Res., 3359.
6. El-Said, M.I. (2006): Studies on some Eco-Physiological factors affecting resistance of five mango cultivars to the Margarodid. mealybugs, *Icerya seychellarum* (Westwood). Ph.D. Thesis, Fac. Agric., Cairo Univ., 121 pp.
7. FAOSTAT (2011): Food and Agriculture Organization of the United Nation (FAO). http://www.fao.org.

8. Fisher, R.A. (1950): Statistical methods for research workers. Oliver and Boyd Ltd., Edinburgh, London. 12th ed., 518 pp.

9. Fouad, M.S.; S.F. Mahmoud and M.M. Sabry (2009): Seasonal abundance and generation numbers of the California red scale insect, *Aonidiella aurantii* (Mask.) infesting mango trees in south Egypt. Egypt. J. Agric. Res. 87 (1): 111-122 pp.

10. Hernandez, P.P.; J.M. Rodriguez Reina and F. Garcia-Mari (2002): Economic threshold for the diaspidid scales, *Aonidiella aurantii, Cornuaspis beckii* and *Parlatoria pergandii* (Homoptera: Diaspididae) in citrus orchards. Boletin de Sanidad Vegetal, Plagas., 28(4): 469-478 pp.

11. Hosny, M.M.; A.H. Amin and G.B. El-Saadany (1972): The damage threshold of the red scale, *Aonidiella aurantii* (Maskell) infesting mandarin trees in Egypt. Z. Ang. Ent., 77: 286-296 pp.

12. Mohamed, G.H. and M.A.M. Asfoor (2004): Effect of *Aonidiella aurantii* infestation on leaf components and fruit quality of two orange varieties. Annuals of Agricultural Science, Moshtohor, 42(2): 821-829 pp.

13. MSTATC (1980): A Microcomputer Program of the Design Management and Analysis of Agronomic Research Experiments. Michigan State Univ., USA.

14. Reddy-Seshu, K.V. (1992): Determination of Economic Injury of the stem borers, *Chilo partellus* (Swinhoe) in Maize, *Zea mays* L. Insect Sci. Appliec., 12(1/2/3): 269-274 pp.

15. Salah, Ghada M.F. (2005): Studies on Certain Coccoids (Homoptera : Coccoidea) infesting ornamental plants in Assiut. M.Sc. Thesis, Fac. Agric., Assiut Univ., 148 pp.

16. Salman, A.M.A. and M.M.S., Bakry (2012): Relationship between the Rate of Infestation with the Mealybug, *Icerya Seychellarum* (Westwood) (Homoptera: Margarodidae) and the yield loss of seedy Balady mango trees at Luxor Governorate. World Rural Observations, 4 (4):50-56 pp.

17. Selim, A.A. (2002): Integrated control of Scale insects on certain fruit trees. Ph.D. Diss, Fac. Agric., Al-Azhar Univ., 173 pp.

العلاقة بين معدلات الإصابة بالحشرة القشرية الحمراء والفقد فى محصول أشجار المانجو فى محافظة الاقصر- مصر

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تعتبر حشرة القشرية الحمراء من الآفات الخطيرة التى تصيب أشجار المانجو فى محافظة الأقصر. تمتص هذه الآفة العصارة النباتية مما يؤدى الي التأثير على نمو الأوراق ومحتواها من العناصر المعدنية. ويعزى الضرر الشديد لهذه الحشرة لسرعة انتشارها وتعدد أجيالها واحتمائها بالإفراز الشمعي. وهذه الحشرة تسبب أضرار بالغة للأشجار المثمرة والإصابة تركز بشكل رئيسي على الأوراق ثم تنتقل إلى الثمار مما تسبب موت الفروع وضعف عام فى الشجرة وصغر حجم الثمار وتغير طعمها وسقوطها وخسارة كبيرة فى المحصول. وتعتبر من أهم العوامل المؤثرة فى خفض أنتاج المحصول والقيمة التسويقية للثمار. ولذلك تم دراسة العلاقة بين معدلات الإصابة بالحشرة القشرية الحمراء خلال أربع قمم والفقد فى محصول المانجو لصنف مانجو بلدى مطعم فى محافظة الاقصر خلال موسمين متتالين من (٢٠١٠/٢٠١١ و ٢٠١١/٢٠١٢). وعند أختيار أشجار متفاوتة فى مستويات الإصابة بالحشرة خلال أربع قمم، أظهرت النتائج، أن الزيادة فى الكثافة العددية خلال أربعة قمم لتعداد الحشرة خفضت المحصول تدريجيا (علاقة عكسية)، حيث ترتب على زيادة تعداد الحشرة بمعدل حشرة واحدة فى أى من القمم الأربعة فقد فى المحصول بمقدار (١.٣٧ و ١.٤٧ و ٤.٢٥ و ١.٧٧ كجم/الشجرة) و (١.٤٥ و ١.٥٣ و ٤.٦٦ و ١.٨٥ كجم/الشجرة) خلال موسمين متتاليين على التوالى. وأن الزيادة فى الكثافة العددية أدت إلى زيادة نسبة الفقد فى المحصول (علاقة طردية) بمقدار (٠.٥٥ و ٠.٥٩ و ١.٧٠ و ٠.٧١%) و (٠.٦٠ و ٠.٦٣ و ١.٩٠ و ٠.٧٦%) فى قمة تعداد أكتوبر وديسمبر وأبريل ويوليو خلال موسمين متتاليين على التوالى. وأوضحت النتائج، أن الإصابة الحشرية فى أبريل كانت أكثر ضررا مسببة أكبر نسبة فقد فى المحصول خلال موسمى الدراسة. وبناء عليه فأن تأثير الحشرة القشرية الحمراء على محصول المانجو هى محصلة لعدة عوامل (أولها مستوى الإصابة الحشرية وتوقيت الإصابة والصنف).