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Population Dynamics of the Mango Shield Scale, Milviscutulus Mangiferae (Green) On Mango Trees in Kafr El-Sheikh Governorate, Egypt

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ABSTRACT

A field study was carried out to study and clarify some ecological aspects of the mango shield scale, Milviscutulus Mangiferae (Green) throughout two successive years (2016/2017 and 2017/2018) infesting mango trees at Motobas district, Kafr El-Sheikh Governorate, Egypt. The obtained results showed that insect population of M. Mangiferae occurred on mango trees all the year round and has two peaks of seasonal activity per year, which was recorded in November and June during the first year (2016/2017) and through in November and July during the second year (2017/2018). Also, the second year of study cleared that the total population of this insect was higher in comparison to the first year of investigation, which may be due to the influence of favourable factors (such as environmental conditions…etc.). As well, the climatic conditions of autumn months during the two years were more suitable for the activity and the maximum values of the total alive stages of M. Mangiferae. Furthermore, the effect of climatic weather factors (daily mean maximum air temperature, daily mean minimum air temperature and mean of relative humidity) was highly significantly effect on the total alive population of M. Mangiferae during the two consecutive years and these factors varied from year to another. As well as, the percentages of explained variance (E.V.%) indicate that all tested variables were responsible on variability in the total insect population by 88.08 and 76.60 % during the first and second years of (2016/2017 and 2017/2018), respectively.

Keywords: *Milviscutulus Mangiferae, seasonal activity, environmental conditions, peaks and mango trees*

INTRODUCTION

Mango trees, *Mangifera indica* L. (Anacardiaceae) are considered of the most popular fruit in Egypt. Egyptian mango occupied economic importance in the world market for rich flavor and tasty. Among several pests, infesting mango trees, the mango shield scale, *Milviscutulus Mangiferae* (Green) (Hemiptera: Coccidae) is considered one of the most main destructive pests of mango trees **(Abd-Rabou and Evans, 2018 and Attia *et al.*, 2018).** *M. Mangiferae* identified and recorded in Egypt for the first time as a new pest attacking mango orchard in Ismaeliya Governorate **(Abd- Rabou and Evans, 2018).** *M. Mangiferae* is polyphagous soft scale insect attacking plants belonging to over 65 genera placed in 40 families including Anacardiaceae, Euphorbiaceae, Moraceae, Myrtaceae and Rutaceae among of them *Mangifera indica* (mango) **(Ben-Dov *et al.*, 2001).** Soft scale insects (Hemiptera: Coccidae) constitute one of the most important group of pest in agriculture, many species are destructive especially to fruit trees and ornamental plants **(Abd-Rabou, 2011).** Adults and nymphs of the soft scale insect attacks tender shoots, twigs, leaflets, veins of leaves and fruits of mango trees **(Hassan *et al.*, 2012 and Bakry *et al.*, 2013).** Usually, this insect weakens the infested plant itself by sucking the sap with the mouth parts causing thereafter deformations by the action of the toxic saliva **(Soliman *et al.*, 2007).** In addition, this pest excrete a large amount of honeydew that cover plant leaves and attract ants on leaves and encourages the growth of sooty mould fungus which give the infested dirty black appearance that effect on photosynthesis and respiration and otherwise reduces the quality of the plant causing considerable economic injury **(Atalla *et al.*, 2007 and Nabil, 2013).** Heavy infestation of *M. Mangiferae* will result in reduced tree vigor and leaf size, causing yellowing of the leaves, leaf drop and death of the branches **(Grimshaw and Donaldson, 2007).** Having information about density and changes in population of *M. Mangiferae* throughout the year and determination of their periods of activity will help in management of this pest. As far as the writers know, few information to recognize its ecological aspects of the mango shield scale, *M. Mangiferae* (Green) on mango trees to specify the proper timing for control. So, it was found necessary to study this point in Kafr El-Sheikh region where there is no reports about any similar research. Therefore, the objective of this study was to estimate the seasonal activity, rate of monthly variation and effect of temperature and relative humidity on the population of this insect was carried out for two successive years (2016/2017 and 2017/2018) in mango trees in Kafr El-Sheikh Governorate.

Materials and Methods

The population fluctuations of this scale found infesting mango trees were carried out at half-monthly intervals at Motobas district, Kafr El-Sheikh Governorate during two successive years extending from beginning of September, 2016 until mid of August, 2018. The selected orchard received the normal agricultural practices without application any chemical control measures before and during the period of study. Five mango trees of Zebda variety similar in age and as uniform as possible in size, shape, height, vegetative growth were selected. Regular half-monthly samples were picked up to randomly from different directions and stratums of tree with rate of 40 leaves per tree. The samples were collected regularly and immediately transferred to laboratory in polyethylene bags for inspection using a binocular microscope. Numbers of alive insects on upper and lower surfaces of mango leaves were individually sorted into immature stages (nymphs) and mature stages (adult females) and then were counted and recorded together opposite to each inspected date.

The studied pest, *M. Mangiferae* identified by Prof. Dr. Sahar A. Attia, Department of scale insect and Mealybugs, Plant Protection Research Institute, Agric. Res. Center, Egypt.

Also, the rate monthly variation in the population (R.M.V.P) was calculated according to the formula reported by **Serag-El-Din (1998):**

$$(\text{R.M.V.P}) = \frac{\text{Av. count of insect at a month}}{\text{Av. count given at the preceding month}}$$

Concerning, the effect of the main weather factors on the different stages of *M. Mangiferae* population. The meteorological data viz., daily mean maximum air temperature, daily mean minimum air temperature and daily mean of relative humidity, for conditions of Kafr El-Sheikh Governorate were obtained from the Central Laboratory for Agricultural climate, Agriculture Research Center, Ministry of Agriculture in Giza. According to the results of the simple correlation, regression coefficient and the partial regression formula which was adopted to find out the simultaneous effects of tested main weather factors on *M. Mangiferae*. The partial regression method termed the C-multipliers was adopted according to **Fisher (1950)**. Averages of different stages of insect population and climatic factors was calculated and shown graphically by Excel sheets. Statistical analysis in the present work was carried out with Computer using (**MSTATC Program software, 1980**) to determine the preferable time for the insect activity and the proper time for its control.

Results and Discussion

Seasonal Activity of *M.* Mangiferae

The monthly counts of *M. Mangiferae* different stages infested mango trees at Motobas district, Kafr El-Sheikh Governorate were recorded through the two successive years (2016/2017 and 2017/2018). Also, means of the monthly records of temperature and relative humidity throughout the two years of investigations and are represented in Tables (1 and 2) and graphically illustrated in Figs. (1and 2). To discuss the seasonal activity of different stages of *M. Mangiferae* based on average number of immature and mature stages counts per leaf were discussed through monthly records.

The First Year (2016/2017)

Data represented in Table (1) and illustrated in Fig. (1) showed that the mean population size was 27.35 ± 1.99, 15.07 ± 0.53 and 42.42 ± 2.45 individuals per leaf for nymphs, adult females and total alive population of *M. Mangiferae*, respectively. The seasonal abundance of total alive population of insect was recorded. Two peaks of activity were observed in November and June when the mean total population density was 89.12 ± 7.27 and 52.02 ± 4.13 individuals per leaf, respectively. A similar trend in the seasonal abundance of nymphs was observed. Two peaks of activity were recorded in November and June when the mean population density was 65.66 ± 6.34 and 34.77 ± 3.62 individuals per leaf, respectively. As well as, however with different values the adult females has three peaks that were occurred in November, February and August when the mean population density was 23.45 ± 0.96, 17.23 ± 0.80 and 17.71 ± 0.44 individuals per leaf, respectively.

The Second Year (2017/2018)

Data tabulated in Table (2) and illustrated in Fig. (2), showed that the mean population density was 30.05 ± 2.09, 17.01 ± 0.46 and 47.06 ± 2.50 individuals per leaf for nymphs, adult females and total alive population, respectively. The seasonal activity of nymphs of insect was recorded. Two peaks of activity were observed in November and July when the mean population density was 63.55 ± 6.18 and 41.18 ± 2.88 individuals per leaf, respectively. A similar trend in the seasonal activity of adult females was observed. Two peaks of activity were recorded in November and July when the mean population density was 23.06 ± 1.15 and 21.36 ± 0.44 individuals per leaf, respectively. The variance in different stages abundance reflected on the total mixed population per leaf which has two peaks of activity were occurred in November and July when the mean population density was 86.60 ± 7.27 and 62.54 ± 3.14 individuals per leaf, respectively.

The result showed that the nymph's population was relatively higher than the adult female's population during the two successive years. Also, the least population density of different stages and total population by *M. mangiferae* were recorded during April for the first year and March month during the second year, which may be attributed to the high relative humidity with the gradual decrease in temperature and dormancy of the trees during winter time. When crawlers emerged after the egg laying period, their population decreased during several months due to mortality of nymph's stage in the winter which is expected to effect dramatically the insect behavior and on rate of growth and infestation.

In contrary, the maximum values of insect population were observed in November month through the two years of study, which may due to the influence of favorable factors (such as environmental conditions…etc.). It appeared that, the annual fluctuations in the population density during the two years were affected by the variability in these physical factors in the both years of investigation. **Dent (1991)** stated that the seasonal phenology of insect numbers, the number of generations, and the level of insect abundance at any location are influenced by the environmental factors at that location. It could concluded that, insect population occurred on mango trees all the year round and has two peaks of seasonal activity per year for different stages and total alive population of pest, which was recorded in November and June during the first year (2016/2017) and through in November and July during the second year (2017/2018). Also, the second year of study cleared that the total population of this insect was higher in comparison to the first year of investigation, which may due to the influence of environmental conditions and others factors, etc. These results were coincided with those obtained by **Kwaiz (1999)** in Egypt, reported that the lowest densities of the the mango soft scale, *Kilifia acuminata* (Signoret) were recorded during the middle of April and August in the first year and in early-September, early-May and mid-August were recorded in the second year. **Attia and Radwan (2013)** reported that the activity period of *K. acuminata* (Green) coincided with the phenology of mango trees, where it was abundant from October to December when the trees showed a good vegetative growth, and also in April when flowering and early fruiting took place.

Data represented in Tables (1 and 2) and illustrated in Fig. (3), showed that the highest population density of *M. Mangiferae*, the nymphs stage (44.43 ± 2.77 and 48.77 ± 2.38 individuals/leaf), adult females (18.24 ± 1.07 and 21.28 ± 0.71 individuals/ leaf), total population (62.67 ± 2.89 and 70.05 ± 2.38 individuals/leaf), were recorded in autumn months during the two years, respectively, thus due to the environmental conditions which were more suitable for the insect activity. The time and sharp of seasonal fluctuation is depending on the geographical studied country.

Based on the data obtained during the two successive years, it could be concluded that the total alive population of *M. Mangiferae* has two peaks, which was recorded in November and June during the first year (2016/2017) and through in November and July during the second year (2017/2018). These results were coincided with those obtained by **El-Dash (1997)** in Shebin El-Kom, Egypt, recorded that *K. acuminata* (Sign.) had two generations annually in mango trees. Also, **Kwaiz (1999)** in Qalubyia, Egypt, reported that *K. acuminata* had two generations, the first generation extended from early September to early May, and the second generation started from early March to early September. **Elwan (2007)** in Qalubyia Governorate, Egypt, he indicated that *K. acuminata* had two annual overlapping generations per year. The first generation occurred during

January and the second generation extended from the late of July to the half of February. **Bakry *et al*. (2013)** in Qena, Egypt, recorded that two peaks of seasonal activity per year. But, **Atalla *et al*. (2007)** in Qalubyia, Egypt, indicated that *K. acuminata* had three annual overlapping generations per year. The peaks occurred in the first of January, mid-October and mid of December. **El-Dash *et al.* (2002)** who revealed that the total average of total monthly count indicated three peaks of abundance in May, July and October- November. **Hassan *et al.* (2012)** in Sharkia Governorate, Egypt, reported that the total alive stages of *K. acuminata* had two to three peaks of activity yearly in both top and bottom levels of the trees. **Attia *et al.* (2018)** in Qalubyia Governorate, Egypt, indicated the occurrence of three generations per year for *M. mangiferae* on mango trees.

Rate of Monthly Variation (R.M.V.P.) in the Population of the Mango Shield Scale, *M. mangiferae*

The monthly variation rates for the total population of *M. mangiferae* were calculated (Tables, 1 and 2). The rate of monthly variation in the population is considered an indicator to the favourable month for insect activity expressed as monthly the increase of this insect population through the year. When R.M.V.P. is > 1 it means more activity, < 1 means less activity and = 1 means no change in the population density during the two successive months **(Bakry, 2009)**.

It was shown as recorded in Tables (1 and 2) that the favourable times of annual increase for total population appeared to be in October, November, May and June months during the first year (2016/2017), when the rates of monthly variation were (1.49, 1.50, 2.24 and 2.21), respectively. While, during the second year (2017/2018) the favourable times of annual increase for total population appeared to be in October, November, April, May, June and July months when the rates of monthly variation were (1.56, 1.15, 1.18, 1.16,1.75 and 1.39), respectively. It is clear that, the climatic conditions of autumn months during the two ears were the optimal for the insect multiplication and build up, since the highest R.M.V.P value was achieved during both years. These results were coincided with those obtained by **El-Dash (1997)** in Shebin El-Kom, Egypt and **Kwaiz (1999)** in Qalubyia, Egypt, they found significant difference in the soft scale insect activity during spring and autumn. Also, **Elwan (2007)** in Qalubyia, Egypt, stated that the population of *K. acuminata* (Sign.) increased in spring and autumn seasons.

Effect of the Main Climatic Factors on the Different Stages of *M. Mangiferae* Population

Nymphs Population

Effect of Daily Mean Maximum Temperature

The results of statistical analysis of simple correlation in Table (3) showed insignificant negative correlation between the daily mean maximum temperature and nymphs' population of *M. mangiferae*, r value was -0.10 during the first year and insignificant positive relation for the second year (r values was 0.19). The unit effect regression coefficient (b) indicates that an increase of 1°C in the daily mean maximum temperature, would decrease the population by 0.34 individuals per leaf through the first year and would increased the population by 0.51 individuals per leaf for the second year. Also, the partial regression values emphasized an highly significantly negative relation (P. reg. value was -7.74) during the first year and significantly negative effect (P. reg. value was -6.74) for the second year. Similarly, however with different values, the partial correlation values were (-0.92 and -0.74) and (t-test values; -6.66 and - 3.13) when the daily mean minimum temperature and mean relative humidity become around their means, during the two years of study, respectively, Table (3). The obtained results revealed that, daily mean maximum temperature entirely above the optimum range of nymph's activity during the first year and above the optimum range of activity in the second years Table (3).

Effect of Daily Mean Minimum Temperature

Regarding the data in Table (3) showed that, the effect of daily mean minimum temperature on nymphs' population was insignificantly positive (r values were +0.22 and +0.21) during the first and second years, respectively. The calculated regression coefficient (b) for the effect of this factor indicated that for every 1°C increase, the population would increase by 0.89 and 0.81 individuals per leaf during the two years, respectively.

The exactly relationship between the daily mean minimum temperature on nymph's population was determined by the partial regression values, which emphasized highly significant positive relations (P. reg.; +10.53 and 10.89) during the first and second years, respectively. The values of the partial correlation were (+0.93 and +0.78), also (t-test values; +7.03 and +3.51) when the daily mean maximum temperature and relative humidity become around their means, during the two years, respectively. The obtained results revealed that, daily mean minimum temperature entirely under the optimum range of nymph's activity during the two years, Table (3).

Effect of Daily Mean of Relative Humidity

Data obtained are represented in Table (3), showed that the daily mean relative humidity had insignificant positive effect on nymph's activity, since the correlation coefficient (r values; +0.13 and +0.55) for the first and second years, respectively. The unit effect (regression coefficient) indicates that an increase of 1% in the mean relative humidity would increase the population density by 0.58 and 1.62 individuals per leaf for the two years of study, respectively.

The real effect of daily mean of relative humidity appeared from the partial regression, which showed that it was significant positive effect (P. reg. value was +2.02) for the first year and highly significantly positive effect (P. reg. value was +3.20) during the second year. The values of the partial correlation were +0.74 and +0.86) and t-test values; +3.12 and +4.71) when the daily mean maximum and minimum temperature become around their means, for the two years of study, respectively. The obtained results revealed that, daily mean relative humidity was under the optimum range of nymphs activity during the first year and entirely under the optimum range of activity for the second year, Table (3).

The Combined Effect of the Tested Climatic Factors on the Nymphs Activity

The combined effect of these climatic factors on the nymph's population was highly significant where the "F" values, were 16.89 and 7.89 during the first and second years, respectively, Table (3). The percentage of variability that could be attributed to the combined effect of these tested factors on the nymph's population which were 86.36 and 74.75% for the two years, respectively. The remaining unexplained variances are assumed to be due to the influences of other unconsidered and undetermined factors that were not included in this study in addition to the experimental error.

Adult Females Population:

Effect of Daily Mean Maximum Temperature

Results are represented in Table (3) showed that the simple correlation (r) between the daily mean maximum temperature and the population density of adult females was insignificant negative (-0.17) during the first year and insignificant positive (r value was +0.22) for the second year. As well as, the calculated regression coefficient (b) for the effect of this factor indicated that every 1˚C increase in the daily mean maximum temperature, would decrease the population by 0.15 individuals per leaf for the first year and would increase the population by 0.13 individuals per leaf during the second year.

The precise effect of this factor on the adult female's population (Table, 3) showed that it was highly significantly negative (P. reg. values were -1.83) for the first year and significantly negative (P. reg. was -1.10) through the second year. Also, the values of partial correlation were (-0.84 and -0.64) and the values of t-test were (-4.42 and -2.37) when the daily mean minimum temperature and relative humidity become around their means, during the two years, respectively. The obtained results revealed that, daily mean maximum temperature entirely above the optimum range of adult females' activity during the first year and above the optimum range of activity for the second year, Table (3).

Effect of Daily Mean Minimum Temperature

Data in Table (3) obtained that, the effect of daily mean minimum temperature on adult females' activity was insignificantly positive (+0.09 and +0.18) during the two years of study, respectively. The calculated regression coefficient (b) for the effect of this factor indicated that for every 1˚C increase, the population would increase by 0.10 and 0.16 individuals per leaf during the first and second years, respectively.

The partial regression coefficient for the effect of daily mean minimum temperature on the adult female's population are represented in Table (3), revealed that it was highly significantly positive relation (P. reg. was +2.49) during the first year and significant positive effect (P. reg. was +1.86) for the second year. The values of the partial correlation were (+0.86 and +0.70), also (t-test values; +4.67 and +2.79) when the daily mean maximum temperature and relative humidity become around their means, during the two years, respectively. The obtained results revealed that daily mean minimum temperature was entirely under the optimum range of adult females' population during the first year and under the optimum range of activity during the second year, Table (3).

Effect of Daily Mean Relative Humidity

As shown in Table (3), it was noticed a insignificant positive correlation between the daily mean relative humidity and the adult females population (r values were +0.36) and significant positive (r value was +0.68) for the first and second years, respectively. The simple regression coefficient indicates that an increase of 1% in the daily mean relative humidity, would increase the population by 0.44 individuals per leaf for the two years.

The real effect of daily mean relative humidity appeared from the partial regression value that, referred to the highly significantly positive effects (P. reg. values; +0.78 and +0.71) during the first and second years, respectively. The values of the partial correlation were (+ 0.77 and +0.87) and t- test values; +3.38 and +4.86) when the daily mean maximum and minimum temperature become around their means, for the two years of study, respectively. Results revealed that, daily mean relative humidity was entirely under the optimum range of adult females activity during the first and second years, respectively, Table (3).

The Combined Effect of the Tested Climatic Factors on the Adult Females

The results showed that the combined effect of these tested factors on the adult female's population was highly significant where the "F" values, were 8.83 and 8.45 during the two years, respectively. The multiple regression analysis revealed that the tested studied variables together were responsible of the changes in the adult females' population. The percentages of explained variance (E.V.%) were 76.80 and 76.01% for the two years of study, respectively, Table (3).

Total Population of M. Mangiferae

Effect of Daily Mean Maximum Temperature

As reported in Table (3), the correlation coefficient (r) between the daily mean maximum temperature and total population was insignificant negative (-0.12) in the first year and insignificant positive (+0.19) during the second year. The effect simple regression coefficient (b) indicates that an increase of 1°C in the daily mean maximum temperature decreased the population by 0.49 individuals per leaf during the first and would increased the population by 0.65 individuals per leaf during the second.

The partial regression values emphasized an highly significantly negative relation (P. reg. was -9.57) during the first years and significant negative effect (P. reg. was -7.83) for the second year. Similarly, however with different values, the partial correlation values were (-0.93 and -0.74) and the values of t-test were -7.12 and -3.14 when the daily mean minimum temperature and relative humidity become around their means, during the two years, respectively. The obtained results revealed that, daily mean maximum temperature entirely above the optimum range of total population activity during the first year and above the optimum range of activity for the second year, Table (3).

Effect of Daily Mean Minimum Temperature

Data in Table (3) showed that, the effect of daily mean minimum temperature on total population activity was insignificantly positive relations (r values; +0.20 and + 0.21) during the two years, respectively. The calculated regression coefficient (b) for the effect of this factor indicated that for every 1˚C increase, the population would increase by 0.98 and 0.97 individuals per leaf during the first and second years, respectively are represented in Table (3).

The relationship between the daily mean minimum temperature on the total alive population was determined by the partial regression values, which emphasized highly significantly positive relations (P. reg.; +13.02 and +12.75) during the first and second years, respectively. The values of the partial correlation were (+0.94 and +0.78), also (t- test) values were (+7.52 and +3.55) during the two successive years, respectively, when the daily mean maximum temperature and relative humidity become around their means. The results revealed that, daily mean minimum temperature was entirely under the optimum range of total population during the two consecutive years, respectively in Table (3).

Effect of the Daily Mean Relative Humidity

Results in Table (3) revealed that, the effect of daily mean relative humidity on total population of *M. mangiferae*. The correlation coefficient (r) was insignificant positive effect (r value was+0.19) for the first year and significant positive relation (r value was +0.58) during the second year. The calculated regression coefficient (b) for the effect of this factor indicated that for every 1% R.H. increase, the population would increase by 1.01 and 2.06 individuals for the first and second years, respectively. As well, the real effect of daily mean of relative humidity appeared from the partial regression, which showed that it was highly significantly positive effects (P. reg.; +2.80 and +3.92) during the two years, respectively. The values of the partial correlation were (+0.80 and +0.87) and t-test values (+3.74 and +4.97) when the daily mean maximum and minimum temperature become around their means, for the two years of study, respectively. The obtained results revealed that, daily mean relative humidity was entirely under the optimum range of activity for the two consecutive years, respectively in Table (3).

The Combined Effect of the Tested Climatic Factors on the Total Population of M. Mangiferae

The results in Table (3) showed that, the combined effect of these tested factors on the total population of *M. Mangiferae* was highly significant where the "F" values, were 19.71 and 8.73 during the first and second years, respectively. The amount of variability that could be attributed to the combined effect of these tested factors on the total population of insect was 88.08 and 76.60% for the two successive years, respectively. The remaining unexplained variances are assumed to be due to the influences of other undetermined and unconsidered factors that were not included in this study in addition to the experimental error.

Table1. *Monthly mean numbers of different stages of M. Mangiferae (Green) and rate of monthly variation in population on mango trees, with climatic factors affecting at Motobas district, Kafr El-Sheikh Governorate during the first year of (2016/2017)*

Season	Date of inspection	Mean number of individuals per leaf ± S.E.			R.M.V.P for total population	Climatic factors		
		Nymphs (Immature stages)	Adult females (Mature stages)	Total		Max. temp. °C	Min. temp. °C	% R.H.
Autumn	Sept., 2016	26.42 ± 1.88	13.23 ± 0.96	39.64 ± 2.55	—	31.47	26.13	55.45
	Oct.	41.21 ± 4.90	18.05 ± 1.05	59.26 ± 5.91	1.49	28.65	23.99	63.92
	Nov.	65.66 ± 6.34	23.45 ± 0.96	89.12 ± 7.27	1.50	24.04	20.94	66.32
	Average	44.43 ± 2.77	18.24 ± 1.07	62.67 ± 2.89	1.50	28.06	23.69	61.90
Winter	Dec.	48.25 ± 3.52	18.65 ± 0.78	66.89 ± 4.24	0.75	21.71	18.93	69.24
	Jan., 2017	27.93 ± 2.66	15.66 ± 0.31	43.59 ± 2.88	0.65	18.85	14.03	69.00
	Feb.	12.03 ± 1.25	17.23 ± 0.80	29.26 ± 1.94	0.67	18.82	13.76	67.00
	Average	29.40 ± 6.22	17.18 ± 0.63	46.58 ± 4.08	0.69	19.80	15.57	68.41
Spring	Mar.	3.68 ± 0.50	8.19 ± 0.87	11.87 ± 1.35	0.41	25.51	16.57	66.85
	April	4.59 ± 0.62	5.89 ± 0.18	10.48 ± 0.78	0.88	27.80	19.94	64.17
	May	14.20 ± 2.06	9.30 ± 0.91	23.50 ± 2.94	2.24	31.25	23.84	60.65
	Average	7.49 ± 2.60	7.79 ± 1.06	15.28 ± 2.43	1.18	28.19	20.12	63.89
Summer	June	34.77 ± 3.62	17.25 ± 0.67	52.02 ± 4.13	2.21	32.61	25.31	64.73
	July	31.23 ± 2.00	16.26 ± 0.43	47.50 ± 2.18	0.91	34.31	25.41	69.32
	Aug.	18.19 ± 1.57	17.71 ± 0.44	35.90 ± 1.65	0.76	33.89	25.23	69.53
	Average	28.06 ± 2.27	17.08 ± 0.38	45.14 ± 1.73	1.29	33.60	25.32	67.86
Total		328.16	180.87	509.03				
General average		27.35 ± 1.99	15.07 ± 0.53	42.42 ± 2.45		27.41	21.17	65.51
%		64.47	35.53	100.00				

Table2. *Monthly mean numbers of different stages of M. Mangiferae (Green) and rate of monthly variation in population on mango trees, with climatic factors affecting at Motobas district, Kafr El-Sheikh Governorate during the second year of (2017/2018)*

Season	Date of inspection	Mean number of individuals per leaf ± S.E.			R.M.V.P for total population	Climatic factors		
		Nymphs (Immature stages)	Adult females (Mature stages)	Total		Max. temp. °C	Min. temp. °C	% R.H
Autumn	Sept., 2017	30.49 ± 2.43	17.78 ± 0.46	48.27 ± 2.88	—	38.32	28.74	67.88
	Oct.	52.28 ± 5.28	23.01 ± 0.94	75.28 ± 6.19	1.56	36.41	26.39	74.68
	Nov.	63.55 ± 6.18	23.06 ± 1.15	86.60 ± 7.27	1.15	23.37	21.94	64.43
	Average	48.77 ± 2.38	21.28 ± 0.71	70.05 ± 2.38	1.36	28.31	23.20	63.09
Winter	Dec.	54.21 ± 3.28	20.98 ± 0.47	75.19 ± 3.72	0.87	24.41	20.82	69.42
	Jan., 2018	29.82 ± 3.36	16.01 ± 0.38	45.83 ± 3.70	0.61	19.82	15.43	69.21
	Feb.	11.26 ± 1.63	14.96 ± 0.89	26.22 ± 1.89	0.57	16.86	15.14	66.74
	Average	31.76 ± 7.02	17.32 ± 1.02	49.08 ± 5.35	0.68	20.36	17.13	68.46
Spring	Mar.	5.93 ± 0.57	12.88 ± 0.79	18.81 ± 1.33	0.72	22.45	18.23	58.80
	April	9.37 ± 0.84	12.76 ± 0.57	22.13 ± 0.79	1.18	26.78	21.94	56.24
	May	15.30 ± 1.61	10.29 ± 0.54	25.58 ± 2.13	1.16	30.60	26.22	53.80
	Average	10.20 ± 1.87	11.97 ± 0.80	22.17 ± 1.33	1.02	26.61	22.13	56.28
Summer	June	30.16 ± 3.96	14.74 ± 0.74	44.89 ± 4.68	1.75	32.58	27.84	55.52
	July	41.18 ± 2.88	21.36 ± 0.44	62.54 ± 3.14	1.39	34.26	27.95	60.10
	Aug.	17.06 ± 1.90	16.32 ± 0.42	33.38 ± 2.30	0.53	33.89	27.75	60.29
	Average	29.46 ± 2.94	17.47 ± 0.80	46.94 ± 2.58	1.23	33.58	27.85	58.63
Total		360.58	204.14	564.73				
General average		30.05 ± 2.09	17.01 ± 0.46	47.06 ± 2.50		28.31	23.20	63.09
%		63.85	36.15	100.00				

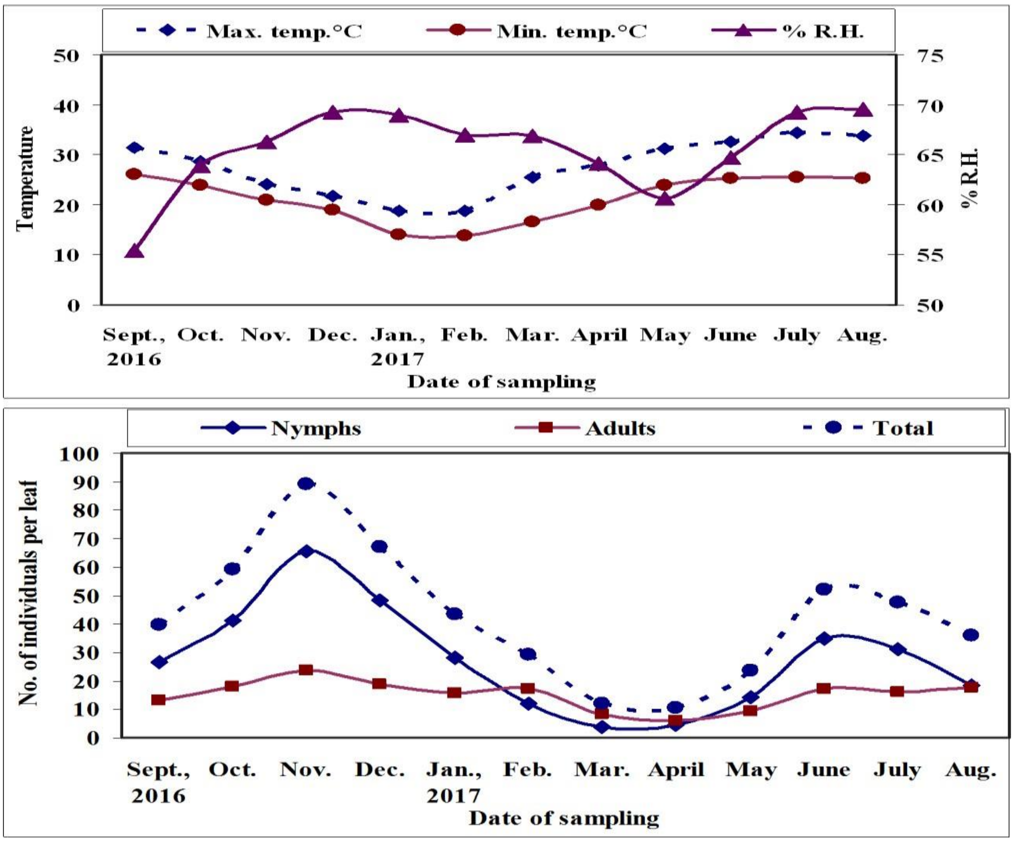

Fig1. *Means of monthly counts of different of stages of M. Mangiferae (Green) on mango trees, with climatic factors affecting at Motobas district, Kafr El-Sheikh Governorate during the first year of (2016/2017)*

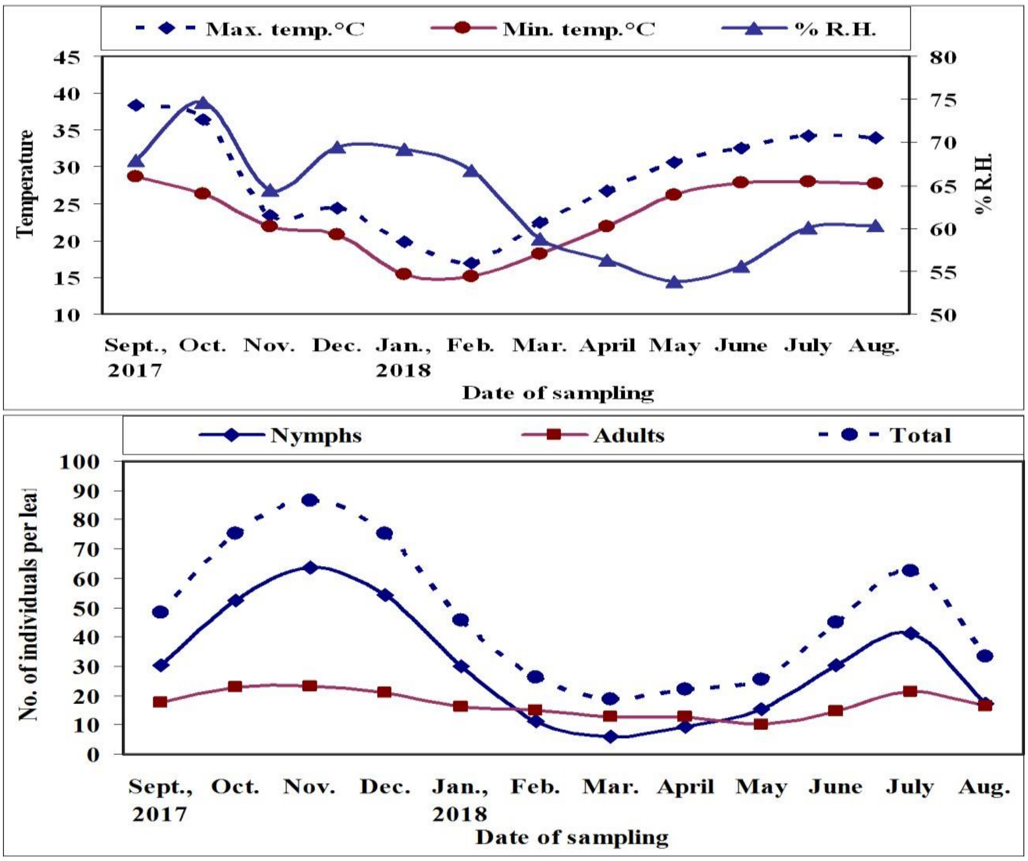

Fig2. *Means of monthly counts of different of stages of M. Mangiferae (Green) on mango trees, with climatic factors affecting at Motobas district, Kafr El-Sheikh Governorate during the second year of (2017/2018)*

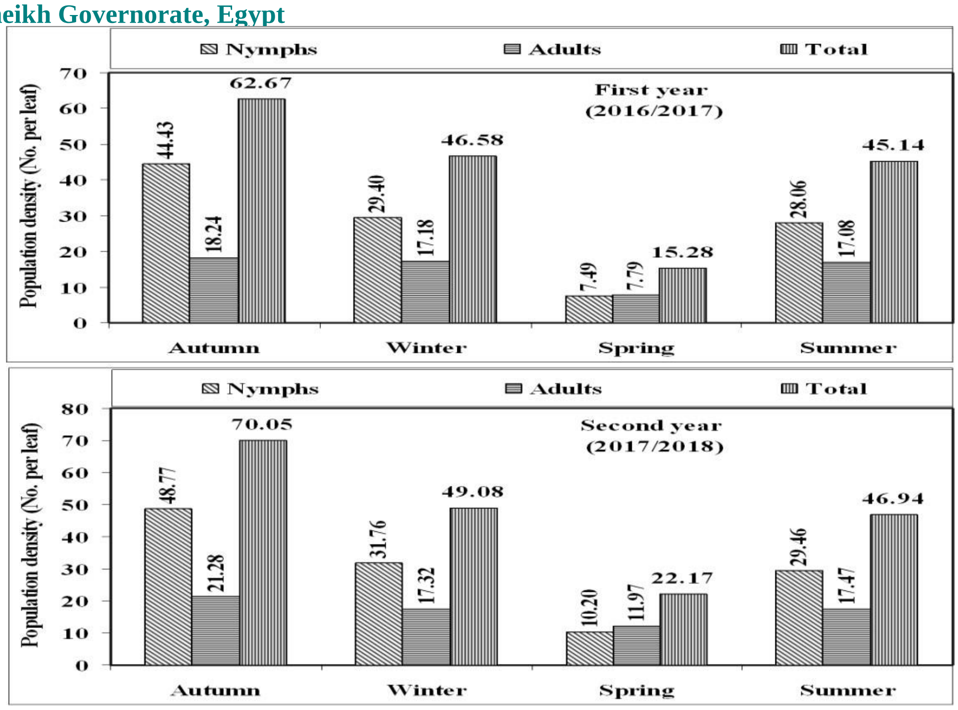

Fig3. *Population density of different stages of M. Mangiferae counted on mango leaves at Motobas district, Kafr El-Sheikh Governorate during the two successive years (2016/2017 and 2017/2018)*

Table2. *Different models of correlation and regression analyses for describing the relationship between different stages of M. Mangiferae and three climatic variables on mango trees at Motobas district, Kafr El-Sheikh Governorate during the two successive years (2016/2017 and 2017/2018).*

Year	Tested counts		Simple correlation and regression values				Partial correlation and regression values				Analysis variance			
			r	b	S.E	t	P. cor.	P. reg.	S.E	t	F value	MR	R^2	E.V.%
2016/2017	Nymphs	Max. temp.	-0.10	-0.34	1.04	-0.33	-0.92	-7.74	1.16	-6.66 **	16.89 **	0.93	0.86	86.36
		Min. temp.	0.22	0.89	1.26	0.71	0.93	10.53	1.50	7.03 **				
		R.H.%	0.13	0.58	1.39	0.42	0.74	2.02	0.65	3.12*				
	Adult female	Max. temp.	-0.17	-0.15	0.28	-0.54	-0.84	-1.83	0.41	-4.42 **	8.83 **	0.88	0.77	76.80
		Min. temp.	0.09	0.10	0.35	0.27	0.86	2.49	0.53	4.67 **				
		R.H.%	0.36	0.44	0.36	1.23	0.77	0.78	0.23	3.38**				
	Total	Max. temp.	-0.12	-0.49	1.28	-0.38	-0.93	-9.57	1.34	-7.12 **	19.71 **	0.94	0.88	88.08
		Min. temp.	0.20	0.98	1.56	0.63	0.94	13.02	1.73	7.52 **				
		R.H.%	0.19	1.01	1.70	0.60	0.80	2.80	0.75	3.74 **				
2017/2018	Nymphs	Max. temp.	0.19	0.51	0.86	0.60	-0.74	-6.74	2.15	-3.13*	7.89 **	0.86	0.75	74.75
		Min. temp.	0.21	0.81	1.19	0.68	0.78	10.89	3.10	3.51**				
		R.H.%	0.55	1.62	0.77	2.11	0.86	3.20	0.68	4.71**				
	Adult female	Max. temp.	0.22	0.13	0.19	0.70	-0.64	-1.10	0.46	-2.37*	8.45 **	0.87	0.76	76.01
		Min. temp.	0.18	0.16	0.26	0.59	0.70	1.86	0.67	2.79*				
		R.H.%	0.68	0.44	0.15	2.91 *	0.87	0.71	0.15	4.86**				
	Total	Max. temp.	0.19	0.65	1.03	0.63	-0.74	-7.83	2.49	-3.14*	8.73**	0.88	0.77	76.60
		Min. temp.	0.21	0.97	1.44	0.68	0.78	12.75	3.59	3.55**				
		R.H.%	0.58	2.06	0.90	2.28 *	0.87	3.92	0.79	4.97**				

*r = Simple correlation; b = Simple regression; P. cor. = Partial correlation; P. reg.= Partial regression; MR = Multiple correlation; R^2= Coefficient of determination; E.V% = Explained variance; S.E = Standard error; * Significant at $P \leq 0.05$ and ** Highly significant at $P \leq 0.01$*

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