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Estimate the effect of climatic factors on population density of parlatoria date scale insect, Parlatoria blanchardii by different models of correlation and regression.

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The parlatoria date scale insect, *Parlatoria blanchardii* (Targioni-Tozzetti) (Hemiptera: Diaspididae) is a serious pest on date palm trees in Egypt. The adults and nymphs of this insect sucking great amount of plant sap that give low rates of photosynthesis and respiration which leads to curling, yellowing, dryness and leaves shedding. The present work was carried out to study the impact of climatic factors on population density of *P. blanchardii* infesting date palm trees by different models of correlation and regression during the current year (average five years from 2009 to 2013) at Esna district, Luxor Governorate, Egypt. The results revealed that the monthly observations of the total population of *P. blanchardii* had three to four peaks of seasonal activity per year. The results showed simple significant positive correlation between the mean temperature and different stages of *P. blanchardii* and total population of insect. Similarly, the relation between mean dew point and different stages of *P. blanchardii* and total population of insect was significantly positive. Differently, the simple correlation between mean of relative humidity and different stages and total population of insects was significantly negative. Among five models of regression, the quartic degree of polynomial regression was exhibiting the highest percentage of explaining variance (E.V.%) as compared with the other models in all studied relations. Also, linear and logarithmic regressions were significant in all studied relations. The results revealed that the mean dew point was below the optimum range for activities of nymphs, adult females and total population of *P. blanchardii.* The most effective variable in population changes was mean dew point and it was 28.05, 23.42 and 26.41% for nymphs, adult females and total population of insect, respectively. The results demonstrated that the combined effect of maximum temperature, relative humidity and dew point was significant effect on the numbers of nymphs of *P. blanchardii*. The percentages of explaining variance (E.V.%) indicated that the effect of all tested climatic factors on population changes of nymphs, adult females and total population of insect were responsible for 73.9, 65.5 and 71.2%, respectively.

Key words: Parlatoria date scale, *Parlatoria blanchardii*, seasonal activity and climatic factors.

INTRODUCTION

Among several pests, infesting date palm trees (*Phoenix dactylifera* L.), parlatoria date scale insect, *Parlatoria blanchardii* (Targioni-Tozzetti) (Hemiptera: Diaspididae) is considered one of the most destructive pests in Egypt. Adults and nymphs of this insect sucking great amount of leaves sap which contain macro- and micro-elements. At high level of infestation, remarkable damage occurs, resulting in shedding new leaves and yield reduction (El-Said, 2000). Great damages can be done by this scale insect by sucking the plant sap that give low rates of photosynthesis and respiration which leads to curling, yellowing and leaves shedding. The subsequent damage leads to considerable quality and quantity yield losses and also marketing value of the fruits. A characteristic symptom of infestation by *P. blanchardii* is appearance and accumulation of its scales on attacked palm parts (El-Said, 2000, El-Sherif *et al*., 2001 and Blumberg, 2008).

To develop an effective control against *P. blanchardii*, it is essential to know its bio-ecology including population dynamics and climatic factors influencing the life history and the densities of different phonological stages. Temperature has a direct effect on insect activity and rate of development (Lamb, 1992). The relation between insect developmental rate and temperature was established very early and represents an important ecological variable for modeling population dynamics of insects (Jarosik *et al*. 2002). According to Zalom *et al.* (1982) the rate of development is based on the accumulation of heat measured in physiological rather than chronological time. 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. Among Idder-Ighili *et al*. (2015) findings, adult females of parlatoria date palm scale, *P. blanchardii* were the most affected by climate factors. For the total population of *P. blanchardii*, high values of minimum temperatures negatively affected population density, while high values of maximum temperature showed a positive influence.

Climate change has become one of the major challenges for mankind and the natural environment. It is related to factors like rise in temperature and increased incidence of extreme weather events that can directly affect rate of development, reproduction, distribution, migration and adaptation in insects. In addition, indirect effects can occur on the insect's host plants, natural enemies and interspecific interactions with other insects (Salem and Hamdy, 1985; Bale *et al*., 2002; Walther *et al*., 2002; Samways, 2005 and Merrill, 2008). There are many models available to describe mean developmental times or rates of development as a function of temperature, but it is not obvious which one is the most suitable for practical integrated pest management (IPM) implementation (Abd-rabou and Farag, 2014; Farag, *et al*., 2014 and El-Sahn and Sadek, 2014).

The objective of this study is to estimate the impact of climatic factors on population density of parlatoria date scale insect, *P. blanchardii* infesting date palm trees using different models of correlation and regression.

MATERIAL AND METHODS

The population fluctuations of *P. blanchardii* which infest date palm trees were carried out at half-monthly intervals at Esna district, Luxor Governorate during five successive years (from 2009 to 2013 years). An orchard about one feddan (4200 m^2) was selected for sampling during the studied period. Ten date palm trees of White variety of almost similar and as uniform as possible in size, age (5 years), shape, height, vegetative growth were selected. These date palm trees were left without fronds pruning as well as they were not exposed for any chemical control measures before and during the period of investigation and randomly chosen for sampling at half-monthly intervals to conduct the study. The sample size (10 leaflets) was taken from different directions and levels of palm trees. The samples were collected regularly and immediately transferred to the laboratory in polyethylene bags and a stereo-microscope was used for inspecting. Numbers of alive insects on upper and lower surfaces of date palm trees leaflets were individually sorted into immature stages (nymphs) and mature stages (adult females) and then were counted and recorded together in each inspected date.

Monthly mean numbers of *P. blanchardii* per date palm leaflet from 2009 to 2013 years was considered in this study as current population of pest. The half-monthly of testing main weather factors (i.e. mean air temperature, mean of % R.H. and mean of dew point °C) at Luxor Governorate from 2009 to 2013 years were obtained from the Central Laboratory for Agricultural Climate, Agriculture Research Center, Ministry of Agriculture in Giza. The altitude, latitude and longitude of this weather region of Luxor were 99 m, 25.67ºN and 32.71ºE, respectively.

- Current climatic condition: (Average of tested climatic factors during five years from 2009 to 2013 years).
- Current population density: (Average of population density during five years from 2009 to 2013 years).

Obtained data were statistically analyzed by the simple correlation and five models of regression (i.e. Linear, Logarithmic, Quadratic, Cubic and Quartic), the independent variable (x) representing the climate factor and the dependent variable (y) represented the numbers of insect. The partial regression was adopted according to Fisher (1950). As well as, the partial and multiple correlation values were calculated and the percentage of explained variance (%E.V.) for the combined effect of these climatic factors.

Averages of different stages of insect population and climatic factors was calculated and shown graphically by Excel sheets.

Statistical analysis was carried out by using MSTATC Program software, 1980 and SPSS (SPSS, 1999) to determine the preferable time for the insect activity and the proper time for its control.

RESULTS AND DISCUSSION

Seasonal fluctuations in population of *P. blanchardii*:

Immature stages (nymphs):

The monthly mean number of nymphs of *P. blanchardii* on date palm leaflets at Esna district, Luxor Governorate during the period from 2009 to 2013 years and current population are graphically illustrated in Figure 1.

The results showed that the nymphs had four peaks per year, in April, June, September and November in all studied years and current population expect 2009. The nymphs had three peaks in 2009, which was recorded in April, June and October, Figure 1.

Mature stages (adult females):

A similar trend in the seasonal fluctuation of adult females of *P. blanchardii* was observed, with different values. The females had four peaks that were recorded in April, June, September and November in all studied years and current population, Figure 1

Total population of *P. blanchardii*:

According to data of total population of insect, four peaks were recorded in April, June, September and November in all studied years and current population expect 2009. The total population of insect had three peaks in 2009, which was recorded in April, June and October, Figure 2

Consideration of annual fluctuations showed relation of insect activity by physical factors. The annual fluctuations of population density were affected by the variability of physical factors in both years. Most authors indicated three or four peaks per year for *P. blanchardii* depending on environmental conditions of the area and the host plant world wide. Hussain (1996) in Egypt, stated that the population density of *P. blanchardii* on date palm had three peaks in October, March and July. Youssef (2002) in Kafr El- Sheikh Governorate, Egypt, reported that this insect had three peaks during the year, the highest peak was found in October, the second in March and the smallest third one in June. But, Eraki (1998), El-Said (2000), El-Sherif *et al*. (2001) and Elwan and El-Said (2009) reported that the *P. blanchardii* had four peaks per year in Egypt.

The climatic factors from 2009 to 2013 years and current conditions in Luxor region:

Trend of air temperature:

The means of the monthly air temperature were recorded from January, 2009 till December, 2013 and current climate (Fig., 2). The highest monthly mean air temperature values were recorded during summer (June, July and August) during all studied years and the current climate. While, winter (January, February and December) had the lowest values of temperature.

The highest annual average of air temperature (27.21ºC) was recorded at 2013, followed by 2012, 2011 and 2010 (25.68, 25.26 and 23.91ºC), respectively. Whereas, the lowest average of air temperature was recorded in 2009 (23.78ºC as a general average of year). The average of temperature degrees during the current climate was 25.17ºC.

Trend of relative humidity:

Monthly average of mean relative humidity and current climate were shown in Fig. (2). The highest monthly mean relative humidity were recorded during winter (January, February and December) in all studied years and the current climate. While, the lowest values were recorded in May, June and July months.

Regarding, the highest average annual relative humidity degree (31.68%) was recorded at 2013, followed by 2012, 2011 and 2010 years (31.14, 29.99 and 28.39 %), respectively. Whereas, the lowest ones was recorded in 2009 year (28.24 % as a general average of year). The mean of relative humidity degrees was 29.89% were recorded in the current climate.

Trend of dew point:

The monthly means of dew point were recorded from January, 2009 till December, 2013 and current climate (Fig., 2). The highest monthly mean dew point was recorded in July, August and September during all studied years and the current climate. While, the lowest values was during January, February and March.

The highest average annual dew point degree (9.50ºC)

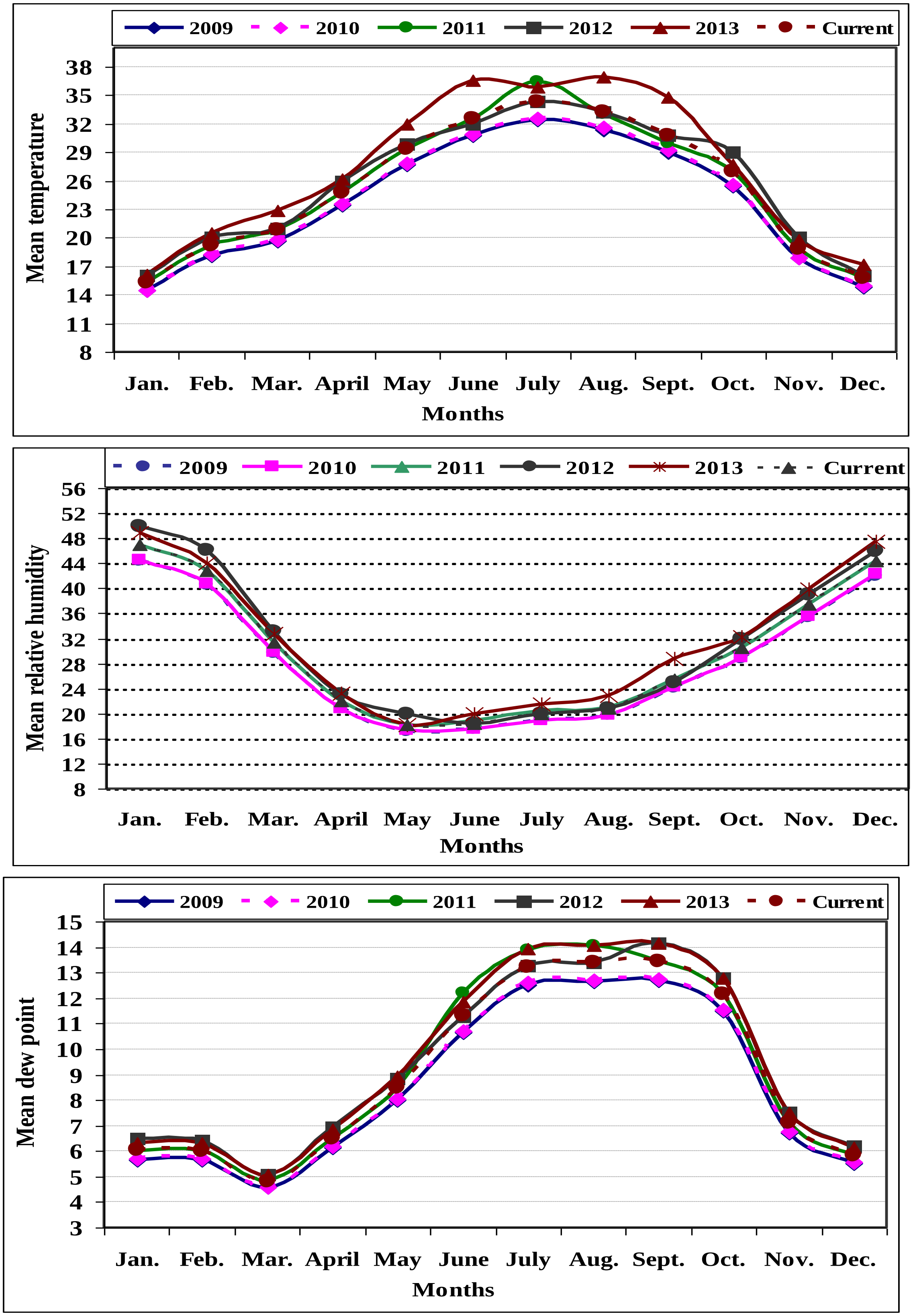

Figure 1: Means of monthly air temperature, relative humidity and dew point under climatic conditions at Esna district, Luxor Governorate during the period from 2009 to 2013 years and current data.

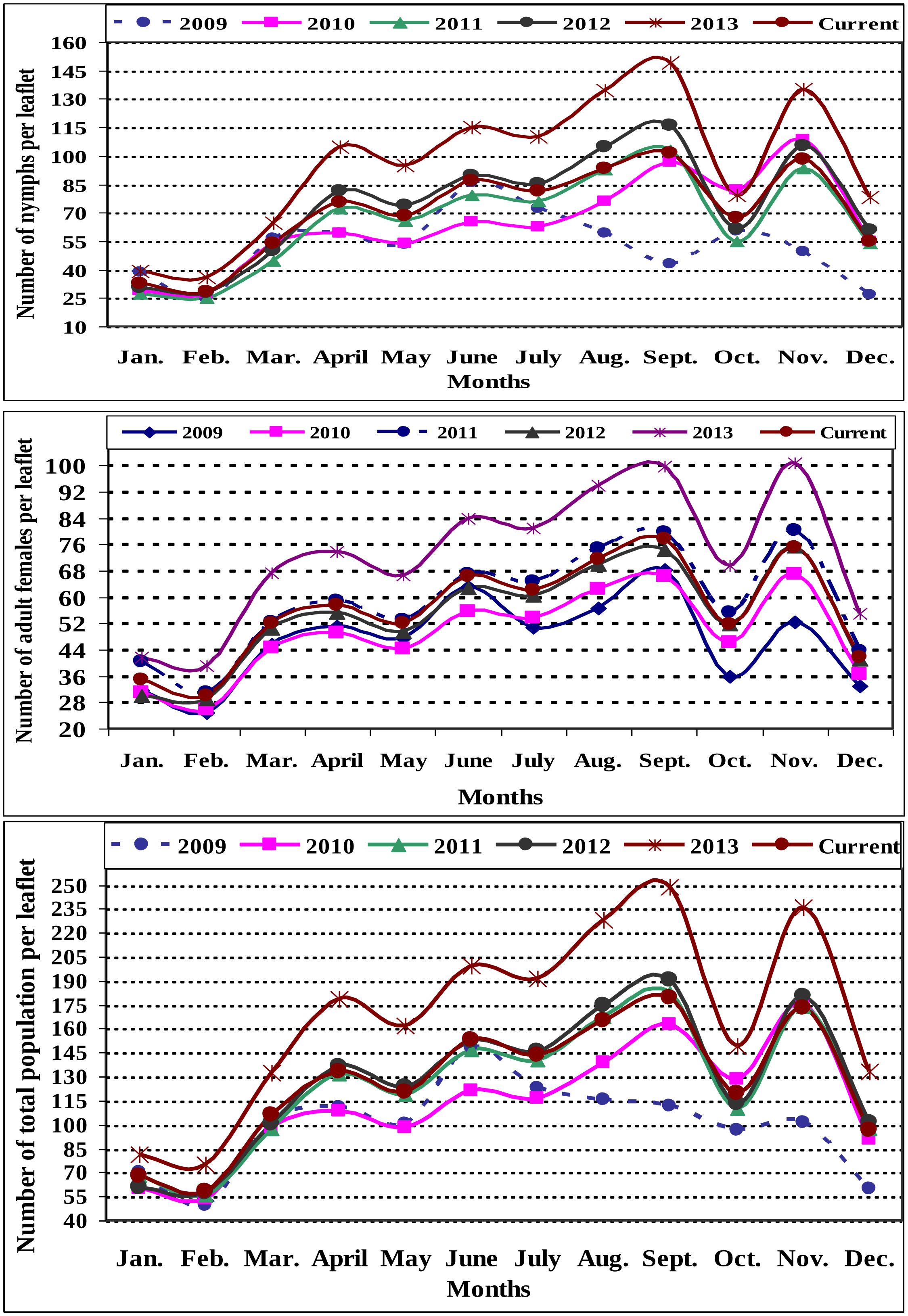

Figure 2: Monthly mean number of nymphs, adult females and total population of *P. blanchardii* on date palm leaflets at Esna district, Luxor Governorate during the period from 2009 to 2013 years and current data.

Table (1): Simple correlation and regression values when the counts of the climatic factors were plotted versus the population density of different stages of *P. blanchardii*.

Stages	Tested factors	Simple correlation and regression values					Coefficient of Variation
		r	b	S.E	t	p	
Nymphs	Mean temp	0.66	2.30	0.82	2.81	0.02	0.27
	R.H.%	-0.66	-1.49	0.53	-2.79	0.02	0.27
	Dew Point (°C)	0.67	4.77	1.66	2.87	0.02	0.27
Adult females	Mean temp	0.64	1.40	0.54	2.60	0.03	0.22
	R.H.%	-0.64	-0.91	0.35	-2.60	0.03	0.22
	Dew Point (°C)	0.63	2.86	1.11	2.59	0.03	0.22
Total	Mean temp	0.66	3.70	1.35	2.75	0.02	0.25
	R.H.%	-0.65	-2.40	0.88	-2.74	0.02	0.25
	Dew Point (°C)	0.66	7.63	2.75	2.78	0.02	0.25

r = Simple correlation b = Simple regression S.E = Standard error
P= Probability, significant at P ≤ 0.05 C.V.= Coefficient of Variation

was recorded at 2013, followed by 2012, 2011 and 2010 (9.36, 9.21 and 8.57ºC), respectively. But, the lowest was recorded in 2009 (8.53ºC as a general average of year). The average of dew point degrees during the current climate was 9.04ºC.

Impact of the main climatic factors on the population density of different stages of *P. blanchardii*:

Nymph population:

A- Effect of mean temperature:

The results of statistical analysis of simple correlation (Table, 1) showed a positive and significant correlation between the mean temperature and nymph population of *P. blanchardii*, (r value was **+**0.66). The effect of regression coefficient (b), indicated that an increase of 1**°**C in the mean temperature, increase the population 2.3 individuals per leaflet in the current year.

Our results suggested that among five models of regression, the quartic degree of polynomial regression between the mean temperature and nymphs population was exhibited the highest percentage of explained variance (E.V.= 49.83%) in the current year as compared with the other models. Also, all models of regression were insignificant except linear and logarithmic regression (Table, 2).

Concerning, the partial regression values (P.reg) are represented in Table (3), emphasized an significant negative relation (-10.73) and t value was (-2.45) in the current year, as well as the partial correlation was significant negative (-0.66). The partial regression values indicate the average rate of change in insect activity due to a unit change in any of the tested factors under test. The results revealed that, mean temperature above the optimum range of nymph population of *P. blanchardii* activity was responsible for the most changes in the insect population by 19.61% during the current year.

B- Effect of mean relative humidity:

The effect of mean relative humidity on nymphs activity was significant negative (r = -0.66) in the current year (Table, 1). The calculated regression coefficient indicated that every 1˚C increase in the mean relative humidity decreased the population density 1.49 individuals per leaflets in the current year, Table (1).

The results suggested that among five models of regression, the quartic degree of polynomial regression between the mean relative humidity and nymph population was exposed the highest percentage of explained variance (E.V.= 54.51%) than the other models in the current year. Also, all models of regression were significant except cubic and quartic degrees of regression (Table, 2).

The precise effect of the mean relative humidity on the population of nymph, showed that it was significant negative (P.reg value = -5.16) and t value was (-2.84). Also, the partial correlation was significant negative (-0.71). The obtained result revealed that, mean relative humidity above the optimum range of nymph population and was responsible for the most changes in the insect population (26.22%) during the current year.

C- Effect of mean dew point:

Concerning the data in Table (1) showed that the simple correlation (r) between the mean dew point and the population density of nymphs was significantly positive (+0.67). As well as, the calculated regression coefficient

Table (2): Regression analysis of five models describing the effect of climatic factors on the population density of different stages of *P. blanchardii*.

Factors	Model	a	Straight-line equation	P	R^2	E.V.%
Mean temp. and Nymphs	Linear	12.32	Y=12.3 + 2.3 X	0.02	0.44	44.12
	Logarithmic	-104.82	Y = 54.922Ln(x) - 104.82	0.02	0.45	44.56
	Quadratic	-12.11	$Y = -0.0428x^2 + 4.4256x - 12.114$	0.07	0.44	44.46
	Cubic	-57.59	$y = 0.0034x^3 - 0.2937x^2 + 10.4x - 57.594$	0.17	0.45	44.52
	Quartic	-2328.2	$Y = -0.007x^4 + 0.72x^3 - 26.1x^2 + 411.3x - 2328.2$	0.25	0.50	49.83
Mean R.H. and Nymphs	Linear	114.86	Y= -1.4926x + 114.86	0.02	0.44	43.83
	Logarithmic	211.40	Y= -42.272Ln(x) + 211.4	0.03	0.39	38.89
	Quadratic	29.45	$Y= -0.0935x^2 + 4.4875x + 29.446$	0.04	0.52	52.43
	Cubic	54.74	$Y = -0.0009x^3 - 0.0067x^2 + 1.8441x + 54.739$	0.10	0.52	52.47
	Quartic	-637.14	$Y= -0.0008x^4 + 0.0997x^3 - 4.74x^2 + 97.08x - 637.1$	0.18	0.55	54.51
Mean Dew point and Nymphs	Linear	27.21	Y= 4.7678x + 27.175	0.02	0.45	45.12
	Logarithmic	-21.50	Y= 42.99Ln(x) - 21.503	0.01	0.47	46.68
	Quadratic	-15.24	Y = -0.5424x2 + 15x - 15.244	0.06	0.47	46.84
	Cubic	-165.22	$Y = 0.2319x^3 - 6.9126x^2 + 70.113x - 165.22$	0.13	0.49	49.01
	Quartic	1119.70	$Y = 0.241x^4 - 8.57x^3 + 108.73x^2 - 574.2x + 1119.7$	0.14	0.59	58.83
Mean temp. and adult females	Linear	20.87	Y = 1.4015x + 20.876	0.03	0.40	40.34
	Logarithmic	-50.82	Y = 33.558Ln(x) - 50.821	0.02	0.41	41.03
	Quadratic	2.98	$Y = -0.0313x^2 + 2.9569x + 2.9813$	0.09	0.41	40.79
	Cubic	-109.14	$Y = 0.0083x^3 - 0.65x^2 + 17.69x - 109.14$	0.21	0.42	40.79
	Quartic	-1813.5	$Y= -0.0054x^4 + 0.55x^3 - 19.99x^2 + 318.6x - 1813.5$	0.26	0.49	41.69
Mean R.H. and adult females	Linear	83.40	Y = -0.9118x + 83.402	0.03	0.40	40.35
	Logarithmic	141.14	Y = -25.455Ln(x) + 141.14	0.04	0.35	34.78
	Quadratic	18.21	$Y= -0.0713x^2 + 3.6525x + 18.208$	0.03	0.53	52.70
	Cubic	1.92	$Y = 0.0006x^3 - 0.1272x^2 + 5.3544x + 1.9235$	0.10	0.53	52.74
	Quartic	-263.40	$Y= -0.0003x^4 + 0.04x^3 - 1.94x^2 + 41.88x - 263.4$	0.20	0.53	53.48
Mean Dew point and adult females	Linear	30.29	Y= 2.8646x + 30.267	0.03	0.40	40.17
	Logarithmic	1.94	Y = 25.399Ln(x) + 1.9385	0.03	0.40	40.19
	Quadratic	24.31	$Y = -0.0762x^2 + 4.3026x + 24.306$	0.10	0.40	40.25
	Cubic	-48.37	$Y= 0.1123x^3 - 3.163x^2 + 31.008x - 48.368$	0.21	0.42	41.51
	Quartic	927.89	$Y = 0.183x^4 - 6.58x^3 + 84.78x^2 - 458.58x + 927.9$	0.17	0.56	55.50
Mean temp. and total population	Linear	33.15	Y = 3.7032x + 33.197	0.02	0.43	42.99
	Logarithmic	-155.64	Y= 88.479Ln(x) - 155.64	0.02	0.44	43.53
	Quadratic	-9.13	$Y = -0.0742x^2 + 7.3825x - 9.1328$	0.08	0.43	43.37
	Cubic	-166.74	$Y = 0.0117x^3 - 0.9437x^2 + 28.088x - 166.74$	0.18	0.44	43.65
	Quartic	-4141.7	$Y = -0.0127x^4 + 1.27x^3 - 46.05x^2 + 729.9x - 4141.7$	0.25	0.50	49.77
Mean R.H. and total population	Linear	198.28	Y = -2.4044x + 198.27	0.02	0.43	42.82
	Logarithmic	352.55	Y = -67.728Ln(x) + 352.55	0.03	0.38	37.58

Table (2): Continuation of Table 2

	Quadratic	47.65	$Y= -0.1648x^2 + 8.14x + 47.654$	0.03	0.53	52.88
	Cubic	56.66	$Y= -0.0003x^3 - 0.1339x^2 + 7.1984x + 56.663$	0.10	0.53	52.88
	Quartic	-900.54	$Y = -0.001x^4 + 0.139x^3 - 6.68x^2 + 138.96x - 900.54$	0.19	0.54	54.35
Mean Dew point and total population	Linear	57.48	$Y = 7.6324x + 57.441$	0.02	0.44	43.52
	Logarithmic	-19.56	$Y = 68.389Ln(x) - 19.564$	0.02	0.44	44.47
	Quadratic	9.06	$Y = -0.6187x^2 + 19.303x + 9.0616$	0.07	0.44	44.36
	Cubic	-213.59	$Y = 0.3442x^3 - 10.076x^2 + 101.12x - 213.59$	0.16	0.46	46.16
	Quartic	2047.60	$Y = 0.42x^4 - 15.1x^3 + 193.4x^2 - 1032.7x + 2047.6$	0.15	0.58	57.62

Y= Prediction value
a= Constant (y - intercept)
X= Independent variable
E.V.%=Explained variance

(b) indicated that every 1˚C increase in the mean dew point increase the population 4.77 individuals per individuals per leaflets in the current year, Table (1).

Among five models of regression were used to describe the relation between the mean dew point and nymph population, the quartic degree of polynomial regression was exposed the highest percentage of explained variance (E.V.= 58.83%) as compared with the other models in the current year. As well as, all models of regression were significant except quadratic, cubic and quartic degrees of regression (Table, 2).

The relation between mean dew point and the activity of the nymphs was determined by the partial regression values (Table, 3), which emphasized significant positive relation between this factor and the nymphs activity (P.reg = +13.56 and t value = + 2.94). Also, the partial correlation was significant positive (+0.72) in Table (3).

The results revealed that, mean dew point under the optimum range of nymph population and this climate factor was the most effective variable in population changes of the nymphs (28.05%) during the current year, Table (3).

D- The combined effect of tested climatic factors on the nymphs activity:

The combined effect of these climatic factors on the nymph population was significant where the "F" value, was 7.57 during the current year in Table (3). The influence of these combined climatic factors was expressed as percentages of explained variance which were 73.9% in the current year. 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. This method was helpful in obtaining basic information about the amount of variability in the insect populations that could be attributed to these factors.

Adult female population:

A- Effect of mean temperature:

Data showed that the simple correlation (r) between the mean temperature and the population density of adult female was significantly positive (**+**0.64) in the current year (Table, 1). As well as, the calculated regression coefficient (b) for the effect of this factor indicated that every 1˚C increase in the mean temperature increased the population 1.40 individuals per leaflet in the current year (Table, 1).

The results showed that the percentage of explained variance (E.V.%) obtained from the quartic degree of polynomial regression was higher (41.69%) as compared with the other models in all studied relation. Also, all models of regression were insignificant except linear and logarithmic regression (Table, 2).

The precise effect of this factor on the adult female population (Table, 3) showed that it was insignificant negative (P.reg = -6.24 and t value = -1.95) in the current year. Also, the partial correlation was insignificant negative (-0.57). The results revealed mean temperature around the optimum range of adult females activity in the current year.

B- Effect of the mean relative humidity:

As shown in Table (1), it was noticed a significant

Table (3): Multiple regression and correlation analysis between three climatic factors and the population density of different stages of *P. blanchardii*.

Stages	Tested factors	Partial regression values					Partial correlation	Individual role %	Analysis variance				
		Constant	P.reg	S.E	t	p			F values	Coefficient of variation	MR	R^2	E.V%
Nymphs	Mean temp	371.98 *	-10.73 *	4.38	-2.45 *	0.039	-0.66	19.61	7.57*	0.21	0.86	0.74	73.90
	R.H.%		-5.16 *	1.82	-2.84 *	0.022	-0.71	26.22					
	Dew Point (°C)		13.56 *	4.62	2.94 *	0.019	0.72	28.05					
Adult females	Mean temp	232.7 *	-6.24	3.21	-1.95	N.S.	-0.57	16.34	5.07*	0.19	0.81	0.66	65.50
	R.H.%		-3.04	1.33	-2.28	N.S.	-0.63	22.47					
	Dew Point (°C)		7.89 *	3.39	2.33 *	0.048	0.64	23.42					
Total	Mean temp	604.72*	-16.97	7.50	-2.26	N.S.	-0.63	18.45	6.58*	0.20	0.84	0.71	71.20
	R.H.%		-8.19 *	3.12	-2.63 *	0.030	-0.68	24.93					
	Dew Point (°C)		21.45 *	7.92	2.71 *	0.027	0.69	26.41					

b.reg = Partial regression S.E = Standard error MR = Multiple correlation
R^2 = Coefficient of determination E.V% = Explained variance
* = Significant at P ≤ 0.05

negative correlation between mean relative humidity and the adult female population (r value = **-**0.64) for the current year. In the same time, the regression coefficient indicated that 1˚C increase of mean relative humidity decreased the population 0.91 individuals per leaflet, in the current year (Table, 1).

The results suggested that among five models of regression, the quartic degree of polynomial regression between the mean relative humidity and adult female population was exposed the highest percentage of explained variance (E.V.= 53.48%) than the other models in the current year. Also, all models of regression were significant except cubic and quartic degrees of regression (Table, 2).

The real effect of this factor appeared from the partial regression (P.reg) value that referred to the insignificant negative effect (P.reg value = **-**3.04 and t value = -2.28) during the current year (Table, 3). As well as, the partial correlation was insignificant negative (-0.63). Also, the results revealed mean relative humidity around the optimum range of adult female activity in the current year.

C- Effect of mean dew point:

Data in Table (1) obtained that, the effect of mean dew point on adult female activity was significant positive correlation for current year (r = **+**0.63). Also, the simple regression coefficient (b) for the effect of this factor indicated that 1˚C increase in the mean dew point, increased the population density 2.86 individuals per leaflet in the current year (Table, 1).

Among five models of regression were used to describe the relation between the mean dew point and adult female population, the quartic degree of polynomial regression was exposed the highest percentage of explained variance (E.V.= 55.5%) as compared with the others models for the current year. As well as, all models of regression were significant except quadratic, cubic and quartic degrees of regression (Table, 2).

As well as, the partial regression coefficient for the effect of mean dew point on the adult females population revealed that it was significant positive for the current year (P.reg value = +7.89 and t value = +2.33). Also, the partial correlation was significant positive (+0.64). The results revealed that, mean dew point under the optimum range of adult females activity in the current year.

D- 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 insect population of adult females during the current year was significant ("F" value = 5.07) (Table, 3). The amount of variability that could be attributed to the combined effect of these tested factors on the insect population was 65.5% for the current year. Most of this change (23.42%) was due to the effect of the dew point. Followed by relative humidity (22.47%). While, the mean temperature was the least effective factor in population changes (16.34%) (Table, 3). The remaining unexplained variances are assumed to be due to the influence of other unconsidered factors that were not included in this study in addition to the experimental error.

Total population of *P. blanchardii*::

A- Effect of mean temperature:

In the current year as reported in Table (1), the correlation coefficient (r) between the mean temperature and total population was positive significant (**+**0.66). The unit effect regression coefficient (b), indicated that 1°C increase of mean temperature increased the population 3.70 individuals per leaflet for the current year.

Our results suggested that among five models of regression, the quartic degree of polynomial regression between mean temperature and total population of *P. blanchardii* was exhibited the highest percentage of explained variance (E.V.= 49.77%) for current year as compared with the other models. Also, all models of regression were insignificant except linear and logarithmic regression (Table, 2).

As well as, the partial regression values (P.reg) in Table (3), emphasized insignificant negative relation (-16.97 and "t value" = 2.26) for current year. Also, the partial correlation was insignificant negative (-0.63). The obtained results revealed that, mean temperature around the optimum range of total population activity in the current year.

B- Effect of mean relative humidity:

The results revealed the effect of mean relative humidity on total population of *P. blanchardii* (Table, 1). The correlation coefficient (r) between mean relative humidity and total population was significant negative for the current year ($r_=$ -0.65). The calculated regression coefficient (b) for the effect of this factor indicated that 1˚C increase decreased the population 2.4 individuals per leaflet in the current year.

The results in Table (2), showed that the percentage of explained variance (E.V.%) obtained from the quartic degree of polynomial regression was higher (54.35%) than the other models in current year in all studied relation. Also, all models of regression were significant except cubic and quartic degrees of regression (Table, 2).

The real effect of this factor on total population of *P. blanchardii* revealed that, it was significant negative from the partial regression (P.reg. value = -8.19 and t value = -2.63) during the current year. Also, the partial correlation was significant negative (-0.68). The results revealed that, mean relative humidity above the optimum range of total population activity in the current year, Table (3).

C- Effect of mean dew point:

Regarding the data in Table (1) showed that, the effect of mean dew point on total population activity was significant and positive for the current year (r = **+**0.66). As well as, the effect of regression coefficient indicated that 1˚C increase in the mean dew point, increased the total population density of insect 7.63 individuals per leaflet for the current year, Table (1).

Among five models of regression were used to describe the relation between the mean dew point and total population of *P. blanchardii*, the quartic degree of polynomial regression was exposed the highest percentage of explained variance (E.V. = 57.6%) as compared with the others models for the current year. As well as, all models of regression were significant except quadratic, cubic and quartic degrees of regression (Table, 2).

Partial regression coefficient for the effect of mean dew point on the total population of insect revealed that it was significant positive for current year (P.reg value = +21.45 and t value = +2.71). Also, the partial correlation was significant positive (+0.69). As well as, the obtained results revealed that, mean dew point under the optimum range of total population of *P. blanchardii* (Table, 3).

D- The combined effect of the tested climatic factors on the total population of *P. blanchardii*:

The results showed that the combined effect of these tested factors on the total population of *P. blanchardii* during the current year was significant ("F" value = 6.58) as recorded in Table (3). The amount of variability that could be attributed to the combined effect of these tested factors on the total population of insect was 71.2% in current year.

Most of this change (26.41%) was due to the effect of the dew point. Followed by relative humidity (24.93% of the total population changes). While, the mean temperature was the least effective factor in total population changes (18.45%) (Table, 3). The remaining unexplained variances are assumed to be due to the influence of other unconsidered factors that were not included in this study in addition to the experimental error. Many investigators studied the effect of weather factors on the population of *P. blanchardii*. Laudeho and Benassy (1969) in Mauritania, stated that Maximum temperature combined with wind and low humidity was very effective for the survival of the crawlers of *P. blanchardii*. Eraki (1998) in Egypt, stated that the responsibility of four factors combined (Maximum temperature, Minimum temperature, mean of % relative humidity and % parasitism), expressed as mount of percentage of explained variance were 72.5, 74.9, 81.5 and 65.2% during 1st, 2nd, 3rd and 4th generations, respectively. In the second year of study, the explained variance was 76.6, 99.6, and 97.3% during 1st, 2nd and 3rd generations, respectively. El-Said (2000) in North Sinai, Egypt, stated that the effect of daily mean relative humidity was insignificant positive for both years of investigation. The simultaneous effect of three considered weather factors on activity was highly significant during both years of investigation. The percentage of variance explained by these factors was 56.5 and 53.6% for two years.

Population abundance was found to be significantly correlated with temperature and relative humidity (Latifian and Zaerae, 2009).

Prediction of different alive stages of *P. blanchardii*:

Furthermore, the most effective climatic factors, which could be used to predict different alive stages, were mean of air temperature, mean of % relative humidity and mean of dew point. Prediction equation for general, nymphs, adult females and total population of *P. blanchardii* were concluded according to the mentioned statistical analysis in Table (3) and presented as follow:

$Y = 371.98 – 10.73\ x_1 – 5.16\ x_2 + 13.56\ x_3$ for nymphs population

$Y = 232.70 – 6.24\ x_1 – 3.04\ x_2 + 7.89\ x_3$ for adult females population

$Y = 604.72 – 16.97\ x_1 – 8.19\ x_2 + 21.45\ x_3$ for total population

Where is, Y= Prediction value X_1= Air temperature
X_2= Relative humidity X_3= Dew point

CONCLUSION

The aforementioned results revealed that the monthly observations of total population of *P. blanchardii* had three to four peaks of seasonal activity per year. The results showed that the simple correlation coefficient (r) between the mean temperature and different stages of *P. blanchardii* and total population of insect was significant positive. Similarly, the relation between mean dew point and different stages of *P. blanchardii* and total population of insect was significant positive correlation. Differently, the simple correlation between mean relative humidity and different stages and total population of insect was significant negative. The percentage of explained variance (E.V.%) obtained from the quartic degree of polynomial regression were higher as compared with the other models in all studied relation. Also, linear and logarithmic regressions were significant in all studied relationships. The results revealed that the mean dew point was under the optimum range of nymphs, adult females and total population of *P. blanchardii* and this climatic factor was the most effective variable in population changes (28.05, 23.42 and 26.41% for nymphs, adult females and total population of insect, respectively). The obtained results showed that the combined effect of these climatic factors such as maximum temperature, relative humidity and dew point was significant effect on numbers of nymphs of *P. blanchardii*. The percentages of explained variance (E.V.%) indicated that all tested climatic factors were responsible for 73.9, 65.5 and 71.2% of the population changes of nymphs, adult females and total population of insect, respectively.

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