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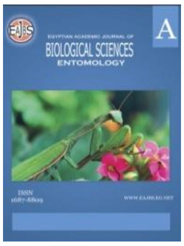

Distribution and Damage Assessment of *Icerya seychellarum* (Westwood) (Hemiptera: Monophlebidae) on Guava Trees Under Environmental Conditions of Luxor, Egypt

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ABSTRACT

Field evaluation studies were conducted during two years (2017/ 2018 and 2018/ 2019) to investigate the distribution and assess infestation degrees of *Icerya seychellarum* (Westwood) (Hemiptera: Monophellidae) on guava trees under selected prevalent climatic factors (daily mean maximum air temperature, minimum air temperature, daily mean of relative humidity and mean of dew point) at Esna district, Luxor Governorate, Egypt. The invasion of *I. seychellarum* was prevalent all year-round. In the first year (2017/ 2018), the population of pests formed three to four peaks (At the beginning of June, mid-September, and mid-November). Afterward, throughout the second year (2018/2019), the outbreaks of the pest were occurred in (The beginning of April, mid-June, mid-August, and mid of October). Furthermore, the percentages of infestation incidence by pests showed three to four peaks per year. With respect to climatic conditions, the autumn months during the two years were more favorable for the seasonal activity of total population density where the maximum values of infestation occurred by *I. seychellarum*.

The weather factors showed an effect on pest activity and percentages of infestations during years of study which varied from year to another with an obvious to the most effective variables [daily mean maximum air temperature °C (DMaxT), daily mean minimum air temperature °C (DMinT), daily mean of relative humidity % (DRH%), and mean of dew point ° C (MDP)] for these changes for both years.

INTRODUCTION

Guava (*Psidium guajava* Linn.) is one of the cheapest fruits in Egypt and contains high nutritive values of vitamin C compared with other fruits. Moreover, its leaves have various medical benefits such as coughs and dental pain. Guava trees are subject to several insect pests' infestation and one of the main destructive insect pests is *Icerya seychellarum* by Sayed (2008). It mainly attacks tender shoots, twigs, veins of leaves, branches, and fruits by sucking the plant sap with mouthparts from the host plant tissues. The pest sap contains very low concentrations of protein. Therefore, it sucks great amounts of plant sap to obtain sufficient portions of protein for its growth and egg development. The great loss of plant sap occurred due to the attack of high numbers of pests to leaves, branches and fruits resulting in defoliation, dryness, wilting, early leaves drop, malformations, dwarfing, and deprive trees of its nutrients, ultimately quality and quantity of fruit (El-Said, 2006, Mangoud, 2000 and Reda *et al*., 2010). Afterwards, the pest excretes large amounts of honeydew which is rich in sugars and nitrogenous components and considers a good medium to sooty molt fungi which increases the inhibition of photosynthesis in Guava trees causes leaf drop. In addition, the secretion of toxic saliva of pests results in malformed leaves and poor shoot growth (Dreistadt *et al.*, 1994 and Osman, 2005).

The aim of the present work was to estimate the seasonal activity, percentages of infestations, rate of monthly variation and effect of main climatic weather factors [daily mean maximum air temperature °C (DMaxT), daily mean minimum air temperature °C (DMinT), daily mean of relative humidity % (DRH%), and mean of dew point ° C (MDP)] on the population density of *I. seychellarum*, for well understanding and establishing IPM strategies against this pest.

MATERIALS AND METHODS

The study was carried out at half-monthly intervals at Esna district, Luxor Governorate during two successive years extending from the beginning of March, 2017 until mid-February, 2019 to investigate two types of insect expression; the numbers of pests and infestation percentages on guava trees which received normal agricultural practices under free insecticides before and during the period of study.

1. The Samples and Sampling Method:

Four trees of guava Balady variety in the same age (ten years old), size, shape, height, and vegetative growth were selected for sampling. Ten leaves (samples) were collected from each cardinal direction (East, West, North, and South) of terminal shoots of each direction per tree. Samples were replicated four times per tree with a rate of 40 leaves per tree. Over the two years of the experiment, the total samples were 7680 leaves conducted as following: 4 trees x 4 directions x 10 leaves x 48 dates of collection.

The samples were collected in polyethylene bags and transferred to the laboratory for daily examination using a binocular microscope and the rest of the samples were frozen for later processing. The numbers of alive insects on upper and lower surfaces of leaves were presented as mean ± SE and individually sorted into immature stages (nymphs) and mature stages (adult females and gravid females) and their numbers were counted and recorded. The half-monthly mean numbers of different stages of *I. seychellarum* per 10 leaves were considered in this study to express the population size of the pest.

2. Infestation Percentages and Population Density:

The percentage of leaves infestation was calculated according to the formula described by **Facylate (1971):**

$$A = (n / N) \times 100.$$

Where,

A = The percentage of infestation incidence or infested leaves.

n = No. of infested leaves in which the pest appeared.

N = Total number of leaves (Uninfested + Infested) collected in each inspection date.

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

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

3.Meteorological Data and Pest Population:

The meteorological data of daily mean maximum air temperature °C, daily mean minimum air temperature °C, daily mean of relative humidity %, and mean of dew point ° C of Luxor governorate conditions 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.

4.Statistical Analysis:

The simple correlation, regression coefficient, and partial regression formula were adopted to find out the simultaneous effects of the main tested weather factors on *I. seychellarum*. The partial regression method termed the C-multipliers was adopted according to Fisher (1950). Statistical analysis in the present work was carried out with Computer using (MSTATC Program software, 1980) to determine the preferable time for pest activity and the proper time for its control.

RESULTS AND DISCUSSION

Seasonal Activity of *I. seychellarum* During (2017/2018):

The total sums of individual’s stages of pest (Table 1) fluctuated from low to high population during this year. The population started to increase gradually at the beginning of the season and formed three peaks: the first one was at the beginning of June (63.75 ± 1.65 means of individuals per 10 leaves; when the field conditions were 38.41°C, 22.12°C, 18.29% and 9.35°C for max. temp., min. temp., relative humidity and dew point; respectively). Afterwards, the second outbreak was recorded in the mid-September (93.75 ± 3.45 means of individuals/ 10 leaves; while the prevalent climatic factors were 40.29°C, 24.43°C, 23.64% and 14.07°C for max. temp., min. temp., relative humidity and dew point; respectively). The last and third peak was built up in mid- November 117.50 ± 3.52 means of individuals/ 10 leaves; under weather factors 33.00°C, 17.00°C, 33.64% and 11.71°C for max. temp., min. temp., relative humidity, and dew point; respectively). At the end of the year, a dramatic decline and gradual decrease occurred in the population of February.

The immature stages (pre-adults) recorded the highest averages of mean numbers in Autumn (71.75 ± 2.94 means of individuals/ 10 leaves) with the highest total of mean averages during this year (1115.00 total sums of individuals means / 10 leaves). Meanwhile, the lowest stage averages were recorded by gravid females in winter (0.92 ± 0.24 means of individuals/ 10 leaves) with the lowest total mean averages (82.50 total sums of individuals means / 10 leaves) during this year.

There were four an obvious high infestation degree recorded in mid-April, beginning of June, mid-September, and mid-November (77.50 ± 8.29, 80.00 ± 7.07, 80.00 ± 5.40 and 82.50 ± 4.33%; respectively for the mentioned periods).

Table 1: Half-monthly mean numbers of different stages of *I. seychellarum* and percentages infestation incidence on guava trees under some climatic factors at Esna district, Luxor Governorate during the first year (2017/ 2018).

Season	Date of inspection		Mean numbers of individuals per 10 leaves ± S.E.				Infestation incidence (%)	Climatic factors			
			Immature stages (Pre-adults)	Mature		Total		Max. temp.°C	Min. temp.°C	% R.H.	Dew point °C
				Adult females	Gravid females						
Spring	Mar., 2017	1	19.25 ± 1.89	9.25 ± 1.38	1.00 ± 0.58	29.50 ± 1.04	62.50 ± 5.95	25.86	12.07	41.36	4.64
		15	23.00 ± 1.68	14.00 ± 2.12	1.25 ± 0.75	38.25 ± 0.85	67.50 ± 3.23	27.21	11.43	30.07	4.36
	Apr.	1	24.75 ± 2.43	19.00 ± 2.89	3.00 ± 1.22	46.75 ± 1.31	72.50 ± 4.33	28.82	15.29	32.41	5.24
		15	30.75 ± 1.38	14.00 ± 2.12	3.50 ± 1.50	48.25 ± 1.70	77.50 ± 8.29	30.29	16.43	25.14	6.64
	May	1	39.75 ± 1.44	7.00 ± 0.91	4.50 ± 1.55	51.25 ± 1.25	70.00 ± 5.40	34.06	18.13	19.19	6.38
		15	46.50 ± 1.19	7.75 ± 1.11	3.25 ± 1.11	57.50 ± 1.19	77.50 ± 6.61	35.86	20.50	18.07	7.43
Average			**30.67 ± 2.10**	**11.83 ± 1.11**	**2.75 ± 0.50**	**45.25 ± 1.95**	**71.25 ± 2.39**	**30.35**	**15.64**	**27.71**	**5.78**
Summer	Jun.	1	58.25 ± 1.89	3.50 ± 0.65	2.00 ± 1.00	63.75 ± 1.65	80.00 ± 7.07	38.41	22.12	18.29	9.35
		15	47.25 ± 1.25	9.25 ± 1.38	1.50 ± 0.87	58.00 ± 1.58	75.00 ± 6.12	41.07	25.57	17.21	10.86
	Jul.	1	42.75 ± 2.90	17.75 ± 2.56	2.00 ± 0.91	62.50 ± 1.76	70.00 ± 5.40	39.25	24.50	19.56	11.63
		15	40.75 ± 2.78	12.00 ± 1.83	3.25 ± 1.31	56.00 ± 1.87	67.50 ± 5.95	41.70	25.30	19.79	12.79
	Aug.	1	44.75 ± 1.49	18.00 ± 2.48	3.75 ± 1.38	66.50 ± 2.06	70.00 ± 6.12	41.82	28.18	20.06	13.65
		15	54.50 ± 5.12	21.25 ± 3.20	5.00 ± 1.58	80.75 ± 2.50	75.00 ± 4.56	40.90	27.70	20.86	14.07
Average			**48.04 ± 1.68**	**13.63 ± 1.49**	**2.92 ± 0.50**	**64.58 ± 1.81**	**72.92 ± 2.31**	**40.53**	**25.56**	**19.30**	**12.06**
Autumn	Sept.	1	61.50 ± 2.60	19.25 ± 2.95	6.00 ± 1.78	86.75 ± 3.20	77.50 ± 4.33	42.06	27.47	21.71	14.88
		15	65.50 ± 3.69	19.25 ± 2.95	9.00 ± 1.91	93.75 ± 3.45	80.00 ± 5.40	40.29	24.43	23.64	14.07
	Oct.	1	60.50 ± 4.21	5.50 ± 1.26	6.75 ± 1.65	72.75 ± 2.87	75.00 ± 4.08	39.69	23.81	25.50	14.31
		15	68.50 ± 3.88	8.75 ± 1.70	5.75 ± 1.60	83.00 ± 2.65	75.00 ± 4.56	38.57	22.64	25.64	13.00
	Nov.	1	83.75 ± 5.81	12.75 ± 2.02	9.00 ± 1.83	105.50 ± 3.38	77.50 ± 4.79	37.59	21.12	26.94	12.41
		15	90.75 ± 6.94	20.25 ± 2.95	6.50 ± 1.55	117.50 ± 3.52	82.50 ± 4.33	33.00	17.00	33.64	11.71
Average			**71.75 ± 2.94**	**14.29 ± 1.47**	**7.17 ± 0.68**	**93.21 ± 3.29**	**77.92 ± 1.75**	**38.53**	**22.75**	**26.18**	**13.40**
Winter	Dec.	1	77.50 ± 5.84	16.75 ± 2.56	2.00 ± 0.91	96.25 ± 3.35	80.00 ± 3.54	31.69	16.13	35.88	10.69
		15	49.50 ± 1.94	3.50 ± 0.65	1.00 ± 0.58	54.00 ± 1.83	70.00 ± 2.89	25.64	10.57	38.50	6.79
	Jan., 2018	1	30.75 ± 1.60	6.50 ± 0.65	1.00 ± 0.58	38.25 ± 2.06	65.00 ± 2.04	25.24	8.94	39.82	5.06
		15	20.50 ± 1.26	10.75 ± 0.75	0.75 ± 0.48	32.00 ± 0.91	65.00 ± 4.56	22.07	7.36	48.29	6.21
	Feb.	1	16.00 ± 0.91	14.00 ± 2.12	0.50 ± 0.50	30.50 ± 1.50	62.50 ± 4.79	23.29	8.24	45.88	5.82
		15	18.00 ± 1.41	12.75 ± 2.02	0.25 ± 0.25	31.00 ± 0.82	57.50 ± 3.23	26.57	12.57	44.36	7.36
Average			**35.38 ± 4.68**	**10.71 ± 1.11**	**0.92 ± 0.24**	**47.00 ± 4.94**	**66.67 ± 1.97**	**25.75**	**10.63**	**42.12**	**6.99**
Total			**1115.00**	**302.75**	**82.50**	**1500.25**	**1732.50**				
General average			**46.46 ± 2.23**	**12.61 ± 0.66**	**3.44 ± 0.34**	**62.51± 2.54**	**72.19 ± 1.12**	**33.79**	**18.65**	**28.83**	**9.56**
%			**74.32**	**20.18**	**5.50**	**100.00**					

Seasonal Activity of *I. seychellarum* during (2018/2019):

The total population of insects during the second year (Table 2) started to increase slightly with the observation of four peaks during this year. The first peak occurred at the beginning of April with the means of (48.00 ± 1.78 individuals per 10 leaves under field conditions with means of 31.94°C, 15.12°C, 24.71% and 7.00°C for max. temp., min. temp., relative humidity and dew point; respectively). The second peak in mid-June when the population reached (87.25 ± 2.87 individuals per 10 leaves with means of 43.00°C, 25.64°C, 15.64% and 11.21°C for max. temp., min. temp., relative humidity and dew point; respectively). The third peak occurred in mid-August (170.50 ± 5.72 individuals per 10 leaves with means of 40.71°C, 23.50°C, 22.36% and 14.00°C for max. temp., min. temp., relative humidity and dew point; respectively). The fourth outbreak occurred in mid of October (137.50 ± 4.65 individuals per 10 leaves with means of 34.36°C, 18.86°C, 30.43% and 11.93°C for max. temp., min. temp., relative humidity and dew point, respectively). The population fluctuation of the pest was gradually declined with low means in the mid of February.

The highest average of mean numbers was recorded in Autumn by immature stages (75.67 ± 3.92 means of individuals/ 10 leaves) with the highest total of mean averages during this year (1208.3 total sums of individuals means / 10 leaves). Meanwhile, the lowest stage averages were recorded by gravid females in winter (1.42 ± 0.22 means of individuals/ 10 leaves) with the lowest total mean averages (123.0 total sums of individuals means / 10 leaves) during this year.

The higher percentages of infestation were observed four times in mid of April, mid-June, mid of August, and mid of October (65.00 ± 5.40, 70.00 ± 4.56, 82.50 ± 3.23 and 82.50 ± 2.50%; respectively for the same mentioned order of periods).

The least density occurred to the total population of *I. seychellarum* in spring during the first year and winter for the second year, while the least percentages of infestations incidence through winter months during the first year and spring months in the second year, which may be attributed to the low daily min. temp. during spring and winter months which affected greatly on the population and infestation. These results are in agreement with Dent (1991) who stated that the seasonal phenology of insect numbers, generation's number and level of insect abundance are influenced by the environmental factors especially with max. and Min. temperatures.

Additionally, the pest population was presented on guava trees all year round with three to four outbreaks per year. Besides, the total population of the second year was higher than the first year, which could be related to the variation in climatic factors between the years of study. These results coincided with those in Egypt Abd-El-Rahman *et al*. (2007) and Sayed (2008) who reported that the occurrence of three or four peaks of *I. seychellarum* per year were mainly related to the prevalent environmental factors.

Table 2: Half-monthly mean numbers of different stages of *I. seychellarum* and percentages of infestation incidence on guava trees under some climatic factors at Esna district, Luxor Governorate during the second year of (2018/ 2019).

Season	Date of inspection		Mean number of individuals per 10 leaves				Infestation incidence (%)	Climatic factors			
			Immature stages (Pre-adults)	Mature		Total		Max. temp.°C	Min. temp.°C	% R.H.	Dew point °C
				Adult females	Gravid females						
Spring	Mar., 2018	1	18.50 ± 2.22	9.75 ± 1.93	2.25 ± 0.85	30.50 ± 1.04	50.0 ± 3.54	27.79	11.00	28.86	4.86
		15	20.25 ± 2.66	15.25 ± 2.50	3.50 ± 0.96	39.00 ± 0.91	55.0 ± 4.08	31.00	13.57	24.93	6.14
	Apr.	1	30.25 ± 1.49	14.75 ± 2.06	3.00 ± 0.91	48.00 ± 1.78	60.0 ± 3.54	31.94	15.12	24.71	7.00
		15	22.25 ± 1.93	11.75 ± 2.14	3.00 ± 0.41	37.00 ± 1.47	65.0 ± 5.40	32.93	16.00	21.93	6.71
	May	1	28.00 ± 2.04	7.50 ± 1.32	3.50 ± 0.87	39.00 ± 1.08	57.5 ± 4.33	33.38	17.31	19.94	6.94
		15	36.00 ± 2.89	8.25 ± 2.02	5.00 ± 1.35	49.25 ± 1.31	60.0 ± 2.04	38.50	21.79	16.57	9.14
Average			**25.88 ± 1.51**	**11.21 ± 0.96**	**3.38 ± 0.38**	**40.46 ± 1.42**	**57.92 ± 1.73**	**32.59**	**15.80**	**22.82**	**6.80**
Summer	Jun.	1	47.50 ± 2.99	22.25 ± 2.66	4.75 ± 0.63	74.50 ± 2.33	70.0 ± 3.54	40.82	23.65	16.35	9.94
		15	63.50 ± 4.33	17.50 ± 2.22	6.25 ± 1.03	87.25 ± 2.87	70.0 ± 4.56	43.00	25.64	15.64	11.21
	Jul.	1	47.75 ± 1.31	11.00 ± 1.78	5.00 ± 0.91	63.75 ± 1.93	65.0 ± 2.89	40.06	25.00	21.88	13.31
		15	67.00 ± 3.87	11.25 ± 0.75	8.00 ± 1.08	86.25 ± 3.35	67.5 ± 3.23	39.50	25.79	26.21	15.57
	Aug.	1	77.25 ± 1.89	10.75 ± 2.06	9.25 ± 0.48	97.25 ± 3.15	72.5 ± 4.79	39.41	25.12	23.41	14.06
		15	133.50 ± 4.84	23.50 ± 2.40	13.50 ± 1.19	170.50 ± 5.72	82.5 ± 3.23	40.71	23.50	22.36	14.00
Average			**72.75 ± 6.20**	**16.04 ± 1.35**	**7.79 ± 0.71**	**96.58 ± 7.34**	**71.25 ± 1.79**	**40.59**	**24.78**	**20.98**	**13.02**
Autumn	Sept.	1	85.00 ± 3.32	22.50 ± 1.89	9.50 ± 0.50	117.00 ± 4.51	80.0 ± 4.08	39.71	25.59	25.35	15.41
		15	52.75 ± 4.17	16.75 ± 1.25	5.75 ± 0.85	75.25 ± 2.87	75.0 ± 4.56	38.64	25.64	27.36	15.57
	Oct.	1	75.50 ± 4.97	16.25 ± 1.75	8.25 ± 0.75	100.00 ± 4.24	80.0 ± 2.89	38.75	23.88	28.25	14.88
		15	103.75 ± 5.84	24.00 ± 1.83	9.75 ± 0.85	137.50 ± 4.65	82.5 ± 2.50	34.36	18.86	30.43	11.93
	Nov.	1	79.25 ± 4.44	29.00 ± 1.29	8.25 ± 0.85	116.50 ± 3.93	80.0 ± 2.04	31.81	17.69	35.56	11.94
		15	57.75 ± 4.52	27.00 ± 1.73	6.00 ± 0.91	90.75 ± 2.69	80.0 ± 3.54	30.43	15.43	39.36	11.57
Average			**75.67 ± 3.92**	**22.58 ± 1.16**	**7.92 ± 0.43**	**106.17 ± 4.43**	**79.58 ± 1.31**	**35.62**	**21.18**	**31.05**	**13.55**
Winter	Dec.	1	42.75 ± 2.75	9.75 ± 0.85	2.50 ± 0.29	55.00 ± 2.38	72.5 ± 4.33	28.75	13.69	45.06	11.69
		15	32.75 ± 0.48	3.50 ± 0.50	1.75 ± 0.63	38.00 ± 1.35	68.75 ± 4.27	24.93	11.64	45.79	9.29
	Jan., 2019	1	27.50 ± 0.50	3.75 ± 0.48	1.75 ± 0.25	33.00 ± 0.91	62.50 ± 2.50	22.35	7.53	46.18	5.88
		15	24.25 ± 0.25	7.25 ± 0.63	1.25 ± 0.63	32.75 ± 1.25	57.50 ± 4.79	23.43	8.93	49.07	7.36
	Feb.	1	20.00 ± 1.08	9.75 ± 0.85	0.75 ± 0.48	30.50 ± 0.87	55.0 ± 2.89	25.82	8.41	32.35	4.41
		15	15.25 ± 0.75	12.50 ± 0.96	0.50 ± 0.50	28.25 ± 1.03	53.75 ± 2.39	25.36	8.79	35.36	5.29
Average			**27.08 ± 1.91**	**7.75 ± 0.74**	**1.42 ± 0.22**	**36.25 ± 1.92**	**61.67 ± 1.97**	**25.11**	**9.83**	**42.30**	**7.32**
Total			**1208.3**	**345.5**	**123.0**	**1676.8**	**1622.5**				
General average			**50.34 ± 3.10**	**14.40 ± 0.78**	**5.13 ± 0.37**	**69.86 ± 3.92**	**67.60 ± 1.21**	**33.47**	**17.90**	**29.29**	**10.17**
%			**72.06**	**20.61**	**7.34**	**100.00**					

1. Monthly Variation Rates in Population of *I. seychellarum* during (2017/ 2018):

The rate of monthly variation in the population (Table, 3) reflects the favorable months for pest activity expressed in monthly rates with an increase of pest population through the year. When R.M.V.P. is > 1 it means that pest is in more activity case, < 1 means less activity and = 1 means no change in population density during the two successive years (Bakry, 2009).

The favorable time of annual increase (Table, 3) for the pre-adults stage appeared to be from April to June and from August to November in the first year (2017/2018), with rates varying from (1.02 to 1.55). The adult females showed that the favourable times for annual increase appeared to be in April, July, August, November, and February during the first year when the rates of monthly variation were ranged from 1.32 to 2.33. With respect to, gravid females showed that the favourable times for annual increase seemed in April, May, July, August, September and November during the first year when the rates of monthly variation were ranged from (1.19 to 2.89).

The infestation recorded their higher percentages in April, June, August, September, and November during the first year of study and ranged from (1.05 to 1.15).

Table 3: Rate of monthly variation (R.M.V.P) between mean numbers of *I. seychellarum* and percentages of infestations incidence on guava trees at Esna district, Luxor Governorate throughout seasons of study (2017/ 2018 and 2018/ 2019).

Years	Month of inspection	Immature stages (Pre-adults)	Mature stages		Total	Infestation incidence (%)
			Adult Females	Gravid females		
2017/ 2018	Mar.	----	----	----	----	----
	Apr.	1.31	1.42	2.89	1.40	1.15
	May	1.55	0.45	1.19	1.14	0.98
	Jun.	1.22	0.86	0.45	1.12	1.05
	Jul.	0.79	2.33	1.50	0.97	0.89
	Aug.	1.19	1.32	1.67	1.24	1.05
	Sept.	1.28	0.98	1.71	1.23	1.09
	Oct.	1.02	0.37	0.83	0.86	0.95
	Nov.	1.35	2.32	1.24	1.43	1.07
	Dec.	0.73	0.61	0.19	0.67	0.94
	Jan.	0.40	0.85	0.58	0.47	0.87
	Feb.	0.66	1.55	0.43	0.88	0.92
2018/ 2019	Mar.	----	----	----	----	----
	Apr.	1.35	1.06	1.04	1.22	1.19
	May	1.22	0.59	1.42	1.04	0.94
	Jun.	1.73	2.52	1.29	1.83	1.19
	Jul.	1.03	0.56	1.18	0.93	0.95
	Aug.	1.84	1.54	1.75	1.79	1.17
	Sept.	0.65	1.15	0.67	0.72	1.00
	Oct.	1.30	1.03	1.18	1.24	1.05
	Nov.	0.76	1.39	0.79	0.87	0.98
	Dec.	0.55	0.24	0.30	0.45	0.88
	Jan.	0.69	0.83	0.71	0.71	0.85
	Feb.	0.68	2.02	0.42	0.89	0.91

2.Monthly Variation Rates in Population of *I. seychellarum* during (2018/ 2019):

The favorable time for pre-adults and gravid females (Table, 3) varied from April to August with rates of monthly variations (1.03 to 1.84) for pre-adults and (1.04 to 1.75) for gravid females. Meanwhile, in October for both pre-adults and gravid females were (1.03 and 1.18); respectively. The adult females showed that the favorable times were in April, June, (August to November), and February when rates ranged from (1.03 to 2.52).

The favorable time for the total alive population appeared to be from April to June, August, and October with rates ranging from (1.04 to 1.83). However, percentages of infestations occurred in April, June, and August to October, when the rates of monthly variation ranged from (1.00 to 1.19); respectively.

Generally, the favorable periods for pest activity varied according to the stage of pest and year of the study. The results of our study are in agreement with other previous studies by Mangoud (2000) who revealed that the population of *I. seychellarum* increased in summer and autumn. Besides, the findings of El-Said (2006) stated that the significant differences in mealybug activity occurred during summer and autumn.

Population and infestation percentages of *I. seychellarum* under prevalent weather factors:

1. Total insect population of *I. seychellarum*:

A- Effect of daily mean maximum temperature:

The simple correlation was highly positive significant (Table 4) between the (DMaxT) and the total population of *I. seychellarum*, r values were (0.62, 0.63 and 0.60) separately during both years of the study, and the same for cumulative two years. The unit effect of the regression coefficient (b) indicates that an increase of 1°C in the (DMaxT), would increase the population by 2.30, 3.84 and 3.00 individuals per 20 leaves; respectively for the first, second, and two cumulative years.

The partial regression values in Table (4) represented an insignificant negative relation (P. reg.= -1.29), significant positive effect (14.28) and insignificant positive relation (4.24) during the first, second year, and their cumulative years, respectively. The values of the partial correlation were (-0.06, 0.48 and 0.16) and (t-test) values were (-0.28, 2.36, and 1.06) for the first, second year, and cumulative years; respectively. The results revealed that (DMaxT) was in the optimum range for the activity of the total population during the first year and the two cumulative years. This climatic factor was the least effective variable in the changes for the total population by 0.12 and 0.97% for the first year and cumulative years; respectively. Meanwhile, during the second year, (DMaxT) was responsible for 7.03% of total population changes.

Table 4: Different models of correlation and regression analyses for describing the relationship between the total population density of *I. seychellarum* and four climate variables on guava trees during the two successive years (2017/ 2018 and 2018/ 2019).

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	Efficiency (%)	Rank	F value	MR	R^2	E.V. (%)
First (2017/2018)	Max. temp.	0.62	2.30	0.62	3.73 **	-0.06	-1.29	4.70	-0.28	0.12	4	11.35 **	0.84	0.70	70.49
	Min. temp.	0.58	2.18	0.65	3.36 **	-0.37	-5.37	3.11	-1.73	4.63	3				
	R.H.%	-0.41	-1.05	0.49	-2.14*	-0.37	-2.49	1.41	-1.76	4.82	2				
	Dew Point	0.77	5.33	0.94	5.69 **	0.61	12.09	3.60	3.35 **	17.47	1				
Second (2018/2019)	Max. temp.	0.63	3.84	0.44	3.80 **	0.48	14.28	6.06	2.36 *	7.03	3	15.00 **	0.87	0.76	75.95
	Min. temp.	0.66	3.94	0.96	4.10 **	-0.63	-22.24	6.33	-3.51 **	15.63	1				
	R.H.%	-0.26	-1.00	0.81	-1.24	-0.19	-1.97	2.30	-0.86	0.93	4				
	Dew Point	0.77	7.97	1.41	5.64 **	0.60	21.56	6.59	3.27 **	13.54	2				
Cumulative years	Max. temp.	0.60	3.00	0.59	5.10 **	0.16	4.24	3.99	1.06	0.97	3	18.28 **	0.79	0.63	62.97
	Min. temp.	0.60	2.99	0.59	5.08 **	-0.35	-7.04	2.87	-2.45 *	5.17	2				
	R.H.%	-0.31	-1.02	0.47	-2.18 *	-0.09	-0.82	1.34	-0.61	0.32	4				
	Dew Point	0.76	6.73	0.86	7.86 **	0.45	10.46	3.18	3.30 **	9.35	1				

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 $P \leq 0.01$.

B- Effect of Daily Mean Minimum Temperature:

The correlation coefficient (r) between (DMinT) and the total population of pests (Table 4) was highly significant positive (r = 0.58, 0.66, and 0.60 for the first, second year and cumulative 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 2.18, 3.94, and 2.99 individuals per 20 leaves for the two years individually and during the cumulative two years; respectively.

The effect of this factor was highly significant negative (P. reg. value = -5.37, -22.24, and -7.04 for the first, second year, and cumulative years; respectively. The partial correlation values were (-0.37, -0.63 and -0.35) and t-test values were (-1.73, -3.51 and -2.45) during the first, second year and cumulative two years; respectively.

The obtained results revealed that (DMinT) was around the optimum range for total population activity in the first year and above the optimum range on the two cumulative years. This factor was responsible for certain changes in the total population by 4.63 and 5.17% during the first year and on the cumulative years; respectively. While, during the second year, the (DMinT) was entirely above the optimum range and recorded the most effective weather variable for the changes in pest population by 15.63%.

C- Effect of the Mean Relative Humidity:

The mean relative humidity (Table, 4) had a significant negative effect on total population activity, while the correlation coefficient was (r values = -0.41 and -0.31 for the first year and cumulative years; respectively); and insignificant negative correlation during the second years (r = -0.26). The unit effect (regression coefficient) indicates that an increase of 1% in the (DRH%) would decrease the total population density by 1.05, 1.00 and 1.02 individuals per 20 leaves for the two years individually and during the two cumulative years; respectively.

The effect of this climatic factor presented by their partial regression values in (Table, 4), which showed that it was insignificant negative effects (-2.49, -1.97 and -0.82) and the partial correlation were (-0.37, -0.19 and -0.09) and t values were (-1.76, -0.86 and -0.61), for the first, second year and cumulative years; respectively. The (DRH%) was around the optimum range for total population activity and this climatic factor showed the least effective variable in population changes for total population by 4.82, 0.93 and 0.32%; respectively for the first, second year, and two cumulative years.

D- Effect of Mean Dew Point:

The effect of mean dew point on total population (Table 4) was highly significantly positive (0.77, 0.77, and 0.76), the calculated regression coefficient (b) for the effect of this factor indicated that for every 1˚C increase, the population would increase by 5.33, 7.97 and 6.73 individuals per 20 leaves during the first, second years and on the two cumulative years; respectively.

The exact relationship between this climatic factor and the activity of the total population was highly significant positive (P. reg.= 12.09, 21.56, and 10.46) and the partial correlation was (0.61, 0.60, and 0.45), while (t-test) values were (3.55, 3.27 and 3.30; respectively for first, second year, and on the cumulative years). An increase of one degree in the (MDP) would increase the population by 12.09, 21.56, and 10.46 individuals per 20 leaves provided that the other three factors remain constant during the first, second year, and the two cumulative years; respectively. The (MDP) was entirely under the optimum range for the total population and was the most effective variable for the changes in the activity of the total population by 17.47, 13.54, and 9.35% during the first, second year, and cumulative years; respectively.

E- The Combined Effect of Tested Climatic Factors on Total Population Activity:

The combined effect of these climatic factors on the total population **(Table 4)** was highly significant where the "F" values, were 11.35, 15.00 and 18.28 during the first, second year, and the cumulative years; respectively. The percentage of variability that could be attributed to the combined effect of these tested factors on pest population was (70.49, 75.95, and 62.97% for the two years individually and their cumulative 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.

2- The Percentages of Infestation by *I. seychellarum*:

A- Effect of Daily Mean Maximum Temperature:

The simple correlation (r) between (DMaxT) and the infestation incidence (Table 5) was highly significant positive relations (0.58 and 0.51) during the first year and on the cumulative years; respectively and r value showed a significant positive effect (0.50) during the second year. The regression coefficient (b) for the effect of this factor indicated that every 1˚C increase in (DMaxT), would increase the percentage of infestation by 0.57, 0.79, and 0.68% for the two years individually and their cumulative years; respectively.

The precise effect of this factor on the infestation incidence (Table, 5) was insignificant negative effects (P. reg. values= -1.53 and -0.54) for first-year and cumulative years; respectively. Meanwhile, the highly significant positive effect (P. reg. = 2.80) for the second year. The values of partial correlation were (-0.23, -0.06, and 0.37) and values of t-test were (-1.02, -0.41, and 1.76) during the first and second years separately and the cumulative years; respectively, when the (DMinT), (DRH%), and (MDP). The results revealed that the (DMaxT) around the optimum range of infestation incidence by pest during the first year and on the cumulative years and entirely under the optimum range during the second year. This climatic factor was the least effective variable in changes of infestation incidence by 2.37, 3.96, and 0.22% during both the two years separately and on two cumulative years; respectively.

Table 5: Different models of correlation and regression analyses for describing the relationship between the percentage of infestation incidence by *I. seychellarum* and four climate variables on guava trees during the two successive years (2017/2018 and 2018/2019).

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	Efficiency (%)	Rank	F value	MR	R^2	E.V. (%)
First (2017/2018)	Max. temp.	0.58	0.57	0.17	3.36 **	-0.23	-1.53	1.50	-1.02	2.37	4	6.23 **	0.75	0.57	56.73
	Min. temp.	0.55	0.54	0.18	3.07 **	-0.24	-1.08	0.99	-1.08	2.67	3				
	R.H.%	-0.58	-0.39	0.12	-3.35 **	-0.55	-1.29	0.45	-2.85 *	18.53	1				
	Dew Point	0.55	1.00	0.33	3.06 **	0.54	3.19	1.15	2.77 *	17.50	2				
Second (2018/2019)	Max. temp.	0.50	0.79	0.29	2.70 *	0.37	2.80	1.59	1.76 **	3.96	3	14.70 **	0.87	0.76	75.58
	Min. temp.	0.58	0.91	0.27	3.38 **	-0.43	-3.44	1.66	-2.06	5.48	2				
	R.H.%	-0.02	-0.02	0.22	-0.08	0.07	0.18	0.60	0.30	0.11	4				
	Dew Point	0.82	2.22	0.33	6.72 **	0.45	3.86	1.73	2.22 *	6.35	1				
Cumulative years	Max. temp.	0.51	0.68	0.17	3.97 **	-0.06	-0.54	1.34	-0.41	0.22	3	8.10 **	0.66	0.43	42.97
	Min. temp.	0.55	0.74	0.17	4.47 **	0.10	0.63	0.96	0.65	0.56	2				
	R.H.%	-0.23	-0.21	0.13	-1.62	0.004	0.01	0.45	0.02	0.001	4				
	Dew Point	0.65	1.56	0.27	5.82 **	0.20	1.40	1.06	1.31	2.29	1				

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 $P \leq 0.01$.

B- Effect of Daily Mean Minimum Temperature (DMinT):

There were positive relations and highly significant correlation resulted in **Table (5)** between (DMinT) and infestation (r= +0.55, +0.58, and +0.55) during the two years separately and on cumulative of years, respectively. An increase of 1°C in the daily mean minimum temperature, would increase the percentage of infestation by 0.54, 0.91 and 0.74% during the first and second year and on cumulative years; respectively according to the unit effect regression coefficient (b) in Table (5).

The partial regression values are represented (Table 5), emphasized an insignificant negative relation (-1.08 and -3.44) for the first and second year; respectively and insignificant positive effect (P. reg. value= +0.63) for the two cumulative years. While, the values of partial correlation were (-0.24, -0.43 and +0.1) and t-test were (-1.08, -2.06 and +0.65) during the first and second year and the cumulative years; respectively. The obtained results revealed that (DMinT) around the optimum range of infestation incidence by pest during the first and second years and within the optimum range on the two cumulative years. This factor was responsible for the certain changes in the infestation incidence by 2.67, 5.48 and 0.56% during both first and second years separately and the two cumulative years; respectively.

C- Effect of the Mean Relative Humidity (DRH%):

Data in Table (5) presented that (DRH%) showed a highly significant negative effect on infestation incidence since the correlation coefficient was (r = -0.58) during the first year and insignificant negative relations (-0.02 and -0.23) during the second year and the cumulative years; respectively. The unit effect (regression coefficient) indicates that an increase of 1% in the mean relative humidity would decrease the percentage of infestation incidence by 0.39, 0.02 and 0.21% for the first, second years and the two cumulative years; respectively. The real effect of this factor according to partial regression values (Table 5) was a significant negative effect (-1.29) for first-year and insignificant positive effects (+0.18 and +0.01) for the second year and cumulative years; respectively. However, the values of partial correlation were (-0.55, +0.07, and + 0.004) and t-test values were (-2.85, +0.30, and +0.02) for the first, second year and the two cumulative years; respectively. The obtained results revealed that (DRH%) was above the optimum range of infestation incidence for the first and second year and the cumulative years. Obviously, this climatic factor was the most effective and responsible variable for the changes in infestation incidence of pests by 18.53 % during the first year and showed the least effective variable for certain changes in infestation incidence by 0.11 and 0.001% during the second year and throughout the cumulative years; respectively.

D- Effect of Mean Dew Point (MDP%):

The effect of (MDP) on infestation incidence by pests (Table 5) was highly significantly positive (+0.55, +0.82, and +0.65) during the first, second year and the cumulative years; respectively. Additionally, the calculated regression coefficient (b) for the effect of this factor indicated that for every 1˚C increase, the infestation incidence would increase by 1.00, 2.22 and 1.56% during the first, second years and the cumulative years; respectively. The relationship between this factor and infestation incidence was determined by the partial regression values in Table (5), which emphasized a significant positive effect (+3.19 and +3.86) for the first and second year; respectively and an insignificant positive relation (+1.40) on the two cumulative years. As well, the values of partial correlation were (+0.54, +0.45 and +0.20) and the values of t-test were (+2.77, +2.22 and +1.31) during the first, second years and on the cumulative years, respectively. The mean dew point factor ranked the second effective variable for the changes in infestation incidence by 17.50, 6.35, and 2.29% during the first, second year and the cumulative years; respectively.

E- The Combined Effects of Climatic Factors on Incidence of Infestation Percentages:

The combined effect of these tested factors on infestation incidence by pest (Table 5) was highly significant "F" values were 6.23, 14.70, and 8.10 during the first, second year and two cumulative years; respectively. The multiple regression analysis revealed that all variables together were responsible for the changes in the infestation incidence by the pest. The percentages of explained variance (E.V.%) were 56.73, 75.58, and 42.97% for the two years individually and during two cumulative 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.

Prediction of Total Population and Percentages of Infestation Incidence:

The most effective climatic factors, which could be used to predict total population and percentages of infestation incidence by *I. seychellarum*, were (DMaxT) (x_1), (DMinT) (x_2), relative humidity (x_3), and dew point (x_4). Prediction equation for total population and percentages of infestation was concluded according to the mentioned statistical analysis on the two cumulative years in Tables (4 and 5) and presented as follow:

For total population

$Y = -27.10 + 4.24\, x_1 - 7.04\, x_2 - 0.82\, x_3 + 10.46\, x_4$; E.V. = 62.97%

For infestation incidence

$Y = + 62.57 – 0.54\ x_1 + 0.63\ x_2 + 0.01\ x_3 + 1.40\ x_4$; E.V. = 42.97%

Where is, Y= Prediction value**.** **E.V.% =** Explained variance

***** Significant at P ≤ 0.05 ****** Highly significant at P ≤ 0.01

The aforementioned results on the effect of four considered weather factors on insect population and percentages of infestation incidence during the two successive years varied from one year to another. The (MDP%) and (DMinT) were the most effective variables in the changes of pest population and the percentages of infestation incidence by pest during the two years individually and during two cumulative years.

The current study revealed that the activity of *I. seychellarum* was mostly related to the simultaneous effect of these selected weather factors rather than the single effect of each factor alone. Previous studies conducted by Fisher (1950) revealed that the method of partial regression was the best way for dealing with uncontrolled variables such as physical factors in the ecosystem. A previous study by El-Said (2006) stated that the effect of temperature on insect activity was strongly positive and significant and the effect of (DRH%) was insignificantly negative for both years of investigation. Also, the percentages of explained variance by these factors were 60 and 76 % for 2003 and 2004 seasons. In addition, Abd-El-Rahman *et al*. (2007) found a significant positive correlation with temperature and an insignificant negative correlation with relative humidity. Also, Sayed (2008) stated that the four tested factors i.e. maximum temperature, minimum temperature, mean temperature and percentage of relative humidity were simultaneously responsible for about 32.8-65% of *I. seychellarum* activity.

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ARABIC SUMMARY

توزيع وتقييم أضرار حشرة البق الدقيقى السيشلارم على أشجار الجوافة في ظل الظروف البيئية للأقصر، مصر

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تعتبر حشرة البق الدقيقى السشيلارم من الآفات الخطيرة التى تصيب أشجار الجوافة فى مصر. تمتص هذه الآفة العصارة النباتية مما يؤدى الي التأثير على نمو الأوراق والفروع والبراعم الزهرية ، كما تودى إلى موت الشتلات الصغيرة وتسبب موت وجفاف الأوراق والفروع وفى حالة الإصابة الشديدة تنتقل إلى الثمار وتسبب تشوهات فى الثمار مما يودى إلى تقليل القيمة التسويقية للثمار. ولتصميم برنامج مكافحة متكامل لهذه الآفة فقد تم دراسة الملاحظات الايكولوجية الحقلية للحشرة وتقدير نمط توزيعها المكانى و حجم العينة الأدنى للحشرة خلال عاميين متتاليين (2018/2017 و 2018/ 2019).

أوضحت النتائج، أن التعداد الحشرى يتواجد على أشجار الجوافة على مدار العام، ولها من ثلاثة الى أربع قمم للنشاط الموسمى خلال العام سجلت فى بداية يونيو، منتصف شهر سبتمبر، منتصف شهر نوفمبر خلال العام الأول من الدراسة، بينما فى بداية شهر ابريل، منتصف شهر يونيه، منتصف شهر أغسطس ومنتصف شهر أكتوبر خلال العامِ الثانيِ من الدراسة. أيضا، أظهرت نسب حدوث الإصابة بالحشرة أن لها ثلاثة إلى أربع قمَمِ خلال العام.

كما لوحظ، أن الظروف البيئية فى الشهورَ الخريفيةَ خلال العامِين كَانتْ أكثر الشهور تفضيلا وملائمة لنمو ونشاط التعداد الكلى للحشرة تحت ظروف المناخيةِ للمنطقة تحت الدراسة.

وأوضحت نتائج الدراسة، أن تأثير العوامل الطقس الجوية (درجة الحرارة القصوى اليومية و درجة الحرارة الصغرى اليومية ومتوسط نسبة الرطوبة النسبية ومتوسط نقطة الندى) على التعداد الحشرى وعلى نسب حدوث الإصابة خلال العامين كان واضحا ومعنوى جدا ، وأن تأثير هذه العوامل يختلف من عام إلى أخر، وأظهر التحليل الاحصائى باستخدام طريقة الانحدار المتعدد، أن متوسط نقطة الندى ودرجة الحرارة الدنيا المميتة كانت المتغيرات الأكثر فعالية للتغيرات فى التعداد الحشرى وعلى نسب حدوث الإصابة خلال العامين المتراكمين معا.