Life tables of the Mealy bug *Phenacoccus solenopsis* Tinsley1898 (Hemiptera: Pseudococcidae) on *Hibiscus mutabilis* (Malvaceae) in Iraq

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ABSTRACT

This study is performed at the gardens of the Agriculture College / Baghdad University, from March to August 2016. The aim is study to create the life tables of the mealy bug *Phenacoccus solenopsis*, the high density is in May. It reveals that the primate mortality factors play a key part in the pest population density, these life table expose that the eggs infertility give rise to mortality rate, then the photoperiodism and sex ratio, play the main role in the hesitation of the high pest density .The limited effect by biotic factors is on the larvae stages. though , the significance of these vital and not vital factors in the population density regularity, below the economic threshold level, with carry on the trend index, to high values in the highest levels direction up to 1.7-1.34, on the cotton rose *Hibiscus mutabilis* (Malvaceae). The results showed that the photoperiodism and the adult mortality were the responsible factors in decreasing the high insect density . And the trend index during the interval from March to August 2016, was 1.07, 1.03, 0.93, 0.88,0.30 and 1.34, in Baghdad respectively. so, it has become meaningful to decrease the insect's natural enemies of from original regions necessary for pest management and decrease the widespread of the high insect density.

Keywords: photoperiodism, trend index, adult mortality,

Introduction

The meal bug *Phenacoccus solenopsis* Tinsley (Hemiptera :Pseudococcidae) is a serious pest on the cotton and a widespread host plant scope (Arif *et al*. ,2009). The authentic description of *P. solenopsis* from *Atriplex canescens*in ,New Mexico, USA in (1898) (McDaniel, 1975; Hodgson *et al*. (2008). It was detected on ornamental plants in

Turkey (Kaydan *et al*., 2013).First record of this pest infested ornamental plant *Lantana camara* (Verbeneceae) in Iraq it was made by Abdul - Rassoul *et al*. (2015).The global trade played a main role in the pest widespread to new areas of the world.

The increase ability of these species of the mealy bug was quickly in population density and widespread of areas where there is existence of host plants in a comparatively curt time duration (Nguyen and Huynh, 2008) . It recorded on 202 field , ornamentals trees ,crops, and vegetables host plant species (Maruthadurai and Singh, 2015) . Causing heavy casualties (779.4 USA $/ha) and decrease a range yield cotton seed by 44 %. In Pakistan the pest caused to loss cotton crop by 14% in 2005 (Dhawan *et al*., 2008). It was classified as a serious pest species threat China with dangerous value 0.856 (Wang *et al*. ,2009).

Several parasitoids and predators are injure the *P. solenopsis*, three parasitic wasps (, *Cheiloneurus* sp., *Chalcaspis arizonensis* and (*Aprostocetus minutus*) detected on the mealybug that found on cotton crop infested in USA (Fuchs *et al*., 1991). In India ,the endoparasitoid , *Aenasius* sp., recorded on *P. solenopsis*, and reported to infest 10-45% of the *P. solenopsis* on cotton) (Bambawale, 2008). The parasitoid *Promuscidea unfasciati,* accomplish 30-80% mortality in fields and promised to use into a integrated pest management programs for the mealybug pest(Franco *et al*. 2009).

The two coccinellids (*Brumoides suturalis* and *Hyperaspis maindroni*) were identified as predators of *P.solenopsis* (Patel *et al*. 2009) . The larvae of the lacewing, *Chrysoperla carnea*, were existed to exhaust 30 eggs daily in laboratory trials (Rabinder Kaur *et al*., 2008). Despite the biological and chemical control, the dangerous of distribution *P. solenopsis* remains steady because of its high fecundity and polyphagous nature (Abbas *et al*., 2010),This nature of *P. solenopsis*, toward the researchers to study the biology of the Mealy bug on different host plants (Sana-Ullah *et al*., 2011). The efficiency of chemicals and biological control agents impacted to control the cotton mealy bug (*P.solenopsis).*

The biological potential, fecundity, Parthenogentic reproduction young ones as biotypes of this pest may produce un insecticides and biological control equipments resistance individuals . that , it requires to reveale the life table factors of *P. solenopsis* and instruction of the ecological parameters (biotic and abiotic factors like parasitoids, predators, relative humidity , temperature , etc.) relative with this pest.This study indicates summarized information on the life table of *P. solenopsis* conducted on the cotton rose *Hibiscus mutabilis* (Malvaceae) at leave of the tree (Al-Nadawi,2014). We determined the life table parameters, age-specific life table under fieild conditions. The main theme of this study is to devote the best understanding of life table of *P. solenopsis*, and to be available information about the preferable phonological stage for development and prophecy of *P. solenopsis* widespread(Al-Nadawi & Al Salihi,2015) .

Material and Methods

Construction of life tables:

Preparing a special life tables to cotton mealybug (*P. solenopsis*)on the cotton rose *Hibiscus mutabilis* (Malvaceae)in accordance to the program results, taking a random sample of the variety mentioned above every ten days of Baghdad University gardens for the period from March until August (2016).

Counting the number of the hatched and non hatched eggs, each stage of the insect and the pupa stage individuals, identified factors of death (parasitism, predation,). While the stages of the insect found dead without knowing the death reason (unknown reasons), where extreme weather conditions play a key role.

Morris and Miller (1954)built life table and put arrangement tables ,then Harcourt (1969) developed by and included the following columns:

X = pivotal age
L × = the number of individuals in the beginning.
d × F = factor responsible for the death in the age group.
d x = number of individuals died.
100q × = "Based on these observations", apparent mortality.
S × = survival rate.

With adding the K-factor (the key factor) column to life tables, which represents the sum of the logarithm of the total mortality at each age group (Varley and Gradwell ,1960)according to the following equation :

$K = \text{Log}(Lx) - \text{Log}(Lx-1)$

As:

K = relative participation of each death factors.
Log (Lx) = logarithm the number of individuals live.
Log (Lx-1) = logarithm the number of live individuals age group that follows the age group.

K represent the total deaths through Generation mortality was calculated from the sum of the values of K for all age groups this means that:

$K = K1+K2+K3...+KN$ (Smith,1973)

Harcourt (1969) developed the expected number of eggs, and Trend index of the population (TI) and the rate of survival of the generation (SG) according to the equations :

Expected eggs = (Normal females ×2)/2×Maximum number of eggs / female

As:

Expected eggs = the expected number of eggs.

Normal female = natural female.

Max. No. of eggs / female = highest number of eggs set by the female.

The Trend Index population (TI) has by and in accordance with the following equation:

T.I.=N2/N1

As:

N1 = Eggs number laid by the females of the current generation.

N2 = number of eggs deposited by a female for the next generation (new).

The (SG) survival rate was as according to the following equation:

SG=N3/N1

As:

N1 = Eggs number of deposited by the females of the first generation.

N3 = number of females depositing from the current generation.

Results and Discussion

Complete life tables built for age group of the Cotton Meal Bug *P. solanopsis* on ornamental plants the cotton rose *Hibiscus mutabilis* (Malvaceae), to figure out the dynamics of the population from month to month, and to identify the factors responsible for the change in population density that could be curb worker maintains the numbers when balanced level or low, Or may be opposite happening divorce her to high levels. Due to the large number of prepared insect partial overlap in the number of generations, they have adopted the monthly data for the construction of the monthly life tables according to the program of sampling every ten days for the period from March until August 2016 in Baghdad.

Table (1) shows the results for the month of March 2016, the percentage of deaths in egg stage is 5%, and for infertility of eggs are the most important role in reducing the hatching percentage . As well as the role of some of the biotic factors predator the eggs by mortality percentage to 2.61%, while the sum of the values of the relative contribution of death is due to the factors referred to (K-value) 0.018.

As it became clear the importance of life-death factors (predation and parasitism) in reducing the number of live nymphs by mortality rate to

0.71, 1.61%, respectively, and the relative contribution of the total at 0.004.The several parasitoids and predators recorded to attack *P. solenopsis* (Fuchs *et al*.(1991). Three parasitic wasps (*Cheiloneurus* sp.,*Chalcaspis arizonensis*, , and *Aprostocetus minutus*) were detected attacking the mealybug on cotton [*Gossypium* spp.] in Texas. And Yadav and Pathak, (2010) mentioned that the most predators feed on the crawlers or eggs within the mealybug's ovisac and decrease the population density available to suck sap and weaken the plant. , The larvae of lacewing, *Chrysoperla carnea* as a potential predators, were existed to exhaust 30 mealybug eggs daily in developmental laboratory trails.

The destroyer of the mealybug was coccinellid predator, *Cryptolaemus montrouzieri* used biological control agent in different parts of the world. It played a main role in the biological control of various sucking pests (Mani, 1990), especially mealybugs (Mani and Krishnamoorthy, 2008).

Also notes from the table that vital factors (parasitism and predation) for the adult stage were relatively high despite the entry the parasites as an additional death with a total relative contribution of mortality K-value reached) 0.011, while the resulting ((Photoperiodism measured by influencing the rates of the number of eggs (maximum and minimum) by the female insect an important role in impact the population density of pest thevalue of (K) 0.041, which exceeded the impact of the rest of the other factors mentioned above, Harcourt (1969) said that the potential energy to lay eggs in insects depended on Photoperiodism promise most important functions, and that the impact of such a factor in female insect caused the reduction of the number of eggs increased by 50.19%, outperforming the factors responsible for the extermination of adult mortality .

Natural female suffered many factors, including predation by predatory insects or birds and mortality due to weather conditions or failure to mating, as well as the severity of overcrowding or immigration to other places because of the storms importance in changing the population density of the density . The separation of such factors from each other is not easy, as settings lacking we have conclusive evidence about the role of each of them accurately and despite the impact of the factors mentioned has noted a trend index to guide a relative increase in the population of the insect, where the rate reached 1.07 as the date coincided with the emergence of the insect in the first week of March .

Figure (1) shows for the month of April that the maximum temperatures rates and minimum relative humidity was 17,32, 36% respectively), relatively high for a record of climatic conditions in the previous month, as shown in Table (2) High Activity of natural enemies at record rates to grow with mortality rates of the insect stages (eggs, nymphs and adult). It has reached the K-value 0.013,0.011,0.013 respectively as compared to its value in the previous month while their value fell for the adults and a significant increase due to the Photoperiodism or the other factors mentioned above, amounting to 0.004,0.387, respectively, the trend index remained conservative on the high level reached 1:03 left to turn on the high population density.

Table (3) shows high mortality rates dramatically decrease from the previous month due to high population density maximum temperatures to 41 C and minimum 27.1 Me and relative humidity 24%, respectively. It is the death relative contribution of the insect stage K-Value (eggs, adult) equal and 0.018 amount that exceeds the percentage of the death relative contribution of the nymphs reaching 0.009.but The impact of adult mortality factors low rate of 0.004 seems to be the effect of those factors combined clear on the population density of the insect as it notes the trend index 0.93 to a decline in the insect density (Persad and Khan, 2002) .

The indicated Results refer to (Table 4) the impact of bio tic -and a biotic factors on the insect density rates increases, the mortality is increased to higher than the May rate is Photoperiodism most huge share in the insect mortality numbers, where K values amounted to 0.387 the trend index dropped to 0.88, which led to relatively low in the insect population from the previous month.

As being noted in table (5) Heats up to high levels, amounting majority of which 44,43 C^0 and minimum 28.35 C^0 relative humidity is low reaching 37,46%, respectively, which are important factors in influencing in immature insect stage for the months of July and August 2016 and that led to a decline in the trend index values, amounting to 0.30, 0.21, respectively.

Rates have deteriorated preparing insect subsequent-month period, as shown in the tables mentioned earlier as a result of the high temperatures to the high levels of temperature and humidity, which shows the key role of the maximum temperatures and a low relative humidity in determining the trend index of the population to rise guide and landing its impact on the insect mortality factors generally (Siswanto *et al* (2001).

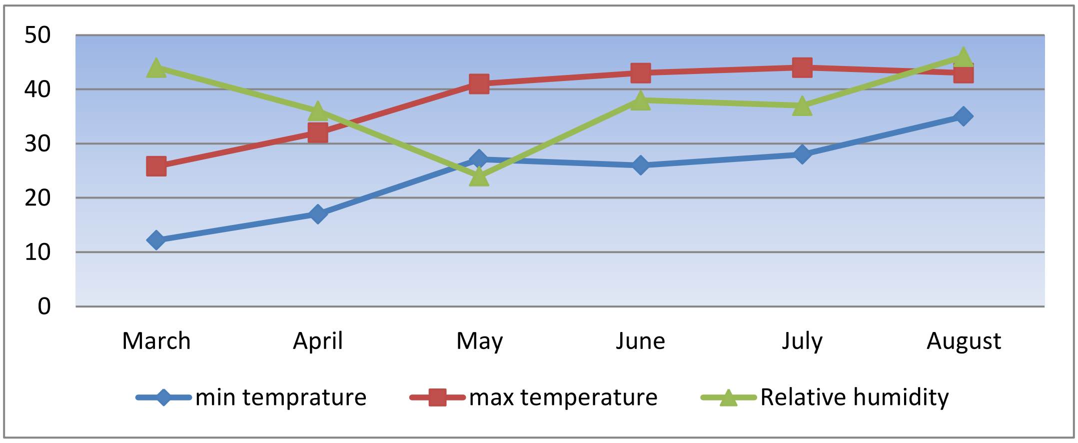

Figure (1) Rates of temperatures and relative humidity in Baghdad governorate for the period of March-August 2016

Table (1): The life table of Meal bug *P. solanopsis* on the cotton rose *Hibiscus mutabilis* (Malvaceae)in Baghdad for the month of March 2016

X	Lx	dxf	dx	100qx	Sx	K-value
Eggs (N_1)	16693	Infertility	835	5	0.95	0.018
		Predators	435	2.61	0.97	
		Total	1270	7.61	0.96	
Nymphs (1-3)	15423	Parasitoid	110	0.71	0.99	0.004
		Predators	243	1.61	0.98	
		Total	353	2.32	0.99	
Adult	15070	Parasitoid	291	1.93	0.98	0.011
		Predators	301	2	0.98	
		Total	592	3.93	0.98	
Adult	14478	Sex ratio♀♀ (75%)	3620	0.17	0.99	0.004
Females x2(N_3)	10858	Photoperiodism	6443	59.19	0.41	0.387
Normal females x2	4415	Adult mortality	4371	1.1	0.99	0.004
Generation totals	44		16649			0.428

Expt. Eggs = (1682115)،(Actual eggs) N_2 (17840) ، (T.I.)= (1.07) ، (S.G.) = (0.61)

Table (2): The life table of Meal bug *P. solanopsis* on the cotton rose *Hibiscus mutabilis* (Malvaceae)in Baghdad for the month of April 2016

X	Lx	dxf	dx	100qx	Sx	K-value
Eggs (N_1)	17840	Infertility	892	5	0.95	0.013
		Predators	326	1.32	0.98	
		Total	1218	6.32	0.97	
Nymphs (1-3)	16622	Parasitoid	201	1.21	0.99	0.011
		Predators	435	2.61	0.97	
		Total	636	3.82	0.98	
Adult	15986	Parasitoid	390	2.44	0.98	0.013
		Predators	602	3.76	0.96	
		Total	992	6.21	0.97	
Adult	14994	Sex ratio♀♀ (75%)	3749	0.17	0.99	0.004
Females x2(N_3)	11245	Photoperiodism	6656	59.19	0.41	0.387
Normal females x2	4589	Adult mortality	4543	1.04	0.99	0.004
Generation totals	46		17794			0.432

Expt. Eggs = 1748409 ،(Actual eggs)= N_2 (18345)، (T.I.)= (1.03) ، (S.G.) = (0.25)

Table (3): The life table of Meal bug *P. solanopsis* on the cotton rose *Hibiscus mutabilis* (Malvaceae)in Baghdad for the month of May 2016

X	Lx	dxf	dx	100qx	Sx	K-value
Eggs (N_1)	18345	Infertility	917	5	0.95	0.018
		Predators	501	2.73	0.97	
		Total	1418	7.73	0.96	
Nymphs (1-3)	16927	Parasitoid	331	2	0.98	0.009
		Predators	392	2.31	0.98	
		Total	723	4.31	0.98	
Adult	16204	Parasitoid	456	2.81	0.97	0.018
		Predators	873	5.39	0.95	
		Total	1329	8.2	0.96	
Adult	14875	Sex ratio♀♀ (75%)	3719	0.17	0.99	0.004
Females x2(N_3)	11156	Photoperiodism	6603	59.19	0.41	0.387
Normal females x2	4553	Adult mortality	4508	0.26	0.99	0.004
Generation totals	45		18300			0.44

Expt. Eggs = 1734693 ، Actual eggs) N_2 (17221 = (T.I.)= 0.93) ، S.G. = (0.64)

Table (4): The life table of Meal bug *P. solanopsis* on the cotton rose *Hibiscus mutabilis* (Malvaceae)in Baghdad for the month of June 2016

X	Lx	dxf	dx	100qx	Sx	K-value
Eggs (N_1)	17221	Infertility	861	5	0.95	0.013
		Predators	245	1.42	0.98	
		Total	1106	6.42	0.97	
Nymphs (1-3)	16115	Parasitoid	195	1.21	0.99	0.004
		Predators	95	0.58	0.99	
		Total	290	1.79	0.99	
Adult	15825	Parasitoid	125	0.79	0.99	0.004
		Predators	84	0.53	0.99	
		A biotic factor Honeydew	30	0.19	0.99	
		Total	239	1.51		
Adult	15586	Sex ratio♀♀ (75%)	3897	0.16	0.99	0.004
Females x2(N_3)	11689	Photoperiodism	6919	59.19	0.41	0.387
Normal females x2	4770	Adult mortality	4722	0.84	0.99	0.004
Generation totals	48		17173			0.416

Expt. Eggs =(1817370)، Actual eggs N_2 =(15321) ، (T.I.)= (0.88) ، (S.G.)= (0.76)

Table (5): The life table of Meal bug *P. solanopsis* on the cotton rose *Hibiscus mutabilis* (Malvaceae)in Baghdad for the month of July 2016

X	Lx	dxf	dx	100qx	Sx	K-value
Eggs (N_1)	15321	Infertility	766	5	0.95	0.013
		Predators	198	1.3	0.99	
		Total	964	6.3	0.97	
Nymphs (1-3)	14357	Parasitoid	88	0.61	0.99	0.004
		Predators	100	0.70	0.99	
		A biotic factor Honeydew	43	0.30	0.99	
		Total	231	1.61	0.99	
Adult	14126	Parasitoid	97	0.56	0.99	0.004
		Predators	33	0.23	0.99	
		A biotic factor Honeydew	45	0.32	0.99	
		Total	175	1.1 1	ز00.99	
Adult	13951	Sex ratio♀♀ (75%)	3488	0.18	0.99	0.004
Females x2(N_3)	10463	Photoperiodism	6193	59.19	0.41	0.387
Normal females x2	4270	Adult mortality	4227	0.86	0.99	0.004
Generation totals	43		15278			0.416

Expt. Eggs =(1626870)، Actual eggs N_2 =(14141) ، (T.I.)= (0.92) ، (S.G.)= (0.30)

X	Lx	dxf	dx	100qx	Sx	K-value
Eggs (N_1)	14141	Infertility	707	5	0.95	0.013
		Predators	191	1.35	0.99	
		Total	898	6.35	0.97	
Nymphs (1-3)	13243	Parasitoid	122	0.92	0.99	0.013
		Predators	72	5.57	0.95	
		A biotic factor Honeydew	13	0.09	0.99	
		Total	207	15.63	0.97	
Adult	13036	Parasitoid	55	0.42	0.99	0.004
		Predators	41	0.31	0.99	
		A biotic factor Honeydew	12	0.09	0.99	
		Total	108	8.75	0.99	
Adult	12928	Sex ratio♀♀ (75%)	3232	0.19	0.99	0.004
Females x2(N_3)	9696	Photoperiodism	5739	59.19	0.41	0.387
Normal females x2	3957	Adult mortality	3917	0.96	0.99	0.004
Generation totals	40		14101			0.43

Table (6): The life table of Meal bug *P. solanopsis* on the cotton rose *Hibiscus mutabilis* (Malvaceae)in Baghdad for the month of August 2016

Expt. Eggs =(1507617)، Actual eggs N_2 =(18985) ، (T.I.)= (1.34) ، (S.G.)= (0.21)

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