Life tables of the Mealy bug *Phenacoccus solenopsis* Tinsley١٨٩٨ (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 ٢٠١٦. 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 ١.٧-١.٣٤, 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 ٢٠١٦, was ١,٠٧, ١.٠٣, ٠.٩٣, ٠,٨٨,٠,٣٠ and ١.٣٤, 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*. ,٢٠٠٩). The authentic description of *P. solenopsis* from *Atriplex canescens*in ,New Mexico, USA in (١٨٩٨) (McDaniel, ١٩٧٥; Hodgson *et al*. (٢٠٠٨). It was detected on ornamental plants in Turkey (Kaydan *et al*., ٢٠١٣).First record of this pest infested ornamental plant *Lantana camara* (Verbeneceae) in Iraq it was made by Abdul - Rassoul *et al*. (٢٠١٥).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, ٢٠٠٨) . It recorded on ٢٠٢ field , ornamentals trees ,crops, and vegetables host plant species (Maruthadurai and Singh, ٢٠١٥) . Causing heavy casualties (٧٧٩,٤ USA $/ha) and decrease a range yield cotton seed by ٤٤ %. In Pakistan the pest caused to loss cotton crop by ١٤٪ in ٢٠٠٥ (Dhawan *et al*., ٢٠٠٨). It was classified as a serious pest species threat China with dangerous value ٠,٨٥٦ (Wang *et al*. ,٢٠٠٩).

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*., ١٩٩١). In India ,the endoparasitoid , *Aenasius* sp., recorded on *P. solenopsis*, and reported to infest ١٠-٤٥٪ of the *P. solenopsis* on cotton) (Bambawale, ٢٠٠٨). The parasitoid *Promuscidea unfasciati*, accomplish ٣٠-٨٠٪ mortality in fields and promised to use into a integrated pest management programs for the mealybug pest(Franco *et al*. ٢٠٠٩).

The two coccinellids (*Brumoides suturalis* and *Hyperaspis maindroni*) were identified as predators of *P.solenopsis* (Patel *et al*. ٢٠٠٩) . The larvae of the lacewing, *Chrysoperla carnea*, were existed to exhaust ٣٠ eggs daily in laboratory trials (Rabinder Kaur *et al*., ٢٠٠٨). 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*., ٢٠١٠),This nature of *P. solenopsis*, toward the researchers to study the biology of the Mealy bug on different host plants (Sana-Ullah *et al*., ٢٠١١). 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,٢٠١٤). 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,٢٠١٥) .

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 (٢٠١٦).

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 (١٩٥٤)built life table and put arrangement tables ,then Harcourt (١٩٦٩) 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.

١٠٠q × = "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 ,١٩٦٠)according to the following equation :

K=Log (Lx) - Log (Lx-١)

As:

K = relative participation of each death factors.

Log (Lx) = logarithm the number of individuals live.

Log (Lx-١) = 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 = K١+K٢+K٣...+KN (Smith,١٩٧٣)
Harcourt (١٩٦٩) 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 ×٢)/٢×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.=N٢/N١
As:
N١ = Eggs number laid by the females of the current generation.
N٢ = number of eggs deposited by a female for the next generation (new).
The (SG) survival rate was as according to the following equation:
SG=N٣/N١
As:
N١ = Eggs number of deposited by the females of the first generation.
N٣ = 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 ٢٠١٦ in Baghdad.

Table (١) shows the results for the month of March ٢٠١٦, the percentage of deaths in egg stage is ٥٪, 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 ٢,٦١٪, while the sum of the values of the relative contribution of death is due to the factors referred to (K-value) ٠,٠١٨.

As it became clear the importance of life-death factors (predation and parasitism) in reducing the number of live nymphs by mortality rate to ٠,٧١, ١,٦١٪, respectively, and the relative contribution of the total at ٠,٠٠٤.The several parasitoids and predators recorded to attack *P. solenopsis* (Fuchs *et al*.(١٩٩١). 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, (٢٠١٠) 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 ٣٠ 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, ١٩٩٠), especially mealybugs (Mani and Krishnamoorthy, ٢٠٠٨).

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) ٠,٠١١, 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) ٠,٠٤١, which exceeded the impact of the rest of the other factors mentioned above, Harcourt (١٩٦٩) 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 ٥٠,١٩٪, 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 ١،٠٧ as the date coincided with the emergence of the insect in the first week of March .

Figure (١) shows for the month of April that the maximum temperatures rates and minimum relative humidity was ١٧,٣٢, ٣٦٪ respectively), relatively high for a record of climatic conditions in the previous month, as shown in Table (٢) 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 ٠،٠١٣,٠،٠١١,٠،٠١٣ 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 ٠،٠٠٤,٠،٣٨٧, respectively, the trend index remained conservative on the high level reached ١:٠٣ left to turn on the high population density.

Table (٣) shows high mortality rates dramatically decrease from the previous month due to high population density maximum temperatures to ٤١ C and minimum ٢٧,١ Me and relative humidity ٢٤٪, respectively. It is the death relative contribution of the insect stage K-Value (eggs, adult) equal and ٠،٠١٨ amount that exceeds the percentage of the death relative contribution of the nymphs reaching ٠،٠٠٩.but The impact of adult mortality factors low rate of ٠،٠٠٤ seems to be the effect of those factors combined clear on the population density of the insect as it notes the trend index ٠،٩٣ to a decline in the insect density (Persad and Khan, ٢٠٠٢) .

The indicated Results refer to (Table ٤) 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 ٠،٣٨٧ the trend index dropped to ٠،٨٨, which led to relatively low in the insect population from the previous month.

As being noted in table (٥) Heats up to high levels, amounting majority of which ٤٤,٤٣ C˙ and minimum ٢٨,٣٥ C˙ relative humidity is low reaching ٣٧,٤٦٪, respectively, which are important factors in influencing in immature insect stage for the months of July and August

٢٠١٦ and that led to a decline in the trend index values, amounting to ٠,٣٠, ٠,٢١, 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* (٢٠٠١).

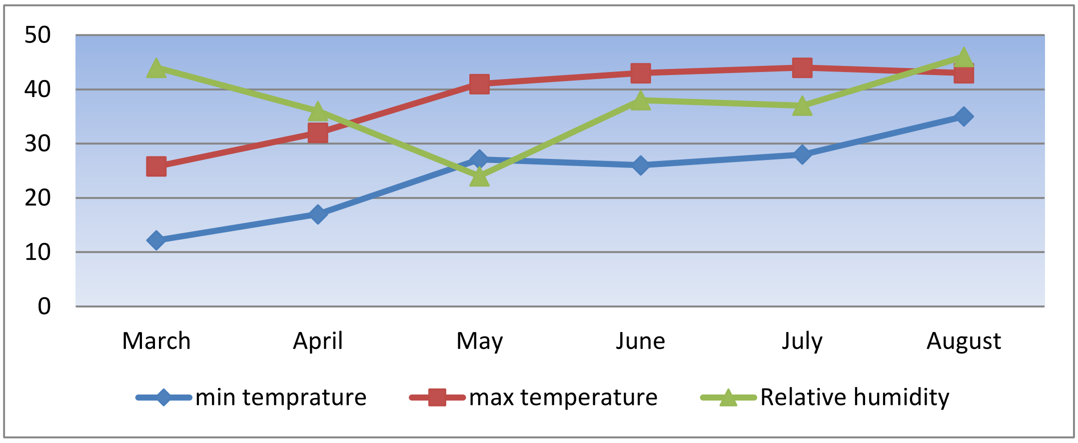

Figure (١) Rates of temperatures and relative humidity in Baghdad governorate for the period of March-August ٢٠١٦

Table (١): The life table of Meal bug *P. solanopsis* on the cotton rose *Hibiscus mutabilis* (Malvaceae)in Baghdad for the month of March ٢٠١٦

X	Lx	dxf	dx	١٠٠qx	Sx	K-value
Eggs (N١)	١٦٦٩٣	Infertility	٨٣٥	٥	٠,٩٥	٠,٠١٨
		Predators	٤٣٥	٢,٦١	٠,٩٧	
		Total	١٢٧٠	٧,٦١	٠,٩٦	
Nymphs (١-٣)	١٥٤٢٣	Parasitoid	١١٠	٠,٧١	٠,٩٩	٠,٠٠٤
		Predators	٢٤٣	١,٦١	٠,٩٨	
		Total	٣٥٣	٢,٣٢	٠,٩٩	
Adult	١٥٠٧٠	Parasitoid	٢٩١	١,٩٣	٠,٩٨	٠,٠١١
		Predators	٣٠١	٢	٠,٩٨	
		Total	٥٩٢	٣,٩٣	٠,٩٨	
Adult	١٤٤٧٨	Sex ratio♀♀ (٧٥%)	٣٦٢٠	٠,١٧	٠,٩٩	٠,٠٠٤
Females x٢(N٣)	١٠٨٥٨	Photoperiodism	٦٤٤٣	٥٩,١٩	٠,٤١	٠,٣٨٧
Normal females x٢	٤٤١٥	Adult mortality	٤٣٧١	١,١	٠,٩٩	٠,٠٠٤
Generation totals	٤٤		١٦٦٤٩			٠,٤٢٨

Expt. Eggs = (١٦٨٢١١٥)،(Actual eggs) N٢ (١٧٨٤٠) ، (T.I.)= (١,٠٧) ، (S.G.) = (٠,٦١)

Table (٢): The life table of Meal bug *P. solanopsis* on the cotton rose *Hibiscus mutabilis* (Malvaceae)in Baghdad for the month of April ٢٠١٦

X	Lx	dxf	dx	١٠٠qx	Sx	K-value
		Infertility	٨٩٢	٥	٠,٩٥	

Eggs (N١)	١٧٨٤٠	Predators	٣٢٦	١,٣٢	٠,٩٨	٠,٠١٣
		Total	١٢١٨	٦,٣٢	٠,٩٧	
Nymphs (١-٣)	١٦٦٢٢	Parasitoid	٢٠١	١,٢١	٠,٩٩	٠,٠١١
		Predators	٤٣٥	٢,٦١	٠,٩٧	
		Total	٦٣٦	٣,٨٢	٠,٩٨	
Adult	١٥٩٨٦	Parasitoid	٣٩٠	٢,٤٤	٠,٩٨	٠,٠١٣
		Predators	٦٠٢	٣,٧٦	٠,٩٦	
		Total	٩٩٢	٦,٢١	٠,٩٧	
Adult	١٤٩٩٤	Sex ratio♀♀ (٧٥%)	٣٧٤٩	٠,١٧	٠,٩٩	٠,٠٠٤
Females x٢(N٢)	١١٢٤٥	Photoperiodism	٦٦٥٦	٥٩,١٩	٠,٤١	٠,٣٨٧
Normal females x٢	٤٥٨٩	Adult mortality	٤٥٤٣	١,٠٤	٠,٩٩	٠,٠٠٤
Generation totals	٤٦		١٧٧٩٤			٠,٤٣٢

Expt. Eggs = ١٧٤٨٤٠٩ ،(Actual eggs)= N٢ (١٨٣٤٥)، (T.I.)= (١.٠٣) ، (S.G.) = (٠.٢٥)

Table (٣): The life table of Meal bug *P. solanopsis* on the cotton rose *Hibiscus mutabilis* (Malvaceae)in Baghdad for the month of May ٢٠١٦

X	Lx	dxf	dx	١٠٠qx	Sx	K-value
Eggs (N١)	١٨٣٤٥	Infertility	٩١٧	٥	٠,٩٥	٠,٠١٨
		Predators	٥٠١	٢,٧٣	٠,٩٧	
		Total	١٤١٨	٧,٧٣	٠,٩٦	
Nymphs (١-٣)	١٦٩٢٧	Parasitoid	٣٣١	٢	٠,٩٨	٠,٠٠٩
		Predators	٣٩٢	٢,٣١	٠,٩٨	
		Total	٧٢٣	٤,٣١	٠,٩٨	
Adult	١٦٢٠٤	Parasitoid	٤٥٦	٢,٨١	٠,٩٧	٠,٠١٨
		Predators	٨٧٣	٥,٣٩	٠,٩٥	
		Total	١٣٢٩	٨,٢	٠,٩٦	
Adult	١٤٨٧٥	Sex ratio♀♀ (٧٥%)	٣٧١٩	٠,١٧	٠,٩٩	٠,٠٠٤
Females x٢(N٢)	١١١٥٦	Photoperiodism	٦٦٠٣	٥٩,١٩	٠,٤١	٠,٣٨٧
Normal females x٢	٤٥٥٣	Adult mortality	٤٥٠٨	٠,٢٦	٠,٩٩	٠,٠٠٤
Generation totals	٤٥		١٨٣٠٠			٠,٤٤

Expt. Eggs = ١٧٣٤٦٩٣ ، Actual eggs) N٢ (١٧٢٢١ = (T.I.)= ٠.٩٣) ، S.G. = (٠.٦٤)

Table (٤): The life table of Meal bug *P. solanopsis* on the cotton rose *Hibiscus mutabilis* (Malvaceae)in Baghdad for the month of June ٢٠١٦

X	Lx	dxf	dx	١٠٠qx	Sx	K-value
Eggs (N١)	١٧٢٢١	Infertility	٨٦١	٥	٠,٩٥	٠,٠١٣
		Predators	٢٤٥	١,٤٢	٠,٩٨	
		Total	١١٠٦	٦,٤٢	٠,٩٧	
Nymphs (١-٣)	١٦١١٥	Parasitoid	١٩٥	١,٢١	٠,٩٩	٠,٠٠٤
		Predators	٩٥	٠,٥٨	٠,٩٩	
		Total	٢٩٠	١,٧٩	٠,٩٩	
Adult	١٥٨٢٥	Parasitoid	١٢٥	٠,٧٩	٠,٩٩	٠,٠٠٤
		Predators	٨٤	٠,٥٣	٠,٩٩	
		A biotic factor	٣٠	٠,١٩	٠,٩٩	

		Honeydew				
		Total	٢٣٩	١,٥١		
Adult	١٥٥٨٦	Sex ratio♀♀ (٧٥%)	٣٨٩٧	٠,١٦	٠,٩٩	٠,٠٠٤
Females x٢(N٣)	١١٦٨٩	Photoperiodism	٦٩١٩	٥٩,١٩	٠,٤١	٠,٣٨٧
Normal females x٢	٤٧٧٠	Adult mortality	٤٧٢٢	٠,٨٤	٠,٩٩	٠,٠٠٤
Generation totals	٤٨		١٧١٧٣			٠,٤١٦

Expt. Eggs =(١٨١٧٣٧٠)، Actual eggs N٢ =(١٥٣٢١) ، (T.I.)= (٠.٨٨) ، (S.G.)= (٠.٧٦)

Table (٥): The life table of Meal bug *P. solanopsis* on the cotton rose *Hibiscus mutabilis* (Malvaceae)in Baghdad for the month of July ٢٠١٦

X	Lx	dxf	dx	١٠٠qx	Sx	K-value
Eggs (N١)	١٥٣٢١	Infertility	٧٦٦	٥	٠,٩٥	٠,٠١٣
		Predators	١٩٨	١,٣	٠,٩٩	
		Total	٩٦٤	٦,٣	٠,٩٧	
Nymphs (١-٣)	١٤٣٥٧	Parasitoid	٨٨	٠,٦١	٠,٩٩	٠,٠٠٤
		Predators	١٠٠	٠,٧٠	٠,٩٩	
		A biotic factor Honeydew	٤٣	٠,٣٠	٠,٩٩	
		Total	٢٣١	١,٦١	٠,٩٩	
Adult	١٤١٢٦	Parasitoid	٩٧	٠,٥٦	٠,٩٩	٠,٠٠٤
		Predators	٣٣	٠,٢٣	٠,٩٩	
		A biotic factor Honeydew	٤٥	٠,٣٢	٠,٩٩	
		Total	١٧٥	١,١١	ز٠٠,٩٩	
Adult	١٣٩٥١	Sex ratio♀♀ (٧٥%)	٣٤٨٨	٠,١٨	٠,٩٩	٠,٠٠٤
Females x٢(N٢)	١٠٤٦٣	Photoperiodism	٦١٩٣	٥٩,١٩	٠,٤١	٠,٣٨٧
Normal females x٢	٤٢٧٠	Adult mortality	٤٢٢٧	٠,٨٦	٠,٩٩	٠,٠٠٤
Generation totals	٤٣		١٥٢٧٨			٠,٤١٦

Expt. Eggs =(١٦٢٦٨٧٠)، Actual eggs N٢ =(١٤١٤١) ، (T.I.)= (٠.٩٢) ، (S.G.)= (٠.٣٠)

X	Lx	dxf	dx	١٠٠qx	Sx	K-value
Eggs (N١)	١٤١٤١	Infertility	٧٠٧	٥	٠,٩٥	٠,٠١٣
		Predators	١٩١	١,٣٥	٠,٩٩	
		Total	٨٩٨	٦,٣٥	٠,٩٧	
Nymphs (١-٣)	١٣٢٤٣	Parasitoid	١٢٢	٠,٩٢	٠,٩٩	٠,٠١٣
		Predators	٧٢	٥,٥٧	٠,٩٥	
		A biotic factor Honeydew	١٣	٠,٠٩	٠,٩٩	
		Total	٢٠٧	١٥,٦٣	٠,٩٧	
Adult	١٣٠٣٦	Parasitoid	٥٥	٠,٤٢	٠,٩٩	٠,٠٠٤
		Predators	٤١	٠,٣١	٠,٩٩	
		A biotic factor Honeydew	١٢	٠,٠٩	٠,٩٩	
		Total	١٠٨	٨,٧٥	٠,٩٩	
Adult	١٢٩٢٨	Sex ratio♀♀ (٧٥%)	٣٢٣٢	٠,١٩	٠,٩٩	٠,٠٠٤
Females x٢(N٢)	٩٦٩٦	Photoperiodism	٥٧٣٩	٥٩,١٩	٠,٤١	٠,٣٨٧
Normal females x٢	٣٩٥٧	Adult mortality	٣٩١٧	٠,٩٦	٠,٩٩	٠,٠٠٤
Generation totals	٤٠		١٤١٠١			٠,٤٣

Table (٦): The life table of Meal bug *P. solanopsis* on the cotton rose *Hibiscus mutabilis* (Malvaceae)in Baghdad for the month of August ٢٠١٦

Expt. Eggs =(١٥٠٧٦١٧)، Actual eggs N٢ =(١٨٩٨٥) ، (T.I.)= (١,٣٤) ، (S.G.)= (٠.٢١)

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