

EFFECT OF SOME INSECTICIDES ON THE LIFE TABLE PARAMETERS OF THE PINK BOLLWORM, *PECTINOPHORA GOSSYPIELLA* (SAUND.)

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Abstract

The pink bollworm, *Pectinophora gossypiella* (Saund.) was treated as newly hatched larvae with LC_{50} 's of different insecticidal groups namely Synthetic pyrethroids (es-fenvalerate, fenprothrin and lambda cyhalothrin), Organophosphorus compound (chlorpyrifos), Carbamate (thiodicarb) and antimoulting compound (tebufenozide) to evaluate the life table parameters which used by program of Abou Setta *et al.* (1986) and resulted many parameters, generation time (T), net reproductive rate (R_0), doubling time (DT), Increase rate (the intrinsic rate of natural increase (r_m) and the finit rate of increase (e^{rm})), female progeny per female (Mx), rate of survival (Lx). The result showed that:

Fenprothrin followed by tebufenozide gave highly decrease from female progeny per female (Mx), rate of survival(Lx), net reproductive rate (R_0), the intrinsic rate of natural increase (r_m) and the finit rate of increase (e^{rm}) compared with the control. While, the aforementioned compounds were increased from the generation time (T) and doubling time (DT).

Es-fenvalerate, lambda cyhalothrin and chlorpyrifos gave a moderate effect. Whereas, compound of thiodicarb was the least effect compared with the other tested compounds.

INTRODUCTION

The pink bollworm, *Pectinophora gossypiella* (Saund.) is the most destructive pest infesting cotton bolls through the world.

Life table parameters gives a measure of the relative suitability of different environment, also it gives the actual rate increase of the insect under different conditions. An index for the possible rate of the increase under different physical conditions would at the same time provide this in an index combining the total number of eggs laid, the survival rate of immature stages, the rate of development and the sex ratio. On the other hand, life tables are basic parameter which may be established for an insect population under specified physical conditions.

For establishing of any management program including chemical compounds for the pest control, it is an important to know the effect of the used compounds on the population growth of the target pest. Population growth can be estimated by life tables because they synthesize data on reproduction and mortality of population. Thus

life tables are considered a powerful tool for clarifying and understanding the impact of an external factor upon the growth, survival, reproduction and rate of increase of an insect population (Birch 1948, Abou-Setta *et al.*, 1986, Wittmeyer & Coudron 2001 and El-Gemeiy 2002).

The present study was conducted to investigate the life table parameters of the pink bollworm, *Pectinophora gossypiella* (Saund.) treated as newly hatched larvae with some insecticides. The insecticides tested were recommended for controlling the cotton bollworms in Egypt i. e., esfenvalerate, fenprothrin, lambda cyhalothrin, chlorpyrifos, thiodicarb and tebufenozide.

MATERIALS AND METHODS

A laboratory strain of the pink bollworm *P.gossypiella* (Saund.) was reared in the Integrated Pest Management Laboratory, Bollworms Department, Plant Protection Research Institute, Agricultural Research Center on modified artificial diet as described by Abdel-Hafez *et al.*, (1982). The insect stages were reared for many successive generations.

Tested compounds:

Synthetic pyrethroid compounds:

- 1.1. Es fenvalerate (Sumi-alpha 5% EC.): (S)- α - cyano -3-phenoxy benzyl (s) - 2-(4-chlorophenyl)-3-methylbutyrate.
- 1.2. Fenprothrin (Danitol 30 % EC.): alpha-cyano- 3 - phenoxy phenyl methyl 2,2,3,3-tetra methyl cyclopropane carboxylate.
- 1.3. Lambda cyhalothrin (Karate 5 % EC.): a reaction product comprising equal quantities of (S)- α - cyano-3- = phenoxy benzyl (z) -(1R)-cis-3-(2-chloro-3,3,3-trifluoropropenyl)-2,2- = dimethyl cyclopropane carboxylate and (R)- α -cyano-3-phenoxy benzyl (Z) - (1S) -cis-3-(2-chloro- =3,3,3-trifluoropropenyl)-2,2-dimethyl cyclopropane carboxylate.

Organophosphorus compound:

Chlorpyrifos (Dursban 48% EC.) 0,0-diethyl 0-(3,5,6 trichloro -2- pyridinyl phosphorothioate .

Carbamate compound:

Thiodicarb (Larvin 80% WP.): 3,7,9,13 - tetramethyl - 5,11-dioxo-2,8,14-trithia-4,7,9,12- tetra- azapentadeca-3,12-diene-6,10-dione.

Antimoulting compound:

Tebufenozide (Memic 24% FL.) : [N - tetra - butyl - N - (4 - ethylbenzoyl) - 3,5 - dimethyl benzohydrazide].

Life table parameters of certain insecticides of the pink bollworm treated as newly hatched larvae:

The changes in the life table parameter of the pink bollworm after treatment as newly hatched larvae with the LC_{50} 's of es fenvalerate, fenprothrin, lambda cyhalothrin, chlorpyrifos, thiodicarb and tebufenozide were studied. Data were analyzed according to Birch (1948) using life 48 basic computer program by Abou-Setta *et al.*, 1986.

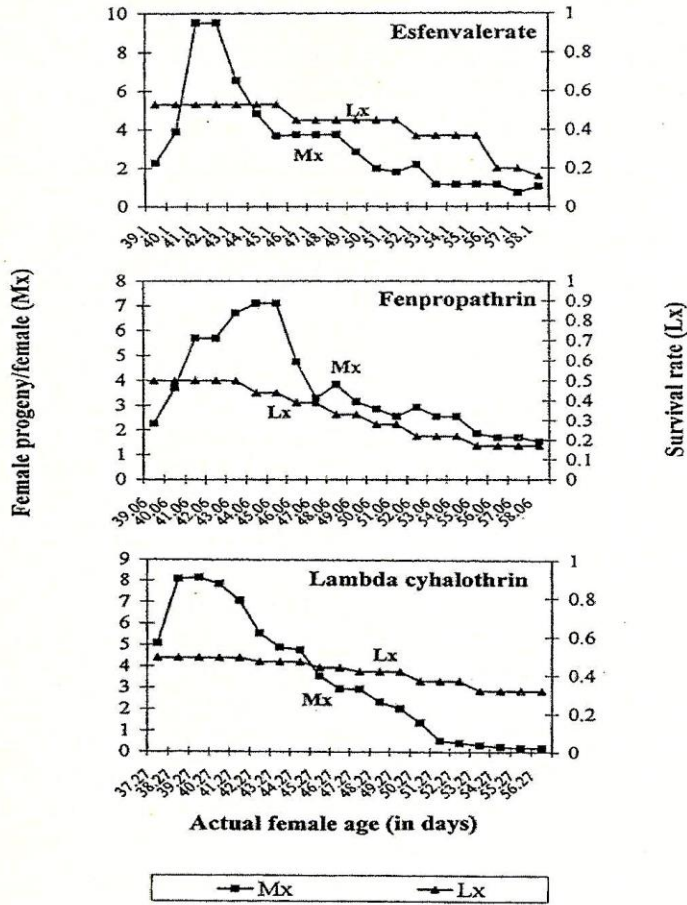
The program includes the following information for each interval of adult female age: total progeny per interval (egg laying rate) (M), number of females alive at age X (L), mean female age at each interval mid-point (X), female progeny per female produced during the day X (M_x), rate of survival (L_x), the product of $[(M_x)(L_x)]$ as $(M_x L_x)$, and the final values of RML (the product of $(M_x)(L_x)$ is then divided by the value of e (the base of natural logarithm) to the power of $[(r_m)(X)]$), finally, the program prints the precise life table parameters of this study as the sum of RML, the generation time (T) was calculated by $[\sum ((X)(L_x)(M_x))/Ro]$, the net reproductive rate (Ro) was calculated by $[\sum ((L_x)(M_x))]$, the doubling time (DT) which was resulted from divided the normal logarithm on r_m , the intrinsic rate of natural increase (r_m) was calculated by $[\ln(Ro)/T]$ and the finite rate of increase (e^{r_m}) is the natural antilogarithm of the intrinsic rate of increase and gives the number of times which the population multiplies in a unit time.

RESULTS AND DISCUSSION

The female progeny produced per female (M_x) and the rate of survival (L_x) of the pink bollworm after treatment as newly hatched larvae with esfenvalerate ($LC_{50}=0.0017$ mg/cm²), fenprothrin ($LC_{50}=0.0009$ mg/cm²), lambda cyhalothrin ($LC_{50}= 0.0160$ mg/cm²), chlorpyrifos ($LC_{50}= 0.0210$ mg/cm²), thiodicarb ($LC_{50}= 0.0620$ mg/cm²) and tebufenozide ($LC_{50}= 1.0560$ mg/cm²) were illustrated in figures (1,2&3). Generally, great progeny were produced per female with the first 10 days of their life time.

As shown in figure (1), fenprothrin gave the highest effect when the newly hatched larvae were treated with this compound compared with the other tested compounds, M_x parameter (female progeny per female) ranged between 0.54 to 7.10 female progeny/female compared with the control values which ranged between 0.18 to 14.84 female progeny /female as illustrated in figure (3). On the other hand, L_x parameter (rate of survival) ranged between 0.17 to 0.50 times as shown in figure (1) as compared with the control values which ranged between 0.29 to 0.93 times.

Figure 1. Female progeny per female (Mx) and survival rate (Lx) of *P.gossypiella* treated as newly hatched larvae with LC₅₀'s of es fenvalerate, fenpropathrin and lambda cyhalothrin.



Es fenvalerate

Figure 2. Female progeny per female (Mx) and survival rate (Lx) of *P.gossypiella* treated as newly hatched larvae with LC₅₀'s of chlorpyrifos and thiodicarb.

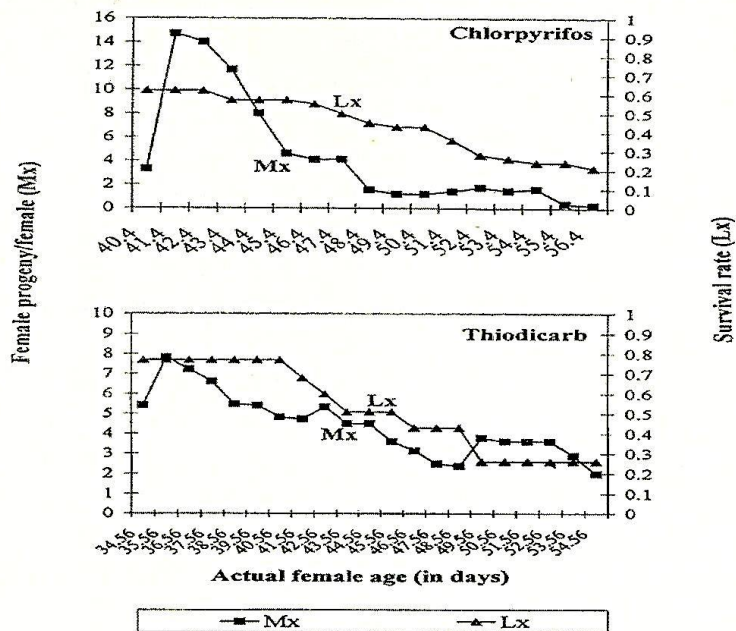


Figure 3. Female progeny per female (Mx) and survival rate (Lx) of *P.gossypiella* treated as newly hatched larvae with LC₅₀'s of tebufenozide and control.

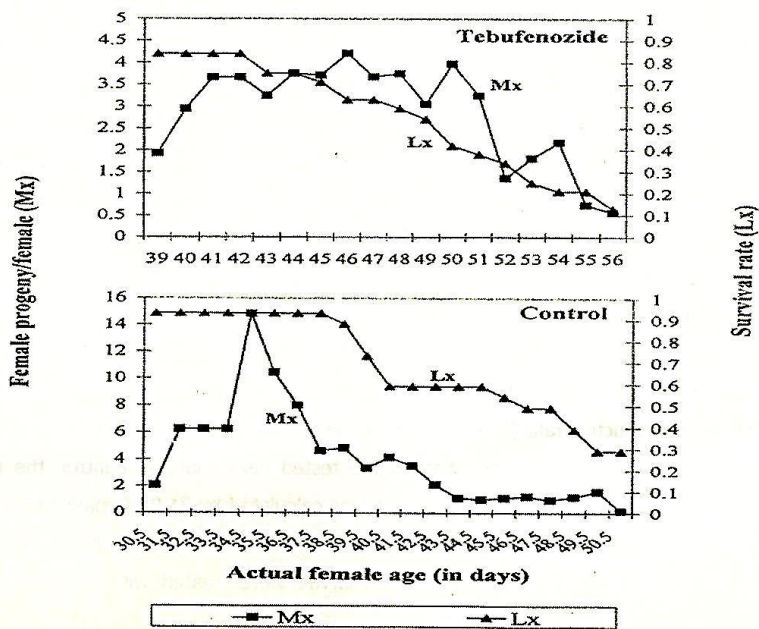


Figure (3) showed that Mx parameter of tebufenozide ranged between 0.57 to 4.21 female progeny/female, and Lx parameter for tebufenozide ranged between 0.13 to 0.84 times compared with the control values.

Also, esfenvalerate in figure (1) showed that highly effect on Mx parameter that was decreased and ranged between 0.73 to 9.52 female progeny/female. In addition, Lx parameter decreased between 0.16 to 0.53 times as compared with the control values. In this respect Abdel-Rahman *et al.* (2002) showed that the treatment of eggs, larvae, pupae and adult moths with LC₅₀ of esfenvalerate caused prolonging effects on the larval and pupal durations, adult life span and oviposition period. The tested insecticide reduced the fecundity of female moths and hatchability of deposited eggs, this effect was reflected in high percentages of sterility.

Mx parameter of lambda cyhalothrin ranged between 0.21 to 8.16 female progeny/female, while Lx parameter ranged between 0.32 to 0.49 times as shown in figure (1). Also, Mx parameter of chlorpyrifos ranged between 0.24 to 14.70 female progeny/female, while Lx parameter ranged between 0.21 to 0.62 times as shown in figure (2). On the other hand, Mx parameter of thiodicarb ranged between 1.99 to 7.82 female progeny/female, also Lx parameter ranged between 0.26 to 0.77 times as shown in figure (2) as compared with the control values.

The five main parameters associated with a fertility life table are the mean generation time (T), the net reproductive rate (Ro), doubling time (DT), the intrinsic rate of natural increase (r_m) and the finite rate of increase (e^{r_m}) as in Table (1).

1. Generation time (T):

Concerning the control, the generation time lasted 35.35 days as represented in Table (1) and fig. (4). While this period was prolonged as a result of treatment to newly hatched larvae with the LC_{50(s)} of the tested insecticides. The maximum mean of generation time occurred in fenprothrin (44.52 days), tebufenozide (44.43 days) and esfenvalerate (44.05 days) followed by chlorpyrifos (43.57 days), lambda-cyhalothrin (41.57 days) and then thiodicarb (39.64 days).

2. Net reproductive rate (Ro):

Regarding the results in shown in Table (1) and fig. (4), it was very clear that the adverse effect of the tested insecticides was expanded to the produced females, as the net reproductive rate (Ro) of those females was greatly reduced. Moreover, the adverse effect was differed according to the tested insecticide. At control, the net reproductive rate (Ro) of the pink bollworm was calculated by 71.05 females/ female, while it was drastically reduced to be 28.23, 31.43, 32.11, 32.99, 41.54 and 54.17 females/ female when the newly hatched larvae were treated with the LC_{50(s)} of

fenpropathrin, tebufenozide, esfenvalerate, lambda cyhalothrin, chlorpyrifos and thiodicarb, respectively.

3. Doubling Time (DT):

At any population, the time of generation doubling is depending directly on the intrinsic rate of natural increase (r_m), which is affected by many factors such as the rate of survival, the time of generation, female progeny and females fecundity. In control, the pink bollworm population had the capacity to multiply every 5.747 days Table (1) and fig. (4). However, this population had the capacity to double every 9.238, 8.932, 8.802, 8.314, 8.104 and 6.883 days when the newly hatched larvae treated with the $LC_{50(s)}$ of fenpropathrin, tebufenozide, esfenvalerate, lambda cyhalothrin, chlorpyrifos and thiodicarb, respectively.

4- Increase rate:

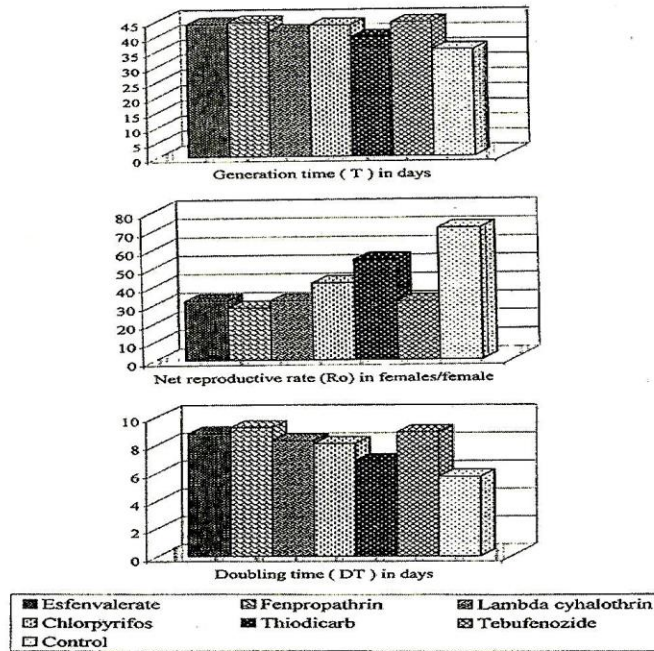
4.1. Intrinsic rate of natural increase (r_m):

The calculated life table parameters in Table (1) and fig. (5) revealed that daily intrinsic rate of natural increase (r_m) greatly affected by the treatment of the pink bollworm with

Table 1. Life Table parameters of *P. gossypiella* treated as newly hatched larvae with LC_{50} 's of tested insecticides.

Treatments	T(days)	(R_0)	DT(days)	Increase rate	
				(r_m)	(e^{r_m})
Esfenvalerate	44.05	32.11	8.802	0.079	1.082
Fenpropathrin	44.52	28.23	9.238	0.075	1.078
Lambda cyhalothrin	41.57	32.99	8.314	0.083	1.086
Chlorpyrifos	43.57	41.54	8.104	0.086	1.089
Thiodicarb	39.64	54.17	6.883	0.101	1.106
Tebufenozide	44.43	31.43	8.932	0.078	1.081
Control	35.35	71.05	5.747	0.121	1.128

(T) = Generation time (R_0) = Net reproductive rate
 (DT) = Doubling time (r_m) = Intrinsic rate of natural increase
 (e^{r_m}) = Final rate of increase

Figure 4. Life table parameters (T, Ro & DT) of *P.gossypiella* treated as newly hatched larvae with LC₅₀'s of tested insecticides.

the LC_{50(s)} of the six tested insecticides. In control, the r_m values were 0.121 times/female/day. These values were decreased to 0.075, 0.078, 0.079, 0.083, 0.086 & 0.101

times/female/day when the newly hatched larvae were treated with fenpropathrin, tebufenozide, esfenvalerate, lambda cyhalothrin, chlorpyrifos and thiodicarb, respectively.

4.2. Finite rate of increase (e^{r_m}):

Data illustrated in Table (1) and fig. (5) represented the finite rate of increase (e^{r_m}). The population of the pink bollworm had the capacity of increase by 1.128 times/female/day for the control. These values were greatly affected in relation to the tested insecticides. The capacity of population increase were 1.078, 1.081, 1.082, 1.086, 1.089 & 1.106 times/female/day when the newly hatched larvae were treated with fenpropathrin, tebufenozide, esfenvalerate, lambda cyhalothrin, chlorpyrifos and thiodicarb, respectively.

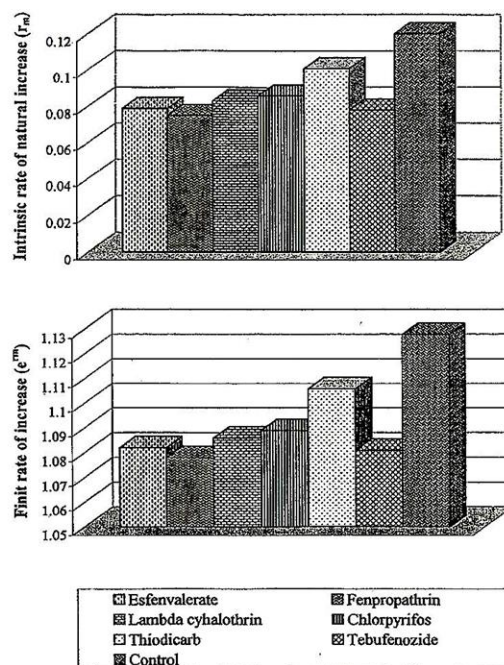
Es fenvalerate

Es fenvalerate

In conclusion, the six tested compounds could be classified into three categories based on their efficacy on the pink bollworm life table parameters as following:

- 1- The first category represented insecticides having a highly effect i.e. fenpropathrin, followed by tebufenozide.
- 2- The second category represented insecticides that revealed a moderately effect as compared with the first category. This category included esfenvalerate, lambda cyhalothrin and chlorpyrifos.
- 3- The third category was thiodicarb that showed the least insecticidal action.

Figure 5. Life table parameters (r_m & $e^{(m)}$) of *P.gossypiella* treated as newly hatched larvae with LC₅₀'s of tested insecticides.



Various workers had used life table analysis defined as the stimulatory effect of sublethal concentrations of insecticides as Draz (1985) who carried out laboratory experiment on certain biological aspects of *S. ocellatella* and found that, the eggs were laid individually on heart-leaf and petioles. The incubation period and hatchability percent were 4.93 days and 98.3%, respectively. The percentage of survivor eggs, larvae and pupae were 98.33, 89.8 and 92.45%, respectively. The sex ratio (0.571) was estimated as a number of females in proportion to the total population. The longevity of adult moths were 14.3 days for males and 15.7 days for females. The net reproductive rate ($R_0=34.98$), the generation duration in days (35.86 days), $r_m=0.9911073$ and $e^{r_m} = 1.104189$. Saadany and Hamed (1985) conducted laboratory life table studies to vary the relative suitability of 3 plants (cotton, berseem and castor-oil) to the cotton leafworm, *Spodoptera littoralis* (Boisd.). The daily mortality and fecundity rates, the net reproductive rate and the instantaneous population increase could be worked out for each host. Larval mortality was comparatively higher on cotton whereas, net reproductive rate and instantaneous rate of population increase were higher on berseem than on either castor-oil or cotton. In other words, higher numbers of female per day were laid on berseem. Sarichai (1991) stated that population dynamics of the castor semilooper, *Achaea janata* Linn. (Noctuidae: Lepidoptera) and its control were carried out under laboratory and field conditions at Suwan Farm, Nakhon Ratchasima. This study included population dynamics and chemical control of castor semilooper. Biological and partial ecological life table of castor semilooper were constructed. The spatial pattern of distribution of *A. janata* was contiguous and the regression line between the population of castor semilooper and rainfall was $y = 247.41 - 4.57X$. Toxicity tested by leaf dipping method, indicated that carbaryl, methomyl, cypermethrin and carbosulfan were highly toxic for the control of the first and second instar larvae, but monocrotophos was highly toxic for the first instar larvae and was moderately toxic for the second instar larvae of castor semilooper bases on their LC_{50} . In field conditions, all insecticides used on castor semilooper gave satisfactory control. There were no difference between insecticides, but results differed from the untreated subjects. Life table analysis yielded the following population parameters: the net reproductive rate (R_0) = 76.2272 the cohort generation time (T) = 34.6756, the capacity for increase (R_0) = 0.7876 and the finite rate of increase (λ) = 2.1981.

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تأثير بعض المبيدات على قياسات جداول الحياه لدودة اللوز القرنفلية

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يهدف هذا البحث الى دراسة تأثير التركيز النصفى المميت (LC_{50}) لمركبات الـ اس.فينفاليرات es fenvalerate و فينبروباثرين fenprothrin و لامبدا سيهالوثرين lambda cyhalothrin من مجموعة البيروثرويدات المخلفة صناعيا و مركب الكلوروبيريفوس chlorpyrifos من مركبات الفوسفور العضوية و مركب الثيوديكارب thiodicarb من مركبات الكرباميت و مانع الإنسلاخ التيبوفينوزيد tebufenozide على طور الفقس الحديث لدودة اللوز القرنفلية *Pectinophora gossypiella* (Saund.) و ذلك لدراسة جداول الحياه.

تم حساب قياسات جداول الحياه باستخدام برنامج الحاسب الآلى الذى أعده Abou-Setta *et al.* (1986) و منها تم حساب ما يلى: عدد الاناث الناتجة من كل أنثى عند عمر ما (Mx) - معدل البقاء (Lx) - فترة الجيل (T) - معدل التناسل (Ro) - فترة تضاعف الجيل (DT) - القدرة التكاثرية الموروثة (r_m) - معدل الزيادة اليومى (e^m) وقد أوضحت النتائج الآتى:

أعطى الفينبروباثرين يليه التيبوفينوزيد أعلى إنخفاض فى عدد الاناث الناتجة من كل أنثى (Mx) و معدل البقاء (Lx) و معدل التناسل (Ro) و القدرة التكاثرية الموروثة (r_m) و معدل الزيادة اليومى (e^m) ذلك مقارنة بالحشرات الغير معاملة. بينما أدى نفس المركبين السابقين إلى زيادة فترة الجيل (T) و فترة تضاعف الجيل (DT). كما أعطت مركبات الـ اس.فينفاليرات و اللامبدا سيهالوثرين و الكلوروبيريفوس تأثيرا متوسطا بينما أعطى مركب الثيوديكارب أقل تأثيرا مقارنة بالمركبات السابقة.