

Life table basic tool parameters for *Pectinophora gossypiella* (Saunders) as affected by certain treatments

Mervat AA Kandil¹, Reda AM Amer², Mohamed SM Salem³

¹⁻³ Plant Protection Research Institute, Agriculture Research Center, Giza, Egypt

Abstract

Life table is a basic tool for eradication the pest offspring as a result of the treatment. *Pectinophora gossypiella* (Saunders) adult moth stage was treated with LC₅₀'s of emamectin benzoate, hexaflumuron and teflubenzuron to study the life table parameters as affected the treatments used.

Hexaflumuron was the best treatment effect on *P. gossypiella* life table parameters, followed by teflubenzuron and emamectin benzoate. The benzoyl phenyl urea of hexaflumuron was the most decreasing of egg hatchability (0.48), net reproductive rate, Ro (15.80 female's daughter/female in one generation), intrinsic rate of natural increase, r_m (0.0536 times/female/day) and finite rate of increase, e^{rm} (1.0551times/day). The same compound (hexaflumuron) increased the developmental time (47.6 days), generation time, T (51.51 days) and doubling time, DT (12.93 days) compared with other treatments used and normal adult moths.

So, hexaflumuron was considered the best treatment comparing with other compounds used for the most life table parameters of *P. gossypiella* adult moths.

Keywords: Life table, *Pectinophora gossypiella*, emamectin benzoate, hexaflumuron, teflubenzuron

Introduction

Pink bollworm, *Pectinophora gossypiella* (Saunders) (Lepidoptera: Gelechiidae) is considerable a worldwide key pest of cotton; adult stage of *P. gossypiella* beginning laid the eggs in any plant axis sheltered places of petioles or peduncles and on buds or flowers. Once the bolls are 15 days old, these become favored sites for adult's oviposition. After the eggs hatchability the newly hatched larvae (from 20 minutes to 1hr.) penetrates the buds, flowers, or bolls cotton plants (during these period the eggs or larvae exposed to any insecticide application on the cotton).

Life tables are a fundamental tool used to study insect populations, resulting in crucial information for integrated pest management programs [1, 2]. Also, [3] the life table for appropriate evaluation of life fecundity, stable age distribution and life expectancy were indicated. The life expectancy of beneficial insects can be calculated and used for biological control program by predicting natural things in particular instar within that the maximum mortality of the pests was obtained and plan for managing pests in time.

Insect growth regulators are a unique class of insecticides with selective effects on various life stages of some order insects. Chitin synthesis inhibitors are a group of IGRs that interfere with the formation of new cuticle [4]. Emamectin benzoate is a semi synthetic insecticide derived from the

avermectin family. Insect Growth Regulator, Hexaflumuron is considerable as one alternative way of synthetic insecticides for controlling some Lepidoptera insects [5]. The Benzoyl phenyl urea insecticides prevent the formation of chitin; thus weakening the exoskeleton. These weaknesses prevent immature insects molting and inhibit the insects hatching from eggs laid by affected females.

The authors worked on the effect of emamectin benzoate or hexaflumuron or teflubenzuron on toxicity and biological parameters [6, 7]. Meanwhile, others worked on life table parameters of bollworms [8, 9].

So, aims of current work that evaluate life table parameters of *Pectinophora gossypiella* (Saunders) treated as adult moths with emamectin benzoate, hexaflumuron and teflubenzuron.

Materials and Methods

a. Insect.

Stock culture of susceptible strain *Pectinophora gossypiella* (Saunders) adult moth that used in these experiments; were collected from mass reared under the laboratory condition at 26±1°C and 75±5 R.H., in semi-artificial diet [10] at Bollworms Research Department, Plant Protection Research Institute, Agriculture Research Center.

b. Compounds.

Table 1: Compounds used information.

Trade name	Common name	Application rate	Groups
Emacte 2.15% EC	Emamectin benzoate	150 cm ³ /100 L	Avermectin
Consult 10%	Hexaflumuron	200 ml/fed.	Benzoyl phenyl urea
Nomolt 15% SC	Teflubenzuron	50 cm ³ / 100 L	benzoyl urea

c. Bioassay

Five concentrations (2.96, 1.98, 0.99, 0.495, and 0.247 ppm) for Emamectin benzoate; (12.5, 6.25, 3.12, 1.56 and 0.78 ppm) for Hexaflumuron and (75, 37.5, 18.75, 9.37, 4.68, and 2.34 ppm) for Teflubenzuron were diluted in water. Three replicates/ concentration were done. Ten pair freshly adult moth (male and female) was exposed to each replicate of concentration prepared/ each compound. Each treatment was done in the chimney glass cage supported by piece of cotton soaked in concentration/ each compound about 48 hours, then replaced by piece of cotton soaked in 20% sugar solution. Untreated one prepared with a piece of cotton soaked in 20% sugar solution was done. Kept glass chimneys treatments under the previously mentioned rearing conditions (26±1°C and 65±5 R.H %).

At three days passed since treatment, the adult mortality was recorded and corrected [11]. LC₅₀, LC₉₀ and slope value data were subjected to probit analysis [12].

Three groups of freshly adult moth treated with LC₅₀ of compounds used; first group, fed on a piece of cotton soaked in LC₅₀ for emamectin benzoate for adults feeding as well as hexaflumuron and teflubenzuron treatments. After 1-day, the treated piece of cotton changed by a piece of cotton soaked in 20% sugar solution. Untreated, one was done by moth feeding on a piece of cotton soaked in 20% sugar solution. Each cage was examined daily for providing life table program parameters.

d. Life table parameters.

Data of life table were analyzed by using the life 48 basic computer program [1]. The program has output data, including the information for each interval of adult female, age: Egg laying rate (M), number of females alive at age x (L), mean female age at each interval midpoint (X), female progeny per female produced during the day (Mx) and rate of survival (Lx). In addition, generation time (T), net reproductive rate (Ro), doubling time (DT), intrinsic rate of natural increase (r_m), finite rate of increase (e^{rm}) and a number of times that the population multiplies in a unit time (doubling time, DT).

e. Statistical analysis

Data were subjected to statistical analysis using the two-way analysis of variance (ANOVA) [13] and separated by the least significant difference (L.S.D) test and the probability level P < 0.05 was considered statistically significant [14].

Results

Toxicity levels for three compounds against freshly emerged adults of *P. gossypiella* were estimated in the presented study at 3-day passed since treatment. Data summarized in Table (2) recorded that the LC₅₀ value of emamectin benzoate compound is considered to be the most toxic for adults' stage, it recorded 0.758 ppm and increased to 2.52 ppm with hexaflumuron, but its high increased to 9.01 with teflubenzuron that considered the least efficacy comparing with the two tested compounds.

Table 2: Efficacy of certain compounds on *P. gossypiella* adult moths.

Compounds	LC ₂₅ (ppm)	LC ₅₀ (ppm)	LC ₉₀ (ppm)	Slope ± SE
Emamectin	0.324	0.758	3.81	1.82± 0.158
Hexaflumuron	0.8713	2.52	19.04	1.46±0.148
Teflubenzuron	2.603	9.01	95.5731	1.25±0.11

Life table parameters.

Freshly emerged moth treated with LC₅₀ of emamectin benzoate, hexaflumuron and teflubenzuron to determine some biological aspects of life table program analysis. The output data parameters showed the following:

The relationship among the developmental responses and life table parameters was too clear for appearing the different responses and life history or eradication as affected by certain treatments.

1. Female progeny/ female (Mx) and survival rate (Lx)

Untreated *P. gossypiella* adult moth had female progeny/ female (Mx) from 8.86 to 10.45 female daughter/ female and their survival rate ranging from 0.58 to 0.96 female daughter/ female; while, their ages ranged from 40.67 to 48.67 days as shown in figure (1). Emamectin benzoate treatment had the highest decreased from Mx that ranging from 3.5 to 3.96 female daughter/ female and their survival from 0.29 to 0.59; also, their ages from 39.3 to 47.3 days comparing with other tested compounds on *P. gossypiella* treated as an adult moth stage. On the other hand, the benzoyl phenyl urea (Hexaflumuron) decreased from Mx values (3.87-4.59 females daughter/ female); its survival rate (0.24-0.48) and their ages from 48.1 to 56.1 days as described in figure (1). Moreover, Teflubenzuron caused the little decreasing on Mx or Lx values comparing with other two compounds used; Mx ranged from 5.43 to 7.76 female's daughter/ female that had 0.43 to 0.61 survivals rate (Lx) and their ages from 46.5 to 54.5 days.

2. Developmental time

One of the output data of the life table program is developmental time; that period extended from egg deposition to adult oviposition period. Untreated developmental time was 40.17 days as in Table (3). *P. gossypiella* treated as an adult moth with LC₅₀ of emamectin benzoate was 38.8 days. Opposite, was found in hexaflumuron and teflubenzuron treatments (47.6 and 46 days) comparing with untreated adult moths.

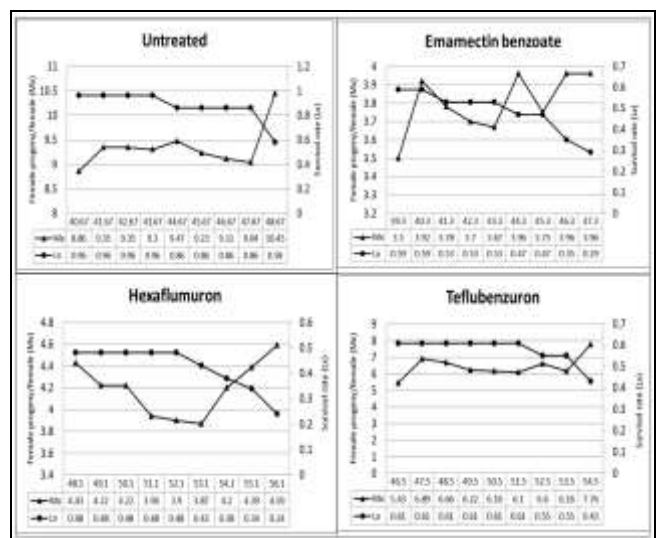


Fig 1: Female progeny/ female (Mx) and survival rate (Lx) of *P. gossypiella* treated as adult moth by certain compounds.

3. Egg hatchability

That parameter as in Table (3) cleared the egg fertility of *P. gossypiella* treated as an adult moth with untreated and

certain compound treatments. Hexaflumuron treatment had the highest effect on egg hatchability of *P. gossypiella* daughter adult moth that treated as an adult moth with hexaflumuron compound (0.48), followed by emamectin benzoate treatment (0.59) and then teflubenzuron treatment (0.61) comparing with normal egg hatchability (0.96).

Table 3: Life table parameters of *P. gossypiella* treated as adult moth with certain compounds.

Parameters	Untreated	Emamectin benzoate	Hexaflumuron	Teflubenzuron	L.S.D. 0.05
Developmental time	40.17 ^b	38.8 ^b	47.6 ^a	46 ^a	5.408
Egg hatchability	0.96 ^a	0.59 ^b	0.48 ^b	0.61 ^b	0.1902
Generation time T (days)	44.12 ^b	41.50 ^b	51.51 ^a	50.18 ^a	4.314
Net reproductive rate (Ro)	73.23 ^a	30.67 ^b	15.80 ^c	33.17 ^b	3.882
Intrinsic time of increase (r_m)	0.0973 ^a	0.0824 ^{ab}	0.0536 ^c	0.0698 ^{bc}	0.0188
Finite rate of increase (e^{rm})	1.1022 ^a	1.0859 ^{ab}	1.0551 ^c	1.0723 ^{bc}	0.0189
Doubling time DT (days)	7.124 ^b	8.412 ^b	12.93 ^a	9.930 ^{ab}	3.261
Sex ratio	0.55 ^a	0.33 ^c	0.41 ^b	0.56 ^a	0.0231

5. Generation time (T).

P. gossypiella daughter adult moth when treated as parent, adult moth with hexaflumuron and teflubenzuron had a high generation time (51.51 and 50.18 days), contrary was happening in emamectin benzoate treatment that had a low generation time (41.50 days) when comparing with the untreated generation time that was 44.12 days (Table 3).

6. Net reproductive rate (Ro).

This parameter explains no. of female daughter/ female parent in one generation (Table 3). Normal *P. gossypiella* net reproductive rate was 73.23 daughter females/ female parent in one generation; this value had the highest decreasing in hexaflumuron treatment to reach 15.8 female daughter/ treated parent female, followed by emamectin benzoate (30.67 daughter females/ parent female in one generation) and teflubenzuron (33.17 daughter females/parent female in one generation).

7. Intrinsic rate of natural increase (r_m).

This parameter is known as ability of inheriting increase in daily or intrinsic rate of natural increase that was 0.0973 times/ female/ day in a normal moth (Table 3). Meanwhile, the values were 0.0536, 0.0698 and 0.0824 times/ daughter, female/ day that was treated as parent *P. gossypiella* adult female moths with LC₅₀'s of hexaflumuron, teflubenzuron and emamectin benzoate.

8. Finite rate of increase (e^{rm})

Table (3) described that finite rate of increase or the daily population per female of untreated *P. gossypiella* was 1.1022 times/ day. When parent, adult moth treated with LC₅₀'s of hexaflumuron, teflubenzuron and emamectin benzoate, the parameter values were 1.0551, 1.0723 and 1.0859 times/ day.

9. Doubling time (DT)

Time that doubling the population or become twice that known as doubling time (DT). Untreated *P. gossypiella* doubling time was 7.124 days; this time had gradually increased in emamectin benzoate, teflubenzuron and hexaflumuron treatments with *P. gossypiella* adult moth to become 8.412, 9.930 and 12.93 day spent to give twice the offspring population.

4. Sex ratio

The normal sex ratio of *P. gossypiella* was 0.55 as in Table (3). Sex ratio parameters were differed according to treatment. It was 0.33, 0.41 and 0.56 for emamectin benzoate, hexaflumuron and teflubenzuron, respectively.

Discussion

It could be concluded that life table was a basic tool about eradication for the pest offspring as a result of different treatments. Benzoyl phenyl urea (hexaflumuron) was considered the best tested compounds in the most investigated parameters of *P. gossypiella* treated as adult moths with LC₅₀'s of the compound, followed by phenyl urea compound (teflubenzuron) and then emamectin benzoate.

^[8] life-table studies were carried out for *Earias vitella* (Fab.) on four *Gossypium* species [*G. barbadense* (Suvini), *G. hirsutum* (MCU 9), *G. herbaceum* (TKHe 44) and *G. arboreum* (K 8)]. Life-table analyses revealed that maximum survival from egg to adult occurred on MCU 9 compared with other varieties. Net reproductive rate (R_0) was also maximum on MCU 9 and minimum on K 8. The intrinsic rate of increase (r_m), finite rate of increase (λ) and weekly multiplication (e^{rm}) were maximized on Suvini and minimum on K 8. The population on reaching stable age distribution (SAD) consisted primarily (c. 99%) of immature stages in all the four species of cotton tested in this study. While, ^[9] the survival fraction at egg, early and late larval stages were 0.840, 0.845 and 0.90, respectively. Indispensable mortality was 10.24, 9.92 and 6.27 at egg stage, early and late instar larval stages, respectively. The net reproductive rate (R_0) was 90.35 females/female, length of generation (T_c) was 34.51 days, potential fecundity (pf) was 125.30 numbers of eggs, hypothetical F_2 female 8163.12 females/female while, intrinsic rate of increase (r_m) was 0.1305 females/female/day, the finite (λ) and annual rate of increase (A.R.I.) 1.1394, 4.807×10^{20} respectively. The doubling time (DT) was 5.3107 days. In addition ^[15], life table and consumption rate of *Helicoverpa armigera* (Hübner) (Lepidoptera: Noctuidae) reared on *Asparagus officinalis* L. under laboratory conditions to assess their interaction. Development, survival, fecundity, and consumption data were analyzed by the age-stage, two-sex life table. The intrinsic rate of increase (r), finite rate of increase (λ), net reproductive rate (R_0) and mean generation time (T) were estimated by the jackknife technique to be 0.0780 day, 1.0811 days, 67.4 offspring, and 54.8 days, respectively, while those estimated by the bootstrap technique were 0.0752 day, 1.0781 days, 68.0 offspring and 55.3 days, respectively. The net consumption rate of *H. armigera*, as estimated by the jackknife and bootstrap technique, was 1183.02 and 1132.9 mg per individual,

respectively. The frequency distribution of sample means obtained by the jackknife technique failed the normality test, while the bootstrap results fit the normal distribution as well. By contrast, the relationship between the mean fecundity and the net reproductive rate, as estimated by the bootstrap technique, was slightly inconsistent with the relationship found by mathematical proof. Meanwhile, ^[2] life tables are a fundamental tool used to study insect populations, resulting in crucial information for integrated pest management programs. *H. gelotopoeon* net reproductive rate (Ro) was 95.49, the mean generation time (T) was 37.53 and the instantaneous rate of population increase “r” was 0.12. The population doubling time (DT) was 5.70 days, and the daily finite rate of increase (λ) was 1.13. The maximum rate of population growth occurred in the day 33. The biotic potential was 2.026×10 individuals/female/ year. Also ^[16], the life table parameters of *E. insulana* treated as egg affected by magnetic flux treatments. Female progeny/female (Mx), the survival rate (Lx), net reproductive rate (Ro), intrinsic rate of natural increase (r_m) and finite rate of increase (e^{rm}) were decreased in both treatments. Meanwhile, generation time (T) and doubling time (DT) were increasing as affected by magnetic flux treatments as one-day old egg compared with untreated *E. insulana* eggs. Recently ^[17], authors worked on *Helicoverpa armigera*, nucleopolyhedrovirus (HearNPV) and *Habrobracon hebetor* that were two important biocontrol agents used to manage *Helicoverpa armigera* pest, sometimes in combination. The sublethal effects of HearNPV on *H. hebetor* life table parameters under laboratory conditions when its host (second instar *H. armigera*) was treated with HearNPV, and tested *H. hebetor* females for their ability to discriminate against inoculated hosts. Emergence of adults reared as solitary larvae was reduced by half on LC₃₀-inoculated larvae compared to controls, but not on LC₅ or LC₁₅-inoculated hosts. Low concentrations (LC₅, LC₁₅, and LC₃₀) of HearNPV had no effects on overall parasitoid developmental time, but longevity and life time fecundity was reduced for females emerging from hosts receiving the LC₃₀ treatment. Net reproductive rate (Ro), intrinsic rate of increase (r_m), and finite rate of increase (λ) were all decreased in a concentration-dependent manner in the LC₁₅ and LC₃₀ treatments, as were female life expectancy, age-specific survivorship (lx), and age-specific fecundity (mx), whereas population doubling time (DT) increased. Parasitoids did not discriminate against LC₁₅-inoculated larvae in choice or no-choice tests, but parasitized more LC₅₀-inoculated hosts than controls in the choice test, with no significant differences in total numbers of eggs laid in either case. Although, parasitoids suffered some loss of fitness in HearNPV-inoculated hosts under these laboratory conditions, these agents still appear compatible for joint application against *H. armigera* under field conditions, provided parasitoid releases are made 2 d after NPV application.

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