

## Life Table viability assays of *Pectinophora gossypiella* (Saund.) as affected by rearing on certain semi-artificial diets

Haity M Tadros<sup>1</sup>, Abeer Sh Awad<sup>2</sup>, Reda AM Amer<sup>3</sup>

<sup>1</sup> Plant Protection Research Institute, Agriculture Research Center, Dokki. Giza, Egypt

### Abstract

Life table parameters used as viability assay for reproductive eradication of *Pectinophora gossypiella* (Saund.) that reared on certain semi-artificial diets (A, B, C, D, E & standard). Semi-artificial diet (D) was the most feature compared with other diets used and standard for consecutive five generations and brought out the highly fertility generations acts in lower the times of developmental, generation (T) and doubling (DT). Meanwhile, diet (D) had the higher female daughter progeny/ female (Mx), survival rate (Lx), egg hatchability, sex ratio, net reproductive rate (Ro), intrinsic rate of natural increase ( $r_m$ ) and finite rate of increase ( $e^{rm}$ ) compared with other semi artificial diets (A, B, C, E) used and standard [1] at the most five generations time of *P. gossypiella*. So, semi-artificial diet (D) was the best diet for reproductive eradication of *P. gossypiella* rearing acts in the most life table viability parameters compared with other tested diets used during five consecutive generations.

**Keywords:** life table, semi-artificial diet, *Pectinophora gossypiella* (Saund)

### Introduction

The pink bollworm has been recorded in nearly all cotton-growing countries of the world and is a key pest in many of these areas. The longstanding nature of the pink bollworm problem in many areas of the world and the likely development of area wide management programs in the future [2] prompted us to develop the semi-artificial diets for helping the researches in different trials done. Life tables consider as a speculation tool about population of the pest. The life table program has speculated about the effecting of the tested effects on the target pest to clarify the impact of tested factors on the developmental increase rate of the pest population [3, 4]. Also, [5] life-table is one of the most useful tools in the study of insect population dynamics. The uses of field life-tables have been made recently for studying the natural population of insect-pests. When the environmental parameters are related to several cases of mortality, the field life-tables form a budget of successive process that operates in a given population. Field life-table studies indicate which age interval and independent variable should be studied in detail for the effective control of the pest. It is also important to grasp the real situation of seasonal prevalence of an insect-pest for its successful control. The field life

table has been constructed for the insect-pests of forests, orchards and agricultural crops. Thus, this an artificial diet prepared indeed from locally available ingredients with easily adoptable methodology [6] with importation of expensive diet premixes can be avoided. So, the aim of the present work is to assay the viability life table parameters of pink bollworm, *Pectinophora gossypiella* (Saund.) as affected by rearing on certain semi-artificial diets (A, B, C, D, E & standard) to obtain on viable species ready for exposing to different trials for developing a mass rearing of *P. gossypiella* by using locally available ingredients as compared to the standard artificial diet [1].

### Materials and Methods

The current work was done at Bollworms Research Department, Plant Protection Research Institute, Agriculture Research Center (ARC), Sabaheia branch, Egypt to evaluate five semi-artificial diets (A, B, C, D & E) for mass rearing the pink bollworm, *P. gossypiella* as compared to semi-artificial diet (standard) [1]. The experiment was performed at  $26 \pm 1^\circ\text{C}$  and 70-75% R.H. Composition of the six semi-artificial diets evaluated in this work as in Table (1). Semi-artificial diets prepared in details previously [6].

**Table 1:** Semi-artificial diet ingredients

| Ingredients                | A    | B   | C   | D   | E   | Standard |
|----------------------------|------|-----|-----|-----|-----|----------|
| Kidney beans (g)           | -    | -   | -   | 125 | -   | 215      |
| Wheat grated (g)           | 50   | 50  | -   | -   | 100 | -        |
| Soy bean (g)               | 225  | 120 | -   | 25  | -   | -        |
| Chick pea (g)              | 125  | 110 | 35  | -   | 125 | -        |
| Cotton seed flour (g)      | -    | -   | 50  | -   | -   | -        |
| Ascorbic acid (g)          | 3    | 3   | 1.2 | 2   | 2.5 | 3        |
| Sorbic acid (g)            | 2.4  | 3   | 0.5 | 1.5 | 2.1 | 1.25     |
| Methyl paraben base Bp (g) | 1.75 | 0.8 | 0.5 | 1.5 | 2.1 | 1.25     |
| Yeast (g)                  | 27   | 30  | 9   | 20  | 18  | 32       |
| Agar-Agar (g)              | -    | 32  | 19  | 20  | 25  | 11.25    |
| Liquid milk (ml)           | 50   | -   | -   | -   | -   | -        |
| Multi- vitamins (ml)       | 8    | 5   | 1   | 5   | 5   | -        |

|                   |     |     |     |     |     |   |
|-------------------|-----|-----|-----|-----|-----|---|
| Formaldehyde (ml) | 2.5 | 3   | 1.5 | 2   | 2   | 3 |
| Antibiotic (g)    | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | - |
| Omega 3 (capsule) | -   | 1   | -   | -   | 1   | - |
| Vitamin B12 (ml)  | -   | 1   | -   | -   | -   | - |

Standard diet <sup>[1]</sup> was modified from those developed previously <sup>[7, 8]</sup> Diet (C) described <sup>[9]</sup>.

**Table 2:** Multi vitamins composition Each 10 ml

|                   |                  |
|-------------------|------------------|
| <b>Vitamine A</b> | <b>2400 I.U.</b> |
| Vitamine D3       | 200 I.U.         |
| Vitamine B1       | 2 mg             |
| Vitamine B2       | 2 mg             |
| Vitamine B6       | 1 mg             |
| Vitamine C        | 100 mg           |
| Vitamine E        | 2 mg             |
| Nicotinamide      | 10 mg            |
| Dexapanthenol     | 4 mg             |
| Ferrous gluconate | 86.356 mg        |

**Omega 3:** 500 mg/one capsule

**Antibiotic used:** Flumox® 500; Amoxicillin 250 mg and Flucloxacillin

250 mg broad-spectrum antibiotic.

A product of Egyptian International Pharmaceutical Industries Co., Egypt

**Table 3:** Antibiotic composition

| Each dosage unit contains   | Film coated tablets | capsules |          | 5 ml suspension |
|-----------------------------|---------------------|----------|----------|-----------------|
|                             |                     | 250 mg   | 500 mg   |                 |
| Amoxicillin                 | 500 mg              | 125 mg   | 250 mg   | 125 mg          |
| (as amoxicillin trihydrate) | 574 mg              |          | 286.9 mg | 143.47 mg       |
| Flucloxacillin              | 500 mg              | 125 mg   | 250 mg   | 125 mg          |
| (Sodium monohydrate)        | 544 mg              |          | 272.5 mg | 136.32 mg       |

**1. Insect rearing**

The newly hatched larvae of the pink bollworm, *P. gossypiella* used in this study was obtained from a culture maintained for many generations at Bollworms Research Department, Plant Protection Research Institute, Sabaheia branch, Agriculture Research Center (ARC) on semi-artificial diet described <sup>[1]</sup>. Five generations (20 observations) of *P. gossypiella* were reared before on each tested semi artificial diets (A, B, C, D & E) <sup>[6]</sup> for preparing to current life table experiment observations.

**2. Life table assays.**

Data of life table were analyzed by using life 48 basic computer programs <sup>[10]</sup>. The program has output data include information for each interval of egg laying rate with adult female age (M), number of females alive at age x (L), mean female age at each interval mid-point (X), female progeny per female produced (Mx), survival rate (Lx). In addition, generation time (T), net reproductive rate (Ro), intrinsic rate of natural increase (r<sub>m</sub>), finite rate of increase (e<sup>rm</sup>) and the number of times which the population multiplies in a unit time (doubling time, DT).

**3. Statistical analysis**

Data were subjected to statistical analysis using the two-way analysis of variance (ANOVA) <sup>[11]</sup> and the least significant difference (LSD). The probability level P <0.05 was considered statistically significant <sup>[12]</sup>.

**Results**

Newly hatched larvae of *P. gossypiella* reared before in details <sup>[6]</sup> with six semi-artificial diets (A, B, C, D, E & standard) to study life table viability assays for reproductive eradication purpose.

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

Figures (1-5) illustrated that *P. gossypiella* was reared on semi-artificial diet (D) had the highest female daughter

progeny/female (Mx) that ranged from 6.48 to 32.4 with survival rate (0.38-0.94) at 5<sup>th</sup> generation comparing with *P. gossypiella* reared on standard semi-artificial diet; Mx: 2.58-27.09 female daughter/female and its survival rate (Lx): 0.18-0.88 as the same figure (5), the results as well as the data of figures (1-4) nearly.

**2. Developmental time.**

That time extended from egg stage to female oviposition period (developmental time) as in Tables (1-5). Diet (D) had the premium developmental time ranged 37.5-39.5 days from 1<sup>st</sup> to 5<sup>th</sup> generation. That time affected by different diets used to reach 45.75 days at 4<sup>th</sup> generation in standard diet that caused the longest time for *P. gossypiella* rearing. Other semi-artificial diets were 35.75 - 44 days for *P. gossypiella* rearing at 1<sup>st</sup> – 5<sup>th</sup> generations.

**3. Egg hatchability.**

Semi-artificial diet (D) was the best diet caused the egg hatchability increasing to reach 0.94 at 5<sup>th</sup> generation (Table 5) comparing with the other semi artificial diets that ranged 0.893-0.92 for diets (A, B & C). On the other hand, diet (E & standard) had the lower egg hatchability (0.87-0.89) for *P. gossypiella* egg hatchability as shown in Tables (1-5).

**4. Sex ratio.**

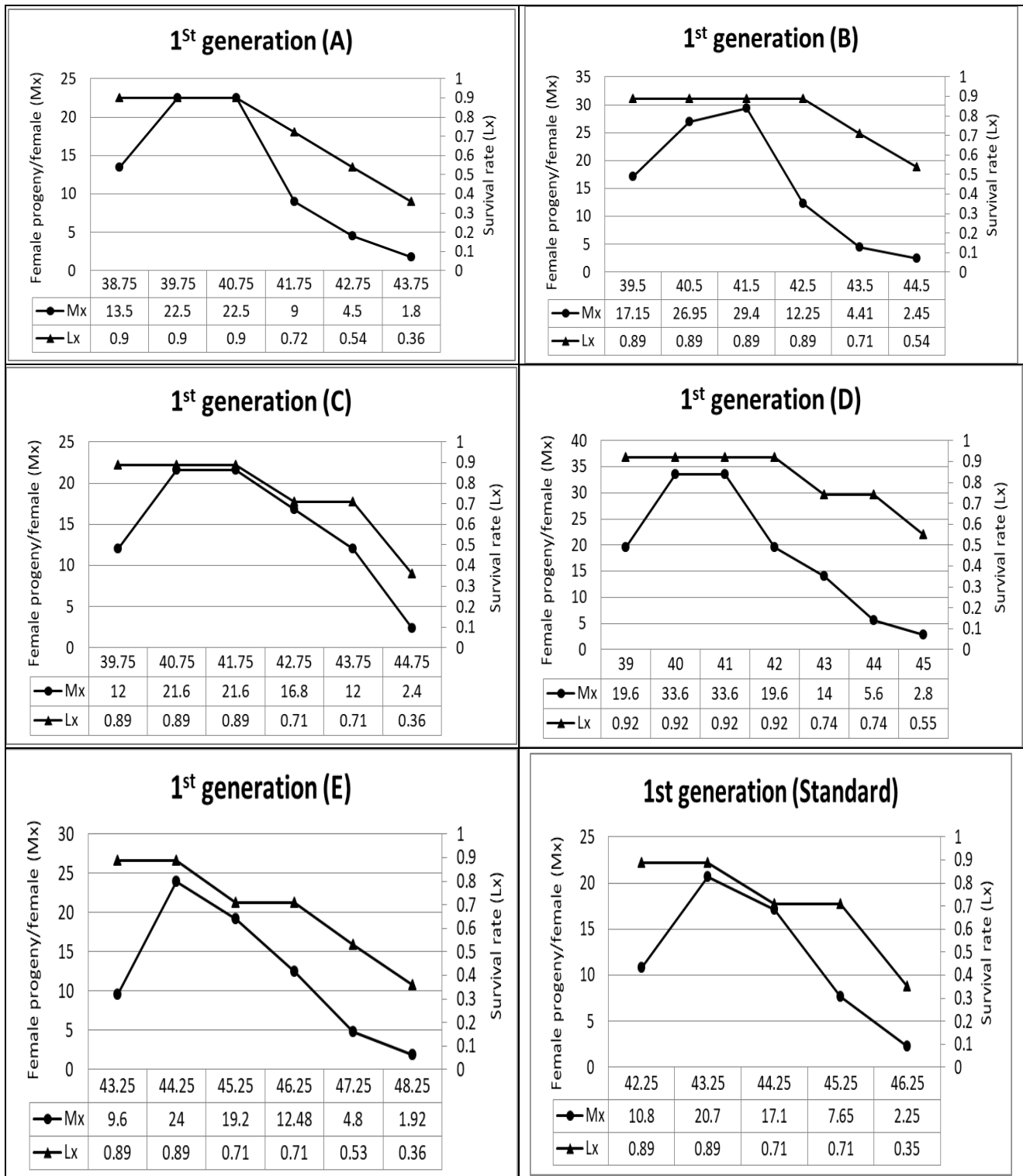
Number of female/total number of male & female known as sex ratio was the higher value (0.54-0.56) for *P. gossypiella* as a result of rearing on semi-artificial diet (D) as in Tables (1-5), followed by rearing on diets B, C, E, A & standard, respectively that had the lowest sex ratio value at the most consecutive generations (1<sup>st</sup> – 5<sup>th</sup>).

**5. Generation time (T).**

*P. gossypiella* reared on semi-artificial diet (A) had the lowest generation time (T) that was 37.22-42.46 days during the five generations used; while, semi-artificial diets (E & standard) had the highest generation time (40.02-47.08 days). Meanwhile, semi-artificial diet (D) had the premium

generation time value during 1<sup>st</sup>-5<sup>th</sup> generations as

mentioned in Tables (1-5).



**Fig 1:** Female progeny/female (Mx) and survival rate (Lx) of *P. gossypiella* 1<sup>st</sup> generation reared on certain semi-artificial diets

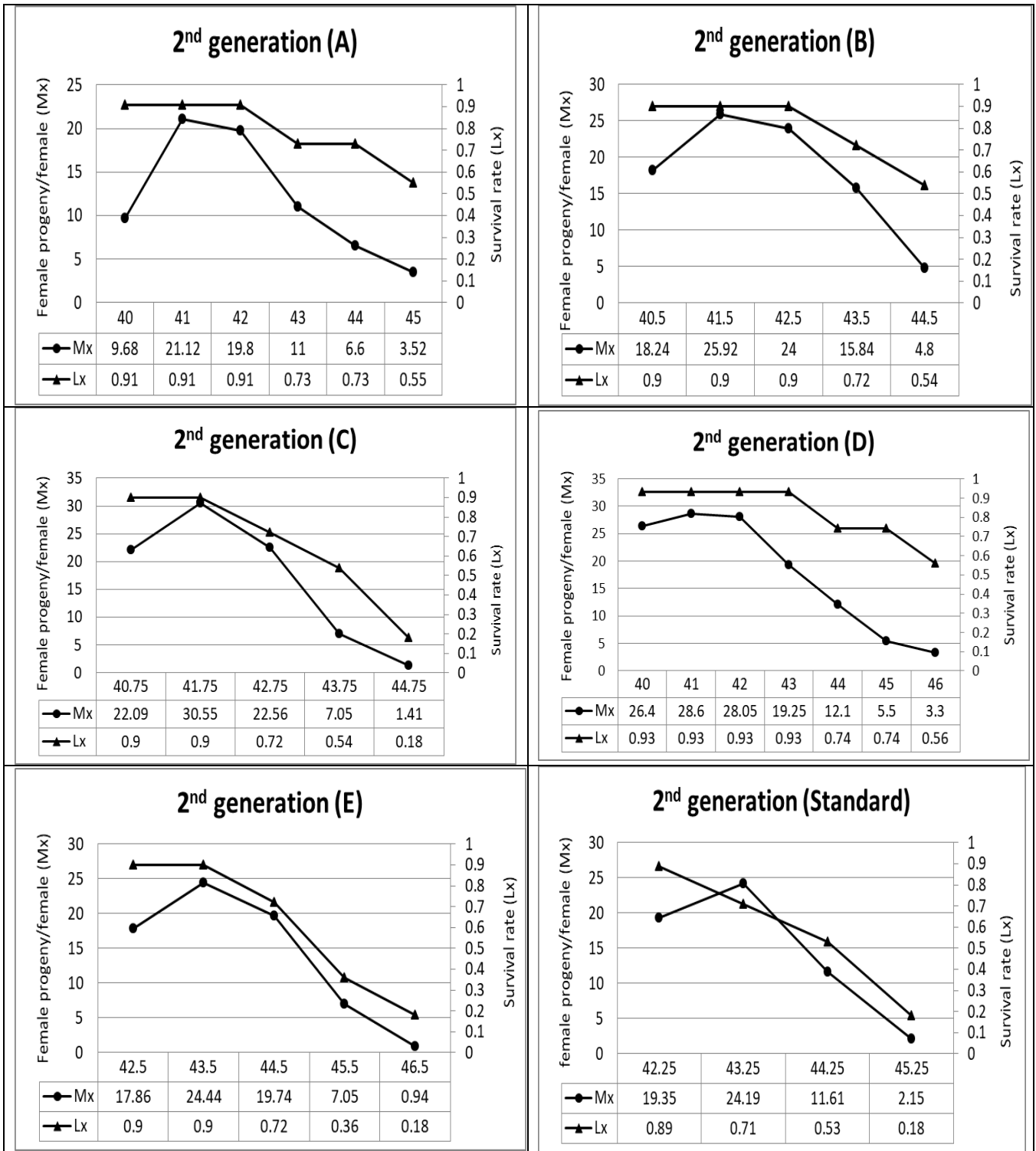
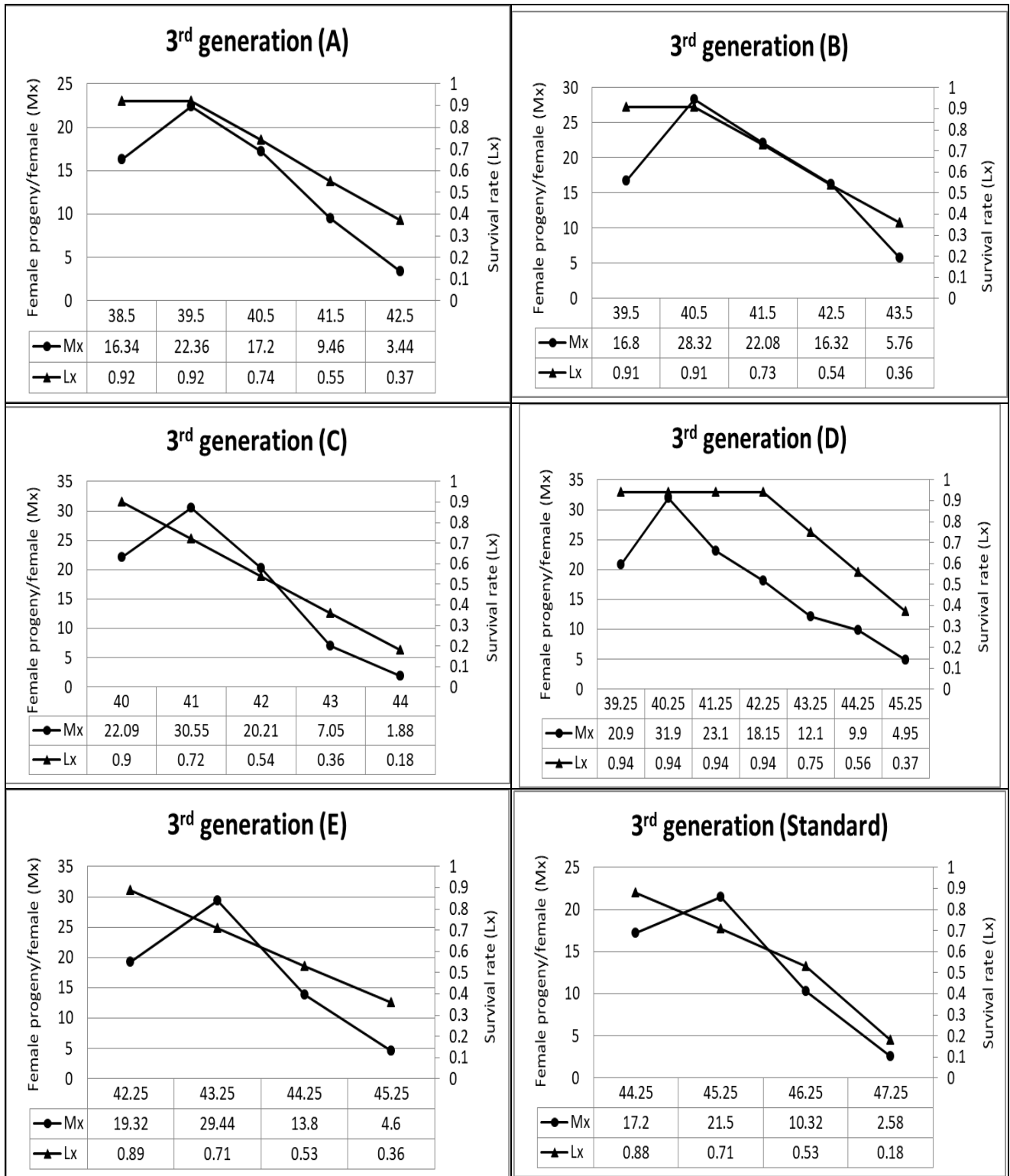
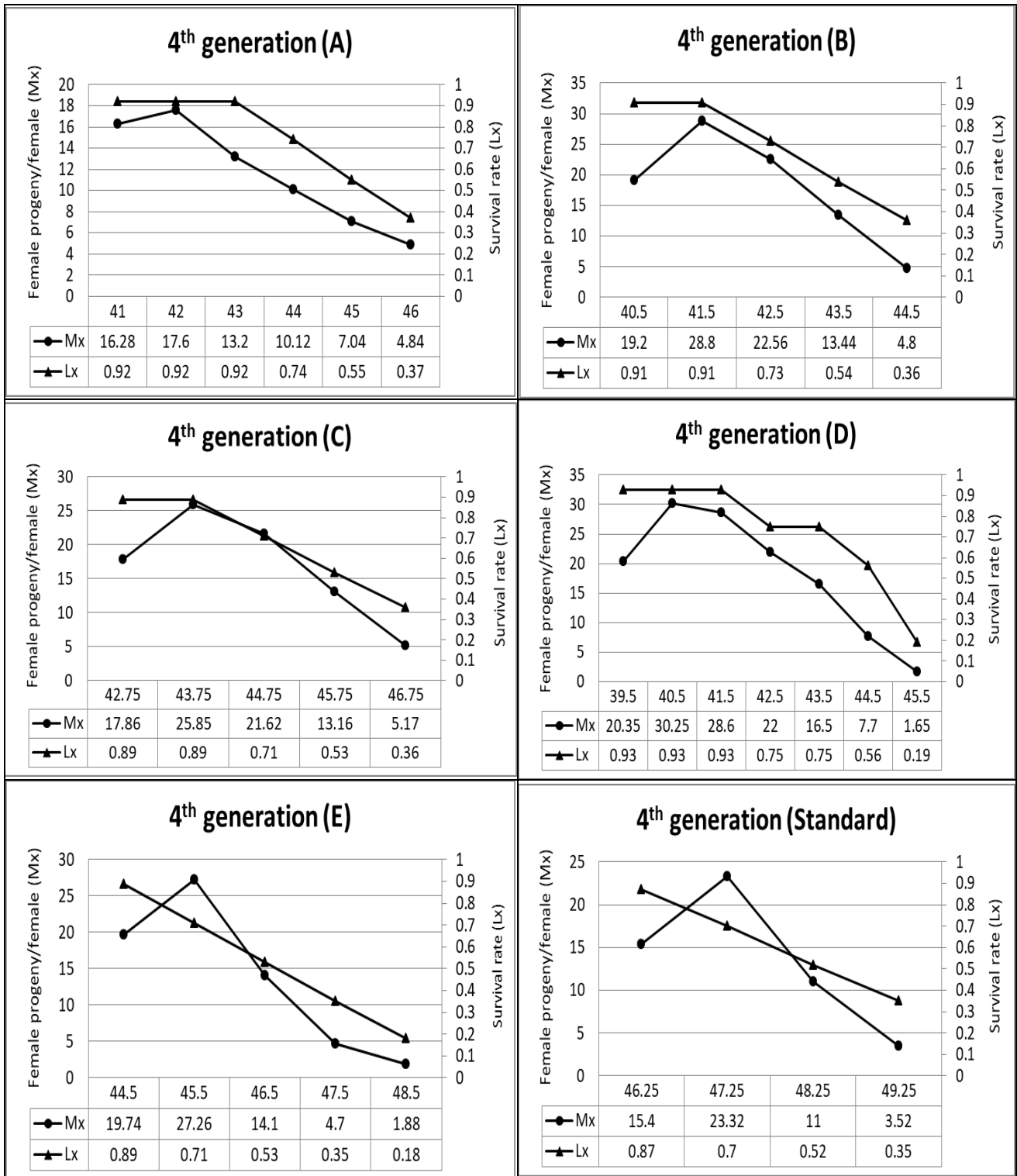


Fig 2: Female progeny/female (Mx) and survival rate (Lx) of *P. gossypiella* 2<sup>nd</sup> generation reared on certain semi-artificial diets



**Fig 3:** Female progeny/female (Mx) and survival rate (Lx) of *P. gossypiella* 3<sup>rd</sup> generation reared on certain semi-artificial diets



**Fig 4:** Female progeny/female (Mx) and survival rate (Lx) of *P. gossypiella* 4<sup>th</sup> generation reared on certain semi-artificial diets

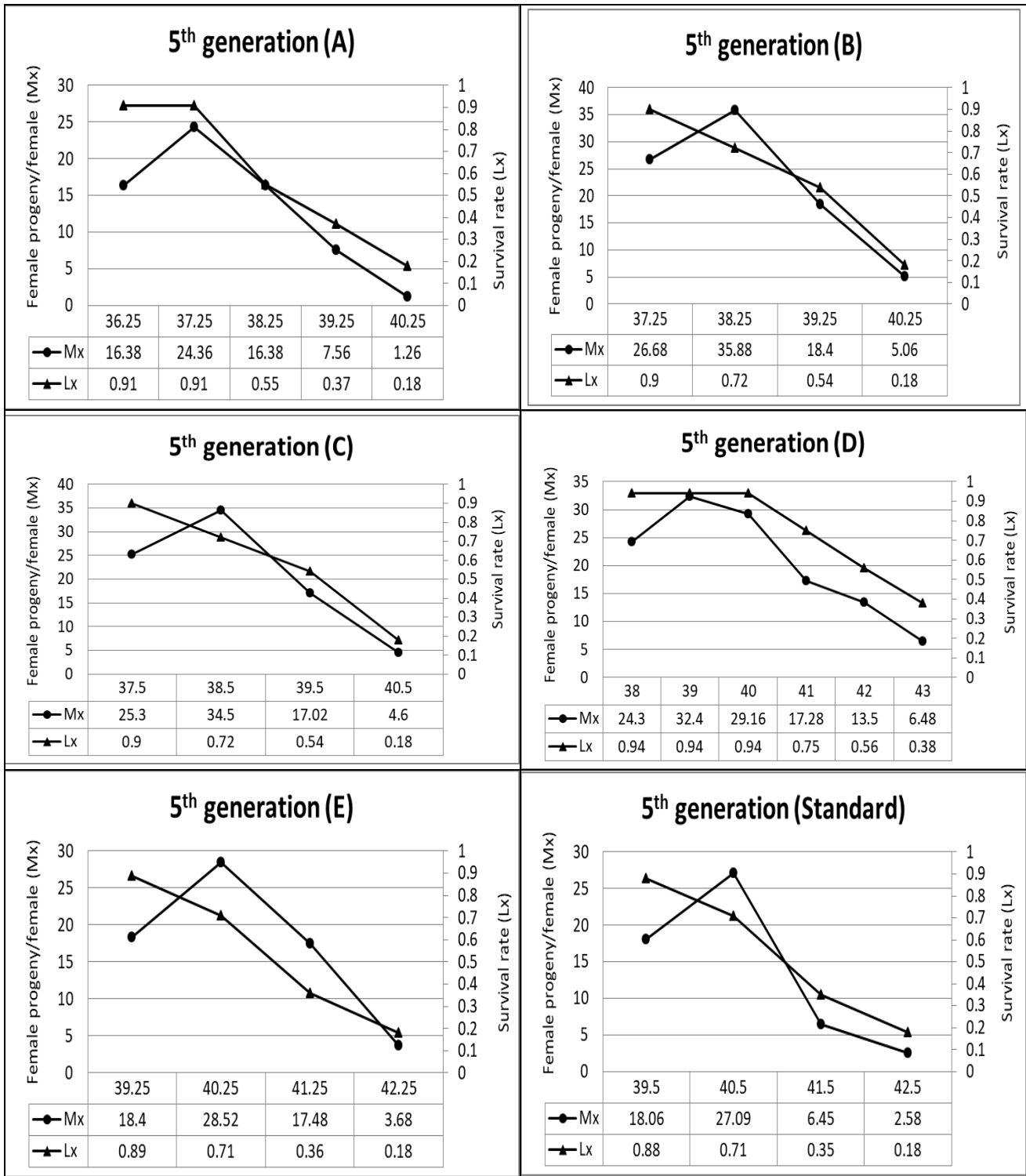


Fig 5: Female progeny/female (Mx) and survival rate (Lx) of *P. gossypiella* 5<sup>th</sup> generation reared on certain semi-artificial diets

**6. Net reproductive rate (Ro).**

Number of females’ progeny (daughters) per female in one generation defined as net reproductive rate. Semi-artificial diet (D) had increasing mentioned in net reproductive rate (103.8-113.9 female progeny/ female in one generation) during the five generations used for *P. gossypiella* compared with Ro for *P. gossypiella* reared on standard diet that have the lowest value (36.29-46.19 female progeny/female in one generation). Other semi-artificial diets arranged; B, C, A & E, respectively had values ranged 43.56-75.59 females progeny/female in one generation for *P. gossypiella* during consecutive five generations (Tables, 1-5).

**7. Intrinsic rate of natural increase (rm).**

Reproductive ability of inheriting increase for the pest defined as intrinsic rate of natural increase ( $r_m$ ). *P. gossypiella* that reared on semi-artificial diet (D) had the highest increase (0.113-0.118 individual/female/ day), followed by *P. gossypiella* reared on diets of B, C & A (0.094-0.108 individual/ female/ day). While, semi-artificial diets E & standard had the least intrinsic rate of natural increase ( $r_m$ ) for *P. gossypiella* during the consecutive five generations (Tables 1-5).

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

Daily population or finite rate of increase,  $e^{rm}$  (individual/day) of *P. gossypiella* as described in Tables (1-5) was considered as well as the same trend of the previous parameter during the five consecutive generations.

**9. Doubling time (DT).**

Population Numbers that to be twice is defined as doubling

time (DT). Tables (1-5) cleared that *P. gossypiella* reared on diet (D) had the shortest generation time (5.901-6.151 days) during the five generations; vice versa with *P. gossypiella* reared on standard diet (7.659-9.066 days). *P. gossypiella* reared on other diets used (A, B, C & E) had intermediate doubling time values between the results of rearing on diet (D) and standard diet as described in Tables (1-5) during 1<sup>st</sup> -5<sup>th</sup> generations passed.

**Table 4:** Life table assays of *P. gossypiella* 1<sup>st</sup> generation reared on certain semi-artificial diets

| Semi-artificial Diets | Developmantal Time (days) | Egg hatchability   | Sex ratio         | T (days)           | (Ro)               | Increase rate       |                    | DT (days)          |
|-----------------------|---------------------------|--------------------|-------------------|--------------------|--------------------|---------------------|--------------------|--------------------|
|                       |                           |                    |                   |                    |                    | $r_m$               | $e^{rm}$           |                    |
| A                     | 38.25 <sup>b</sup>        | 0.903 <sup>a</sup> | 0.45 <sup>a</sup> | 40.19 <sup>a</sup> | 62.42 <sup>d</sup> | 0.103 <sup>b</sup>  | 1.108 <sup>a</sup> | 6.73 <sup>ab</sup> |
| B                     | 39 <sup>ab</sup>          | 0.893 <sup>a</sup> | 0.49 <sup>a</sup> | 41.02 <sup>a</sup> | 81.04 <sup>b</sup> | 0.107 <sup>ab</sup> | 1.113 <sup>a</sup> | 6.47 <sup>ab</sup> |
| C                     | 39.25 <sup>ab</sup>       | 0.893 <sup>a</sup> | 0.48 <sup>a</sup> | 41.54 <sup>a</sup> | 70.73 <sup>c</sup> | 0.103 <sup>b</sup>  | 1.108 <sup>a</sup> | 6.76 <sup>ab</sup> |
| D                     | 38.5 <sup>b</sup>         | 0.92 <sup>a</sup>  | 0.56 <sup>a</sup> | 40.81 <sup>a</sup> | 113.9 <sup>a</sup> | 0.116 <sup>a</sup>  | 1.123 <sup>a</sup> | 5.97 <sup>a</sup>  |
| E                     | 42.75 <sup>a</sup>        | 0.888 <sup>a</sup> | 0.48 <sup>a</sup> | 44.79 <sup>a</sup> | 55.58 <sup>d</sup> | 0.089 <sup>c</sup>  | 1.094 <sup>a</sup> | 7.73 <sup>b</sup>  |
| Standard              | 41.75 <sup>ab</sup>       | 0.885 <sup>a</sup> | 0.45 <sup>a</sup> | 43.55 <sup>a</sup> | 46.19 <sup>e</sup> | 0.088 <sup>c</sup>  | 1.092 <sup>a</sup> | 7.88 <sup>b</sup>  |
| L.S.D. 0.05           | 3.703                     | 0.075              | 0.164             | 6.076              | 7.754              | 0.0105              | 0.730              | 2.179              |

(T) = Generation time (Ro) = Net reproductive rate ( $r_m$ ) = Intrinsic rate of natural increase ( $e^{rm}$ ) = Finit rate of increase (DT) = Doubling time

**Table 5:** Life table assays of *P. gossypiella* 2<sup>nd</sup> generation reared on certain semi-artificial diets

| Semi-artificial Diets | Developmantal Time (days) | Egg hatchability    | Sex ratio         | T (days)           | (Ro)                | Increase rate      |                    | DT (days)           |
|-----------------------|---------------------------|---------------------|-------------------|--------------------|---------------------|--------------------|--------------------|---------------------|
|                       |                           |                     |                   |                    |                     | $r_m$              | $e^{rm}$           |                     |
| A                     | 39.5 <sup>a</sup>         | 0.91 <sup>b</sup>   | 0.44 <sup>a</sup> | 41.70 <sup>a</sup> | 60.78 <sup>cd</sup> | 0.099 <sup>d</sup> | 1.104 <sup>a</sup> | 7.04 <sup>ab</sup>  |
| B                     | 40 <sup>a</sup>           | 0.903 <sup>bc</sup> | 0.48 <sup>a</sup> | 41.91 <sup>a</sup> | 75.59 <sup>b</sup>  | 0.103 <sup>b</sup> | 1.109 <sup>a</sup> | 6.717 <sup>a</sup>  |
| C                     | 40.25 <sup>a</sup>        | 0.90 <sup>bc</sup>  | 0.47 <sup>a</sup> | 41.78 <sup>a</sup> | 67.68 <sup>bc</sup> | 0.101 <sup>c</sup> | 1.106 <sup>a</sup> | 6.871 <sup>a</sup>  |
| D                     | 39.5 <sup>a</sup>         | 0.928 <sup>a</sup>  | 0.55 <sup>a</sup> | 41.69 <sup>a</sup> | 109.8 <sup>a</sup>  | 0.113 <sup>a</sup> | 1.119 <sup>a</sup> | 6.151 <sup>a</sup>  |
| E                     | 42 <sup>a</sup>           | 0.895 <sup>bc</sup> | 0.47 <sup>a</sup> | 43.53 <sup>a</sup> | 54.69 <sup>d</sup>  | 0.092 <sup>e</sup> | 1.096 <sup>a</sup> | 7.541 <sup>ab</sup> |
| Standard              | 41.75 <sup>a</sup>        | 0.89 <sup>c</sup>   | 0.43 <sup>a</sup> | 42.98 <sup>a</sup> | 41.03 <sup>e</sup>  | 0.086 <sup>f</sup> | 1.090 <sup>a</sup> | 8.021 <sup>b</sup>  |
| L.S.D. 0.05           | 4.536                     | 0.0168              | 0.326             | 2.516              | 8.806               | 0.002              | 1.030              | 2.619               |

(T) = Generation time (Ro) = Net reproductive rate ( $r_m$ ) = Intrinsic rate of natural increase ( $e^{rm}$ ) = Finit rate of increase (DT) = Doubling time

**Table 6:** Life table assays of *P. gossypiella* 3<sup>rd</sup> generation reared on certain semi-artificial diets

| Semi-artificial Diets | Developmantal Time (days) | Egg hatchability   | Sex ratio         | T (days)           | (Ro)               | Increase rate      |                    | DT (days)           |
|-----------------------|---------------------------|--------------------|-------------------|--------------------|--------------------|--------------------|--------------------|---------------------|
|                       |                           |                    |                   |                    |                    | $r_m$              | $e^{rm}$           |                     |
| A                     | 38 <sup>c</sup>           | 0.92 <sup>a</sup>  | 0.43 <sup>a</sup> | 39.67 <sup>a</sup> | 54.75 <sup>c</sup> | 0.101 <sup>a</sup> | 1.106 <sup>a</sup> | 6.87 <sup>b</sup>   |
| B                     | 39 <sup>c</sup>           | 0.908 <sup>a</sup> | 0.48 <sup>a</sup> | 40.81 <sup>a</sup> | 67.99 <sup>b</sup> | 0.103 <sup>a</sup> | 1.109 <sup>a</sup> | 6.704 <sup>b</sup>  |
| C                     | 39.5 <sup>bc</sup>        | 0.895 <sup>a</sup> | 0.47 <sup>a</sup> | 40.91 <sup>a</sup> | 55.36 <sup>c</sup> | 0.098 <sup>a</sup> | 1.103 <sup>a</sup> | 7.065 <sup>ab</sup> |
| D                     | 38.75 <sup>c</sup>        | 0.935 <sup>a</sup> | 0.55 <sup>a</sup> | 41.03 <sup>a</sup> | 104.4 <sup>a</sup> | 0.113 <sup>a</sup> | 1.119 <sup>a</sup> | 6.119 <sup>b</sup>  |
| E                     | 41.75 <sup>ab</sup>       | 0.89 <sup>a</sup>  | 0.46 <sup>a</sup> | 43.08 <sup>a</sup> | 47.16 <sup>d</sup> | 0.089 <sup>a</sup> | 1.094 <sup>a</sup> | 7.749 <sup>ab</sup> |
| Standard              | 43.75 <sup>a</sup>        | 0.883 <sup>a</sup> | 0.43 <sup>a</sup> | 44.99 <sup>a</sup> | 36.29 <sup>e</sup> | 0.079 <sup>a</sup> | 1.083 <sup>a</sup> | 8.681 <sup>a</sup>  |
| L.S.D. 0.05           | 2.516                     | 0.0758             | 0.262             | 5.626              | 5.084              | 0.079              | 0.726              | 2.813               |

(T) = Generation time (Ro) = Net reproductive rate ( $r_m$ ) = Intrinsic rate of natural increase ( $e^{rm}$ ) = Finit rate of increase (DT) = Doubling time

**Table 7:** Life table assays of *P. gossypiella* 4<sup>th</sup> generation reared on certain semi-artificial diets

| Semi-artificial Diets | Developmantal Time (days) | Egg hatchability   | Sex ratio         | T (days)            | (Ro)                | Increase rate      |                    | DT (days)          |
|-----------------------|---------------------------|--------------------|-------------------|---------------------|---------------------|--------------------|--------------------|--------------------|
|                       |                           |                    |                   |                     |                     | $r_m$              | $e^{rm}$           |                    |
| A                     | 40.5 <sup>ab</sup>        | 0.92 <sup>a</sup>  | 0.44 <sup>a</sup> | 42.46 <sup>ab</sup> | 56.43 <sup>c</sup>  | 0.095 <sup>c</sup> | 1.099 <sup>a</sup> | 7.304 <sup>c</sup> |
| B                     | 40 <sup>b</sup>           | 0.91 <sup>a</sup>  | 0.48 <sup>a</sup> | 41.72 <sup>b</sup>  | 69.04 <sup>b</sup>  | 0.102 <sup>b</sup> | 1.107 <sup>a</sup> | 6.829 <sup>d</sup> |
| C                     | 42.25 <sup>ab</sup>       | 0.89 <sup>a</sup>  | 0.47 <sup>a</sup> | 44.0 <sup>ab</sup>  | 63.16 <sup>bc</sup> | 0.094 <sup>c</sup> | 1.099 <sup>a</sup> | 7.357 <sup>c</sup> |
| D                     | 39 <sup>b</sup>           | 0.933 <sup>a</sup> | 0.55 <sup>a</sup> | 41.29 <sup>b</sup>  | 107.3 <sup>a</sup>  | 0.113 <sup>a</sup> | 1.119 <sup>a</sup> | 6.122 <sup>d</sup> |
| E                     | 44 <sup>ab</sup>          | 0.885 <sup>a</sup> | 0.47 <sup>a</sup> | 45.35 <sup>ab</sup> | 46.25 <sup>d</sup>  | 0.085 <sup>d</sup> | 1.088 <sup>a</sup> | 8.198 <sup>b</sup> |
| Standard              | 45.75 <sup>a</sup>        | 0.87 <sup>a</sup>  | 0.44 <sup>a</sup> | 47.08 <sup>a</sup>  | 36.59 <sup>e</sup>  | 0.076 <sup>e</sup> | 1.079 <sup>a</sup> | 9.066 <sup>a</sup> |
| L.S.D. 0.05           | 5.084                     | 0.0769             | 0.229             | 4.763               | 6.774               | 0.0043             | 0.073              | 2.905              |

(T) = Generation time (Ro) = Net reproductive rate ( $r_m$ ) = Intrinsic rate of natural Increase ( $e^{rm}$ ) = Finit rate of increase (DT) = Doubling time

**Table 5:** Life table assays of *P. gossypiella* 5<sup>th</sup> generation reared on certain semi-artificial diets

| Semi-artificial Diets | Developmantal Time (days) | Egg hatchability   | Sex ratio         | T (days)            | (Ro)               | Increase rate       |                    | DT (days)           |
|-----------------------|---------------------------|--------------------|-------------------|---------------------|--------------------|---------------------|--------------------|---------------------|
|                       |                           |                    |                   |                     |                    | $r_m$               | $e^{rm}$           |                     |
| A                     | 35.75 <sup>b</sup>        | 0.913 <sup>a</sup> | 0.42 <sup>a</sup> | 37.22 <sup>c</sup>  | 49.16 <sup>c</sup> | 0.105 <sup>c</sup>  | 1.11 <sup>ab</sup> | 6.601 <sup>ab</sup> |
| B                     | 36.75 <sup>ab</sup>       | 0.903 <sup>a</sup> | 0.46 <sup>a</sup> | 38.02 <sup>bc</sup> | 60.89 <sup>b</sup> | 0.108 <sup>b</sup>  | 1.11 <sup>ab</sup> | 6.413 <sup>ab</sup> |
| C                     | 37 <sup>ab</sup>          | 0.90 <sup>a</sup>  | 0.46 <sup>a</sup> | 38.26 <sup>bc</sup> | 57.63 <sup>b</sup> | 0.106 <sup>bc</sup> | 1.11 <sup>ab</sup> | 6.542 <sup>ab</sup> |
| D                     | 37.5 <sup>ab</sup>        | 0.94 <sup>a</sup>  | 0.54 <sup>a</sup> | 39.52 <sup>b</sup>  | 103.8 <sup>a</sup> | 0.118 <sup>a</sup>  | 1.13 <sup>a</sup>  | 5.901 <sup>b</sup>  |

|             |                    |                    |                   |                    |                    |                    |                    |                    |
|-------------|--------------------|--------------------|-------------------|--------------------|--------------------|--------------------|--------------------|--------------------|
| E           | 38.75 <sup>a</sup> | 0.89 <sup>a</sup>  | 0.46 <sup>a</sup> | 40.02 <sup>a</sup> | 43.56 <sup>d</sup> | 0.094 <sup>d</sup> | 1.09 <sup>bc</sup> | 7.350 <sup>a</sup> |
| Standard    | 39 <sup>a</sup>    | 0.883 <sup>a</sup> | 0.43 <sup>a</sup> | 40.14 <sup>a</sup> | 37.82 <sup>c</sup> | 0.090 <sup>e</sup> | 1.09 <sup>c</sup>  | 7.659 <sup>a</sup> |
| L.S.D. 0.05 | 2.516              | 0.1459             | 0.163             | 3.407              | 4.477              | 0.002              | 0.015              | 1.258              |

(T) = Generation time (Ro) = Net reproductive rate ( $r_m$ ) = Intrinsic rate of natural increase ( $e^{rm}$ ) = Finit rate of increase (DT) = Doubling time

## Discussion

Current work was extended the study done [6] that evaluated the same six semi-artificial diets (A, B, C, D, E & standard) which used in the current work for pink bollworm, *Pectinophora gossypiella* (Saund.) rearing. They found that semi-artificial diet (D) was the best diet evaluated for *P. gossypiella* rearing. Diet (D) based on kidney bean and soybean that was the best source for protein, carbohydrate, folic acid, iron & glycinin, followed by diets (A&B) that based on wheat grated, soybean & chick pea proteins. Meanwhile, diet (E) that based on wheat grated and chick pea proteins had the medium evaluation for *P. gossypiella* rearing quality. Diet (C) is the least quality for *P. gossypiella* rearing viability. On the other hand, standard diet [1] had the minor efficiency in the insect rearing.

So, current work evaluated the life table viability parameters for *P. gossypiella* reproductive eradication which reared on certain semi-artificial diets aforementioned. Semi-artificial diet (D) was the most suitable diet for *P. gossypiella* rearing and support the insect with featured viability; Diet (D) caused the reducing in developmental time, generation time (T) and doubling time (DT) of *P. gossypiella*. Meanwhile, the same diet (D) had the highly female progeny/female (Mx) & its survival rate (Lx), egg hatchability, sex ratio, net reproductive rate (Ro), intrinsic rate of natural increase ( $r_m$ ), finite rate of natural increase ( $e^{rm}$ ) compared with other semi-artificial diets to give eligible generation for different scientific trials. Diets arranged; B, C, A, E & standard can be use, but in case of absent the ingredients of diet (D) contents. On the other hand, standard diet had the least viability assays for *P. gossypiella* rearing.

Authors worked on life table parameters for many pests as [13] the study on the life-table 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 (Ro) was also maximum on MCU 9 and minimum on K 8. The intrinsic rate of increase ( $r_m$ ), finite rate of increase ( $\lambda$ ) 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 the study. While, [14] another work mentioned that 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 (Ro) was 90.35 females/female, length of generation (Tc) was 34.51 days, potential fecundity (pf) was 125.30 numbers of eggs, hypothetical F2 female 8163.12 females/female while, intrinsic rate of increase ( $r_m$ ) was 0.1305 females/female/day, the finite ( $\lambda$ ) and annual rate of increase (A.R.I.) 1.1394, 4.807 x 10<sup>20</sup> respectively. The doubling time (DT) was 5.3107 days. In addition, [15] the illustration of the life table and consumption rate for *Helicoverpa armigera* (Hübner) 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 ( $\lambda$ ), net reproductive rate (Ro) 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 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. 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. In addition, [16] authors worked on the cotton bollworm, *Helicoverpa armigera* (Hübner) to study the age-stage, two-sex life table on different bean cultivars including white kidney bean (cultivars Daneshkadeh, Pak, and Shokufa), red kidney bean (cultivars Akhtar, Naz, and Sayyad) and common bean (cultivar Talash) under laboratory conditions (25±1°C, 65±5% RH, a 16:8 h light-dark photoperiod). The lowest intrinsic rate of increase ( $r$ ) was on red kidney bean Akhtar (0.115 day) and the highest on white kidney bean Pak and common bean Talash (0.142 day). The lowest and highest values of the net reproductive rate (Ro) were on red kidney bean Akhtar (177.3 offspring) and white kidney bean Shokufa (270.1 offspring), respectively. The mean generation time (T) on different bean cultivars ranged from 37.03 to 44.64 days, which was shortest on white kidney bean Pak and longest on red kidney bean Akhtar. The cultivar Akhtar was the most unsuitable host for population growth of *H. armigera*. Meanwhile, [17] another description that life tables are a fundamental tool used to study insect populations to evaluate the biotic potential and the construction of a life table of this species under laboratory conditions. In South America *Helicoverpa gelatopoeon* 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 ( $\lambda$ ) was 1.13. The maximum rate of population growth occurred in the day 33. The biotic potential was 2.026 x 10 individuals/female/year. Additional work, [18] studied the life table parameters of *P. gossypiella* affected the treatments with triflumuron +500 Gy that was the most potent compound effect on the most life table aspects, followed by triflumuron + 50 Gy, emamectin benzoate and triflumuron when used singly. The life table parameters used were female progeny/female (Mx), survival rate (Lx), net reproductive rate (Ro), intrinsic rate of natural increase ( $r_m$ ) and finite rate of increase ( $e^{rm}$ ), generation time (T) and doubling time (DT). While, [19] *Helicoverpa armigera*, nucleo polyhedron virus (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 LC<sub>30</sub>-inoculated larvae compared to controls, but not on LC<sub>5</sub> or LC<sub>15</sub> inoculated hosts. Low concentrations (LC<sub>5</sub>, LC<sub>15</sub> and LC<sub>30</sub>) 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 LC<sub>30</sub> treatment. Net reproductive rate (R<sub>0</sub>), intrinsic rate of increase (r<sub>m</sub>), and finite rate of increase (λ) were all decreased in a concentration-dependent manner in the LC<sub>15</sub> and LC<sub>30</sub> treatments, as were female life expectancy, age-specific survivorship (l<sub>x</sub>), and age-specific fecundity (M<sub>x</sub>); whereas, population doubling time (DT) increased. Parasitoids did not discriminate against LC<sub>15</sub> inoculated larvae in choice or no-choice tests, but parasitized more LC<sub>50</sub> 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 day after NPV application.

### Conclusion

Semi-artificial diet (D) depends on kidney bean and soybean was the best diet used for *P. gossypiella* rearing and increase the insect viability throughout investigated the insect reproductive eradication by using different life table assays included the highly fertility generations represented acts in lower the developmental, generation (T) and doubling (DT) times. Addition, the higher female progeny/ female (M<sub>x</sub>), survival rate (L<sub>x</sub>), egg hatchability, sex ratio, net reproductive rate (R<sub>0</sub>), intrinsic rate of natural increase (r<sub>m</sub>) and finite rate of increase (e<sup>rm</sup>) compared with other semi artificial diets (A, B, C, E & standard) during the consecutive five generations time of *P. gossypiella*.

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