Reproductive and Population Parameters of *Empoasca Decipiens* Paoli (Hemiptera: Cicadellidae) on Different Host Plants

Adnan AE Darwish*  
Plant Protection Department, Faculty of Agriculture, Damanhour University, Damanhour, Egypt

*Corresponding author: adnandarwish2012@yahoo.com

Received 3 October, 2020  Accepted 2 December, 2020

### Abstract

Knowing the reproductive and population parameters (life table parameters) of a particular insect pest is very essential to develop its integrated pest management strategy. In this study, life table parameters of the leafhopper, *Empoasca decipiens* Paoli (Hemiptera - Cicadellidae) were calculated on four different host plants viz., potato (*Solanum tuberosum* L.), common bean (*Phaseolus vulgaris* L.), cotton (*Gossypium barbadense* L) and zucchini squash (*Cucurbita pepo* L.). The results showed that, the net reproduction rates (*R₀*) were 18.77, 38.3, 30.63 and 27.27 offspring/ female / generation on cotton, common bean, potato and zucchini squash, respectively. The intrinsic rates of increase (*λ̂*) were 0.15, 0.19, 0.149 and 0.186 female⁻¹ day⁻¹ with finite rates of increase (*A*) of 1.16, 1.21, 1.16 and 1.21 females / female / day on cotton, common bean, potato and zucchini squash, respectively. The values of both of mean generation time (*T*) and corrected generation time (*T_c*) were highest for leafhopper insect reared on potato plant compared with those which reared on other three host plants. While the require times to duplicate the population (*T_D*) were 4.6041, 3.6597, 4.661 and 3.727 days on cotton, common bean, potato and zucchini squash, respectively. The annual rates of increase (*ARI*) of *E. decipiens* were obtained as 7.28x10⁰²³, 1.05x10²⁰, 3.71x10²³ and 3.03x10²³ and it further reveal that the population would multiply 2.8 times in a year on each of cotton, common bean, potato and zucchini squash, respectively. On another hand, the calculated birth rates were 0.185, 0.225, 0.171 and 0.224 and the intrinsic death rates were 0.0347, 0.035, 0.022 and 0.038 in the leafhopper reared on the four host plants cotton, common bean, potato and zucchini squash, respectively. The mean durations (day) of *E. decipiens* nymphaal instars on the four different hosts also were studied. The duration of nymphaal instars was significantly different from host plant to another. The nymphaal stage of *E. decipiens* was completed in 11.04, 13.75, 12.28 and 13.37 days on common bean, cotton, squash and potato, respectively.

### Keywords: *Empoasca decipiens*. Life table, Net reproduction rates, Intrinsic rates

### 1 Introduction

The leafhopper, *Empoasca decipiens* Paoli (Hemiptera - Cicadellidae) is one of the most destructive sucking insect pests of vegetable and ornamental crops throughout the world. It has a wide range of plant hosts, short generation time and ability to transmit important plant viruses. The nymphs and adults of *E. decipiens* suck the plant sap by using its piercing-sucking mouthparts, injects it toxic saliva into leaves and cause Phytotoxicity (phytotoxic symptoms). Feeding injury of *E. decipiens* can result in discoloration, sometimes called “hopper burn” and consequently yield loss (Nault and Ammar 1989, Atwal and Singh 1990, Singh et al 2008, Mahmoud et al 2011, Khalafallah et al 2015, Darwish 2018). The green leafhopper usually colonized on the leaves undersurface of its plant hosts. The females of *E. decipiens* lay their eggs within the tissue of leaf vein (Raupach et al 2002, Backus et al 2005). In general, the host plants of a particular insect pest have a major effect on the biological aspects of this pest (Kim and Lee 2002, Bullas-appleton et al 2004, Naseri et al 2009, Khalafallah et al 2015). Also, many authors have reported that the differences in plant hosts of the insect pests may play an important role in it’s population dynamic (Lu
The life cycle parameters of the green leafhopper have been studied by different authors under different conditions (Raupach et al 2002) and different hosts (Medeiros et al 2005, Naseri et al 2007, Fathi et al 2009). The basic knowledge of the pest’s population dynamics is required for development of an adequate control strategy for any insect pest. Life tables are a fundamental tool for understanding the population dynamics of an insect pest (Pascua and Pascua 2002). The life table parameters such as mean generation time, gross reproduction rate and net reproduction rate are considered useful indices for comparing and/or predict the population growth potential of different insect pests under different environmental conditions such as food quality or host plants (Southwood 1966). Keeping in view the above mentioned information, this investigation was undertaken to evaluate the effect of host plants on life table parameters of Empoasca decipiens Paoli (Hemiptera: Cicadellidae).

2 Materials and Methods

2.1 Stock cultures of E. decipiens

To establish a stock culture of E. decipiens, the adults were collected using sweep net (or an aspirator) from unsprayed fields of four plant hosts (potato, common bean, cotton and zucchini squash). The collected adults were used to start stock colony for the present study. The insects were transferred with a fine hair brush after a temporary anesthetized for 5 min at -4°C and reared on seedlings (at 2nd and 3rd leaf stage) cultivated individually in plastic pots. The adults that collected from a specific crop plants were rearing on seedlings of the same crop. Each seedlings species were separately placed inside wire breeding chamber (semi-field condition). Therefore, prior to the experiment the offspring of E. decipiens were reared at least for two generations on the above mentioned plants.

2.2 Plant hosts

Four plants species (represent four different families) namely potato (Solanum tuberosum L., variety Cara), common bean (Phaseolus vulgaris L. variety Nebraska), cotton (Gossypium barbadense L. variety Ashmouni) and zucchini squash (Cucurbita pepo L. variety Eskandran) were used in this study. The plants were individually cultivated in plastic pots placed inside wire breeding chamber. No insecticides were applied to the plants.

2.3 The life table parameters of E. decipiens on different hosts

The life table parameters of E. decipiens on the above mentioned plant hosts were studied by confining 20 pairs (one day old adult) of the insect with the leaves of 20 seedlings (1–2 month old plants) of each host using clip cages as described by Costa et al (1991). The females were allowed to lay eggs for 24 hour. The clip cages with the same pairs of E. decipiens were moved to another leaf. Until the last individual from each treatment was died, each part of leaf harbouring eggs (leaf disc) was examined by microscope to determine the daily egg numbers. Life tables were constructed using the following parameters following the method by Birch (1948) Southwood (1978), Carey (1993), Carey (1995) and Price (1997).

\[
Pf\ or\ GRR = \sum_{x=0}^{\infty} m_x
\]
\[
R_0 = \sum_{x=0}^{\infty} i_x m_x
\]
\[
AE = \sum_{x=0}^{\infty} x m_x
\]
\[
AFs = \sum_{x=0}^{\infty} x^2 m_x
\]
\[
T = \sum_{x=0}^{\infty} x i_x m_x
\]
\[
T_{e} = \frac{\ln (R_0)}{r_m}
\]
\[
r_m = \frac{\ln (R_0)}{T}
\]
\[
D(T) = \frac{\ln (2)}{r_m}
\]
\[
\lambda = e^{r_m}
\]
\[
WM = e^{r_m} or = (e^{r_m})^2
\]
\[
ARI = \text{Antilog} e^{r_m}365
\]
\[
HF_2 = (R_0)^2
\]
\[
b = \frac{\sum_{x=0}^{\infty} e^{-r_m x} I(x)}{d=b-r_m}
\]

where (x) is the age of individuals in days, (l_x) is the surviving individuals at age x (Proportion of original cohort surviving to each stage), (m_x) is the expected reproductive of female at age x, (Pf or GRR) is the potential fecundity or the gross reproductive rate, (R_0) is the net reproductive rates in days, (AE) is the mean egg / day, (AFs) is the mean age fecundity schedule, (T) is the mean of generation time in days, (D(T)) is the corrected generation time in days, (r_m) is the intrinsic rate of natural increase, (DT) is the doubling time in days, (\lambda) is the finite capacity of increase, (WM) is the weekly multiplication rate, (ARI)
is the annual rate of increase, \((F_2)\) is the hypothetical \(F_2\) females, \((b)\) is the intrinsic instantaneous birth rate and \((d)\) is the intrinsic death rate.

2.4 Biological parameters of nymphs of *E. decipiens*

The 2nd experiment was planned to study the biological parameters of nymphs of *E. decipiens* on the above mentioned host plants (common bean, cotton and zucchini squash). For each host species, 20 newly emerged nymphs were singly maintained in glass jars and supplied with fresh leaves of the specific host. Jars were covered with muslin cloth at top and kept at 25 ± 1°C temperature and 65 ± 5 RH. The nymphs were observed every 6 hours and the durations of nymphal instars were recorded. The obtained data were subjected to statistical analysis (ANOVA). Differences among the means were determined by least significant differences test and difference was considered 95% significant at \(P\) value ≤ 0.05.

3 Results

Based on the data presented in Tables 1-4, the 1st deposited egg of *E. decipiens* was observed in the 11th, 8th, 8th, 10th day on potato, zucchini squash, cotton and common bean, respectively. The parameters of population and reproductive of *E. decipiens* on four different hosts (extracted from Tables 1-4) are given in Table 5. The potential fecundity (PF) was 45.897, 47.32, 34.14 and 61.896 eggs / female, with a \(R_0\) of 30.63, 27.26825, 18.76775 and 38.3 offspring / female and average number of laid eggs / female / day of 1.113823, 1.236655, 0.926802 and 1.605886 in potato, zucchini squash, cotton and common bean, respectively. The average duration between the parent's birth to that of their progeny or the mean length of generation \((T)\) of *E. decipiens* can be arranged in a descending order as follows: potato (23.013 days) > common bean (19.247 days) > cotton (18.121 days) > zucchini squash (17.772 days) with corrected generation values \((T_c)\) values of 23.013, 19.247, 18.83976 and 17.7727 days. The \(r_m\) values were 0.1487, 0.186, 0.15055 and 0.1894 / female / day with a \(\lambda\) of 1.1604, 1.205, 1.16258 and 1.209 females / female / day for *E. decipiens* insects which fed on potato, zucchini squash, cotton and common bean, respectively. In another hand, the leafhopper *E. decipiens* had the capacity to double its population in 4.661 days, with a weekly multiplication rate (WM) of 2.8336 times on potato plant. Each of zucchini squash, cotton and common bean required 3.727, 4.6041, and 3.6597 days to double their populations with MW of 3.6797, 2.8706, and 3.7684 folds, respectively. The HF values in F2 generation were 352.228, 1466.89, 938.1969 and 743.5574 in cotton, common bean, potato and zucchini squash, respectively. The ARI of *E. decipiens* were obtained as 7.283x10\(^{23}\), 1.047x10\(^{30}\), 3.708x10\(^{23}\) and 3.026x10\(^{23}\) and these values further reveal that the population would multiply 23, 30, 23 and 29 times in a year on each of cotton, common bean, potato and zucchini squash, respectively. Also, the results of time table of *E. decipiens* shows that the calculated birth rate was 0.185289, 0.224865, 0.170718 and 0.223747 while the intrinsic death rate was 0.034739, 0.035465, 0.022018 and 0.037747 in the four host plants cotton, common bean, potato and zucchini squash, respectively. Data in Table 6 revealed that the mean durations (in days) of *E. decipiens* nymphal instars on different host plants. The duration of nymphal instars was significantly different from host plant to another. On common bean plants, the mean durations of the five nymphal stadia were 1.91, 2.02, 2.13, 2.33 and 2.65 days, respectively. These durations on cotton plant recorded 2.35, 2.48, 2.77, 2.89 and 3.23, days respectively. While in squash the durations of the five stadia of *E. decipiens* were 2.09, 2.39, 2.34, 2.52 and 2.86 days and finally in potato plants these durations were 2.29, 2.56, 2.77, 2.83 and 3.08 days, respectively. The nymphal stage of *E. decipiens* was completed in 11.04, 13.75, 12.28 and 13.37 days on common bean, cotton, squash and potato, respectively \((F = 59.324, P = 0.005)\).
Table 1. Life table and age-specific fecundity of *E. decipiens* feeding on potato

| Age (Day) | $i_x$ | Eggs/one female | $m_x$ | $i_xm_x$ | $i_xm_x$ | $e^{-r mx}$ | $e^{-r mx}i_x$ |
|-----------|-------|-----------------|-------|----------|----------|-------------|----------------|
| 1         | 1     | 0               | 0     | 0        | 0        | 0.8617465  | 0.861747     |
| 2         | 1     | 0               | 0     | 0        | 0        | 0.742607   | 0.742607     |
| 3         | 1     | 0               | 0     | 0        | 0        | 0.639939   | 0.639939     |
| 4         | 1     | 0               | 0     | 0        | 0        | 0.551466   | 0.551466     |
| 5         | 1     | 0               | 0     | 0        | 0        | 0.475224   | 0.475224     |
| 6         | 1     | 0               | 0     | 0        | 0        | 0.409522   | 0.409522     |
| 7         | 0.95  | 0               | 0     | 0        | 0        | 0.352905   | 0.352905     |
| 8         | 0.95  | 0               | 0     | 0        | 0        | 0.304114   | 0.288909     |
| 9         | 0.9   | 0               | 0     | 0        | 0        | 0.262069   | 0.235863     |
| 10        | 0.9   | 0               | 0     | 0        | 0        | 0.225837   | 0.203254     |
| 11        | 0.9   | 0.2             | 0.2   | 0.2      | 0.2      | 0.194615   | 0.175153     |
| 12        | 0.9   | 0.35            | 0.15  | 0.35     | 0.35     | 0.167709   | 0.150938     |
| 13        | 0.9   | 0.6             | 0.54  | 0.6      | 0.6      | 0.144522   | 0.13007      |
| 14        | 0.85  | 0.75            | 0.6375| 0.75     | 0.75     | 0.124542   | 0.10586      |
| 15        | 0.85  | 1.7             | 1.45  | 1.7      | 1.7      | 0.107323   | 0.091225     |
| 16        | 0.8   | 1.15            | 0.92  | 1.15     | 1.15     | 0.092486   | 0.073988     |
| 17        | 0.8   | 2.9             | 2.32  | 2.9      | 2.9      | 0.076989   | 0.063759     |
| 18        | 0.75  | 2.8             | 2.1   | 2.8      | 2.8      | 0.06888    | 0.05151      |
| 19        | 0.75  | 2.6             | 2.15  | 2.6      | 2.6      | 0.059185   | 0.044389     |
| 20        | 0.75  | 3.25            | 2.4375| 3.25     | 3.25     | 0.051003   | 0.038525     |
| 21        | 0.75  | 3.5             | 2.625 | 3.5      | 3.5      | 0.043951   | 0.032963     |
| 22        | 0.75  | 3.9             | 2.925 | 3.9      | 3.9      | 0.037875   | 0.028406     |
| 23        | 0.7   | 3.95            | 2.765 | 3.95     | 3.95     | 0.032639   | 0.022847     |
| 24        | 0.7   | 3.6             | 2.52  | 3.6      | 3.6      | 0.028126   | 0.019688     |
| 25        | 0.7   | 4.4             | 3.08  | 4.4      | 4.4      | 0.024238   | 0.016966     |
| 26        | 0.7   | 4.8             | 3.36  | 4.8      | 4.8      | 0.020887   | 0.014621     |
| 27        | 0.65  | 4.15            | 2.6975| 4.15     | 4.15     | 0.017999   | 0.011699     |
| 28        | 0.6   | 4.05            | 2.43  | 4.05     | 4.05     | 0.015511   | 0.009306     |
| 29        | 0.6   | 3.9             | 2.34  | 3.9      | 3.9      | 0.013366   | 0.00802      |
| 30        | 0.55  | 3.55            | 1.9525| 3.55     | 3.55     | 0.011518   | 0.006335     |
| 31        | 0.5   | 3.6             | 1.8   | 3.6      | 3.6      | 0.009926   | 0.004963     |
| 32        | 0.4   | 3.15            | 1.26  | 3.15     | 3.15     | 0.008554   | 0.003421     |
| 33        | 0.35  | 3.05            | 1.0675| 3.05     | 3.05     | 0.007371   | 0.00258      |
| 34        | 0.35  | 2.25            | 0.7875| 2.25     | 2.25     | 0.006352   | 0.002233     |
| 35        | 0.3   | 1.8             | 0.54  | 1.8      | 1.8      | 0.005474   | 0.001642     |
| 37        | 0.25  | 1.55            | 0.3875| 1.55     | 1.55     | 0.004065   | 0.001016     |
| 38        | 0.25  | 1.2             | 0.3   | 1.2      | 1.2      | 0.003503   | 0.000876     |
| 39        | 0.15  | 0.6             | 0.09  | 0.6      | 0.6      | 0.003019   | 0.000453     |
| 40        | 0.1   | 0.55            | 0.055 | 0.55     | 0.55     | 0.002601   | 0.00026      |
| 41        | 0.1   | 0.4             | 0.04  | 0.4      | 0.4      | 0.002242   | 0.000224     |
| 42        | 0.05  | 0.4             | 0.02  | 0.4      | 0.4      | 0.001932   | 0.00066-05   |
| 43        | 0.05  | 0.2             | 0.01  | 0.2      | 0.2      | 0.001665   | 8.32E-05     |
| 44        | 0     | 0               | 0     | 0        | 0        | 0.001435   | 0            |

\[
\begin{array}{lllll}
\Sigma m = & \Sigma i_x m_x = & \Sigma i_x m_x = & \Sigma m_x = & \\
45.8975 & 30.63013 & 704.9554 & 1107.738 & \\
\end{array}
\]
Reproductive and Population Parameters of *Empoasca Decipiens* Paoli (Hemiptera: Cicadellidae) on Different Host Plants

Table 2. Life table and age-specific fecundity of *E. decipiens* feeding on squash

| Age (Day) | iₓ | Eggs/one female | mₓ | iₓmₓ | iₓmₓX | xₘₓ | e⁻ʳmx | e⁻ᵢₓmₓ Xₓ |
|-----------|----|-----------------|----|------|-------|-----|-------|------------|
| 1         | 1  | 0               | 0  | 0    | 0     | 0   | 0.830176| 0.830176   |
| 2         | 1  | 0               | 0  | 0    | 0     | 0   | 0.689192| 0.689192   |
| 3         | 1  | 0               | 0  | 0    | 0     | 0   | 0.572151| 0.572151   |
| 4         | 0.95 | 0          | 0  | 0    | 0     | 0   | 0.474986| 0.451237   |
| 5         | 0.95 | 0          | 0  | 0    | 0     | 0   | 0.394322| 0.374606   |
| 6         | 0.95 | 0          | 0  | 0    | 0     | 0   | 0.327357| 0.310989   |
| 7         | 0.9  | 0             | 0  | 0    | 0     | 0   | 0.271764| 0.244587   |
| 8         | 0.9  | 0.4           | 0.36| 0.324| 2.592| 2.88| 0.225612| 0.20305    |
| 9         | 0.85 | 1.15          | 0.9775| 0.830875| 7.477875| 8.7975| 0.187297| 0.159203   |
| 10        | 0.8  | 1.95          | 1.56| 1.248| 12.48| 15.6| 0.15549| 0.124392   |
| 11        | 0.8  | 3             | 2.4 | 1.92 | 21.12| 26.4| 0.129084| 0.103267   |
| 12        | 0.75 | 3             | 2.25| 1.6875| 20.25| 27  | 0.107162| 0.080372   |
| 13        | 0.75 | 3.2           | 2.4 | 1.8  | 23.4 | 31.2| 0.088964| 0.066723   |
| 14        | 0.7  | 3.35          | 2.345| 1.6415| 22.981| 32.83| 0.073855| 0.051699   |
| 15        | 0.7  | 3.5           | 2.45| 1.715| 25.725| 36.75| 0.061733| 0.042919   |
| 16        | 0.65 | 3.3           | 2.145| 1.39425| 22.308| 34.32| 0.050901| 0.030855   |
| 17        | 0.65 | 3.85          | 2.5025| 1.626625| 27.65263| 42.5425| 0.042256| 0.027467   |
| 18        | 0.65 | 4.15          | 2.6975| 1.753375| 31.56075| 48.555| 0.03508| 0.022802   |
| 19        | 0.6  | 4.05          | 2.43| 1.458| 27.702| 46.17| 0.029123| 0.017474   |
| 20        | 0.6  | 4.3           | 2.58| 1.548| 30.96| 51.6| 0.024177| 0.014506   |
| 21        | 0.55 | 4.2           | 2.31| 1.2705| 26.6805| 48.51| 0.020071| 0.011039   |
| 22        | 0.5  | 4.55          | 2.275| 1.1375| 25.025| 50.05| 0.016663| 0.008331   |
| 23        | 0.5  | 4.05          | 2.025| 1.1025| 23.2875| 46.575| 0.013833| 0.006916   |
| 24        | 0.45 | 4.1           | 1.845| 0.83025| 19.926| 44.28| 0.011484| 0.005168   |
| 25        | 0.45 | 4.2           | 1.89| 0.8505| 21.2625| 47.25| 0.009534| 0.004429   |
| 26        | 0.45 | 3.95          | 1.7775| 0.799875| 20.79675| 46.215| 0.007915| 0.003562   |
| 27        | 0.4  | 3.85          | 1.54| 0.616| 16.632| 41.58| 0.006857| 0.002628   |
| 28        | 0.35 | 3.9           | 1.365| 0.47775| 13.377| 38.22| 0.005455| 0.001909   |
| 29        | 0.3  | 3.7           | 1.11| 0.333| 9.657| 32.19| 0.004528| 0.001358   |
| 30        | 0.3  | 3.1           | 0.93| 0.279| 8.37 | 27.9 | 0.003759| 0.001128   |
| 31        | 0.25 | 3.25          | 0.8125| 0.203125| 6.296875| 25.1875| 0.003121| 0.00078   |
| 32        | 0.25 | 2.7           | 0.675| 0.16875| 5.4 | 21.6 | 0.002591| 0.000648   |
| 33        | 0.25 | 2.3           | 0.575| 0.14375| 4.74375| 18.975| 0.002151| 0.000538   |
| 34        | 0.2  | 2.1           | 0.42| 0.084| 2.856| 14.28| 0.001786| 0.000357   |
| 35        | 0.2  | 1.35          | 0.27| 0.054| 1.89 | 9.45 | 0.001482| 0.000296   |
| 36        | 0.2  | 1.1           | 0.22| 0.044| 1.584| 7.92 | 0.001231| 0.000246   |
| 37        | 0.1  | 0.8           | 0.08| 0.008| 0.296| 2.96 | 0.001022| 0.000102   |
| 38        | 0.1  | 0.7           | 0.07| 0.007| 0.266| 2.66 | 0.000848| 8.48E-05   |
| 39        | 0.05 | 0.45          | 0.0225| 0.001125| 0.043875| 0.8775| 0.000704| 3.52E-05   |
| 40        | 0.05 | 0.2           | 0.01| 0.0005| 0.02 | 0.4 | 0.000585| 2.92E-05   |
| 41        | 0    | 0             | 0  | 0    | 0     | 0   | 0.000485| 0          |

Σmₓ = 47.32
Σᵢₓmḵ = 27.26825
ΣᵢₓmₓXₓ = 484.62
ΣmₓXₓ = 931.725
Table 3. Life table and age-specific fecundity of *E. decipiens* feeding on common bean

| Age (Day) | $i_x$ | Eggs/one female | $m_x$ | $i_xm_x$ | $i_xm_{mx}$ | $x_m$ | $e^{rmx}$ | $e^{-rm_{mx}}$ |
|-----------|-------|-----------------|-------|----------|-------------|-------|----------|-------------|
| 1         | 1     | 0               | 0     | 0        | 0           | 0     | 1.0725   | 0.00051    |
| 2         | 1     | 0               | 0     | 0        | 0           | 0     | 0.00051  | 0.000000   |
| 3         | 1     | 0               | 0     | 0        | 0           | 0     | 0.00051  | 0.000000   |
| 4         | 1     | 0               | 0     | 0        | 0           | 0     | 0.00051  | 0.000000   |
| 5         | 0.95  | 0               | 0     | 0        | 0           | 0     | 0.00051  | 0.000000   |
| 6         | 0.95  | 0               | 0     | 0        | 0           | 0     | 0.00051  | 0.000000   |
| 7         | 0.9   | 0               | 0     | 0        | 0           | 0     | 0.00051  | 0.000000   |
| 8         | 0.85  | 0.55            | 0.4675| 0.397375 | 3.179       | 3.74  | 0.219554 | 0.186621   |
| 9         | 0.85  | 1.15            | 0.9775| 0.830875 | 7.477875    | 8.7975| 0.181649 | 0.154402   |
| 10        | 0.85  | 2.25            | 1.9125| 1.625625 | 16.25625    | 19.125| 0.150289 | 0.127745   |
| 11        | 0.8   | 2.45            | 1.96  | 1.568    | 17.248      | 21.56 | 0.124342 | 0.099474   |
| 12        | 0.8   | 2.85            | 2.28  | 1.824    | 21.888      | 27.36 | 0.102875 | 0.0823     |
| 13        | 0.75  | 2.2             | 1.65  | 1.2375   | 16.0875     | 21.45 | 0.085115 | 0.063836   |
| 14        | 0.75  | 4               | 3     | 2.25     | 31.5        | 42    | 0.07042  | 0.052815   |
| 15        | 0.75  | 4.25            | 3.1875| 2.390625 | 35.85938    | 47.8125| 0.058626 | 0.043697   |
| 16        | 0.75  | 4.05            | 3.0375| 2.278125 | 36.45       | 48.6  | 0.048204 | 0.036153   |
| 17        | 0.7   | 4.65            | 3.255 | 2.2785   | 38.7345     | 55.335| 0.039882 | 0.027917   |
| 18        | 0.7   | 3.4             | 2.38  | 1.666    | 29.988      | 42.84 | 0.032996 | 0.023098   |
| 19        | 0.7   | 4               | 2.8   | 1.96     | 37.24       | 53.2  | 0.0273   | 0.019111   |
| 20        | 0.7   | 5.65            | 3.955 | 2.7685   | 55.37       | 79.1  | 0.022587 | 0.015811   |
| 21        | 0.7   | 4.65            | 3.255 | 2.2785   | 47.8485     | 68.355| 0.018687 | 0.013081   |
| 22        | 0.6   | 4.05            | 2.43  | 1.458    | 32.076      | 53.46 | 0.015461 | 0.009277   |
| 23        | 0.6   | 4.05            | 2.43  | 1.458    | 33.534      | 55.89 | 0.012792 | 0.007675   |
| 24        | 0.55  | 5.2             | 2.86  | 1.573    | 37.752      | 68.64 | 0.010583 | 0.005821   |
| 25        | 0.5   | 5.4             | 2.7   | 1.35     | 33.75       | 67.5  | 0.008756 | 0.004378   |
| 26        | 0.5   | 5.5             | 2.75  | 1.375    | 35.75       | 71.5  | 0.007245 | 0.003622   |
| 27        | 0.45  | 5.35            | 2.4075| 1.083375 | 29.25113    | 65.0025| 0.005994 | 0.002697   |
| 28        | 0.45  | 5.55            | 2.4975| 1.123875 | 31.4685     | 69.93 | 0.004959 | 0.002232   |
| 29        | 0.45  | 5.75            | 2.5875| 1.164375 | 33.76688    | 75.0375| 0.004103 | 0.001846   |
| 30        | 0.4   | 4.85            | 1.94  | 0.776    | 23.28       | 58.2  | 0.003395 | 0.001358   |
| 31        | 0.4   | 3.85            | 1.54  | 0.616    | 19.046      | 47.74 | 0.002808 | 0.001123   |
| 32        | 0.35  | 3.2             | 1.12  | 0.392    | 12.544      | 35.84 | 0.002324 | 0.000813   |
| 33        | 0.3   | 2.6             | 0.78  | 0.234    | 7.722       | 25.74 | 0.001922 | 0.000577   |
| 34        | 0.25  | 2.5             | 0.625 | 0.15625  | 5.3125      | 21.25 | 0.001591 | 0.000398   |
| 35        | 0.2   | 2.7             | 0.54  | 0.108    | 3.78        | 18.9  | 0.001316 | 0.000263   |
| 36        | 0.15  | 1.95            | 0.2925| 0.043875 | 1.5795      | 10.53 | 0.001089 | 0.000163   |
| 37        | 0.15  | 1.4             | 0.21  | 0.0315   | 1.1655      | 7.77  | 0.000901 | 0.000135   |
| 38        | 0.05  | 0.85            | 0.0425| 0.002125 | 0.08075     | 1.615 | 0.000745 | 0.3738-05   |
| 39        | 0.05  | 0.55            | 0.0275| 0.001375 | 0.053625    | 1.0725| 0.000617 | 0.308-05    |
| 40        | 0     | 0               | 0     | 0        | 0           | 0     | 0.00051  | 0          |

Σ$m_m$ = 61.8975  Σ$m_{m_{x}}$ = 38.30038  Σ$m_{m_{x}}$ = 73.07894  Σ$m_{x}$ = 1294.893
### Table 4. Life table and age-specific fecundity of *E. decipiens* feeding on cotton

| Age (Day) | $i_x$ | Eggs/one female | $m_x$ | $i_xm_x$ | $i_xm_x^2$ | $x_m$ | $e^{-rmx}$ | $e^{-rmx}i_x$ |
|-----------|-------|-----------------|-------|----------|------------|-------|------------|--------------|
| 1         | 1     | 0               | 0     | 0        | 0          | 0     | 0.860153   | 0.860153     |
| 2         | 1     | 0               | 0     | 0        | 0          | 0     | 0.739863   | 0.739863     |
| 3         | 1     | 0               | 0     | 0        | 0          | 0     | 0.636395   | 0.636395     |
| 4         | 0.95  | 0               | 0     | 0        | 0          | 0     | 0.547397   | 0.520027     |
| 5         | 0.95  | 0               | 0     | 0        | 0          | 0     | 0.470845   | 0.447303     |
| 6         | 0.9   | 0               | 0     | 0        | 0          | 0     | 0.404999   | 0.364499     |
| 7         | 0.9   | 0               | 0     | 0        | 0          | 0     | 0.348361   | 0.313525     |
| 8         | 0.85  | 0               | 0     | 0        | 0          | 0     | 0.299644   | 0.254697     |
| 9         | 0.85  | 0               | 0     | 0        | 0          | 0     | 0.257739   | 0.219079     |
| 10        | 0.8   | 0.35            | 0.28  | 0.0224   | 2.24       | 2.8   | 0.221695   | 0.177356     |
| 11        | 0.8   | 1.05            | 0.84  | 0.0672   | 7.392      | 9.24  | 0.190692   | 0.152553     |
| 12        | 0.8   | 2.15            | 1.72  | 1.376    | 16.512     | 20.64 | 0.164024   | 0.131219     |
| 13        | 0.75  | 2.95            | 2.2125| 2.157188 | 25.7265    | 0.141086       | 0.105814     |
| 14        | 0.75  | 2.25            | 1.6875| 1.265625 | 17.71875   | 23.625| 0.121355   | 0.091017     |
| 15        | 0.7   | 2.55            | 1.785 | 1.2495   | 18.7425    | 26.775| 0.104384   | 0.073069     |
| 16        | 0.85  | 2.95            | 1.9175| 1.246375 | 19.942     | 30.68 | 0.089786   | 0.058361     |
| 17        | 0.85  | 3.95            | 2.5675| 1.668875 | 28.37088   | 43.8475| 0.07723   | 0.0502       |
| 18        | 0.65  | 3.05            | 1.9825| 1.288625 | 23.19525   | 35.685| 0.06643    | 0.043179     |
| 19        | 0.6   | 3.05            | 1.83  | 1.098    | 20.862     | 34.77 | 0.05714    | 0.034264     |
| 20        | 0.55  | 3.15            | 1.7325| 0.952875 | 19.0575    | 34.65 | 0.049149   | 0.027032     |
| 21        | 0.5   | 5.05            | 2.525 | 1.2625   | 26.5125    | 53.025| 0.042275   | 0.021138     |
| 22        | 0.45  | 5.45            | 2.4525| 1.103625 | 24.27975   | 53.955| 0.036363   | 0.016364     |
| 23        | 0.45  | 4.35            | 1.9575| 0.880875 | 20.26013   | 45.0225| 0.031278   | 0.014075     |
| 24        | 0.4   | 4.05            | 1.62  | 0.648    | 15.552     | 38.88 | 0.026904   | 0.010762     |
| 25        | 0.4   | 4.75            | 1.9   | 0.76     | 19         | 47.5  | 0.023141   | 0.009257     |
| 26        | 0.35  | 4.15            | 1.4525| 0.508375 | 13.21775   | 37.765| 0.019905   | 0.006967     |
| 27        | 0.3   | 3.95            | 1.185 | 0.3555   | 9.5985     | 31.995| 0.017122   | 0.005136     |
| 28        | 0.25  | 3.15            | 0.7875| 0.196875 | 5.5125     | 22.05 | 0.014727   | 0.003682     |
| 29        | 0.25  | 2.25            | 0.5625| 0.140625 | 4.078125   | 16.3125| 0.012668   | 0.003167     |
| 30        | 0.2   | 2.05            | 0.41  | 0.082    | 2.46       | 12.3  | 0.010896   | 0.002179     |
| 31        | 0.2   | 2.25            | 0.45  | 0.09     | 2.79       | 13.95 | 0.009372   | 0.001874     |
| 32        | 0.15  | 1.35            | 0.2025| 0.030375 | 0.972      | 6.48  | 0.008062   | 0.001209     |
| 33        | 0.1   | 0.5             | 0.05  | 0.005    | 0.165      | 1.65  | 0.006934   | 0.000693     |
| 34        | 0.1   | 0.25            | 0.025 | 0.0025   | 0.085      | 0.85  | 0.005964   | 0.000596     |
| 35        | 0.05  | 0.1             | 0.005 | 0.00025  | 0.00875    | 0.175 | 0.00513    | 0.000257     |
| 36        | 0     | 0               | 0     | 0        | 0          | 0     | 0.004413   | 0             |

| $\Sigma m_x$ | $\Sigma i_xm_x$ | $\Sigma i_xm_x^2$ | $\Sigma m_xx$ | $\Sigma m_xx^2$ | $\Sigma m_xx^3$ | $\Sigma m_xx^4$ |
|--------------|-----------------|------------------|----------------|-----------------|-----------------|-----------------|
| 34.14        | 18.7675         | 340.0968         | 673.185        |
The parameters of life table of different insect pests. The higher reproductive rates and the suitability of the plants species as a host to various insect pests. The higher reproductive rates and short development time of an insect pest on a particular host plant reflect the suitability of this plant species as a host. (Van Lenteren and Noldus 1990, Awmack and Leather 2002, Saeed et al 2010). From the above-mentioned results, its obvious that the parameters of life table of Empoasca decipiens differed when reared in different hosts. The shorted pre-oviposition period for females of E. decipiens was observed in zucchini squash and cotton pants (8 days), while the longest pre-oviposition period was recorded at the potato plants (11 day). These results are slightly different with the results of Kha-alfallah et al (2015) who reported 6.76 and 6.5 days as a pre-oviposition period for E. decipiens in each of cotton and fava bean, respectively. In this study, the $R_0$ of E. decipiens ranged from 18.77 in cotton to 38.3 in common bean plants, respectively. In similar results, Talebi et al (2010) found that the $R_0$ of E. decipiens was 22.03, 20.07, 22.06 and 22.31 in four cultivars of sugar beet namely, Shirin, Rasool, Khamseh and cotton pants (8 days), while the longest pre-oviposition period was recorded at the potato plants (11 day). These results are slightly different with the results of Khalfallah et al (2015) who reported 6.76 and 6.5 days as a pre-oviposition period for E. decipiens in each of cotton and fava bean, respectively. In this study, the $R_0$ of E. decipiens ranged from 18.77 in cotton to 38.3 in common bean plants, respectively. In similar results, Talebi et al (2010) found that the $R_0$ of E. decipiens was 22.03, 20.07, 22.06 and 22.31 in four cultivars of sugar beet namely, Shirin, Rasool, PP8 and IC, respectively. The $r_m$ varied from 0.1487 to 0.1894 in potato and common bean. The values of this parameter on the four different hosts are similar with those reported by Talebi et al (2010) who reported 0.099, 0.103, 0.102 and 0.104 $r_m$, for four different sugar beet cultivars. Also these results are in agreement with Tokuda and Matsumura (2004)
who reported 0.105 as a value of \( r_m \) for Cicadulina bipunctata (Hemiptera: Cicadellidae) at 28.3°C. Increase of the \( r_m \) value on common bean can be attributed both to decline in generation time and to an increase in \( R_0 \) value. The decreasing on generation time was due to a reduction in the reproductive period. The fore-mentioned results confirm that common bean demonstrated higher degree of feed sources and preferred by the pest as indicated by \( R_0 \), \( r_m \) and \( \lambda \). The results of studying the nymphal instar durations clarify that the common bean plant was the most suitable host for E. decipiens followed by squash, potato and finally cotton plants. These results are in synchronize with the results of both Raupach et al. (2002) and Mahmoud et al. (2011) who found that the broad bean was the most suitable host (short development time) and Khalafallah, et al. (2015) who stated that the faba bean was most suitable than cotton for E. decipiens.

Acknowledgment

The author would like to thank the members of plant protection department, Faculty of Agriculture, Damanhour University for their efforts during these experiments.

References

Atwal, AS; Singh, B (1990) Pest population and assessment of crop losses. ICAR Publication, Indian council of Agricultural Research, New Delhi, 265 pp.

Backus, EA; Serrano, MS; Ranger, CM (2005) Mechanism of Hopperburn: An Overview of Insect Taxonomy, Behavior and Physiology. Ann Rev Entomol, 50, 125-151.

Awmack, CS; Leather, SR (2002) Host plant quality and fecundity in herbivorous insects. Annual Review of Entomology 47, 817–844.

Birch, LC (1948) The intrinsic rate of natural increase of an insect population. J Anim Ecol 17, 15-26.

Bullas-appleton, ES; Otis, G; Gillard, C; Schaafsmia, AW (2004) Potato Leafhopper (Homoptera: Cicadellidae) Varietal Preferences in Edible Beans in Relation to Visual and Olfactory Cues. Environmental Entomology 33, 1381–1388.

Carey, JR (1993) Applied Demography for Biologists with Special Emphasis in Insects. Oxford University Press, New York, 206 pp.

Carey, JR (1995) Insect Demography. In: Encyclopedia of Environmental Biology, Academic Press, San Diego, pp. 289-303.

Costa, HS; Brown, JK; Byrne, DN (1991) Life history traits of the whitefly, Bemisia tabaci (Homoptera: Aleyrodidae) on six virus-infected or healthy plant species. Environmental Entomology 20, 1102-1107.

Darwish, AAE (2018) Variations in the susceptibility of some potato (Solanum tuberosum L.) cultivars to infestation with certain piercing sucking insect pests. Journal of Plant Protection and Pathology 9, 849-853.

Fathi, SAA; Nouri-Ganbalani, G; Rafiee-Dashtjedi, H (2009) Life cycle parameters of Empoasca decipiens Paoli (Hom.: Cicadellidae) on four potato cultivars (Solanum tuberosum L.) in Iran. J Entomol 6, 96-101.

Khalafallah, EME; Khattab, MA; EL-Srand, EA (2015) Biology of Empoasca decipiens Paoli (Homoptera: Cicadellidae) on four potato cultivars (Solanum tuberosum L.) in Egypt. J Basic Appl Sci Res 5, 132-136.

Mahmoud, YA; Amr, EM; Ebadah, IM (2011) Some ecological behaviors of the leafhopper, Empoasca decipiens (Paoli) on some winter plantations in Egypt. J Basic Appl Sci Res 1, 88-94.

Medeiros, AH; Delalibera, IJ; Tingey, WM (2005) Aspects of potato leafhopper (Homoptera: Cicadellidae) biology on Solanum berthaultii and other potato genotypes. J Econ Entomol 98, 1704-1709.

Nault, LR; Ammar, ED (1989) Leafhopper and plant hopper transmission of plant viruses. Annual Rev Ins 34, 301–329.

Naseri, B; Fathipour, Y; Talebi, AA (2007) Comparison of some biological aspects of Empoasca decipiens (Homoptera: Cicadellidae) on four bean species. J Entomol Soc Iran 27, 1-3.

Naseri, B; Fathipour, Y; Talebi, AA (2009) Population density and spatial distribution pattern of Empoasca decipiens Paoli (Hemiptera: Cicadellidae) on Different Host Plants.
poasca decipiens (Hemiptera: Cicadellidae) on different bean species. J Agric Sci Technol 11, 239-248

Pascua, LT; Pascua, ME (2002) Life Table of Cotton Bollworm, Helicoverpa armigera Hübner (Lepidoptera: Noctuidae) in Batac, Ilocos Norte, Philippines. Philipp J Sci 131, 75-89.

Price, P (1997) Insect Ecology. New York, John Wiley & Sons, 874 pp.

Raupach, K; Borgemeister, C; Hommes, M; Poehling, H; Sétamou, M (2002) Effect of temperature and host plants on the bionomics of Empoasca decipiens (Homoptera: Cicadellidae). Crop Protection 21, 113-119.

Saeed, R; Sayyed, AH; Shad, SA; Zaka, SM (2010) Effect of different host plants on the fitness of diamond-back moth, Plutella xylostella (Lepidoptera: Plutellidae). Crop Protection 29, 178–182.

Singh, S; Choudhary, DP; Sharma, HC; Mahia, RS; Mathur, YS; Ahuja, DB (2008) Effect of insecticidal molecules against jassid and shoot and fruit borer in okra. Indian Journal of Entomology 70, 197-199.

Southwood, TRE (1966) Ecological Methods With Particular Reference To The Study of Insect Populations. Methuen, London, UK, 524 pp.

Southwood, TRE (1978) Ecological Methods With Particular Reference To The Study of Insect Populations. 2nd edition. London: Chapman and Hall, 524 pp.

Talebi, AA; Izadpanah, A; Moharramipour, S; Fathipour, Y; Naseri, B (2010) Demographic study of the green leafhopper, Empoasca decipiens (Hemiptera: Cicadellidae) on four sugar beet cultivars. Appl Ent Phytopath 77, 1-13.

Tokuda, M; Matsumura, M (2004) Effect of temperature on the development and reproduction of the maize orange leafhopper Cicadulina bipunctata (Melichar) (Homoptera: Cicadellidae). Appl Entomol Zool 40, 213-220.

Van Lenteren, JC; Noldus, LPJJ (1990) Whitefly-plant relationship: Behavioural and ecological aspects. In: Gerling D, ed. Whiteflies: Their bionomics, pest status and management. Hampshire, Intercept Ltd, pp 47-89.
Empoasca decipiens Paoli

إنحصارات التكاثر والعشيرة لنطاط الاوراق

علي عوائل نباتية مختلفة

عدنان عبد الفتاح السيد درويش *
قسم وقاية النبات - كلية الزراعة - جامعة دمنهور - دمنهور - مصر
*Corresponding author: adnandarwish2012@yahoo.com

Received 3 October, 2020 Accepted 2 December, 2020

الموجز

معرفة الإحصاءات البيولوجية (إحصاءات جداول الحياة) لأفة حشرية معينة ضرورية جدا لتطوير برامج الإدارة المتكاملة لهذه الأفة. في هذه الدراسة تم حساب الإحصاءات البيولوجية لحشرة نطااط الاوراق Empoasca decipiens على أربعة عوائل نباتية مختلفة و هي نبات البطاطس، نبات الفاصوليا، نبات القطن، نبات الكوسة. أوضحت النتائج أن معدل التكاثر Net reproduction rate سجل 18.77 و 38.3 و 27.27 و 30.63 فرد / أنثي / جيل في حالة التربية علي نباتات القطن والفاصوليا والبطاطس والكوسه، علي الترتيب.

الاحصائيات البيولوجية 

Net reproduction rate:

| نبات  | Net reproduction rate |
|-------|-----------------------|
| البطاطس | 18.77 |
| الفاصوليا | 38.3 |
| القطن | 27.27 |
| الكوسة | 30.63 |

Intrinsic rates of increase:

| نبات  | Intrinsic rates of increase |
|-------|-----------------------------|
| البطاطس | 1,16 |
| الفاصوليا | 1,21 |
| القطن | 1,16 |
| الكوسة | 1,21 |

Finite rates of increase:

| نبات  | Finite rates of increase |
|-------|--------------------------|
| البطاطس | 1.16 |
| الفاصوليا | 1.21 |
| القطن | 1.16 |
| الكوسة | 1.21 |

مدة الجيل المصححة Duplicate the population:

| نبات  | Duplicate the population |
|-------|---------------------------|
| البطاطس | 4.6 |
| الفاصوليا | 3.66 |
| القطن | 4.6 |
| الكوسة | 3.73 |

مدة الزيادة remorseful:

| نبات  | remorseful |
|-------|------------|
| البطاطس | 3.73 |
| الفاصوليا | 3.66 |
| القطن | 4.6 |
| الكوسة | 4.6 |

مدة التكاثر reproductive:

| نبات  | reproductive |
|-------|---------------|
| البطاطس | 3.3 |
| الفاصوليا | 3.73 |
| القطن | 4.6 |
| الكوسة | 4.66 |

مدة النمو النموذجي Net generation time:

| نبات  | Net generation time |
|-------|----------------------|
| البطاطس | 7.7 |
| الفاصوليا | 11 |
| القطن | 8.3 |
| الكوسة | 9.3 |

مدة النمو الفعلي Net generation time:

| نبات  | Net generation time |
|-------|----------------------|
| البطاطس | 5 |
| الفاصوليا | 9.3 |
| القطن | 8.3 |
| الكوسة | 9.3 |

مدة البقاء إعادة التعبئة Densification time:

| نبات  | Densification time |
|-------|--------------------|
| البطاطس | 1 |
| الفاصوليا | 6 |
| القطن | 9.3 |
| الكوسة | 9.3 |