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

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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 (R_o) 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 (r_m) were 0.15, 0.19, 0.149 and 0.186 female^{-1} day^{-1} with finite rates of increase (λ) 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 (TD) 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 7.28×10^{23}, 1.05×10^{30}, 3.71×10^{23} and 3.03×10^{29} and it 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. 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* nymphal instars on the four different hosts also were studied. The duration of nymphal instars was significantly different from host plant to another. 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.

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

and Xu 1998). The life cycle parameters of the green leafhopper have been studied by different authors under different condition (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 Eskandrani) 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 mention 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).

$$\text{Pf or GRR} = \sum_{x=0}^{\infty} m_x$$

$$R_0 = \sum_{x=0}^{\infty} i_x m_x$$

$$AE = \frac{\sum_{x=0}^{\infty} m_x I_x}{\sum_{x=0}^{\infty} I_x}$$

$$AFs = \frac{\sum_{x=0}^{\infty} x\, m_x}{\sum_{x=0}^{\infty} m_x}$$

$$T = \frac{\sum_{x=0}^{\infty} x\, i_x m_x}{\sum_{x=0}^{\infty} i_x m_x}$$

$$T_c = \frac{\ln(R_0)}{R_m}$$

$$r_m = \frac{\ln(R_0)}{T}$$

$$DT = \frac{\ln(2)}{r_m}$$

$$\lambda = e^{r_m}$$

$$WM = e^{7 r_m} \underline{\text{ or }} = (e^{r_m})^7$$

$$ARI = \text{Antilog } e^{r_m} 365$$

$$HF_2 = (R_0)^2$$

$$b = \frac{1}{\sum_{x=0}^{\infty} e^{-r_m x} I_x}$$

$$d = b - r_m$$

where (**x**) is the age of individuals in days, (I_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 average egg / day, (AFs) is the mean age fecundity schedule, (T) is the mean of generation time in days, (T_c) is the corrected generation time in days, (r_m) is the intrinsic rate of natural increase, (DT) is the doubling time in days, (λ) is the finite capacity of increase, (WM) is the weekly multiplication rate, (ARI)

is the annual rate of increase, (HF$_2$) 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 determine 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 61.898 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 (23.015 days) > common bean (19.245 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 λ 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$_2$ 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 3.028x10^{29} and these values further reveal that the population would multiply 23, 30, 23 and 29 times in a year on each of on 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_xx	xm_x	e^{-rmx}	$e^{-rmx}i_x$
1	1	0	0	0	0	0	0.86174665	0.861747
2	1	0	0	0	0	0	0.742607	0.742607
3	1	0	0	0	0	0	0.639939	0.639939
4	1	0	0	0	0	0	0.551466	0.551466
5	1	0	0	0	0	0	0.475224	0.475224
6	1	0	0	0	0	0	0.409522	0.409522
7	0.95	0	0	0	0	0	0.352905	0.335259
8	0.95	0	0	0	0	0	0.304114	0.288909
9	0.9	0	0	0	0	0	0.262069	0.235863
10	0.9	0	0	0	0	0	0.225837	0.203254
11	0.9	0.2	0.18	0.162	1.782	1.98	0.194615	0.175153
12	0.9	0.35	0.315	0.2835	3.402	3.78	0.167709	0.150938
13	0.9	0.6	0.54	0.486	6.318	7.02	0.144522	0.13007
14	0.85	0.75	0.6375	0.541875	7.58625	8.925	0.124542	0.10586
15	0.85	1.7	1.445	1.22825	18.42375	21.675	0.107323	0.091225
16	0.8	1.15	0.92	0.736	11.776	14.72	0.092486	0.073988
17	0.8	2.9	2.32	1.856	31.552	39.44	0.079699	0.063759
18	0.75	2.8	2.1	1.575	28.35	37.8	0.06868	0.05151
19	0.75	2.6	1.95	1.4625	27.7875	37.05	0.059185	0.044389
20	0.75	3.25	2.4375	1.828125	36.5625	48.75	0.051003	0.038252
21	0.75	3.5	2.625	1.96875	41.34375	55.125	0.043951	0.032963
22	0.75	3.9	2.925	2.19375	48.2625	64.35	0.037875	0.028406
23	0.7	3.95	2.765	1.9355	44.5165	63.595	0.032639	0.022847
24	0.7	3.6	2.52	1.764	42.336	60.48	0.028126	0.019688
25	0.7	4.4	3.08	2.156	53.9	77	0.024238	0.016966
26	0.7	4.8	3.36	2.352	61.152	87.36	0.020887	0.014621
27	0.65	4.15	2.6975	1.753375	47.34113	72.8325	0.017999	0.011699
28	0.6	4.05	2.43	1.458	40.824	68.04	0.015511	0.009306
29	0.6	3.9	2.34	1.404	40.716	67.86	0.013366	0.00802
30	0.55	3.55	1.9525	1.073875	32.21625	58.575	0.011518	0.006335
31	0.5	3.6	1.8	0.9	27.9	55.8	0.009926	0.004963
32	0.4	3.15	1.26	0.504	16.128	40.32	0.008554	0.003421
33	0.35	3.05	1.0675	0.373625	12.32963	35.2275	0.007371	0.00258
34	0.35	2.25	0.7875	0.275625	9.37125	26.775	0.006352	0.002223
35	0.3	1.8	0.54	0.162	5.67	18.9	0.005474	0.001642
37	0.25	1.55	0.3875	0.096875	3.584375	14.3375	0.004065	0.001016
38	0.25	1.2	0.3	0.075	2.85	11.4	0.003503	0.000876
39	0.15	0.6	0.09	0.0135	0.5265	3.51	0.003019	0.000453
40	0.1	0.55	0.055	0.0055	0.22	2.2	0.002601	0.00026
41	0.1	0.4	0.04	0.004	0.164	1.64	0.002242	0.000224
42	0.05	0.4	0.02	0.001	0.042	0.84	0.001932	9.66E-05
43	0.05	0.2	0.01	0.0005	0.0215	0.43	0.001665	8.32E-05
44	0	0	0	0	0	0	0.001435	0
			$\Sigma m_x=$ 45.8975	$\Sigma i_xm_x=$ 30.63013	$\Sigma i_xm_xx=$ 704.9554	$\Sigma m_xx=$ 1107.738		

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

Age (Day)	i_x	Eggs/one female	m_x	i_xm_x	i_xm_xx	xm_x	e^{-rmx}	$e^{-rmx}i_x$
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	0.061313	0.042919
16	0.65	3.3	2.145	1.39425	22.308	34.32	0.050901	0.033085
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	1.0125	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	0.00429
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	0.00657	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
			$\Sigma m_x=$ 47.32	$\Sigma i_xm_x=$ 27.26825	$\Sigma i_xm_xx=$ 484.62	$\Sigma m_xx=$ 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	$i_x m_x$	$i_x m_x x$	$x m_x$	e^{-rmx}	$e^{-rmx} i_x$
1	1	0	0	0	0	0	0.827356	0.827356
2	1	0	0	0	0	0	0.684519	0.684519
3	1	0	0	0	0	0	0.566341	0.566341
4	1	0	0	0	0	0	0.468566	0.468566
5	0.95	0	0	0	0	0	0.387671	0.368287
6	0.95	0	0	0	0	0	0.320742	0.304705
7	0.9	0	0	0	0	0	0.265368	0.238831
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	0.058263	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	0.01911
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	19.096	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	3.73E-05
39	0.05	0.55	0.0275	0.001375	0.053625	1.0725	0.000617	3.08E-05
40	0	0	0	0	0	0	0.00051	0
			$\Sigma m_x =$ 61.8975	$\Sigma l_x m_x =$ 38.30038	$\Sigma l_x m_x x =$ 737.0894	$\Sigma m_x x =$ 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_xx	xm_x	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	0.224	2.24	2.8	0.221695	0.177356
11	0.8	1.05	0.84	0.672	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	1.659375	21.57188	28.7625	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	0.65	2.95	1.9175	1.246375	19.942	30.68	0.089786	0.058361
17	0.65	3.95	2.5675	1.668875	28.37088	43.6475	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	0.034284
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
			$\Sigma m_x=$ 34.14	$\Sigma l_xm_x=$ 18.76775	$\Sigma l_xm_xx=$ 340.0968	$\Sigma m_xx=$ 673.185		

Table 5. Life parameters of *E. decipiens* on four different plant hosts

	Parameter	Formula	Cotton	Common bean	Potato	Zucchini squash
Reproductive parameters:	Potential fecundity (Pf)	$=\Sigma m_x$	34.14	61.898	45.897	47.32
	Net reproduction rate	$Ro =\Sigma\ l_x m_x$	18.76775	38.3	30.63	27.26825
	Average eggs / day	$\Sigma\ l_x m_x / \Sigma\ l_x$	0.926802	1.605886	1.113823	1.236655
	Mean age fecundity schedule	$\Sigma\ x m_x / \Sigma\ m_x$	19.71837	20.91995	24.13503	19.68988
Population parameters	Mean generation time	$T=\Sigma\ l_x m_x x/\Sigma\ l_x m_x$	18.121	19.245	23.015	17.772
	The intrinsic rate of natural increase	$r_m=\ln R_o/T$	0.15055	0.1894	0.1487	0.186
	Finite rate of increase	$\lambda=e^{rm}$	1.16258	1.209	1.1604	1.205
	Corrected generation time	$T_c=\ln Ro/r_m$	18.83976	19.247	23.013	17.7727
	Doubling time	$DT=\ln 2/r_m$	4.6041	3.6597	4.661	3.727
	Weekly multiplication rate (WM)	e^{7rm} or $(e^{rm})^7$	2.8706	3.7684	2.8336	3.6797
	Intrinsic birth rate	$b=1/\Sigma\ e^{-rmX}l_x$	0.185289	0.224865	0.170718	0.223747
	Intrinsic death rate	$d=b-r_m$	0.034739	0.035465	0.022018	0.037747
	Annual Rate of Increase	Antilog $e^{rm}365$	7.283×10^{23}	1.047×10^{30}	3.708×10^{23}	3.028×10^{29}
	Hypothetical F2 females	$(R_0)^2$	352.228	1466.89	938.1969	743.5574

Table 6. Mean durations (in days) of the nymphal instars of *E. decipiens* on different host plants

Hosts	1st instar	2nd instar	3rd instar	4th instar	5th instar	Total duration
Common bean	1.91±0.22[d]	2.02±0.17[c]	2.13±0.23[b]	2.33±0.24[c]	2.65±0.28[c]	11.04±0.58[c]
Cotton	2.35±0.2[a]	2.48±0.23[ab]	2.77±0.25[a]	2.89±0.21[a]	3.23±0.22[a]	13.75±0.54[a]
Squash	2.09±0.26[c]	2.39±0.19[b]	2.34±0.23[b]	2.52±0.21[bc]	2.86±0.28[bc]	12.28±0.58[b]
Potato	2.29±0.26[ab]	2.56±0.19[a]	2.77±0.31[a]	2.83±0.25[a]	3.08±0.3[ab]	13.37±0.24[a]
General mean	2.15±0.29[bc]	2.34±0.29[b]	2.48±0.38[b]	2.62±0.32[b]	2.92±0.35[bc]	12.44±1.242[b]
F value	11.815	22.579	20.682	15.870	9.368	59.324
L. S. D.	0.17015	0.1556	0.2173	0.2044	0.28875	0.5367

4 Discussion

Information of the biological parameters of a particular insect pest can vary from one host to another, and this factor is very essential to determine 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 Khalafallah et al (2015) who reported 6.76 and 6.5 days as a pre-oviposition period for *E. decipiens* in each of cotton and faba 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* (Hemoptera: 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 $λ$. 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 of 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

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إحصائيات التكاثر والعشيرة لنطاط الاوراق Empoasca decipiens Paoli علي عوائل نباتية مختلفة

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الموجـــــــز

معرفة الإحصاءات البيولوجية (إحصاءات جداول الحياه) لآفة حشرية معينة ضروري جدا لتطوير برامج الادارة المتكاملة لهذه الآفة. في هذه الدراسة تم حساب الإحصاءات البيولوجية لحشرة نطاط الاوراق Empoasca decipiens علي أربعة عوائل نباتية مختلفة وهي نبات البطاطس، نبات الفاصوليا، نبات القطن، نبات الكوسة. أوضحت النتائج أن معدل التكاثر الصافي Net reproduction rate سجل 18,77 و38,3 و 30,63 و 27,27 فرد / أنثي / جيل في حالة التربية علي نباتات القطن والفاصوليا والبطاطس والكوسة، علي الترتيب. في حين أن قيم معدل الزيادة

الحقيقية Intrinsic rates of increase سجلت 0,15 و 0,189 و 0,148 و 0,186/ انثي / يوم مع معدل محدد للزيادة Finite rates of increase بلغ 1,16 و 1,21 و 1,16 و 1,21 انثي / انثي / يوم في حالة الحشرات التي تم تربيتها علي نباتات القطن والفاصوليا والبطاطس والكوسة، علي الترتيب. متوسط مدة الجيل ومدة الجيل المصححة كانت اعلي ما يمكن للحشرات التي تم تربيتها علي نباتات البطاطس بالمقارنة بالحشرات التي ربيت علي النباتات الاخري. سجلت قيم الزمن اللازم لتضاعف المجموع Duplicate the population 4,6 و 3,66 و 4,66 و 3,73 يوم للحشرات المرباه علي نباتات القطن والفاصوليا والبطاطس والكوسة، علي الترتيب.