

Comparative Life Table Parameters of the Vine Mealybug, *Planococcus ficus* (Signoret) (Hemiptera: Pseudococcidae), Fed on Some Ornamental Plants.

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ABSTRACT

This study aimed to assessment survivorship and fecundity of the vine mealybug, *Planococcus ficus* (Signoret) reared on different hosts (*Hedra helix* L., *Pittosporum tobira* (Thunb.) and *Nerium oleander* L.). The experiment was carried under laboratory conditions, life table and population parameters were structure to assessment survivorship in all stages of the vine mealybug life cycle. Results displayed that the highest mortality existed in the immature stages (nymphal stages) for all hosts were 32.02, 42.05 and 56.63 % and the total mortality were 35.89, 48 and 64.50 % on *H.helix* , *P. tobira* and *N. oleander* on respectively. Fertility tables showed that the net reproductive rate (R_0) of population were (105.08, 58.90 and 54.11), mean generation time (T) were (27.42, 40.33 and 43.68), innate capacity for increase (r) were (0.17, 0.10 and 0.09), finite rate of increase (λ) were (1.85, 1.11 and 1.09) and the population doubling time (D_T) were within (4.08, 6.93 and 7.70 day) for three hosts on respectively. According to the results, it could be concluded that the survivorship curve of *Planococcus ficus* (Signoret) approach to a diagonal model curve, which reflects a humble rate of mortality through life stages and piecemeal decreasing when oncoming adulthood with a significant effect of food preference for *H.helix* comparative with *P. tobira* and *N. oleander*.

Keywords: Vine mealybug, *Planococcus ficus*, life table, fecundity parameters and ornamental plants.

INTRODUCTION

The vine mealybug, *Planococcus ficus* (Signoret) considered as a local pest of the North Africa region and it converted to the main pest in the cultivation of grapes in many countries around the world such as USA, Turkey, Morocco, Italy, France, Spain and South America .The vine mealybug has been recorded on many different plant hosts such as mango, avocado, date palm, pomegranate, apple and ornamental plants in addition to grapes (Daane *et al.*, 2012). The life cycle of the vine mealybug included three female nymphal phases and it has nearly 5 to 8 generations over the year, Influenced by many weather elements, the most important effect of it revealed to temperature and humidity. *Planococcus ficus* feeds on sucking plant sap from bark in all grapevine parts, creating in shriveling, deformed and pallid leaves, precocious leaf falling, and flagging development and sometimes kill infected plants or parts of them (Kosztarab and Kozar 1988). *P. ficus* cause many damages in host plants even if the numerical density of this pest is low, mainly because its transfer the grapevine leafroll-associated virus (GLRaV) (Cabaleiro and Segura 1997) and secretes large quantity of the of honeydew, which helps the black sooty mold fungus to grow on leaves and fruits plus reduces their marketing value (Sforza *et al.*, 2005 and Daane *et al.*, 2006).

Life tables are one of the most important methods which used in realization population dynamics and evaluation the growth parameters and reproduction potential of insect populations (Chi and Su 2006). Life table studies are predominantly utilized by researchers as a technique of evaluating the growth of populations and predicting the dimension of a population. The life table providing a full description which involves the specifics of development times, the survival rates of each development stage, and the fecundity and life expectancy of a population (Carey 1993 and Yang *et al.* 2013).

Assessing the survivorship in a population and the fecundity of adults supply substantial birth to death acquaintance of individuals in the association (Carey 1993). fundamental parameters can be evaluated out of life table analysis, and they can be utilized to predict insect action and reconnoiter mortality and increasing types of a

population appropriate host are one of the most substantial agents affecting the biology of insects (Price *et al.* 1980). By recognize the life table parameters of the vine mealybug on various host plants, its host plant appropriate can be specified on host plants. Therefore, information on the suitable use of these plants in parks and large squares can be provided. However, their importance of *P. ficus* as a pest, no comparison studies on the biology of *P. ficus* breed on several host plants have been executed.

The purpose of the current studies was to estimate some biological characteristic, such as number surviving individuals at beginning of each age (lx), gross reproductive rate (Σmx), net reproductive rate (R_0), mean length of a generation (T), innate capacity for increase (r), finite rate of increase/ day (λ) and doubling time (DT), moreover the life table parameters of *P. ficus* when breed on three plants, *H.helix*, *P. tobira* and *N. oleander* provide a better understanding information about the appropriate phonological stage for growth and forecast of *P. ficus* distribution.

MATERIALS AND METHODS

Plants and the vine mealybug, *Planococcus ficus* cultures

Host plants (*Hedra helix* L., *Pittosporum tobira* (Thunb.) and *Nerium oleander* L.) were obtained from The Agricultural Experimental Station of the Faculty of Agriculture, Assiut University where the growth of plants in natural light. The plants were preserved under the environmental chamber conditions. The ovisacs of the vine mealybug, *P. ficus* were obtained from *H.helix* plants were placed over pumpkin. The pumpkin was infested with mealybugs kept in the cylindrical plastic cage with 30 cm diameter in a climate chamber. The vine mealybug was reared for one generation on all kinds of ornamental plants which used in the experiment. After 30-40 days of colony formation on each plant, the 10- day old adult females was collected by a brush from the three ornamental plants for use in the experiment Construction of life table:

Newly emerged adults female were obtained from laboratory culture and transferred to three ornamental plant leaves in petri plates for oviposition. One day old eggs were gathered for the construction of life tables. To

regulate the life tables were taking number of eggs laid by the females consisting of 560, 475 and 507 eggs on the leaves of *H. helix*, *P. tobira* and *N. oleander* respectively. The number of eggs, which taken are differed depending on the number of eggs, which female laid on each ornamental plants. For life table study 9 cm diameter plastic petri plates were utilized. About 0.5 cm diameter pit was made in the bottom of the petri plate utilizing a heated Iron nail for the stalk of each ornamental plants leaf and the cover of petri plate was cut off in the center in square form about 5 cm diameter to stick muslin cloth with glue to allow the air spread out inside the Petri plate. The three ornamental plants leaf with a 3-4 cm long stem was placed in each Petri plate with the stalk entered through the pit at the bottom of the Petri plate. All of Petri plate with ornamental plants leaf was put in a glass of water so that the stems to be submerged for preserve leaf vitality. Eggs were distributed on Petri plates and the petri plate was locked around by utilizing parafilm to avert the exit of mealybug nymphs. Survival and fecundity of each individual were recorded till the death of the last individual according to (Mastoi *et al.* 2014).

Data analysis:

Life and fecundity tables were constructed from a daily account of mortality and fecundity of three ornamental plant leaves cohorts subsequent accomplishment of Birch (1948) and South wood (1978). The parameters calculated were as follows:

- x: age class in units of time (days) / developmental stage
- lx: number surviving individuals at beginning of age class(x)
- L_x: number of individuals alive between age and the age period that followed
- d_x: number dying during age interval x
- 100q_x : Percent apparent mortality, 100q_x = (dx/lx) 100
- S_x : survival stage rate within stage
- T_x : total number of age x units beyond the age x
- e_x : life expectancy for individuals of age x, e_x = T_x/l_x

Table 1. Life Table of Vine mealybug, *P. ficus* on *h. helix*

x	l _x	L _x	d _x	100q _x	s _x	T _x	e _x
Eggs	560	547	30	5.36	94.64	2069	3.69
1 st instar	534	490.5	97	18.16	81.84	1522	2.85
2 nd instar	447	431	42	9.4	90.6	1031.5	2.31
3 rd instar	415	404	32	7.71	92.29	600.5	1.45
Adults	393	196.5					

Highest mortality in the first instar nymphs may be due to overcrowding along the basal part of the midrib of leaf and can be considered as the key element in organizing population volume. The high mortality in

Table 2. Life Table of Vine mealybug, *P. ficus* on *P. tobira*

x	l _x	L _x	d _x	100q _x	s _x	T _x	e _x
Eggs	475	457.5	43	9.05	90.95	179.5	3.93
1 st instar	440	417.5	101	22.95	77.05	1339	3.04
2 nd instar	395	385.5	48	12.15	87.85	921.5	2.33
3 rd instar	376	362	36	9.57	90.43	536	1.43
Adults	348	174					

Overall, nymphal stage recorded the highest mortality rate in view of the length of the nymphal period compared to the remnant of other stages. The mortality percentage of the nymphal stage record 30.02, 42.05 and 56.63% on *H. helix* L., *P. tobira* (Thunb.) and

- X : Actual female age (time from eggs).
- mx : age-specific fertility, the number of living females born per female in each age interval
- Ro: net reproductive rate, multiplication rate per generation,
- Ro=Σ l_xm_x
- T : corrected generation time, T = ln Ro / r
- D_T: doubling time, the number of days required by a population to double, DT= ln2 / r
- R: innate capacity for increase, r = ln Ro / T
- λ : finite rate of increase, λ= e^r

RESULTS AND DISCUSSION

Studying life tables are mostly utilized by researchers as a technique for estimating the development of populations and forecasting the volume of a population. The life table supplies a full description implicate the specifics of development times, the survival rates of each growth stage, and the fecundity and life anticipation of a population Yang *et al.* (2013). Host plant species are an essential agent in the outgrowth of Mealybugs; the development of the mealybugs was considered as a symbol of the goodness of that host plant to avail as a food exporter for its development. Most of our results are in assent with Patil *et al.* (2011) and Rashid *et al.* (2012).

1-Age-Specific Survival Life Table:

Data present in Tables (1, 2 and 3) indicated that the high mortalities were registered in nymphal stages particularly in early instar stage, then progressively reduce in later instars. The highest mortality was recorded in the first instar nymphs (18.16, 22.95 and 28.84) followed by second instar nymphs (9.40, 12.15 and 19.95) and third instar nymphs (7.71, 9.57 and 15.63) on three ornamental plant leaves *H. helix*, *P. tobira* and *N. oleander* respectively.

1st instar nymphs was also reported in many insects especially in Lygus bug, plant hopper and citrus psyllid (Siswanto *et al.* 2008, Win *et al.* 2011 and Sule *et al.* 2012).

N. oleander L. respectively. Generality of our results are consent with Tok *et al.* (2016) in Turkey, when they studied the life tables of the Madeira mealybug *Phenacoccus madeirensis* Green were reared in the laboratory under control conditions on for ornamental

plant species. The mortality percentage of the nymphal stage record 1.0, 6.9, 10.8 and 11.1% on *Cestrum*

nocturnum, *Pelargonium zonale*, *Hibiscus syriacus* and *Hibiscus rosa-sinensis* respectively.

Table 3. Life table of Vine mealybug, *P.ficus* on *N. oleander*

x	l_x	L_x	d_x	$100q_x$	s_x	T_x	e_x
Eggs	507	491	58	11.44	88.56	1804.5	3.56
1 st instar	475	430.5	137	28.84	71.16	1313.5	2.77
2 nd instar	386	369	77	19.95	80.05	883	2.29
3 rd instar	352	345	55	15.63	83.37	514	1.46
Adults	338	169					

The percentage of mortality in egg stage registered 5.36, 9.05 and 11.44% on ornamental plant species, *H. helix* L., *P. tobira* (Thunb.) and *N. oleander* L., respectively, which represent the hatching percentage on leaves of the three ornamental plants, which due to the Physiological reasons for the infertility and other genetic factors. Consistent with our results Mastoi *et al.* (2011) reported that the percentage of mortality in egg stage recorded 5.66% when they studied the life table of *Paracoccus marginatus* Williams on *Hibiscus sp.*

In general, the tables (1,2 and 3) showed that the total percentage of the mortality of the vine mealybug, *P. ficus* was 35.89, 48.00 and 64.50% on the three ornamental plant species, *H. helix* L., *P. tobira* (Thunb.) and *N. oleander* L., respectively. The study goes in the same line of the findings of Mastoi *et al.* (2011) who found that the total percentage of the mortality of *P. marginatus* on *Hibiscus sp.* recorded 36.38%. In line with the present findings, also Kumar *et al.* (2013) observed up to 59% total percentage of the mortality of *Phenacoccus solenopsis* Tinsley on different phenological phase of cotton growth.

Survivorship curves (l_x) of *P. ficus* studies on tree ornamental plant species in figure (1) showed that these curves started with moderate mortality rates in the early stages of *P. ficus* life, followed by a gradual decrease when reaching adulthood for all three ornamental plant species. The results indicated that the survivorship curve of *P. ficus* identical to the diagonal model curve which distributing by Pearl (1928) and Schowalter (2011). Results also demonstrate that the humble rate of mortality through life stages and piecemeal decreasing when approximating adult stage with considerable influence of food priority for *H.helix* relative with *P. tobira* and *N. oleander*.

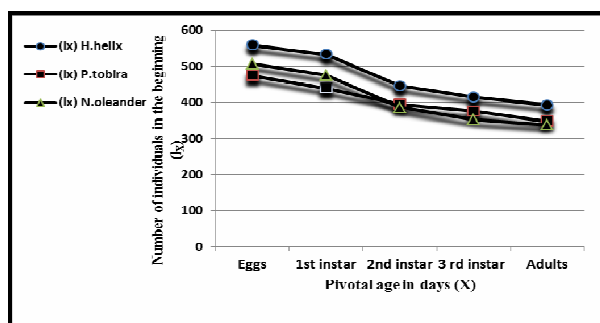


Fig. 1. The age-stage specific survival rates of *P. ficus* on three different host plants

Food effect, as shown clearly in the ability to survive (the number of individuals alive for different age) of the *P. ficus* on the *H. helix* L. leaves, which recorded the

highest rates compared to leaves of *P. tobira* (Thunb.), followed by *N. oleander* L. This showed food preference for an insect on the leaves of *H. helix*.

In this field, there are diverse studies on the influence of host plants on the evolution and increase parameters of mealybug insect pests such as *Phenacoccus solenopsis* Tinsley (Hemiptera: Pseudococcidae) on four decorative plants Filiz *et al.* (2016), *Pseudococcus comstocki* (Kuwana) on *Morus* spp. Atas and Kaydan(2014), *Pseudococcus cryptus* Hempel on Citrus spp. (Rutaceae) Holat *et al.* (2014), *Planococcus citri* Risso on citrus, grape and guava Ahmed and Abd-Rabou (2010) and *Planococcus citri* Risso on different decorative plants Polat *et al.* (2008).

From previous researches that reported, it was explained that the species of host plant affected in the Biological traits and life table parameters of the insects. The selection of phytophagous insects for host plants depends on the behavioral response of insects to the morphological and chemical properties of plants. Morphological characteristics of the host plant have an essential role in the acceptability of the host by the insect, either directly by visual cues or indirectly by affecting the strength of the insect to walk on or penetrating the plant tissue. Moreover, the differences in concentrations of nutrients in the host plant have a large impact in the selection of insect species. Chemical features found in certain parts of the plant are considered attractive for most types of phytophagous insects, and this will define the physical and chemical proportion to which the insect will react Bernays and Chapman (1994). Obviously, some scientists declare that several mealybug species show the different reaction to various plant species that have different morphological and chemical characteristic (Yang and Sadof 1995; Tobih *et al* 2002 and Hogendorp *et al* 2006). However, we did not concentrate on morphological and/or chemical properties of the experiment plants and their influence on the biological characters of the vine mealybug, *P. ficus* (Signoret) in this search.

Age-Specific fecundity table:

Age-specific survivorship (l_x) and fecundity (m_x) of the vine mealybug, *P. ficus* (Signoret) on three ornamental plant leaves are shown on a comprehensive data in Tables (4, 5 and 6) and figure (2). The first adult female appeared on day (20, 35 and 38) and the precocious egg laying was recorded just after (5, 3 and 3) days of female emergence and egg laying almost continued till the death. On the other hand the first adult female death was recorded in the 36, 46 and 49 day on three ornamental plant leaves *H. helix* L., *P. tobira* (Thunb.) and *N. oleander* L. respectively.

Table 4. Age -specific life and fecundity table of *P. ficus* on *H.helix*

X	L_x	M_x	$L_x M_x$	$XL_x M_x$
0 - 20	immature stage			
24	pre-oviposition			
25	0.55	58.33	32.08	802.00
26	0.48	43.11	20.69	537.94
27	0.41	37.17	15.24	411.48
28	0.36	25.07	9.03	252.84
29	0.33	20.58	6.79	196.91
30	0.31	18.16	5.63	168.90
31	0.29	16.02	4.65	144.15
32	0.27	13.71	3.70	118.40
33	0.24	11.06	2.65	87.45
34	0.21	9.75	2.05	69.70
35	0.18	7.37	1.33	46.55
36	0.14	5.96	0.83	29.88
37	0.11	2.18	0.24	8.88
38	0.08	1.86	0.15	5.70
39	0.05	0.35	0.02	0.78
40	0.02	0.17	0.00	0.00
41	0.01	0	0.00	0.00
Total		270.85	105.08	2881.56

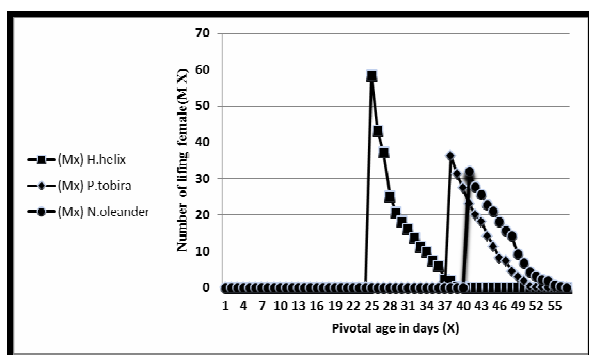


Fig. 2. The female fertility of on three different host plants

The last female died on day (41, 54 and 56). Results also showed the pre-oviposition took about several hours on leaves of *H. helix* L. and one day on leaves of *P. tobira* (Thunb.) and *N. oleander* L. respectively. Tables generally showed that adult female laid the greatest number of eggs in precocious day oviposition whereas the minimum numbers of eggs were laid in later days of adult female life length.

Table 5. Age -specific life and fecundity table of *P. ficus* on *P.tobiro*

X	L_x	M_x	$L_x M_x$	$XL_x M_x$
0 - 35	immature stage			
36-37	pre-oviposition			
38	0.41	36.31	14.89	565.82
39	0.38	31.25	11.88	463.32
40	0.35	27.45	9.61	384.40
41	0.31	23.14	7.17	293.97
42	0.27	20.07	5.42	227.64
43	0.22	18.11	3.98	171.14
44	0.17	14.16	2.41	106.04
45	0.14	11.37	1.59	71.55
46	0.11	8.1	0.89	40.94
47	0.08	7.35	0.59	27.73
48	0.07	4.44	0.31	14.88
49	0.04	3.03	0.12	5.88
50	0.02	1.77	0.04	2.00
51	0.02	0.22	0.00	0.00
52	0.02	0.15	0.00	0.00
53	0.01	0.1	0.00	0.00
54	0.01	0	0.00	0.00
Total		207.02	58.90	2375.31

Many researchers reported that the Fecundity, pre-oviposition, oviposition, postoviposition time and longevity of the mealybug insects were influenced by host plant kinds. Ahmed and Abd-Rabou (2010) mention that the host plant species impacted on pre-oviposition, oviposition, postoviposition periods of *P. citri* Risso, Arif *et al.* (2013) obtained the highest fecundity of *phenacoccus solenopsis* Tinsley on *Hibiscus sp.* among 25 various guest plants and Filiz *et al.* (2016) Proved that the longest oviposition span was noted when breeding mealybug on *Hibiscus rosa*, whereas the shortest one was recorded on *Cestrum laevigatum*.

Table 6. Age -specific life and fecundity table of *P. ficus* on *N.oleander*

X	L_x	M_x	$L_x M_x$	$XL_x M_x$
0 - 38	immature stage			
39-40	pre-oviposition			
41	0.38	31.84	12.10	496.10
42	0.36	27.61	9.94	417.48
43	0.33	25.53	8.42	362.06
44	0.28	22.75	6.37	280.28
45	0.26	21.05	5.47	246.15
46	0.22	18.17	4.00	184.00
47	0.19	15.8	3.00	141.00
48	0.15	14.11	2.12	101.76
49	0.13	9.33	1.21	59.29
50	0.1	6.73	0.67	33.50
51	0.09	4.36	0.39	19.89
52	0.07	3.11	0.22	11.44
53	0.06	2.21	0.13	6.89
54	0.03	1.77	0.05	2.70
55	0.02	0.62	0.01	0.55
56	0.02	0.3	0.01	0.56
57	0.01	0	0.00	0.00
Total		205.29	54.12	2363.65

The present study evident that host plant species extremely affected by the biological attributes instance as development, fecundity, and life table parameters of the vine mealybug, *P. ficus* (Signoret) . Innate capacity for increase (r) and finite rate of increase (λ) of the vine mealybugs reared on three ornamental plants were significantly different.

Table (7) describes the population and reproductive parameter of *P. ficus*. The Innate capacity for increase (r) was the highest in populations reared on *H. helix* (0.17). Identically, the highest net reproductive rate (Ro) was observed on *H. helix* (105.08). Results in Table (7) also showed that the doubling time (D_T) was recorded (4.08, 6.93 and 7.70) on *H. helix* L., *P. tobira* (Thunb.) and *N. oleander* L. respectively, which clarified the effect of food and determined that the vine mealybug preference the leaves of *H. helix* compared with the leaves of *P. tobira* and *N. oleander*. Mean generation time (T) displayed a clear difference in mealybugs reared on the various host. The longest mean generation time was instituted on mealybugs breed on *N. oleander* and *P. tobira*, but the shortest mean generation time was observed in mealybugs breeding on *H. helix*. As for the fertility of females, it has reached the highest total of age-specific fertility (Σm_x) around 270.85 on *H. helix* leaves. The intrinsic rate of natural increase was first utilized by Birch (1948) as a measurement of animal population increase average and since then, used on numerous insects Lee *et al.* (2002).

Table 7. Population and reproductive parameters of vine mealybug, *P. ficus* on three ornamental plants under laboratory conditions

Parameters	<i>Headra helix</i>	<i>Pottosporum tobira</i>	<i>Nerium Oleander</i>
R_0	105.08	58.90	54.11
T	27.42	40.33	43.68
r	0.17	0.10	0.09
λ	1.85	1.11	1.09
D_T	4.08	6.93	7.70
$\sum M_x$	270.85	207.02	205.29

In this study, the evolution and life table parameters of *P. ficus* were studied on the three various ornamental plants. *P. ficus* accomplished its development and reproduce on all the examined plants. Knowing the life table parameters of *P. ficus* on different host plants will assistance in the protection and forecast of its population development, which will lead to the enforcement of programs to decrease economic losses. Subsequently, the perception the life cycle of the mealybug on diverse host plants is fateful for the evolution of the program of pest control. Based on the results obtained, the vine mealybug *P. ficus* can be considered a menace to the husbandry of decorative plants in great capitals, orchard and famous squares. If the environmental conditions are appropriate, the mealybug population will augmentation fastly in a stumpy period and cause important spoilage to ornamental plants. In addition, the vine mealybug *P. ficus* has a wide host range encompass of fruits, vegetables, field crops as well as ornamental plants and weeds, consequently *P. ficus* considered as an important pest in any agricultural system.

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مقارنة جداول الحياة لبق العنب الدقيقي (*Planococcus ficus* (Signoret)) على بعض أنواع نباتات الزينة

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استهدف البحث دراسة لكافة المقاييس الحياتية ومقاييس الخصوبة والقابلية على التكاثر والإنتاجية لحشرة بق العنب الدقيقي *Planococcus ficus* (Signoret) (Hemiptera: Pseudococcidae) على عدة عوائل نباتية من نباتات الزينة وهي الهيدرا، البنسبورم و الدفلة. أجريت الدراسة في ظروف مختبريه، حيث تم تنظيم جداول الحياة ومقاييس الكثافة العددية لتحديد القابلية على البقاء للحشرة في اطوارها المختلفة، أظهرت النتائج في جداول الحياة ان أعلى نسبة للموت في الاطوار غير الناضجة كانت في طور الحوريات والتي بلغت 56,63، 42,05، 32,02 % وكانت النسب المئوية الكلية للموت للحشرة الكاملة هي 64,50، 48، 35,89 % على أوراق نباتات الهيدرا، البنسبورم و الدفلة على التوالي. كذلك نظمت جداول الخصوبة للحشرة، وفيها ظهرت نسبة التعويض الصافي (R_0) 105,08، 58,90، 54,11. وكان معدل طول الجيل (T) 43,68، 40,33، 27,42. وكان معدل الزيادة الطبيعية للحشرة (r) 0,17، 0,10، 0,09 بينما كان معدل الزيادة النهائي لتعداد الحشرة (λ) 1,85، 1,11، 1,09 وكان الوقت اللازم للتضاعف (D_T) 4,08، 6,93، 7,70 يوم على أوراق نباتات الهيدرا، البنسبورم و الدفلة على التوالي. وعلى ضوء نتائج الدراسة يظهر منحنى نموذج الحياة لحشرة بق العنب الدقيقي من النوع المائل حيث يبدأ بنسب موت معتدلة في المراحل المبكرة من حياتها يليه انخفاض تدريجي عند الوصول الى مرحلة البلوغ بالنسبة لنباتات الزينة الثلاثة وتأثير واضح لنوع الغذاء في تفضيل الحشرة لأوراق نباتات الهيدرا مقارنة بأوراق البنسبورم و الدفلة.