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LIFE TABLE OF *ASPIDIOTUS NERII* BOUCHÉ (HEMIPTERA, DIASPIDIDAE) ON SIX POTATO VARIETIES AT THE LABORATORY CONDITIONS

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ABSTRACT

Aspidiotus nerii Bouché (Hemiptera, Diaspididae) is a polyphagous species and the host of many effective biological control agents. It has short generation time and produces on potato tubers easily. The oleander scale is commonly used at the mass production studies of many natural enemies. The most appropriate host plant selection to oleander scale is important for mass production studies. The life table is a good way to understand the population dynamic of an organism. In this study, the life table parameters of oleander scale on six potato varieties (Agria, Sante, Marabel, Granola, Vanba and Provento) were estimated by using the Euler-Lotka method at the climatic cabinets which have 25ºC constant temperature, 60±5% relative humidity and 16:8 hours light–dark periods. The life table parameters were calculated as follows: intrinsic rate of increase (r_m), 0.049, 0.048, 0.045, 0.034, 0.046 and 0.026 females/female/day, net reproductive rates (R_0) 19.35, 18.52, 16.67, 8.31, 16.34 and 5.01 females/female, mean generation time (T_0) 61.15, 60.72, 62.20, 62.79, 60.79 and 62.66 days, gross reproductive rate (*GRR*) 30.53, 23.90, 20.85, 10.66, 31.76 and 19.72, doubling time (T_2) 14.31, 14.42, 15.32, 20.56, 15.08 and 26.96 days, finite rate of increase (λ) 1.05, 1.05, 1.05, 1.03, 1.05 and 1.03 females/days, respectively.

KEYWORDS:
Aspidiotus nerii, potato varieties, life table, mass production

INTRODUCTION

Citrus fruits include grapefruit, lemon, mandarin and orange which have high economical value among exported products in Turkey. While China, Brazil and U.S.A are at the top of citrus producing countries, Turkey is the 9th among them with its 3.7 million tone production [1]. In the citrus produced areas, 34 disease, 16 nematodes, 155 weeds and 89 pests were found in Turkey [2]. Among these, the California Red Scale insect, *Aonidiella aurantii* (Maskell) (Hemiptera: Diaspididae) is one of the important pest which attacks to fruits, leaves, stems, branches and shoots of citrus [3, 4]. Many parasitoids and predators are used in the biological control of *A. aurantii* in the integrated pest management programmes. These are *Aphytis africanus* Quednau, *Aphytis coheni* DeBach, *Aphytis lingnanensis* DeBach, *Aphytis melinus* DeBach, *Comperiella bifasciata* Howard, *Encarsia perniciosi* (Tower) [5], *Chilocorus bipustulatus* (L.), *Chilocorus nigritus* (Fabricius), *Rhyzobius lophantae* (Blaisdell) [3, 6, 7, 8]. At among these species, *A. nerii* which is easily produced and has short generation time on potato tubers is preferred for mass production of *Aphytis melinus* which is widely used as a biological control agent around the world [9, 10]. Oleander scale is a polyphagous species that as more than 100 plants as host in the tropic and subtropic regions of Mediterranean countries. It causes considerable harm especially to oleander, ornament plants, olive and lemon trees [11]. Appropriate host selection is economically important at the mass production of biological control agents. In this study, 6 different potato varieties as host were selected for production of oleander scale and life tables of pest were constructed on different potato varieties and best varieties were determined as host for oleander scale insect among test varieties.

MATERIALS AND METHODS

Biparental form of *A. nerii* was used at the experiments. Agria, Sante, Marabel, Granola, Vanba and Provento potato varieties (*Solanum tuberosum* L.) were used as host to oleander scale. Studies were conducted at climate cabinets which have 25ºC constant temperature, 60±5% relative humidity and 16:8 hours light–dark periods. Newly emerged active crawlers were transferred to experimented potato tubers during 24 hours and settled on tubers. Experiment replicates were selected and surrounded by cells with 2x2 cm^2on tubers by 'Stickem Special'. Each of experiment individuals was daily observed and their development times,

preoviposition, oviposition, postoviposition periods, sex ratio, fecundities and survivals were recorded until last individual died. The period of time between beginning of young female and emergence of first active crawler was determined as preoviposition period; between first emergences to last emergences of crawlers were recorded as oviposition period; and between emergences of last crawler and last female die was recorded as post oviposition period.

Life tables. The life tables were constructed by obtained data according to Euler-Lotka equation [12]. Life table parameters were calculated by using RmStat-3 software [13, 14, 15].
These parameters,
Age-specific survivor rate (l_x) and fecundity rate (m_x), [12],
Net reproductive rate (female/female), $R_0 = \sum l_x.m_x$ [12],
Intrinsic rate of increase (female/female/day)(r_m), $\sum e^{(-r_m.x)}.l_x.m_x = 1$ [12],
Mean generation time (day), $T_0 = \frac{\ln.R_0}{r_m}$ [12],
Gross reproduction rate (crawler/female), $GRR = \sum m_x$ [12],
Finite rate of increase (crawler/female/day), $\lambda = e^{r_m}$ [12],
Doubling time (day), $T_2 = \frac{\ln 2}{r_m}$ [16],
Reproductive value (female/female), $V_x = \frac{\sum_{y=x}(e^{r_m.y}.l_y.m_y)}{l_x.e^{-r_m.x}}$ [17],
Life expectancy (day), $E_x = \frac{\sum_{y=x}\frac{l_y + l_{y+1}}{2}}{l_x}$ [18, 19],
Stable age distribution, $C_x = \frac{l_x.e^{-r_m.x}}{\sum_{x=0}(l_x.e^{-r_m.x})}$ [12],

The Jack-knife method [20, 21] was used at comparisons of the intrinsic rate of increase, r_m which has obtained the life table parameters for every potato varieties. Statistical differences were determined with one way analysis by using SPSS® Statistics (Version 20.0, August 2011, SPSS Inc., Chicago, IL, USA.) software package.

RESULTS AND DISCUSSION

The total development times, oviposition periods, generation time and life span times, daily and total fecundity of oleander scale on different potato varieties were illustrated in Table 1. Oleander scale was completed its first nymph stages at 27 days on all experiment varieties, but second nymph stages and total development times were observed at different times on experiment varieties (P<0.05).

TABLE 1
Development and fecundity of Oleander Scale, *Aspidiotus nerii* Bouché (Hemiptera, Diaspididae) on potato varieties (days± SE).

	PotatoVarieties											
	n	Agria	n	Sante	n	Marabel	n	Granola	n	Vanba	n	Provento
Nymph1	49	27.01± 0.001a*	64	27.01± 0.001a	51	27.01± 0.001a	48	27.01± 0.001a	19	27.01± 0.001a	20	27.01± 0.001a
Nymph2	49	24.92± 0.235bc	64	24.47± 0.137c	51	23.45± 0.071d	48	25.58± 0.197b	19	28.42± 0.623a	20	25.01± 0.001bc
Total development	49	51.92± 0.235bc	64	51.47± 0.137c	51	50.45± 0.071d	48	52.58± 0.197b	19	55.42± 0.623a	20	52.01± 0.001bc
Preoviposition	49	1.14± 0.082a	64	0.86± 0.077a	51	0.98± 0.044a	48	0.33± 0.101b	19	0.32± 0.111b	20	0.31± 0.147b
Oviposition	49	22.41± 0.852ab	64	21.73±0. 805abc	51	25.18± 0.661a	48	17.51± 1.006c	19	19.21± 1.169bc	20	22.01± 1.612ab
Postoviposition	49	1.01± 0.058ab	64	1.16± 0.138ab	51	0.57± 0.129b	48	1.56± 0.295a	19	0.42± 0.116b	20	0.71± 0.147b
Generation	49	53.06± 0.248b	64	52.33± 0.144bc	51	51.43± 0.08c	48	52.92± 0.245b	19	55.74± 0.601a	20	52.31± 0.147bc
Adult life time	49	28.59± 0.89ab	64	28.21± 0.874ab	51	31.81± 0.436a	48	28.02± 0.34ab	19	22.63± 1.551c	20	25.81± 1.861bc
Total life time	72	62.03± 3.302ab	76	69.25± 2.901a	72	72.63± 3.666a	61	67.21± 3.382a	34	49.65± 5.736b	63	32.73± 4.032c
Fecundity	49	2.01± 0.145a	64	1.51± 0.09b	51	1.24± 0.068b	48	0.73± 0.058c	19	2.17± 0.177a	20	1.22± 0.087b
Total Fecundity	49	55.52± 3.729a	64	43.6±3.0 02abc	51	39.23± 2.172bc	48	20.61± 1.701d	19	48.84± 5.09ab	20	31.55± 3.016cd

* Means within a same row followed by the same letter do not differ significantly in Tukey test (P < 0.05)

TABLE 2
Life table parameters of Oleander Scale, *Aspidiotus nerii* Bouché (Hemiptera, Diaspididae) on potato varieties (Euler-Lotka equation- Birch, 1948).

	Agria	Sante	Marabel	Granola	Vanba	Provento
Intrinsic rate of increase, r_m	0.049±0.002a*	0.048±0.016a	0.045±0.001a	0.034±0.002b	0.046±0.002a	0.026±0.012c
Net reproduction rate, R_o	19.35	18.52	16.67	8.31	16.34	5.01
Meangeneration time, T_o	61.15	60.72	62.20	62.79	60.79	62.66
Grossreproductive rate, *GRR*	30.53	23.90	20.85	10.66	31.76	19.72
Doubling time, T_2	14.31	14.42	15.32	20.56	15.08	26.96
Finite rate of increase, λ	1.05	1.05	1.05	1.03	1.05	1.03
n	72	76	60	61	34	63

* Means within a same row followed by the same letter do not differ significantly in Tukey test ($P < 0.05$)

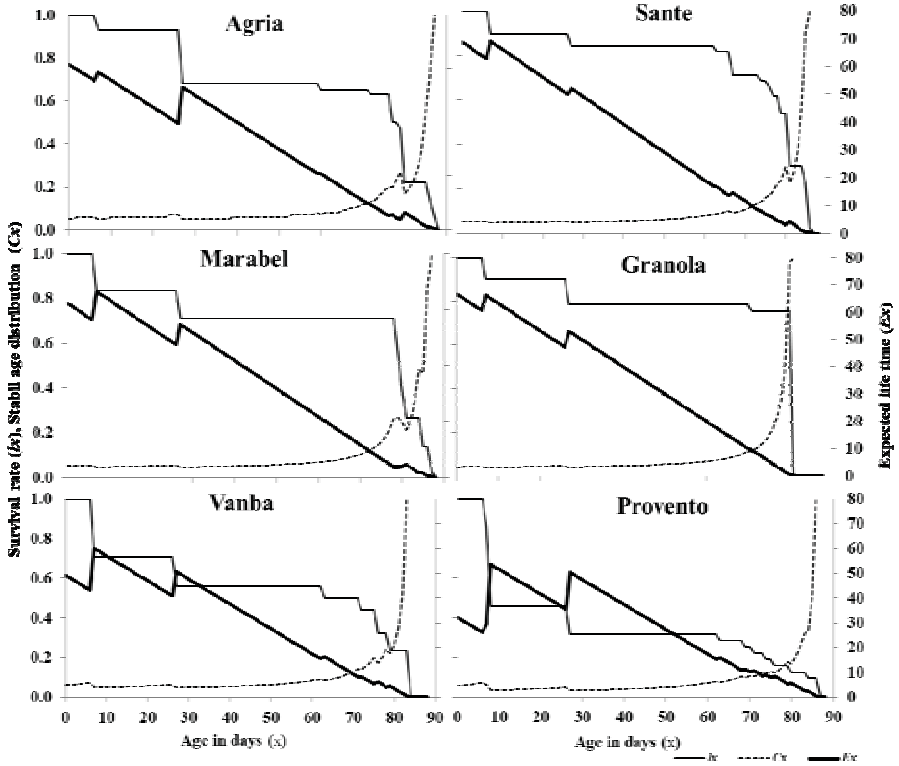

FIGURE 1
Survival rate (l_x), stabil age distribution (C_x) and expected life time (E_x) of *Aspidiotus nerii* on potato varieties.

Shortest development time was observed on Marabel variety as 50.45 days and longest development time was on Vanba as 55.42 days (P<0.05). These results resemble to generation times also (Table 1). The shortest preoviposition periods were 0.31, 0.32 and 0.33 days on the Provento, Vanba and Granola, and longest preoviposition periods were 0.86, 0.98, 1.14 days on Sante, Marabel and Agria, respectively (P<0.05). The oviposition periods were observed at 25.18 days on Marabel as longest and at 17.51 days on Granola as shortest (P<0.05) [22]. Informed that oviposition period of oleander scale on Marabel variety at same climatic conditions was recorded as 18.8 days. This result is lower than our records. And in another work, the oviposition period of oleander scale was observed as 57.6 days on Granola variety at same climatic conditions [23]. This result also is higher than our records. The postoviposition periods were observed longest on Granola as 1.56 days and shortest on Vanba and Provento as 0.42 and 0.71 days, respectively (P<0.05).

The longest adult lifetime and total lifetime of oleander scale were observed on Marabel, Agria, Sante and Granola (P<0.05). But because of the high mortality rate at development time on Vanba and especially on Provento, the total lifetime was found shorter than generation periods on these experiment groups (Table 1). Mortality rates of oleander scale were recorded as 0.68, 0.44, 0.32, 0.26, 0.21 and 0.16 on Provento, Vanba, Agria, Marabel, Granola and Sante, respectively (Figure 1). [23] Declared that generation time of oleander scale was 51.8 days on Granola, this result resemble to our study.

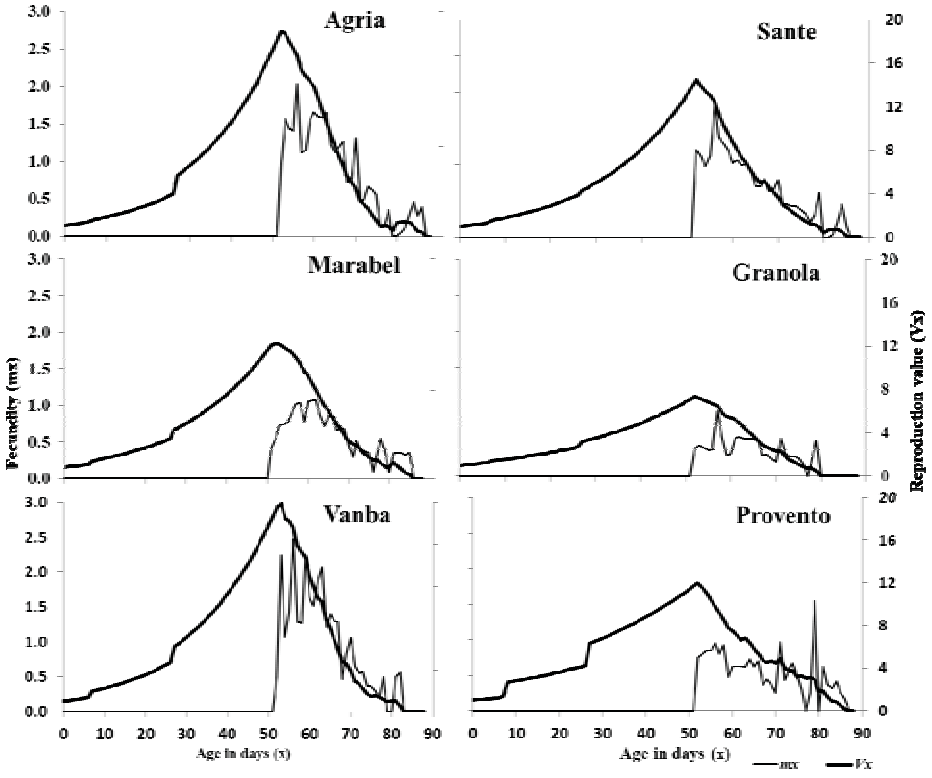

FIGURE 2
Fecundity (m_x) and reproduction value (Vx) of *Aspidiotus nerii* on potato varieties

While the daily and total fecundity were recorded as highest numbers on Vanba as 2.17 and 48.84 individuals and on Agria as 2.01 and 55.52 individuals, it was fewest on Granola as 0.73 and 20.61, respectively (P<0.05). At the contrast to our records, [23] reported that total fecundity was 169.74 individuals on Granola. [22] Recorded as daily and total fecundity of oleander scale on Marabel variety as 3.5 and 72.6 individuals than our results that was 1.24 and 39.23 individuals, respectively.

The life table parameters were estimated as obtained data on different potato varieties of oleander scale and results were given on Table 2. The shortest development time, the highest survival and fecundity are important biological data at comparing of the different organisms. The life tables give us a brief biological summary of an organism by using these data. The intrinsic rate of increase (r_m) is important to explain the all calculated life table parameters for an organism. So according to compared intrinsic rate of increase of oleander scale, it was the highest on Agria, Sante, Vanba and Marabel varieties, and the shortest on Granola and Provento (P<0.05).

The survival rate (l_x), stable age distribution (C_x), expected lifetime (E_x), fecundity rate (m_x), reproductive value (V_x) of oleander scale on potato varieties were illustrated on Figure 1 and Figure 2. High nymph mortality affected the shape of survival, expected lifetime and stabile age distribution curves on especially Provento, Vanba and partially Agria varieties (Figure 1).

Fecundity and reproductive value are higher on all varieties than Granola and Provento Figure 2. Lower fecundity and higher mortality rates affected the all life table parameters of oleander scale for these varieties.

CONCLUSIONS

There are not enough studies on about the mass production of oleander scale to favourable host selection. Potato tubers are very suitable hosts for mass production studies, because of durability, attainability, cost and sustainability. By this study, best varieties were determined for oleander scale. According to life table parameters Agria, Sante, Marabel and Vanba potato varieties are very favourable for reproduction of oleander scale between experimented potato varieties.

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