JOURNAL OF ENTOMOLOGICAL SOCIETY OF IRAN
2021, 41(2), 151 –161
نامه انجمن حشره‌شناسی ایران ۱۶۱-۱۵۱ ,(۲)۴۱ ,۱۴۰۰

JESI

DOI: 10.22117/JESI.2021.355175.1421

Research Article

Comparing life table parameters of *Brachycaudus cardui* (Hemiptera: Aphididae) on artichoke under laboratory and semi-field conditions

Alireza RajabiMazhar[1,*] & Zahra Tazerouni[2]

1. Natural Resources Research Department, Hamadan Agricultural and Natural Resources Research and Education Center, Agricultural Research Education and Extension Organization (AREEO), Iran, & 2. Department of Biological Control, Raha Andish Kavan Company, Tehran, Iran.
* Corresponding Author: rajabi1351@yahoo.com

Abstract
Life table parameters of *Brachycaudus cardui* L. (Hemiptera: Aphididae) feeding on the host plant, *Cynara scolymus* L. (Artichoke) were studied under laboratory (22 ± 1°C, relative humidity of 65 ± 5% and a photoperiod of 14L : 10D h) and semi-field conditions (22 – 34°C, and relative humidity of 25 – 70%). Under laboratory condition, *B. cardui* reared on artichoke had a higher survival rate, fecundity, and longevity than those reared under semi-field condition. When *B. cardui*reared under semi-field condition, they had a longer nymphal developmental time, shorter adult longevity, and lower fecundity than those reared under laboratory condition. The intrinsic rate of increase (r_m), net reproductive rate (R_0), and the finite rate of increase (λ) under laboratory condition were higher than those obtained under semi-field condition. However, the mean generation time T (days) aphids in the semi-field were higher than those reared under laboratory condition. In the present study, the results clearly showed that life table parameters of *B. cardui*were different under semi-field and laboratory conditions. These results canhelp us to understand the population dynamics of *B. Cardui* under semi-field condition and make better management decisions for economically important crops.
Key words: *Brachycaudus cardui*, artichoke, life table parameters

مقایسه پراسنجه‌های رشد جمعیت شتهٔ *Brachycaudus cardui* (Hemiptera: Aphididae) روی گیاه آرتیشو در شرایط مزرعه و آزمایشگاه

علیرضا رجبی‌مظهر[۱و*] و زهرا تازرونی[۲]

۱- بخش تحقیقات منابع طبیعی، مرکز تحقیقات کشاورزی و منابع طبیعی استان همدان، سازمان تحقیقات، آموزش و ترویج کشاورزی، همدان، ایران و ۲- بخش کنترل بیولوژیک، شرکت رها اندیش کاوان، تهران، ایران.
* مسئول مکاتبات، پست الکترونیک: rajabi1351@yahoo.com

چکیده
پراسنجه‌های جدول زندگی شته *Brachycaudus cardui* L. (Hemiptera: Aphididae) روی گیاه کنگر فرنگی (آرتیشو) *Cynara scolymus* L. در شرایط آزمایشگاهی (۱ ± ۲۲درجه سلسیوس، رطوبت نسبی ۵ ± ۶۵ درصد و دوره نوری ۱۴ ساعت روشنایی و ۱۰ ساعت تاریکی) و شرایط نیمه صحرایی (۲۲–۳۴ درجه سلسیوس و رطوبت نسبی ۲۵–۷۰ درصد) مورد مطالعه قرار گرفت. شته‌های *B. cardui* پرورش یافته در شرایط آزمایشگاهی نسبت به شرایط نیمه صحرایی از میزان زنده مانی، باروری و طول عمر بالاتری برخوردار بودند. در شرایط نیمه صحرایی به طورمعنی‌داری طول دوره پورگی، طول عمرحشرات کامل و چرخهٔ زندگی کوتاه‌تری نسبت به شرایط آزمایشگاهی داشت. نرخ ذاتی افزایش (r_m)، نرخ خالص تولیدمثل (R_0) و نرخ متناهی افزایش جمعیت (λ) در شرایط آزمایشگاهی بیشتر از مقادیر به دست آمده در شرایط نیمه صحرایی بودند، ولی مقدار متوسط یک نسل T در مزرعه بیشتر از شرایط آزمایشگاهی بود. در این بررسی نتایج به وضوح نشان داد که پراسنجه‌های جدول زندگی *B. Cardui* در شرایط نیمه صحرایی و آزمایشگاهی تفاوت داشتند. این نتایج به ما در درک پویایی جمعیت *B. Cardui* در شرایط مزرعه کمک می‌کند تا تصمیمات مدیریت بهتری برای محصولات مهم اقتصادی بگیریم.
واژه‌های کلیدی: *Brachycaudus cardui*، آرتیشو، پراسنجه‌های جدول زندگی

دریافت: ۱۴۰۰/۰۴/۱۷، پذیرش: ۱۴۰۰/۰۶/۱۵

Received: 8 July 2021, *Accepted:* 6 September 2021
Subject Editor: Ahad Sahragard

Introduction

Artichoke (*Cynara scolymus* L.) the plant is about 20-150 cm high, that its leaves are eatable (Rajabimazhar & Sadeghi, 2015), cultivated in 29 countries around the world (Anonymous, 2013) and 164 tones were in 19 hectares produced in Iran (Anonymous, 2016). *Brachycaudus cardui* L. (Hemiptera: Aphididae) is one of the important pests of artichoke. This pest causes a physiological disorder, plant's weakness and destruction by feeding. In addition, they produce honeydew and results to reduction photosynthesis. This species distribute in Asia, Europe, North Africa and America (Rezwani, 2001), also it has been reported from Iran, Hamadan province as a main pest on artichoke (Rajabimazhar *et al.*, 2009). The aphid colonies usually protect by ants, which feed on the aphid honeydew. *Brachycaudus cardui* were host–alternating between *Prunus* spp. (Rosaceae) and various Astraceae and Boraginaceae (Blackman & Eastop, 2006).

Life table studies are essential tools for understanding population dynamics and estimating the population growth parameters and reproduction potential of insect populations (Chi & Su, 2006). The life table information provides an integrated and comprehensive description including developmental time, the survival rate, fecundity and life expectancy of population (Carey, 1993; Chi, 1990; Vaupel *et al.*, 1998; Yang *et al.*, 2013). Population growth rate is a basic ecological characteristic that usually describe as the intrinsic rate of increase (r_m), it was introduced by Birch (1948) for the first time. Southwood (1966) demonstrated that the intrinsic rate of increase is the most practical parameter to compare different populations and species under specific climatic and nutritional conditions (Roy *et al.*, 2003). The intrinsic rate of increase has been widely used as a bioclimatic index (Hulting *et al*., 1990).

A few faunistic studies (Rezwani, 2001; Blackman & Eastop, 2006) and demographic evaluation in laboratory (Rajabimazhar & Sadeghi, 2015) have been done on *B. cardui* in Iran and other countries. Furthermore, some studies were done on the life table parameters of other species of *Brachycaudus* such as *B. amygdalinus* Schout. (Nourbakhsh *et al*., 2006), *B. schwartzi* (Borner) (Satar &Yokomi, 2002) and *B. divaricate* Shaposhnikov (Wilkaniec & Wilkaniec, 2013). However, there are no studies on demographic parameters of the Iranian population of *B. cardui* on Artichoke in semi-field in Iran. The main purpose of this study was to determine the life table parameters of *B. cardui* on *C. scolymus* in semi-field and laboratory conditions.

Materials and methods

This study was carried out during 2016 - 2017 at the Botanical Garden, Hamadan Agriculture and Natural Resources Research Center (HANRC), Iran. The seeds of artichoke used in experiment were obtained from Botanical Garden (HANRC), they were planted in

10cm plastic pots that filled with suitable field soil. When the plant grew, they were used for the experiments. The experiments carried out under laboratory (22 ± 1°C and relative humidity of 65±5% and a photoperiod of 14L : 10D h) and semi-field (22 – 34°C, and relative humidity of 25–70%) conditions. The temperature and RH were obtained by data logger (DAQ) in field condition.

The aphids used in the laboratory were collected from artichoke semi-fields in HANRC, Iran (34° 35' N, 49° 27' E, 1850 m.). The Colony of aphid reared for two generations before the beginning of the life table experiments. Then, newly emerged nymphs of *B. cardui* were placed, separately, on a *C. scolymus* new leaf in pyramid shape leaf cage (trapezoidal transparent plastic sheet at 10.5×9×6 cm). Each cage had two holes (1 cm diameter) in the sides for ventilation, were covered using fine mesh (Fig. 1). A 1 cm-thickness layer of cotton was rounded the petiole, for fixed in base of cage was placed (Rajabimazhar & Sadeghi, 2015). A similar methodology was used to study the life table of *B. cardui* in leaf cages. The life table studies were started with 20 nymphs under laboratory and semi-field conditions, respectively. The aphid's development was checked every 24 h; from the first instars to death of the adults. A magnifier 15× was used to observe ecdysis. This study was replicated with 20 nymphs under laboratory and semi-field conditions.

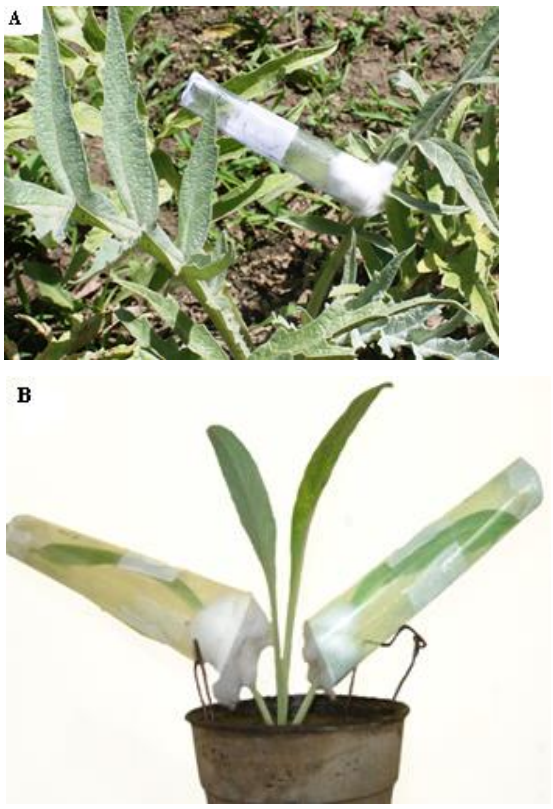

Fig. 1. Leaf cage used to study life table of *Brachycaudus cardui* on artichoke (*Cynara scolymus*) in semi-field (A) and laboratory (B) conditions.

The survivorship of apterous aphids and each nymph were recorded at 24h intervals. The percentages of survival of each aphid as well as the longevity of each aphid were calculated. The r_m for apterous aphids on different conditions were estimated using the following equation (Birch, 1948): $\Sigma e^{-rx} l_x m_x = 1$

Where: r_m is intrinsic rate of natural increase, l_x is age-specific survival rate, m_x is age-specific number of female offspring, x is age in days. Also, the life expectancy (e_x), as the mean number of days of life remaining at age *x*, was calculated. In addition, the net reproductive rates ($R_0 = \Sigma l_x m_x$), mean generation time ($T = \frac{Ln\, R_0}{r_m}$), doubling time ($DT = \frac{Ln\, 2}{r_m}$), and finite rate of increase ($\lambda = e^{rm}$) were estimated (Birch, 1948; Carey, 1993). The means, variances and standard errors of the life table parameters were estimated with the jackknife method (Maia *et al.*, 2000).

The graphs of parameters were calculated and plotted by Excel 2007. Comparison of treatments was done by using the paired t- test in SPSS 16.

Results

The biological parameters are listed in Table 1. The nymph duration of *B. cardui* were 12.75 ± 0.26 in laboratory and 18.90 ± 0.25 days in semi-field conditions, this showed that aphids develop faster under laboratory condition (Table 1).

Table 1. Duration period (mean ± SE) of *Brachycaudus cardui* reared on *Cynara scolymus* under laboratory and semi-field conditions

Parameters	Laboratory	Semi-field	T value	Pr> | t |
Developmental time (day)	12.75 ± 0.26[b]	18.90 ± 0.25[a]	12.50	0.0001
Life span (day)	33.70 ± 1.01[a]	26.30 ± 0.87[b]	4.30	0.0001
Adult longevity (day)	20.95 ± 1.01[a]	7.40 ± 0.75[b]	7.41	0.0001
Reproduction period (day)	16.55 ± 0.99[a]	6.30 ± 0.66[b]	6.23	0.0001
Post reproduction period (day)	4.40 ± 0.61[a]	0.75 ± 0.11[b]	4.25	0.0001
Mean fecundity(number of nymphs)	26.35 ± 2.47[a]	12.10 ± 1.51[b]	3.57	0.001

Means in the same row followed by the same letters are not significantly different ($P<0.05$) using the t-test

The life span of *B. cardui* was different under laboratory and semi-field conditions and it was shorter under natural condition. The reproduction period was not similar under laboratory and semi-field conditions, which this parameter was lower in semi-field condition. It showed little opportunity of the *B. cardui* for reproduction. This aphid in semi-field has short post reproduction period than laboratory condition, therefore *B. cardui* adults in semi-field condition sooner died after end of reproduction period, There was a significant difference between the statistics of the laboratory and semi-field conditions using the t-test ($P<0.05$)(Table 1). Mean fecundity (m_x) of *B. cardui* in both condition were different, that rate of m_x in laboratory was 26.35 ± 2.47 and 12.10 ± 1.51 nymphs in semi-field condition. The parameters l_x, m_x and age- specific maternity ($l_x m_x$) are plotted in Fig 2. The survival rate (l_x) showed mortality start in 17th and 19th days of aphid age in laboratory and semi-field

respectively (Fig. 4). The age-specific survivorship (l_x) decreased more rapidly at 27 and 37 days in semi-field and laboratory respectively (Fig. 4).

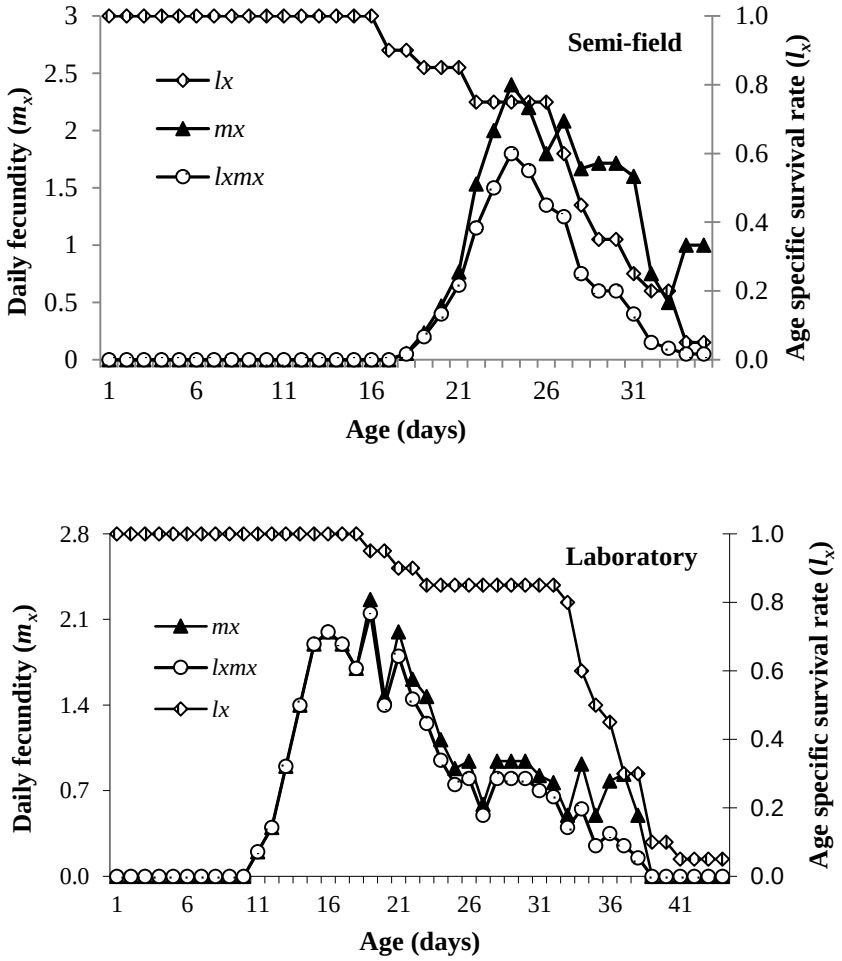

Fig. 2. Age specific survival rate (l_x), age specific fecundity (m_x) and maternity ($l_x m_x$) of *B. cardui* on artichoke (*Cynara scolymus*) under laboratory and semi-field conditions

Age specific fecundity (m_x) of *B. cardui* curves showed in Fig. 5, the first instar nymph took about 10 days in laboratory and 17 day in semi-field condition to become adult and it started producing nymphs. The number of nymphs/female/day (m_x) were >2 up to day 19th and 24th under laboratory and semi-field conditions, respectively and it declined in the later days of the life span (Fig. 5). The fecundity peak started when females were 9 days old in laboratory and 7 days old in semi-field conditions. The end of fecundity happened when females were 29 and 19 days old under laboratory and semi-field conditions, respectively (Fig. 5).

The life expectancy (e_x) gives the expected life span of an individual can live after age x (Fig. 3). The trends of life expectancy in conditions were 33 and 26 days under laboratory and semi-field conditions, respectively. The life table parameters of *B. cardui* indicated slower development of the semi-field population than those in the laboratory (Table 2). In Table 2 has been showed significant differences of population growth parameters of *B. cardui* between laboratory and natural conditions. The intrinsic rate of increase (r), the finite rate of increase (λ) and net reproductive rate (R_0) were significantly higher under laboratory condition. Mean generation time (T) and doubling time (DT) were significantly lower under laboratory condition.

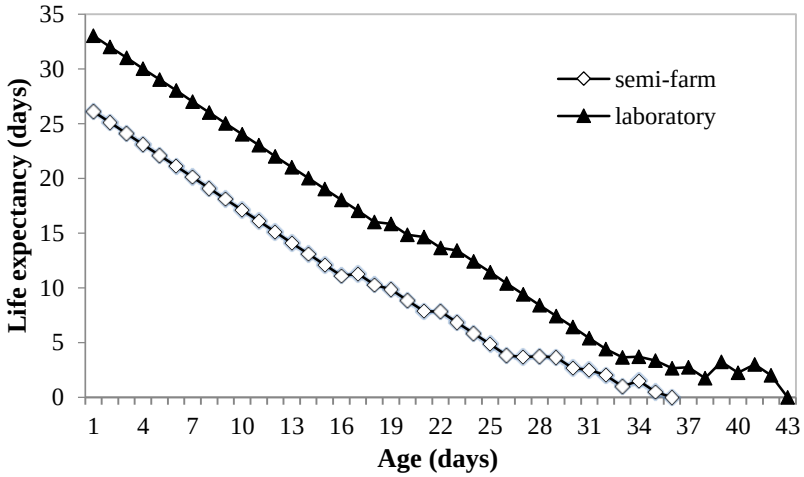

Fig. 3. Age specific life expectancy (e_x) of *B. cardui* on artichoke (*Cynara scolymus*) under laboratory and semi-field conditions

Table 2. Population growth parameters (mean ± SE) of *Brachycaudus cardui* in laboratory and in semi-field conditions

Population parameters	Laboratory	Semi-field	T value	$P>\|t\|$
Intrinsic rate of increase (r) (per day)	0.217 ± 0.01^a	0.111 ± 0.001^b	12.50	0.0001
Finite rate of increase (λ) (per day)	1.24 ± 0.01^a	1.11 ± 0.01^b	4.30	0.0001
Net reproductive rate (R_0) (offspring)	50.07 ± 6.47^a	10.29 ± 1.77^b	7.41	0.0001
Mean generation time (T) (day)	17.99 ± 0.77^b	21.15 ± 0.47^a	6.23	0.0001
Doubling time (day)	3.18 ± 0.12^b	6.22 ± 0.41^a	3.57	0.001

Means in the same row followed by the same letter are not significantly different ($P \leq 0.05$) using the t-test.

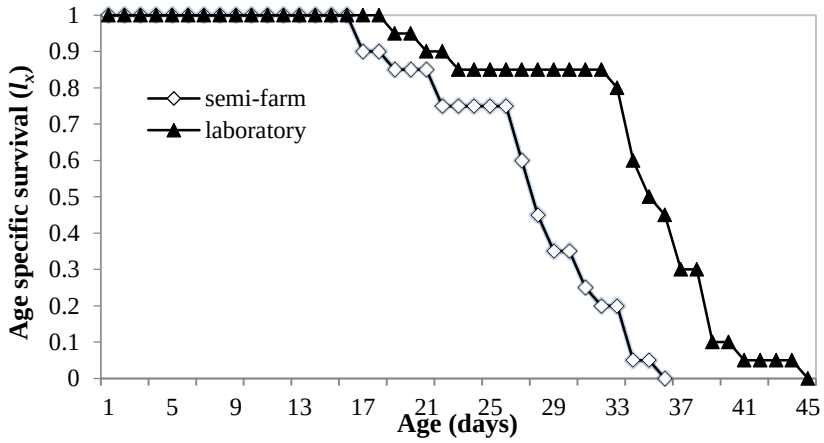

Fig. 4. Age specific survival rate (l_x) of *B. cardui* on artichoke (*Cynara scolymus*) under laboratory and semi-field conditions

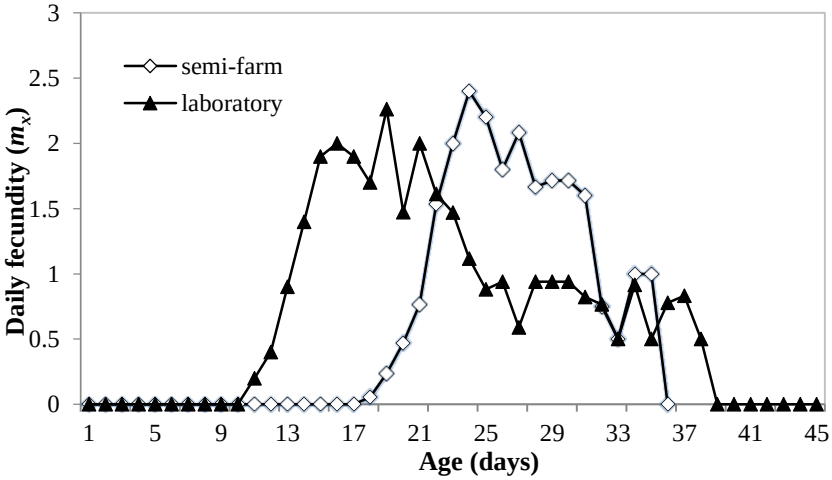

Fig. 5. Age specific fecundity (m_x) of *B. cardui* on artichoke (*Cynara scolymus*) under laboratory and semi-field conditions

Discussion

Environmental conditions especially temperature can affect development time, maturation, survival, demographic parameters and population dynamics of insect pests. This study showed that developmental times of *B. cardui* under laboratory condition were lower than semi-field condition. The prolonged immature developmental times in the semi-field may reflect the unsuitability of the environmental condition.

In the past, the response of aphids to environmental condition has been used to develop phenological models to forecast aphid outbreaks (Collier *et al.,* 1994; Ro *et al.,* 1998). Similar studies found that aphid population dynamics was affected by the abiotic factors such as environmental factors including; temperature, humidity and etc. (Ruggle & Gutierrez, 1995; Diaz & Fereres, 2005; Arbab *et al.,* 2006; Hosseini-Tabesh *et al.,* 2015).

This result were consistent with those of Hosseini-Tabesh *et al*. (2015) who stated that longevity of *Aphis gossypii* (Glover), was longer under semi-field condition. Jalalipour *et al*. (2017) reported that the fluctuating climatic and natural conditions of cotton fields could increase immature development time and decrease adult development times and reproduction of *Aphis craccivora* Koch. The adult longevity and life span of *B. cardui* in semi-field condition were shorter due to the fluctuating temperature and humidity.

Jalalipour *et al*. (2017) reported that female longevity of *A. craccivora* reared on *Robinia pseudoacacia* was shorter under semi-field condition (21.4 days) comparison to laboratory condition (24.3 days). The results of Hosseini- Tabesh *et al*. (2015), was the same to our finding. These results corroborate studies on the reverse relationship between temperature and adult longevity of *Hyalopterus pruni* (Geoffroy) (Latham & Mills, 2011), mean developmental times of *Bemisia argentifolii* (Bellows & Perring) (Yang & Chi, 2006), *B. schwartzi* (Satar &Yokomi, 2002) and *Aphis spiraecola* Patch (Wang & Tsai, 2000). Nourbakhsh *et al*. (2006) also explained that high temperature had negative impact on the developmental time of *B. amygdalinus* reared on almond under laboratory condition. According to study of Jalalipour *et al*. (2017), the *r* value of *A. craccivora* on *Robinia pseudoacacia* under laboratory and semi-field conditions were 0.234 and 0.191, which were higher than our results (0.175 and 0.103 in laboratory and semi-field conditions, respectively).These differences may be due to host plants and environmental conditions such as temperature and relative humidity. The *r* of *A. gossypii* fed on *Hibiscus syriacus* was also significantly higher in the laboratory (0.271) than in semi-field conditions (0.140) (Hosseini-Tabesh *et al*., 2015). The R_0 was also higher under laboratory condition. Similar results was found for *A. craccivora* (Jalalipour *et al.*, 2017) and *A. gossypii* (Hosseini-Tabesh *et al*., 2015), as the net reproductive rate was higher under laboratory condition.

The mean generation time (*T*) for *A. craccivora* (Jalalipour *et al.*, 2017) and *A. gossypii* (Hosseini-Tabesh *et al*., 2015) in laboratory and semi-field condition nearly equal, but in this study, the (*T*) in semi-field was higher than laboratory condition(Table-1). It suggests that laboratory condition is more suitable for *B. cardui*. It is concluded that life table of insect pests in semi-field conditions could be a useful tool for making accurate management decisions and selecting proper measures to control insect pests of economically important crops. The differences reported here between the laboratory and semi-field studies, together with the life table analysis, provide valuable information leading to establish a successful control program.

Acknowledgments

We thank the Bu-AliSina Medicinal Plants Garden in Hamadan for providing us with the research facilities and their full support.

References

Anonymous. (2013) Major Food And Agricultural Commodities And Producers–Countries By Commodity. *FAO.org* (Archived from the original on 2013-01-14).

Anonymous. (2016) Ministry of Agriculture Jihad statistics. *Plans and Programs of Ministry of Jihad-e-Agriculture*.

Arbab, A., Kontodimas, D. C. & Sahragard, A. (2006) Estimating development of Aphis pomi (DeGeer)(Homoptera: Aphididae) using linear and nonlinear models. *Environmental Entomology* 35 (5), 1208-1215.

Birch, L. C. (1948) The intrinsic rate of natural increase of an insect population. *The Journal of Animal Ecology* 15-26.

Blackman, R. L., & Eastop, V. F. (2006) *Aphids on the world's herbaceous plants and shrubs* (Vol. 2): John Wiley & Sons.

Carey, J. R. (1993) *Applied demography for biologists with special emphasis on insects.* Oxford University Press, New York, USA, 206.

Chi, H. (1990) Timing of control based on the stage structure of pest populations: a simulation approach. *Journal of Economic entomology* 83(4), 1143-1150.

Chi, H., & Su, H. Y. (2006) Age-stage, two-sex life tables of *Aphidius gifuensis* (Ashmead)(Hymenoptera: Braconidae) and its host *Myzus persicae* (Sulzer) (Homoptera: Aphididae) with mathematical proof of the relationship between female fecundity and the net reproductive rate. *Environmental Entomology* 35(1), 10-21.

Collier, R., Davies, J., Roberts, M., Leatherland, M., Runham, S. & Blood Smyth, J. (1994) Monitoring and forecasting the times of attack of the lettuce root aphid, Pemphigus bursarius L. *Bulletin OILB SROP (France)*.

Diaz, B. M. & Fereres, A. (2005) Life table and population parameters of *Nasonovia ribisnigri* (Homoptera: Aphididae) at different constant temperatures. *Environmental Entomology* 34(3), 527-534.

Hosseini-Tabesh, B., Sahragard, A. & Karimi-Malati, A. (2015) A laboratory and field condition comparison of life table parameters of *Aphis gossypii* Glover (Hemiptera: Aphididae). *Journal of Plant Protection Research* 55(1), 1-7.

Hulting, F. L., Orr, D. B. & Obrycki, J. J. (1990) A computer program for calculation and statistical comparison of intrinsic rates of increase and associated life table parameters. *Florida Entomologist* 601-612.

Jalalipour, R., Sahragard, A., Madahi, K. & Karimi-Malati, A. (2017) Comparative life table of *Aphis craccivora* (Hem.: Aphididae) on host plant, *Robinia pseudoacacia* under natural and laboratory conditions. *Journal of Entomological Society of Iran* 36(4), 249-257.

Latham, D. R., & Mills, N. J. (2011) Effects of temperature on the life history parameters and population growth rates of *Hyalopterus pruni* (Hemiptera: Aphididae). *Journal of Economic Entomology* 104(6), 1864-1869.

Maia, A. H. N., A. J. B. Luiz & Campanhola, C. (2000) Statistical inferences on associated life table parameters using jackknife technique: computational aspects. *Journal of Economic Entomology* 93: 511-518.

Nourbakhsh, S., Soleymannezhadian, E., Mosadegh, S. & Rezvani, A. (2006) Effect of temperature on the biology of almond green aphid *Brachycaudus amygdalinus* under laboratory conditions. *Applied Entomology and Phytopathology* 73, 1-6.

Rajabimazhar, A., Rezwani, A., Rakhshani, E. & Yarmand, H. (2009) Survey of medicinal plants aphids and it's natural enemies in Hamadan province of Iran. *Iranian Journal of Forest and Range Protection Research* 7(2), 115-127.

Rajabimazhar, A. & Sadeghi, E. (2015) Some life table parameters of the aphid, *Brachycaudus cardui* L. on artichoke, *Cynara scolymus* L. in laboratory conditions. *Iranian Journal of Forest and Range Protection Research* 12(2), 153-158.

Rezwani, A. (2001) Key to the aphids in Iran. *Agricultural Research, Education and Extension Organization press*, Tehran, 304.

Ro, T. H., Long, G. E. & Toba, H. H. (1998) Predicting phenology of green peach aphid (Homoptera: Aphididae) using degree-days. *Environmental Entomology* 27(2), 337-343.

Roy, R. N., Misra, R. V., Lesschen, J. P. & Smaling, E. (2003) *Assessment of soil nutrient balance: approaches and methodologies*: Food & Agriculture Org.

Ruggle, P. & Gutierrez, A. P. (1995) Use of life tables to assess host plant resistance in Alfalfa to *Therioaphis trifolii. muculata* (Homoptera: Aphididae): Hypothesis for Maintenance of Resistance. *Environmental Entomology*, 24(2), 313-325.

Satar, S. & Yokomi, R. (2002) Effect of temperature and host on development of *Brachycaudus schwartzi* (Homoptera: Aphididae). *Annals of the Entomological Society of America* 95(5), 597-602.

Southwood, T. R. E. (1966) Ecological methods with particular reference to the study of insect populations. *Methuen* (London, UK), 524.

Vaupel, J. W., Carey, J. R., Christensen, K., Johnson, T. E., Yashin, A. I., Holm, N. V. & Liedo, P. (1998) Biodemographic trajectories of longevity. *Science* 280 (5365), 855-860.

Wang, J. J. & Tsai, J. H. (2000) Effect of temperature on the biology of *Aphis spiraecola* (Homoptera: Aphididae). *Annals of the Entomological Society of America* 93(4), 874-883.

Wilkaniec, B. & Wilkaniec, A. (2013) The biology and ecology of *Brachycaudus divaricatae*Shaposhnikov (Hemiptera, Aphidoidea) on *Prunus cerasifera* Ehrhart in Western Poland. *Journal of Plant Protection Research* 53(1), 42-47.

Yang, T. C. & Chi, H. (2006) Life tables and development of *Bemisia argentifolii* (Homoptera: Aleyrodidae) at different temperatures. *Journal of Economic Entomology* 99(3), 691-698.

Yang, X. B., Zhang, Y. M., Henne, D. C. & Liu, T. X. (2013) Life tables of *Bactericera cockerelli* (Hemiptera: Triozidae) on tomato under laboratory and field conditions in southern Texas. *Florida Entomologist* 904-913.