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Comparative Life Table of Mustard Aphid, *Lipaphis erysimi* (Kaltenbach) (Hemiptera: Aphididae) on Canola Cultivars

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ABSTRACT

Life table parameters of *Lipaphis erysimi* (Kaltenbach) (Hemiptera: Aphididae) were determined on four canola (*Brassica napus* L.) cultivars (Nathalie, Neptune, Danube, and Okapi) at 25±1 °C, 60±5% RH, and 16L:8D hours photoperiods. Data were analyzed using the female age-specific life table. There were significant differences in duration of nymphal developmental time and fecundity of aphid on the experimental canola cultivars. The shortest (7.13±0.07 day) and longest (8.91±0.15 day) nymphal developmental time were on Nathalie and Okapi, respectively. The r_m value of *L. erysimi* ranged between 0.30 on Nathalie and 0.21 day^{-1} on Okapi. The highest values of r_m (0.30±0.00 day^{-1}), R_0 (30.62±1.35 offspring), finite rate of increase (1.35±0.01 day^{-1}), and the lowest mean generation time (11.54±0.12 days) and *DT* (2.34±0.03 days) were recorded on Nathalie. Shorter nymphal developmental time, longer adult longevity as well as greater intrinsic rate of increase, net reproductive rates, finite rate of increase, fecundity and survivorship revealed that this pest performed well on Nathalie, Neptune and Danube cultivars. Consequently, the results indicated that canola cultivars had significant effect on life table parameters of *L. erysimi* and the Nathalie, Neptune, and Danube cultivars were suitable hosts for population growth of the pest.

Keywords: Age-specific life table, Nymphal development, cv. Nathalie, cv. Danube, cv. Neptune

INTRODUCTION

Canola (*Brassica napus* L.) is an important economic crop in Iran. Insect pests pose a great challenge to *Brassica* crop production worldwide. The mustard aphid, *Lipaphis erysimi* (Kaltenbach) (Hemiptera: Aphididae) is one of the most severe pests of cruciferous crops worldwide (Prasad and Phadke, 1982; Begum, 1995; Liu *et al*., 1997), causing damage of 10-90% depending upon the severity of the infestation and plant stage (Rana, 2005). This pest causes damage to canola plants at vegetative, flowering, and pod formation stages (Goggin, 2007). Chemical pesticides application causes various undesirable effects including toxic effects on non-target species, secondary pest outbreak, residual effects on the food chain, and problems of residue hazard to human, animals and environment (Singh and Singh, 2013). Therefore, effects of alternative control measures, such as biological control (Shukla *et al*., 1990; Singh, 2013; Fallahpour *et al*., 2015), host plant resistance (Yue and Liu, 2000; Mamun *et al*., 2010; Roudposhti *et al*., 2012; Fallahpour *et al*., 2015) or an integration of these methods need to be evaluated.

Host plant resistance can be a valuable component of an IPM system that is compatible with other control measures such as chemical control (Fathipour and Maleknia, 2016). Furthermore, plant resistance can be created by antixenosis, antibiosis, tolerance, or some combinations of these mechanisms (Painter, 1951, Kogan

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and Ortman, 1978). Among these mechanisms, antibiosis is the most important, which has a direct influence on the demographic parameters of a pest such as fecundity, mortality and development time (Sedaratian *et al*., 2011). Host quality depends on differences among the cultivars of a plant, including differences in morphological traits, nutrient contents, and the concentration of secondary metabolites (Levin, 1973). It is now well recognized that host plant quality can affect several life history characteristics of their herbivores by impairing growth, lowering resistance to disease, and reducing fecundity (Price *et al*. 1980).

Life table studies facilitate the understanding of insect population dynamics (Wittmeyer and Coudron, 2001) and provide information about survival, development, and reproduction (Taghizadeh *et al*., 2012, Karimi-Malati *et al*., 2014, Nikooei *et al*., 2015). Various studies have evaluated the effect of different *Brassica* cultivars on demographic parameters of *Plutella xylostella* (L.) (Ebrahimi *et al*., 2008, Fathi *et al*., 2011a, Akandeh *et al*., 2016, Nikooei *et al*., 2015), *Chromatomya horticola* Goureau (Fathi, 2010), *Myzus persicae* (Fathi *et al*., 2010), *Thrips tabaci* (Fathi *et al*., 2011b), *Brevicoryne brassicae* L. (Ulusoy and Olmez Bayhan, 2006; Mirmohammadi *et al*., 2009). Furthermore, effects of various canola cultivars on some biological parameters of *Lipaphis erysimi* were previously studied (Rana, 2005; Choudhury and Pal, 2009; Roudposhti *et al*., 2012), and few researchers have focused on demographic parameters of this pest and its predators on canola cultivars at different nitrogen fertilization treatments (Fallahpour *et al*., 2015). No published information concerning life table parameters of this pest on different populations of canola (*Brassica napus* L.) is available.

The aim of our study was to determine the female age-specific life table and biological parameters of *L. erysimi* on four canola cultivars, and find out if those cultivars were suitable host plants for growth and reproduction of the pest.

MATERIALS AND METHODS

Plants

Seeds of four most-planted winter cultivars of canola (Nathalie, Neptune, Danube, and Okapi) were obtained from Agricultural and Natural Resource Research Center, Miandoab, Iran. Seeds were planted in 20 cm diameter plastic pots filled with appropriate field soil in a greenhouse located in Miandoab University campus, northwest Iran. There were 10 pots for each cultivar in a completely randomized design and 15 seeds were sown in each pot. All cultivars were grown under greenhouse conditions at 25 ± 1 °C, 65 ± 5 % RH, and 16L:8D hours photoperiods, without any fertilizer and pesticides. Two seedlings (3-4 leaf stage) were kept in each pot after thinning. Plants were 4 wk old when they were used in the experiments.

Insects

Lipaphis erysimi populations were collected from canola fields in West Azerbayjan Province, Iran, during May 2016. Aphid colonies were established on ‘Nathalie’ in the above-mentioned conditions. The pots were maintained in greenhouse to get a large population of aphids for experiments. Plants were confined inside a cylindrical transparent cage (30 cm diameter × 60 cm height), top of which was covered with fine mesh cloth to prevent escape.

Demographic Parameters

Life table parameters of *L. erysimi* were assessed at 25±1 °C, 65±5% RH, and 16L:8D h. photoperiods. One apterous aphid was put on each leaf by fine paintbrush and was confined with a clip cage. Sixty aphids

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were used as a replicate for each cultivar per treatment. After 24 h, leaves were checked and all aphids except one newborn nymph were removed. Clip cages were observed daily and number of aphid progeny was recorded. Counting and observation were continued until the death of all aphids. The development, survival, and fecundity of aphids were recorded daily. The data were analyzed using the female age-specific life table (Carey, 1993). In this way, it is necessary to calculate the age-specific survival rate (l_x) and the age-specific fecundity (m_x) based on female individuals, where l_x is the probability that a newborn individual will survive to age *x*, and m_x is the mean number of female progeny per female adult at age *x*. Life table parameters were calculated as follow:

$$R_0 = \sum l_x m_x, \quad \sum l_x m_x e^{-rx} = 1, \quad \lambda = e^r,$$

$$T = \frac{\ln R_0}{r}, \quad DT = \frac{\ln 2}{r}$$

Net reproductive rate (R_0), intrinsic rate of natural increase (r_m), finite rate of increase (λ), mean generation time (T), and doubling time (DT).

Statistical Analysis

Statistical analysis was done using SPSS 19.0 software. Normality of the data was tested by Kolmogorov-Smirnov (Kolmogorov, 1933; Smirnov, 1933) method. One-way analysis of variance with Tukey's test ($P < 0.05$) was used to determine differences between means. Differences in R_0, r_m, λ, T, and DT values were tested for significance by estimating variances through the jackknife procedure (Meyer *et al*., 1986; Maia *et al*., 2000) using the SAS system ver. 9.2. (SAS Institute, 2004).

RESULTS

Development and Survivorship

The effect of different canola cultivars on developmental times for total nymphal stages of *L. erysimi* are shown in Table 1. Statistical analysis showed that there were significant differences between nymphal developmental times on different canola cultivars ($F=46.91$; df= 3, 199; $P< 0.05$). The nymphal developmental time of *L. erysimi* on Okapi (8.91d) were longer than those on other cultivars. The shortest nymphal developmental time was observed on Nathalie (7.13d) (Table 1). The age-specific survival rate curves (l_x) of *L. erysimi* on different canola cultivars are presented in Figure 1. The survival rate of total nymphal stages was the highest on Nathalie compared with the other cultivars tested. The results showed that feeding on Okapi caused a steep decline in l_x, whereas nymphal survival rate decreased at a constant rate by feeding on other cultivars (Figure 1).

Adult Longevity and Fecundity

The effect of different canola cultivars on adult longevity, reproduction period, and fecundity of *L. erysimi* are shown in Table 1.

Table 1. Biological parameters (mean ± SE) of the mustard aphid, *Lipaphis erysimi* on four canola cultivars. [a]

Cultivar	Nymphal developmental time (d)	Adult longevity (d)	Fecundity (offspring)	Reproduction period (d)
Nathalie	7.13 ± 0.07d	20.12 ± 0.31a	57.12 ± 2.57a	11.08 ± 0.19a
Danube	7.84 ± 0.11c	18.16 ± 0.19b	46.64 ± 1.55b	9.55 ± 0.29b
Neptune	8.30 ± 0.11b	18.06 ± 0.37b	46.05 ± 1.67b	9.30 ± 0.36b
Okapi	8.91 ± 0.15a	15.14 ± 0.31c	36.13 ± 2.34c	7.87 ± 0.40c

[a] Means followed by different letters within a column were significantly different at $P < 0.05$ (Tukey test).

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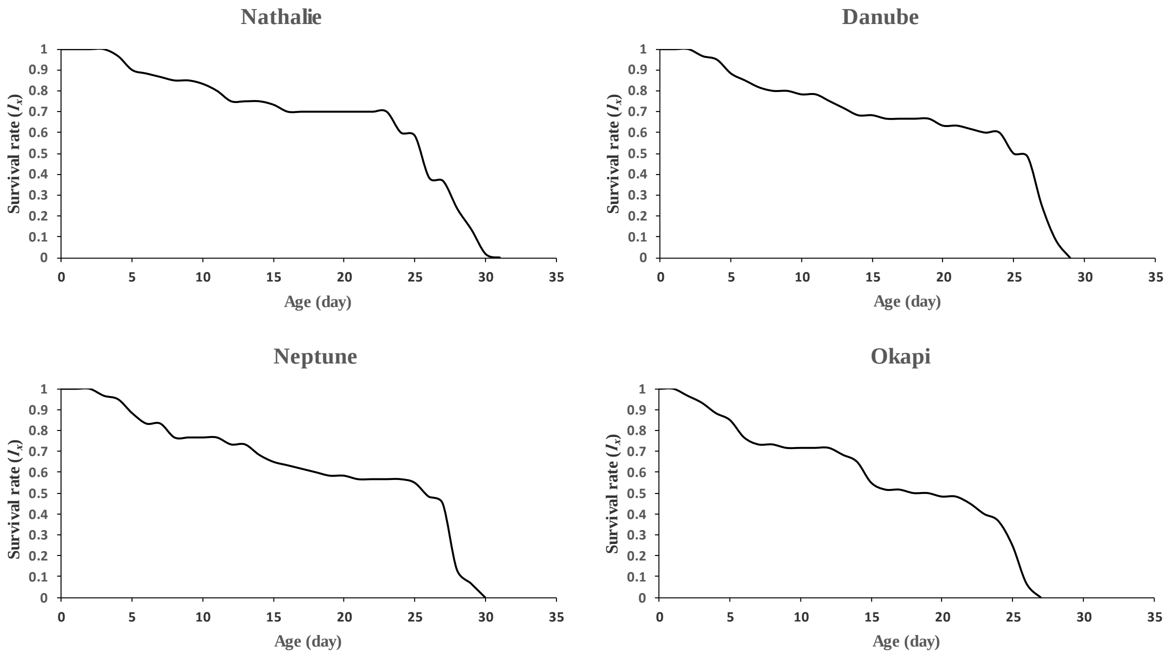

Figure 1. Survival rate (l_x) of the mustard aphid, *Lipaphis erysimi* on four canola cultivars.

The results showed that there were significant differences between adult longevity on different canola cultivars ($F=42.76$; df= 3, 143; $P< 0.05$). The longest adult longevity was observed in aphids reared on Nathalie. In addition, adult longevity of aphids reared on Okapi was significantly shorter than that of the other three cultivars. Significant differences in reproduction period were observed among different canola cultivars ($F=18.73$; df= 3, 79; $P< 0.05$). The shortest reproduction period and the lowest fecundity were observed on Okapi, while the longest reproduction period and highest fecundity were observed on Nathalie. Moreover, the mean total fecundity per female aphids was significantly affected by canola cultivars ($F=15.14$; df=3, 79; $P< 0.05$), and ranged from 36.13 (Okapi) to 57.12 (Nathalie) nymphs per female (Table 1).

Life Table Parameters

Age specific life table parameters of *L. erysimi* on different canola cultivars are shown in Table 2. The R_0 values of *L. erysimi* showed significant differences on four canola cultivars ($F=31.28$; df= 3, 79; $P< 0.05$). The lowest net reproductive rate

Table 2. Life table parameters (mean ± SE) of the mustard aphid, *Lipaphis erysimi* on four canola cultivars. [a]

Cultivar	R_0 (female offspring)	r_m (d^{-1})	λ (d^{-1})	T (d)	DT (d)
Nathalie	30.62 ± 1.35a	0.30 ± 0.00a	1.35 ± 0.01a	11.54 ± 0.12c	2.34 ± 0.03d
Danube	23.39 ± 0.47b	0.26 ± 0.00b	1.30 ± 0.00b	12.02 ± 0.09b	2.64 ± 0.02c
Neptune	22.55 ± 0.73b	0.23 ± 0.00c	1.26 ± 0.00c	13.46 ± 0.11a	2.99 ± 0.03b
Okapi	16.40 ± 0.73c	0.21 ± 0.00d	1.23 ± 0.00d	13.29 ± 0.20a	3.29 ± 0.05a

[a] Means followed by different letters within a column were significantly different at $P < 0.05$ (Tukey test).

was observed in aphids reared on Okapi, while those reared on Nathalie had the highest R_0 values. The *T* values of *L. erysimi* showed significant differences on four canola cultivars (F=61.39; df=3, 79; P< 0.05). The highest and lowest mean generation time of aphid were observed on Neptune or Okapi (with no significant difference), and Nathalie, respectively. The values of intrinsic rate of increase in canola cultivars (Nathalie, Neptune, Danube and Okapi) were 0.30, 0.23, 0.26 and 0.21 (female/ female/ day), respectively (Table 2). The *r* values showed significant differences on the four canola cultivars (F=114.58; df= 3, 79; P< 0.05). In addition, life table parameters of *L. erysimi* were significantly affected by canola cultivars (*DT*: F=142.25, df= 3, 79; P< 0.05; λ: F=109.67, df= 3, 79; P< 0.05).

DISCUSSION

Our results showed that different canola cultivars could significantly affect developmental time, survival, and fecundity of *L. erysimi*. In this research, nymphal developmental times of the aphid on different canola cultivars (Nathalie, Neptune, Danube and Okapi) were 7.13, 8.30, 7.84 and 8.91 days, respectively. The nymphal developmental time of *L. erysimi* on Okapi was significantly longer than on other cultivars, which is probably attributed to low nutritional value of this cultivar (Talaee *et al*., 2016). Similar results reported by Amjad and Peters (1992) for *L. erysimi* demonstrated that the duration of immature stages of aphid on different canola cultivars was 9.75 days. However, Yue and Liu (2000) revealed that the duration of immature stages of aphid on different cabbage cultivars was 7±0.2 days. The shortest nymphal developmental time was observed on Nathalie and was close to that reported by Roudposhti *et al*. (2012) on canola (7.13d). The maximum duration of nymphal stages of aphid was recorded on Okapi. The minimum survivorship of aphids was observed on Okapi. Therefore, according to the nymphal developmental time and survivorship, Okapi was a less suitable host for *L. erysimi* and reduced the performance of the insect, in agreement with the results of Roudposhti *et al*. (2012). The green peach aphid, *Myzus persicae* (Sulzer) had lower survival rate and preference on Okapi (Fathi *et al*., 2010).

The effect of different canola cultivars on adult longevity of *L. erysimi* was similar to those reported for *L. erysimi* on canola (Roudposhti *et al*., 2012). However, there were no significant differences among *Brassica* species (Rana, 2005) and green and red cabbage (Yue and Liu, 2000) for adult longevity of aphid in previous studies. The differences in adult longevity may be attributed to the quality of the plants, such as nutrition and chemicals in the leaves (Yue and Liu, 2000). Effect of canola cultivars was significant in the reproduction of aphid. These findings agreed with those reported by other researchers that showed plant cultivar and especially its quality significantly affected the fecundity of *L. erysimi* (Choudhury and Pal, 2009, Mamun *et al*., 2010, Fallahpour *et al*., 2015). In addition, when aphids were reared on Okapi, m_x was lower than that of aphids grown on Nathalie, Neptune or Danube (Figure 2).

The intrinsic rate of increase is a measure of performance commonly used to assess the level of plant resistance to aphids (Bethke *et al*., 1998). The intrinsic rate of natural increase (*r*) is the basic parameter for explanation of a population growth potential under certain food conditions and the best single value reflecting survival, fecundity, longevity, and speed of species development (Carey, 1993). In this study, the higher intrinsic rate of increase of *L. erysimi* was obtained on Nathalie, which was lower than the highest value reported by Roudposhti *et al*. (2012) on land race canola cultivar (0.32 day^{-1}). However, r_m value of *L. erysimi* on the other canola cultivars was close to the one reported by Roudposhti *et al*. (2012). The highest and lowest r_m (0.25 and 0.12 day^{-1}) were achieved for aphids reared on

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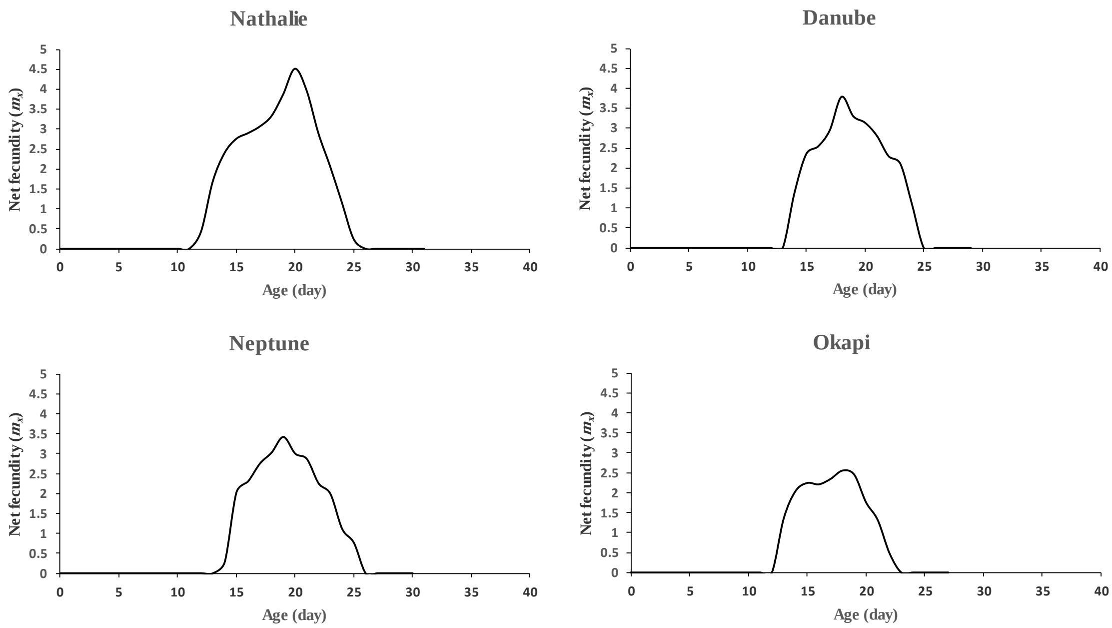

Figure 2. Age-specific net fecundity rates of the mustard aphid, *Lipaphis erysimi* on four canola cultivars.

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Zarfam and Modena, respectively (Fallahpour *et al*., 2015). In the present study, the lower r_m of *L. erysimi* was obtained on Okapi and was higher than the lowest value reported by Fallahpour *et al*. (2015). However, according to our results, r_m of this pest was similar to that reported by Fallahpour *et al*. (2015) on other canola cultivars. Differences in life table parameters of aphid in our study and other researchers can be due to the influence of different rearing methods applied (Lamb *et al*., 1987) and host plants (Dixon, 1987). In the present study, higher values for R_0, r_m, λ and lower values for *DT* on Nathalie, Neptune and Danube was mainly due to lower nymphal developmental time and mortality, and higher reproduction of the aphid on these cultivars.

Host plant quality is known to be an important factor affecting aphid demography, survival, fecundity, and life expectancy (Dixon, 1987). Biological parameters of insects can be influenced by several biotic and abiotic features of these factors; host plant species can significantly affect mortality and reproductive capacity rates (Tsai and Wang, 2001). Host plant effects on aphids' biological characteristics have been studied by many researchers (Polat-Akkopru *et al*., 2015, Karami *et al*., 2016, Doryanizadeh *et al*., 2016). However, there are limited studies on performance of *L. erysimi* on canola cultivars. Biological parameters of *L. erysimi* on canola cultivars have been studied under different nitrogen fertilization regimes (Fallahpour *et al*., 2015) and on *brassica* species (Khajehzadeh *et al*., 2010, Rudposhti *et al*., 2012). They showed that nitrogen fertilization positively affected r_m of aphids on all canola cultivars.

In conclusion, our experimental results showed significant effect of canola cultivars on life table parameters of *L. erysimi*. This study illustrates that aphids feeding on Danube, Neptune, and especially Nathalie had shorter nymphal developmental time, longer adult longevity, and higher survival rate, r_m, R_0, and fecundity. Consequently, these cultivars were suitable hosts for population growth of the pest. The less susceptibility to *L. erysimi* observed in aphids reared on Okapi was due to the species' longer immature developmental time, shorter adult longevity, and lower survival rate, r_m, R_0, and fecundity. This suggested Okapi as a less suitable host compared to the others. In addition, using the less susceptible cultivars could be effective in decreasing pest control costs.

REFERENCES

1. Akandeh, M., Kocheili, F., Soufbaf, M., Rasekh, A. and Mozafari, K. 2016. Effect of Canola Physical Mutation on *Plutella xylostella* (L.) Life Table. *J. Agr. Sci. Tech.,* **18**: 985-998.
2. Amjad, M. and Peters, D. C. 1992. Survival, Development, and Reproduction of Turnip Aphids (Homoptera: Aphididae) on Oilseed *Brassica*. *J. Econ. Entomol.,* **85**: 2003-2007.
3. Begum, S. 1995. Observations on the Economic Threshold Level of the Mustard Aphid *Lipaphis erysimi* (Kaltenbach) on Mustard in Bangladesh. *Bangladesh J. Zool*. **23**: 13-16.
4. Bethke, J. A., Redak, R. A. and Schuch, U.K. 1998. Melon Aphid Performance on Chrysanthemum as Mediated by Cultivar, and Differential Levels of Fertilization and Irrigation. *Entomol. Exp. Appl.,* **88**: 41-47.
5. Carey, J. R. 1993. Applied Demography for Biologists with Special Emphasis on Insects. Oxford University Press, New York, NY.
6. Choudhury, S. and Pal, S. 2009. Population Dynamics of Mustard Aphid on Different *Brassica* Cultivars under Terai Agro-Ecological Conditions of West Bengal. *JPPS*, **1**(1): 83-86.
7. Dixon, A.F.G. 1987. Cereal Aphids as an Applied Problem. *Agr. Zool. Rev.*, **2**: 1-57.
8. Doryanizadeh, N., Moharramipour, S., Hosseininaveh, V. and Mehrabadi, M. 2016. Effect of Eight *Cucumis* Genotypes on Life Table and Population Growth Parameters of Melon Aphid: An Approach to assess Antibiosis Resistance. *J. Agr. Sci. Tech.,* **18**: 1819-1832.
9. Ebrahimi, N., Talebi, A. A., Fathipour, Y. and Zamani, A. A. 2008. Host Plants Effect on Preference, Development and Reproduction of *Plutella xylostella* (L.) (Lepidoptera: Plutellidae) under Laboratory Conditions. *Adv. Environ. Biol.,* **2**(3): 108-114.
10. Fallahpour, F., Ghorbani, R., Nassiri Mahallati, M. and Hosseini, M. 2015. Demographic Parameters of *Lipaphis erysimi* on Canola Cultivars under Different Nitrogen Fertilization Regimes. *J. Agr. Sci. Tech.,* **17**: 35-47.
11. Fathi, S. A. A. 2010. Host Preference and Life Cycle Parameters of *Chromatomya horticola* Goureau (Diptera: Agromyzidae) on Canola Cultivars. *Mun. Ent. Zool.,* **5**: 247-252.
12. Fathi, S. A. A., Nouri-Ganbalani, G. and Sadagati, M. 2010. Resistance of some Canola Cultivars to *Myzus persicae* (Hemiptera: Aphididae). *Appl. Entomol. Zool.,* **45**(4): 601-608.
13. Fathi, S.A.A., Bozorg-Amirkalaee, M. and Sarfaraz, R.M. 2011a. Preference and Performance of *Plutella xylostella* (L.) (Lepidoptera: Plutellidae) on Canola Cultivars. *J. Pest Sci.,* **84**: 41-47.
14. Fathi, S. A. A., Gholami, F., Nouri-Ganbalani, G. and Mohseni, A. 2011b. Life History Parameters of *Thrips tabaci* (Thysanoptera: Thripidae) on Six Commercial Cultivars of Canola. *Appl. Entomol. Zool.,* **46**: 505-510.
15. Fathipour, Y. and Maleknia, B. 2016. Mite Predators. In: Omkar (Ed.), Ecofriendly Pest Management for Food Security. Elsevier, San Diego, USA, pp. 329-366.
16. Goggin, F. L. 2007. Plant-aphid Interactions: Molecular and Ecological Perspectives. *Curr. Opin. Plant Biol.,* **10:** 399–408.
17. Karami, L., Amir-Maafi, M., Shahrokhi, S., Imani, S. and Shojai, M. 2016. Demography of the Bird Cherry-oat Aphid, (*Rhopalosiphum padi* L.) (Hemiptera: Aphididae) on Different Barley Varieties. *J. Agr. Sci. Tech.,* **18**: 1257-1266.
18. Karimi-Malati, A., Fathipour, Y., Talebi, A. A. and Bazoubandi, M. 2014. Life Table Parameters and Survivorship of *Spodoptera exigua* (Lepidoptera: Noctuidae) at Constant Temperatures. *Environ. Entomol.,* **43**(3): 795-803.
19. Khajehzadeh, Y. A., Malekshi, S. H. and Keyhanian, A. A. 2010. The Population Dynamism of Canola Aphids, Biology of *Lipaphis erysimi* Kalt. And its Natural Enemies Efficiency in the Rapeseed Fields of Khuzestan Province, Iran. *IJPPS,* **41**(1): 165-178. (in Persian with English Summary)

20. Kogan, M. and Ortman, E. F. 1978. Antixenosis-a New Term Proposed to Replace Painter's 'Non-preference' Modality of Resistance. *Bull. Ent. Soc. Am.*, **24**: 175–176.
21. Kolmogorov, A. N. 1933. Sulla determinazione empirica di una legge di distribuzione. Giornale dell' Istituto Italiano degli Attuari, **4**: 83-91.
22. Lamb, R. J., MacKay, P. A. and Gerber, G. H. 1987. Are Development and Growth of Pea Aphids, *Acyrthosiphon pisum*, in North America Adapted to Local Temperatures? *Oecologia*, **72**: 170-177.
23. Levin, D. A. 1973. The Role of Trichomes in Plant Defense. *Q. Rev. Biol*., **48**: 3–15.
24. Liu, S. S., Wang, X. G., Wu, X. J., Shi, Z. H., Chen, Q. H. and Hu, H. X. 1997. Population fluctuation of aphids on crucifer vegetables in Hangzhou suburbs. (Chinese) *Acta Appl. Ecol*. **8**: 510-514.
25. Maia, A. H. N., Luiz, A. J. B. and Campanhola, C. 2000. Statistical Inference on Associated Fertility Life Parameters Using Jackknife Technique: Computational Aspects. *J. Econ. Entomol.*, **93**: 511-518.
26. Mamun, M. S. A., Ali, M. H., Ferdous, M. M., Rahman, M. A. and Hossain, M. A. 2010. Assessment of Several Mustard Varieties Resistance to Mustard Aphid, *Lipaphis erysimi*. *JSN*, **4**(1): 34-38.
27. Meyer, J. S., Ingersoll, C. G., McDonald, L. L. and Boyce, M. S. 1986. Estimating Uncertainty in Population Growth Techniques. *Ecol.*, **67**: 1156-1166.
28. Mirmohammadi, S., Allahyari, H., Nematollahi, M. R. and Saboori, A. R. 2009. Effect of Host Plant on Biology and Life Table Parameters of *Brevicoryne brassicae* (Hemiptera: Aphididae). *Ann. Entomol. Soc. Am*., **102**: 450-455.
29. Nikooei, M., Fathipour, Y., Jalali Javaran, M. and Soufbaf, M. 2015. How Different Genetically Manipulated *Brassica* Genotypes Affect Life Table Parameters of *Plutella xylostella* (Lepidoptera: Plutellidae). *J. Econ. Entomol.,* **108**(2): 515-524.
30. Painter, R. H. 1951. Insect Resistance in Crop Plants. Macmillan, New York.
31. Polat Akkopru, E., Atlıhan, R., Okut, H. and Chi, H. 2015. Demographic Assessment of Plant Cultivar Resistance to Insect Pests: A Case Study of the Dusky-Veined Walnut Aphid (Hemiptera: Callaphididae) on Five Walnut Cultivars. *J. Econ. Entomol.,* **108**: 378–387.
32. Prasad, S. K. and Phadke, K. G. 1982. Yield-infestation relationship and economicinjury level of mustard aphid, *Lipaphis erysimi* Kaltenbach infesting rapeseed crop. *J. Entomol. Res*. **6**: 117-122.
33. Price, P. W., Bouton, C. E., Gross, P., McPheron, B. A. N., Thompson, J. N. and Weis, A. E. 1980. Interactions among Three Trophic Levels: Influence of Plants on Interactions between Insect Herbivores and Natural Enemies. *Annu. Rev. Ecol. Evol. Syst.,* **11**: 41-65.
34. Rana, J. 2005. Performance of *Lipaphis erysimi* (Homoptera: Aphididae) on Different *Brassica* Species in a Tropical Environment. *J. Pestic. Sci.,* **78**: 155–160.
35. Roudposhti, S., Moravej, G. and Hosseini, M. 2012. Evaluation the Resistance of Different *Brassica* Species to *Lipaphis erysimi* at Greenhouse Conditions. *Plant Prot.,* **26**(2): 224-230. (in Persian with English Summary)
36. SAS Institute. 2004. *SAS/STAT 9.2, User's Guide*. SAS Institute Inc., Carey, NC, USA.
37. Sedaratian, A., Fathipour, Y. and Moharramipour, S. 2011. Comparative Life Table Analysis of *Tetranychus urticae* (Acari: Tetranychidae) on 14 Soybean Genotypes. *Insect Sci.*, **18**: 541–553.
38. Shukla, A. N., Singh, R. and Tripathi, C. P. M. 1990. Effect of Predation Period on the Functional Response of *C. septempunctata* Linn. (Coleoptera: Coccinellidae) a Predator of *Lipaphis erysimi* (Kalt.) (Hemiptera: Aphididae). *J. Adv. Zool.,* **11**: 27–32.
39. Singh, K. 2013. Preying Propensity of Larvae/Grubs of Syrphid and Coccinellid Predators on Mustard Aphid, *Lipaphis erysimi* (Kalt.). *Int. J. Agric. Food. Sci. Tech.,* **4**: 687-694.
40. Singh, K. and Singh, N. 2013. Preying Capacity of Different Established Predators of the Aphid *Lipaphis erysimi* (Kalt.) Infesting Rapeseed-Mustard Crop in Laboratory Conditions. *Plant Protect. Sci.,* **49**(2): 84-88.
41. Smirnov, N. V. 1933. Estimate of Deviation between Empirical Distribution Functions in two Independent Samples. *Bulletin Moscow University,* **2**: 3-16.

42. SPSS, Inc. 2010. SPSS 19 for Windows, users guide. SPSS, Inc. Chicago, IL.
43. Taghizadeh, R., Talebi, A. A., Fathipour, Y. and Khalghani, J. 2012. Effect of Ten Soybean Cultivars on Development and Reproduction of Lima Bean Pod Borer, *Etiella zinckenella* (Lepidoptera: Pyralidae) under Laboratory Conditions. *Appl. Entomol. Phytopath.*, **79**(2): 15-28.
44. Talaee, L., Fathipour, Y., Talebi, A. A. and Khjehali, J. 2016. Screening of Potential Sources of Resistance to *Spodoptera exigua* (Lepidoptera: Noctuidae) in 24 Sugar beet Genotypes. *J. Econ. Entomol.*,**110**(1): 250-258.
45. Tsai, J. H. and Wang, J. J. 2001. Effects of Host Plants on Biology and Life Table Parameters of *Aphis spiraecola* (Homoptera: Aphididae). *Environ. Entomol.*, **30**: 44-50.
46. Ulusoy, M. R. and Olmez-Bayhan, S. 2006. Effect of certain *Brassica* plants on biology of the cabbage aphid *Brevicoryne brassicae* under laboratory conditions. *Phytoparasitica*., **34**(2): 133-138.
47. Wittmeyer, J. L., Coudron, T. A., 2001. Life Table Parameters, Reproductive Rate, Intrinsic Rate of Increase, and Estimated Cost of Rearing *Podisus maculiventris* (Heteroptera: Pentatomidae) on an Artificial Diet. *J. Econ. Entomol.*, **94**: 1344–1352.
48. Yue, B. and Liu, T. X. 2000. Host Selection, Development, Survival, and Reproduction of Turnip Aphid (Homoptera: Aphididae) on Green and Red Cabbage Varieties. *J. Econ. Entomol.*, **93**(4): 1308-1314.

جدول زندگی مقایسه‌ای شته خردل *Lipaphis erysimi* (Kaltenbach) (Hemiptera: Aphididae) روی ارقام کلزا

ر. تقی زاده

چکیده

پارامترهای جدول زندگی شته خردل *Lipaphis erysimi* (Kaltenbach) (Hemiptera: Aphididae) روی چهار رقم کلزا (ناتالی، نپتون، دانوب و اوکاپی) در دمای ۱± ۲۵ درجه سلسیوس، رطوبت نسبی ۵±۶۰ درصد و دوره نوری ۱۶ ساعت روشنایی و ۸ ساعت تاریکی مورد مطالعه قرار گرفت. داده‌ها به‌وسیله جدول زندگی ویژه سنی ماده آنالیز شد. در طول دوره رشد پورگی و باروری شته روی ارقام کلزای آزمایشی، تفاوت معنی‌داری وجود داشت. کوتاه‌ترین (۰/۰۷ ± ۷/۱۳ روز) و طولانی‌ترین (۰/۱۵ ± ۸/۹۱ روز) دوره رشد پورگی به ترتیب روی ارقام ناتالی و اوکاپی مشاهده شد. نرخ ذاتی افزایش جمعیت (r_m) شته بین ۰/۳۰ روی رقم ناتالی و ۰/۲۱ روی رقم اوکاپی بود. بیش‌ترین مقدار نرخ ذاتی افزایش جمعیت (۰/۰۰ ± ۰/۳۰ بر روز)، نرخ خالص تولیدمثل (۱/۳۵ ± ۳۰/۶۲ نتاج)، نرخ متناهی افزایش جمعیت (۰/۰۱ ± ۱/۳۵ بر روز) و کمترین مقدار مدت زمان تولید یک نسل (۰/۱۲ ± ۱۱/۵۴ روز) و مدت زمان دو برابر شدن جمعیت (۰/۰۳ ± ۲/۳۴ روز) روی رقم ناتالی به دست آمد. دوره رشد پورگی کوتاه‌تر، طول دوره رشدی بالغ طولانی‌تر و همچنین نرخ ذاتی افزایش جمعیت، نرخ خالص تولیدمثل، نرخ متناهی افزایش جمعیت، باروری و نسبت بقاء بیش‌تر، نشان داد که این آفت روی

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ارقام ناتالی، نپتون و دانوب عملکرد مطلوبی دارد. به‌طور کلی نتایج نشان داد که ارقام کلزا روی پارامترهای جدول زندگی شته خردل اثر معنی‌داری دارد و ارقام ناتالی، نپتون و دانوب به عنوان ارقام مطلوب برای رشد جمعیت آفت می‌باشند.

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