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LIFE HISTORY AND DEMOGRAPHIC PARAMETERS OF *APHIS FABAE* (HEMIPTERA: APHIDIDAE) AND ITS PARASITOID, *APHIDIUS MATRICARIAE* (HYMENOPTERA: APHIDIIDAE) ON FOUR SUGAR BEET CULTIVARS

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Abstract

The black bean aphid, *Aphis fabae* Scopoli (Hemiptera: Aphididae) is one of the important pests of sugar beet in Iran. *Aphidius matricariae* Haliday (Hymenoptera: Braconidae, Aphidiinae) is a key parasitoid used in various integrated pest management (IPM) programs worldwide. This study was conducted to determine the effects of four cultivars of sugar beet (IC, PP8, Rasoul and Shirin) on biology and demographic parameters of *A. fabae* and *A. matricariae* as a step toward biological control of black bean aphid. Experiments were performed in a growth chamber with 25±1ºC, 70±5 % RH and a photoperiod of 16L : 8D hours. Survival rates (l_x) of *A. fabae* and *A. matricariae* were highest on Rasoul and PP8 cultivars, respectively. The life expectancy of 1-day-old adults of *A. fabae* and *A. matricariae* was estimated to be 4.25, 4.3, 4.15, 4.5 and 3.8, 3.8, 3.45, 3.65 days on IC, PP8, Rasoul and Shirin cultivars, respectively. There were significant differences between r_m values of *A. fabae* and *A. matricariae* on PP8, Shirin and Rasoul cultivars. There were no significant differences between net reproductive rates (R_o) of *A. fabae* on different cultivars of sugar beet, while there were clear differences in R_o values of *A. matricariae* on various cultivars. The highest value of R_o for *A. matricariae* was obtained on Shirin cultivar. The parasitoid performed better on Shirin than other cultivars, while the aphid performance was poorly affected by cultivars. Therefore, we suggest the use of Shirin cultivar to maximize the natural biological control of *A. fabae* by *A. matricariae.*

KEY WORDS: *Aphidius matricariae*, *Aphis fabae*, Sugar beet, Biology, Demography

Introduction

The black bean aphid, *Aphis fabae* Scopoli (Hemiptera: Aphididae), is one of the most important pests of several cultivated crops throughout the world (VÖLKL & STECHMANN, 1998). Aphis fabae has a very wide host range. It has been recorded on more than 200 host plant species in the world and about 50 plant species are susceptible to attack by this aphid in Iran (HODJAT, 1986; CAB INTERNATIONAL, 2000). The taxa of the A. fabae group are morphologically difficult to separate (TOSH *et al*., 2004). Sugar beet (*Beta vulgaris* Linnaeus) is an important crop in Iran and damage by *A. fabae* reduces both quality and quantity of crop yield. Host plants are damaged either directly by aphid feeding or indirectly by transmission of viruses and excretion of honeydew (MILLS, 1989; SCHEPERS, 1989). Black bean aphid is currently mainly managed with broad-spectrum insecticides. This can be followed by the target pest resurgence, secondary pest outbreaks and the development of insecticide resistance in target pest (SCHEPERS, 1989; HARDIN *et al*., 1995; LONGLEY *et al*., 1997).

To avoid the negative effects of broad-spectrum insecticide use, biological control has increasingly been considered in the field and greenhouse crops (HAGVAR & HOFSVANG, 1991). Many species have been successfully used in biological control programs of various host aphids (MACKAUER & STARY, 1967). So far, about 55 species of Aphidiinae have been identified in Iran and more than 400 others in different parts of the world that related to 60 genus and subgenus (MACKAUER & STARY, 1967; MESCHELOFF & ROSEN, 1988; STARY, 1988; RAKHSHANI *et al*., 2005). The species of the subfamily Aphidiinae and family Aphelinidae (only genus *Aphelinus*) are important biological control agents of aphids worldwide (GONZÁLES *et al*., 1978; HAGVAR & HOFSVANG, 1991; HUGHES *et al*., 1992; HEIMPEL & LUNDGREN, 2000). The aphidiine braconid, *A. matricariae*, is a broadly oligophagous parasitoid found on the various species of aphids all over the world (STARY, 1988). Parasitoids can help reduce pest infestation levels and the number of their hosts, preventing the outbreak of the pests (VAN DRIESHE & BELLOWS, 1996). The information about the demographic parameters of aphid and its parasitoids is essential to understand their role in preventing the pest outbreak. Several factors may influence the performance and efficiency of aphid parasitoids. Both host plant and temperature affect the rate of development and reproduction of aphids (TSAI, 1998; TANG & YOKOMI, 1995). Particularly, the levels of nutrients and secondary compounds present in host plants (1st trophic level) can influence the quality of herbivorous insects (2nd trophic level) as hosts for parasitoids (3rd trophic level) (TURLINGS & BENREY, 1998).

The performance of black bean aphid and its parasitoid, *A. matricariae*, are still to be determined on different cultivars of sugar beet in Iran. Therefore, the current research evaluates the effect of four sugar beet cultivars as host plant on demographic parameters of black bean aphid and *A. matricariae.* An appreciation of the interactions between *A. fabae* and *A. matricariae* will improve biocontrol efforts for *A. fabae* and will assist in reducing the consumption of chemically-synthesized compounds.

Materials and Methods

Insect culture

A. fabae was collected from sugar beet fields in the suburbs of Tehran, Iran, in October 2005 to initiate the culture. Laboratory colonies of black bean aphid were continuously reared on young foliage of sugar beets at 25±1 °C, relative humidity of 65±5 %, and a photoperiod of 16L : 8D h. The *A. matricariae* colony was originally established from parasitized black bean aphids collected in Tehran, in May 2005 and has since been maintained on the original collection propagated on black bean aphids at the laboratory of Department of Entomology, College of Agriculture, Tarbiat Modares University, Iran. Four sugar beet cultivars were used in the experiments, including seedlings of IC (multigerm seed), PP8 (multigerm seed), Rasoul (monogerm hybrid seed) and Shirin (monogerm hybrid seed). The seedlings (12-15 cm in height and 2-month-old) of each sugar beet cultivar were grown in 300-cm^3 containers with potting soil. The black bean aphid and its parasitoid, *A. matricariae*, were reared for three months prior to the start of the experiments to adapt to the laboratory conditions.

Demographic parameters

In order to calculate demographic parameters of black bean aphid, randomly selected apterous females of *A. fabae* from the stock culture were transferred individually into a sugar beet leaf cage (7.5 × 2 cm), and placed in a growth chamber with a temperature of 25±1 °C, relative humidity of 65±5 %, and a photoperiod of 16L : 8D h. After 24 hours leaf cages were examined and black bean aphid nymphs transferred gently with a fine brush to establish one nymph per each sugar beet leaf cage (all nymphs were females). The nymph and adult on each leaf cage were checked daily and their survival recorded on various cultivars. The presence of the discarded exuviae were used to determine when molting had occurred. When the immature nymphs become adults, they were observed daily for reproduction and survival, and all new-born nymphs were removed from each sugar beet leaf cage after counting. These observations continued until the mature aphids died in all treatments. The duration of adult pre-reproductive, reproductive, and post-reproductive periods, lifetime fecundity, and average daily reproduction were calculated for each aphid. Twenty aphids were tested for each sugar beet cultivar. For studying demographic parameters of *A. matricariae*, black bean aphid were reared on the four sugar beet cultivars described above and exposed to *A. matricariae*. Single plants of each sugar beet cultivar containing young foliage were infested initially with 50 black bean aphid adults. Aphid populations were allowed to increase their population on each cultivar. Seedlings were caged in 1-liter clear plastic containers with ventilated lids affixed by elastic bands. A 1 cm diameter opening was cut in the side of each container to provide access for parasitoid introductions. Then, 20 mated females of *A. matricariae* were released separately into each container. After 24 h, female wasps were removed and the exposed aphids were transferred into a growth chamber with a temperature of 25±1 °C, relative humidity of 65±5%, and a photoperiod of 16L : 8D h until parasitoid wasps emerged. These parasitoids were used in the experiments <12 h after emergence, without regard for prior mating or oviposition experience (WEATHERSBEE *et al*., 2004). After that, young seedlings of each sugar beet cultivar (12-15 cm in height and 2-month-old) with 50 third nymph instars of black bean aphid were separately exposed to one-day-old pairs of *A. matricariae* (CAREY, 1993). This experiment was replicated 20 times. Adults of *A. matricariae* were daily fed on a diluted honey solution (10 %) streaked on the inside of each container. When the male died before the female, an alternative male that had been maintained in the stock culture was introduced. Fresh sugar beet seedlings and black bean nymphs were replaced every 24 h until the death of all the female parasitoids, and exposed nymphs were maintained in the growth chamber with previously described conditions to assess the total number of mummified aphids, the number of adults emerged and their sex ratio (proportion of females) for each treatment.

Data analysis

Using survivorship and fertility life table, the demographic parameters of black bean aphid and *A. matricariae* including net reproductive rate (R_o), intrinsic rate of increase (r_m), finite rate of increase (λ), mean lifetime (T), doubling time (D_T) and life expectancy (e_x) were calculated. All terminology and formulae for computing demographic parameters are consistent with CAREY (1993, 2001) as follows:

$$\sum_{\alpha}^{\beta} l_x m_x e^{\ r_m .x} = 1$$

$$R_0 = \sum l_x . m_x$$

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

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

$$D_T = \frac{\ln 2}{r_m}$$

$$e_x = \frac{T_x}{l_x}$$

Where *e* is the base of natural logarithms, *β* is the maximum age among the *n* individuals, *α* is the preimaginal development time, *x* is the individual age, l_x is the probability of an individual surviving to age *x* and m_x is the age-specific number of female offspring. The gross fecundity rate, is the mean offspring per female insect during its lifetime, but the gross fertility rate is the mean of hatching eggs per female insect during its lifetime. The net fecundity rate is the mean of offspring by each female insect during its lifetime along with its survival probability (L_x), but net fertility rate is the mean of hatching eggs by each female insect during its lifetime along with its survival probability (L_x). Since the egg hatch rate was postulated equal to one, because the black bean aphid is viviparous and the hatching eggs of parasitoid wasp pass into the aphid's body, the gross fertility rate was obtained equal to the gross fecundity rate and the net fertility rate equal to the net fecundity rate.

After r_m was computed for the original data (r_{all}), the jackknife method was applied to evaluate the differences in r_m values by estimating the variances. The jackknife pseudo-value $r_{m(j)}$ was estimated for the *n* samples by using the following formula (MAIA *et al*., 2000):

$$r_{m(j)} = n \times r_{all} - (n-1) \times r_{m(i)}$$

$$r_{m(mean)} = \frac{\sum_{1}^{n} r_{m(j)}}{n}$$

$$VARr_{m(mean)} = \frac{\sum_{1}^{n} (r_{m(j)} - r_{m(all)})^2}{n \quad 1}$$

$$SEMr_{m(mean)} = \sqrt{\frac{VAR(r_{m(mean)})}{n}}$$

Where *n* is the number of replications (*n=20*), $r_{m(i)}$ is the intrinsic rate of *n*-1 females. Algorithms for jackknife estimation of the means and variances were described only for r_m. Similar procedures were used for the other parameters (R_o, λ, T and D_T). The mean values of (*n*) jackknife pseudo-values for each treatment were subjected to an analysis of variance (ANOVA). The effect of sugar beet cultivars on survivorship and life history parameters of black bean aphid and *A. matricariae* was analyzed using one-way ANOVA. Differences among treatment means were determined by Student-Newman-Keuls multiple comparison at a probability level of 5% (P <0.05). Statistical analysis was carried out using Minitab software (MINITAB, 2000).

Results

Fecundity, longevity and survivorship

Age-specific survivorship of black bean aphid on various sugar beet cultivars is presented in Fig. 1 or means for the total number of offspring per female aphid (Gross fecundity rate) on various sugar beet cultivars (F = 0.50; df= 79; P= 0.682) (Tab. I). The number of offspring per female per day of *A. fabae* indicated significant differences among various sugar beet cultivars (F=331.80; df=79; P=0.000) (Tab. I). There were no significant differences among *A. matricariae* longevity on various cultivars (Fig. 2), while significant differences were observed among the gross (F=4.24; df=79; P=0.008) and net (F=2.74; df=79; P=0.049) fecundity rates of *A. matricariae* on various sugar beet cultivars (Tab. I). The total number of eggs per female was highest on Shirin and PP8 (Tab. I). The host plant cultivars showed significant effects on the number of eggs per female per day of *A. matricariae* which ranged from 7.14±0.13 to 5.57±0.12 on Shirin and IC, respectively (Tab. I).

The percentage of nymphal mortality was the highest for Shirin and Rasoul (Fig. 1). The life expectancy (e_x) of one-day-old nymphs of black bean aphid on the first day was estimated to be 11.32, 9.91, 9.81 and 11.06 days and in *A. matricariae* were 9.59, 9.40, 9.45 and 9.45 days on IC, PP8, Rasoul and Shirin, respectively (Fig. 1). No significant differences were observed among mortality and life expectancy of *A. matricariae* on various sugar beet cultivars (Fig. 2). The life expectancy at the age of adult emergence of *A. matricariae* on IC, PP8, Rasoul and Shirin cultivars were 3.8, 3.8, 3.45, 3.65 days, and in *A. fabae* were 4.25, 4.30, 4.15 and 4.50 days, respectively.

Table I. The reproductive parameters of *Aphis fabae* and its parasitoids *Aphidius matricariae* on four sugar beet cultivars.

Parameter*		Sugar beet cultivars			
	Species	IC	PP8	Rasoul	Shirin
Gross fecundity rate	*A. fabae*	30.11±2.85 [a]	30.84±3.08 [a]	28.68±2.40 [a]	31.60±2.29 [a]
	A. matricariae	28.44±1.85 [b]	33.69±2.40 [a]	30.67±1.12 [b]	35.75±1.68 [a]
Net fecundity rate	*A. fabae*	21.43±2.47[a]	21.00±2.54 [a]	18.45±1.82 [a]	25.42±2.53 [a]
	A. matricariae	17.53 ±0.91 [b]	19.62±1.50 [a]	16.649±1.07 [b]	19.52±1.09 [a]
Mean offspring per day	*A. fabae*	5.02±0.11 [b]	5.22±011[a]	4.35±0.10[c]	5.27±0.11 [a]
	A. matricariae	5.57±0.12 [c]	7.09±0.13 [a]	6.13±0.12[b]	7.14±0.13 [a]

This means following by different letters in the rows are significantly different (P<0.01)
Formula and calculations conform to CAREY (1993, 2001).

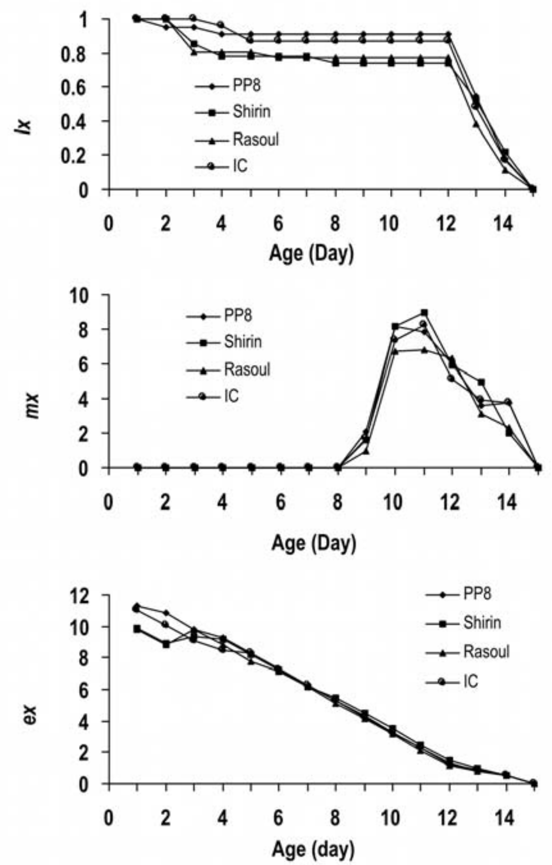

Figure 1. Age-specific survivorship (l_x), age-specific fecundity (m_x) and life expectancy (e_x) of *Aphis fabae* on four sugar beet cultivars.

Population parameters

There were no significant differences between the net reproductive rates (R_o) of *A. fabae* on four cultivars of sugar beet (*F*=2.07; *df*=79; *P*=0.112), while there were clear differences for *A. matricariae* on the same cultivars of sugar beet (*F*=8.49; *df*=79; *P*=0.000). The highest amount of R_o of *A. matricariae* was observed on Shirin cultivar. The intrinsic rate of increase of *A. fabae* (*F*=3.01; *df*=79; *P*=0.035) and *A. matricariae* (*F*=5.87; *df*=79; *P*=0.001) were also found to be significantly different depending on the sugar beet cultivars on which they were reared. The lowest r_m-values of *A. fabae* and *A. matricariae* were obtained on Rasoul and IC, respectively. No significant differences were observed between the r_m values of *A.fabae* and *A. matricariae* on IC (*F*=0.57; *df*=37; *P*=0.570). Among the various cultivars, the λ-values of black bean aphid (*F*=2.98; *df*=79; *P*=0.036) and *A. matricariae* (*F*=5.75; *df*=79; *P*=0.001) showed significant differences. The aphids reared on PP8 had the largest λ-value, and the highest λ-value for *A. matricariae* was obtained on

Shirin. Significant differences were observed between λ-values of *A. fabae* and *A. matricariae* on PP8, Rasoul and Shirin (t-test; $P<0.05$), but there was no significant difference on IC. The doubling time (D_T) of both black bean aphid ($F=3.08$; $df=79$; $P=0.032$) and *A. matricariae* ($F=6.34$; $df=79$; $P=0.001$) was also found to be significantly different between sugar beet cultivars on which they were reared (Table 2). The highest D_T-values of *A. fabae* and *A. matricariae* were observed on Rasoul and IC, respectively. The doubling time values of black bean aphid were significantly higher than *A. matricariae* when reared on PP8, Rasoul and Shirin cultivars. However, the mean lifetime (*T*) of both black bean aphid ($F=0.29$; $df=79$; $P=0.832$) and *A. matricariae* ($F=0.56$; $df=79$; $P=0.643$) showed no significant differences among various sugar beet cultivars, the *T*-values of *A. matricariae* were significantly shorter than black bean aphid on all cultivars (Tab. II).

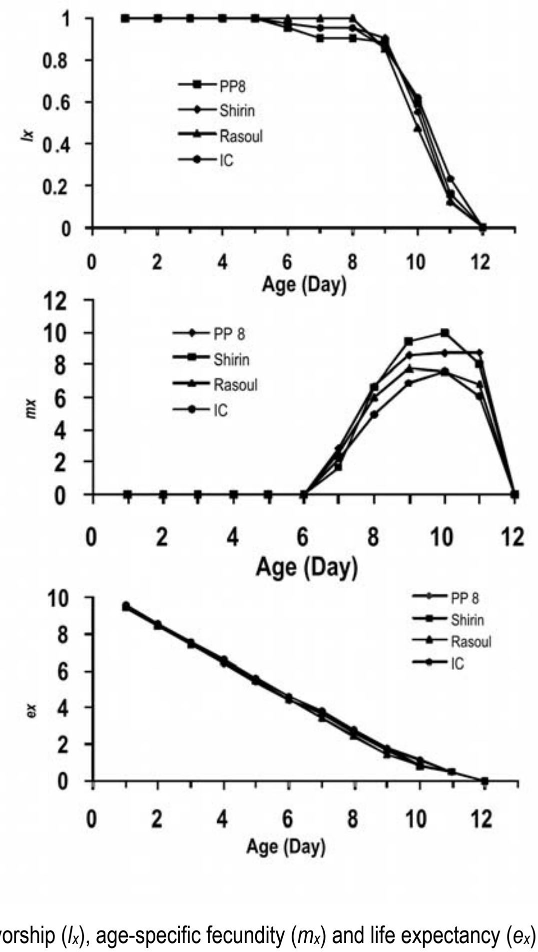

Figure 2. Age-specific survivorship (l_x), age-specific fecundity (m_x) and life expectancy (e_x) of *Aphidius matricariae* on four sugar beet cultivars.

Table II. Population growth parameters of *Aphis fabae* and its parasitoids, *Aphidius matricariae* on four sugar beet cultivars.

Parameter	Species	Sugar beet cultivars IC	PP8	Rasoul	Shirin
Net reproductive rate (R_0)	*A. fabae*	21.90±2.29[a,x]	24.25±2.44[a,x]	17.120±1.540[a,x]	21.30±1.87[a,x]
	A. matricariae	13.31±0.59[c,y]	18.18±1.03[a,y]	16.54±0.77[b,x]	18.579±0.84[a,x]
Intrinsic rate of increase (r_m)	*A. fabae*	0.35±0.01[a,x]	0.36±0.01[a,y]	0.32±0.01[b,y]	0.35±0.01[a,y]
	A. matricariae	0.36±0.01[b,x]	0.41±0.01[a,x]	0.40±0.01[a,x]	0.41±0.01[a,x]
Finite rate of increase (λ)	*A. fabae*	1.42±0.02[a,x]	1.44±0.01[a,y]	1.38±0.01[b,y]	1.41±0.01[a,y]
	A. matricariae	1.43±0.01[b,x]	1.50±0.02[a,x]	1.49±0.01[a,x]	1.50±0.01[a,x]
Doubling time (D_T)	*A. fabae*	1.97±0.06[b,x]	1.90±0.05[b,x]	2.15±0.07[a,x]	2.00±0.05[b,x]
	A. matricariae	1.92±0.05[a,x]	1.70±0.05[b,y]	1.73±0.03[b,y]	1.67±0.03[b,y]
Mean life time (T)	*A. fabae*	8.78±0.07[a,x]	8.76±0.07[a,x]	8.82±0.08[a,x]	8.85±0.06[a,x]
	A. matricariae	7.18±0.13[a,y]	7.14±0.10[a,y]	7.00±0.12[a,y]	7.17±0.10[a,y]

Different letters (a, b, c) in the rows indicate significant ($P < 0.05$) differences within species on various sugar beet cultivars and different letters (x, y) indicate significant ($P < 0.05$) differences between aphid and parasitoid on the same sugar beet cultivars.

Discussion

The present study demonstrated significant differences in the performance of the black bean aphid and its parasitoid, *A. matricariae*, among the four sugar beet cultivars tested. In regard to insect-plant interactions, it is useful to determine the effect of the host plant cultivars not only on the herbivores but also on the performance of the natural enemies to obtain optimal biological control. The net fecundity rates of aphid and its parasitoid are among the most important factors in selecting natural enemies (BIGLER, 1994). SHAHROKHI *et al*. (2004) have reported the number of eggs produced per female of *A. matricariae* was 168.50 eggs on green bug aphid, *Schizaphis graminum* (Rondani), while SALJOQI & VAN EMDEN (2003) observed that the number of eggs produced per female of *A. matricariae* was 200 on green peach aphid, *Myzus persicae* (Sulzer). The net fecundity rate of *A. matricariae* estimated in the current study ranged from 16.65 to 19.62 eggs per female on various sugar beet cultivars (Tab. I); as well, SHAHROKHI *et al*. (2004) have reported the R_o-value of *A. matricariae* on *S. graminum* to be 65.2 in wheat fields which is greater than the obtained data in the current study (13.31 to 18.58). Therefore, we can state that *A. fabae* is a relatively unfavorable host for *A. matricariae* reproduction (ZAMANI et al., 2007; RAKHSHANI et al., 2008). However, direct comparison among these studies is difficult because factors such as temperature, photoperiod, host aphid species and host plant species strongly influence reproduction and these factors differed among experiments.

The net fecundity rate of *A. fabae* estimated in the current study ranged from 18.45 to 25.42 nymphs per female during its adult lifetime on various sugar beet cultivars (Tab. I). These values are close to those estimated for *A. fabae* reared on *Vicia faba* Linnaeus (24.4 nymphs/female) (DOUGLAS, 1997) and clearly different with the value estimated for *A. fabae* reared on *Tropaeolum majus* Linnaeus (8.6 nymphs/female) (DOUGLAS, 1997). Also, CICHOCKA *et al*. (2000) showed that the growth population parameters of *A. fabae* are significantly different on different varieties of beans. DOUGLAS (1997) mentioned that the intrinsic rate of increase, nymph mortality and adult weight of black bean aphids were significantly different on various host plants. SHIRVANI & HOSSEINI (2004) studied various aspects of biology (net reproductive rates, intrinsic rate of increase, finite rate of increase, doubling time and mean lifetime) of *Aphis gossypii* Glover on cucumber, marrow and vegetable marrow. Their results showed that the demographic parameters of *A. gossypii* were significantly different on various host plants.

The r_m-value of *A. fabae* estimated in the current study ranged from 0.32 to 0.36 female nymphs per female per day (Tab. II). These values are close to those estimated for *A. fabae* reared on *V. faba* (0.34 female/female/day) plants (DOUGLAS, 1997). The r_m-values of *A. matricariae* were significantly greater than its host, *A. fabae*, on PP8, Rasoul and Shirin cultivars. Consequently, *A. matricariae* has performed better on these cultivars than *A. fabae.* The intrinsic rate of increase (r_m) shows the difference between intrinsic birth rate and intrinsic death rate in the population (CAREY, 1993). Since the intrinsic rate of increasing population is not an absolute factor, TRIPATHI & SINGH (1990) noticed that a number of extrinsic and intrinsic factors have been shown to affect the r_m-value and related demographic parameters, such as host and parasitoid species (JERVIS & COPLAND, 1996), host size (SINHA & SINGH, 1982), parasitoid size (JERVIS & COPLAND, 1996), host plant and temperature (FORCE & MESSENGER, 1964), the number of male, Kairomone and adult feeding (JERVIS & COPLAND, 1996) and method of testing. Since the doubling time of *A. matricariae* was significantly shorter than *A. fabae* on PP8, Rasoul and Shirin cultivars, this parasitoid reproduces more generations than its host aphid. SHAHROKHI *et al*. (2004) reported R_o, r_m, λ, D_T and *T* of *A. matricariae* on green bug aphid equal to 65.21 (female/female/gen), 0.240 (female/female/day), 1.27 (1/day), 2.88 (day) and 17.29 (day), respectively. REED *et al*. (1992) estimated the r_m of *A. matricariae* on Russian wheat aphid, *Diuraphis noxia* (Kurdj.) equal to 0.202 (female/female/day), which is smaller than those estimated for *A. matricariae* in the current study. STARY (1966) reported that the parasitism percentage of *A. fabae* by parasitoid wasp, *Binodoxys angelicae* (Haliday), was significantly different on *Euonymus europea* Linnaeus (Celastraceae) and *Philadelphus coronarius* Linnaeus (Saxifragaceae) host plants. MACKAUER *et al*. (1996) found that *Lysiphlebus cardui* (Marshall) parasitizes a greater percent of *A. fabae* on *Cirsium arvense* Scopoli (Asteraceae) than *C. palustre* Scopoli (Asteraceae). Therefore, the quality of host plant affects growth population parameters of pests directly and on natural enemies indirectly (VÖLKL & STECHMANN, 1998(. For example, genetically modified potato plants expressing the lectin Galanthus Nivalis Agglutinin (GNA) to confer resistance to pest insects, decrease survival, development, size, sex ratio and fertility of pest insects directly and also affect growth and development of parasitoids indirectly (COUTY *et al*., 2001). It is observed that the soybeans and the beans which contain PIs (Protease inhibitors) decrease mortality of *Acyrthosiphon pisum* (Harris) (ABE *et al*., 1987). Some host plants affect the weight, size, mortality and fecundity of phythophagus insects. For example, Medicoside A, that is the extract of the root of alfalfa, decreases the body length and fertility rate of *Aulacorthum solani* (Kaltenbach) and also Soyasaponin 1, that is the extract from the leaves of alfalfa, will cause the death of aphids up to 60% during 5-11 days in comparison with control (MAZAHERY-LAGHAB & AHMADVAND, 2004). MONFARED *et al*. (2003) studied the effects of different varieties of *Brassica napus* Linnaeus on *Brevicoryne brassicae* Linnaeus under field conditions. They found that some varieties of *B. napus* are resistant on *B. brassicae*. TAKALLOOZADEH *et al*. (2003), who reported that the host plants affect growth population and reproductive parameters of *Lysiphlebus fabarum* Marshall. VÖLKL & STECHMANN (1998), have studied the influence of host plants on parasitism of *A. fabae* by *L. fabarum*. They found that parasitism in *A. fabae* was host plant specific. Black bean aphids were less parasitized on broad bean. Also they found that *L. fabarum* stayed a shorter time and laid fewer eggs on broad bean than on other host plants. Natural enemies of phytophagous insects function and develop in a multi-trophic context and their behavior and physiology are influenced by many factors and stimuli derived from the plant (first trophic level) and the phytophagous host (second trophic level) (PRICE *et al*., 1980). Undoubtedly, the compositions and concentrations of nutrients and secondary substances vary greatly among host plant cultivars, sometimes increasing their suitability as host plants, whereas at other times conferring resistance to insect herbivores (WEATHERSBEE *et al*., 2004). Although the compounds causing these differences have not been identified specifically in sugar beet, it is reasonable to assume that factors present in the plant that affect the vigor of the host aphid also would influence the fitness of the parasitoid (WEATHERSBEE *et al*., 2004). Whether differences in parasitoid reproduction observed in this experiment were due to plant nutritional effects on the fitness of the host aphid or to the presence of plant allelochemicals ingested by the host aphid would be an interesting aspect for further study, and indicate that the multitrophic interactions among sugar beet cultivars, the black bean aphid and this native parasitoid should be further investigated.

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ЖИВОТНИ ЦИКЛУС И ДЕМОГРАФСКИ ПАРАМЕТРИ *APHIS FABAE* (HEMIPTERA: APHIDIDAE) И ЊЕНОГ ПАРАЗИТОИДА, *APHIDIUS MATRICARIAE* (HYMENOPTERA: APHIDIIDAE) НА ЧЕТИРИ КУЛТИВИСАНА СОЈА ШЕЋЕРНЕ РЕПЕ

Сепидех Тахрири Адаби, Али Асгар Талеби, Јагуб Фатипур и Абас Али Замани

Извод

Црна пасуљева лисна ваш, *Aphis fabae* Scopoli (Hemiptera: Aphididae) једна је од најважнијих штеточина на шећерној репи у Ирану. *Aphidius matricariae* Haliday (Hymenoptera: Aphidiidae) је главни паразитоид који се користи у бројним интегрисаним програмима управљања штеточинама (IPM) широм света. Циљ овог истраживања је да се одреди утицај четири култивисана соја шећерне репе (IC, PP8, Rasoul и Shirin) на биологију и демографске параметре *A. fabae* и *A. matricariae*, што би био корак према биолошкој контроли црне пасуљеве лисне ваши. Експерименти су вршени у одељку за раст и одгајање, где су услови били 25±1 ºC, 70±5 % релативне влажности ваздуха и фотопериод од 16 часова светлости : 8 часова таме. Стопе преживљавања (l_x) *A. fabae* биле су највише на сојевима Rasoul а *A. matricariae* на PP8. Очекивана дужина живота једнодневних адулата *A. fabae* процењена је на 4,25; 4,3; 4,15 и 4,5 дана на сојевима IC, PP8, Rasoul и Shirin, а код *A. matricariae* вредности су биле 3,8; 3,8; 3,45 и 3,65 дана. Постојале су значајне разлике у r_m вредностима за *A. fabae* и *A. matricariae* на сојевима PP8, Shirin и Rasoul. Није било значајних разлика између нето брзине репродукције (R_o) *A. fabae* на различитим сојевима шећерне репе, док су код R_o вредности *A. matricariae* постојале јасне разлике. Највиша вредност R_o за *A. matricariae* забележена је на соју Shirin. Паразитоид је показао бољу активност на соју Shirin него на другим сојевима, док је на активност афиде сој слабо утицао. Зато препоручујемо употребу соја Схирин како би се до максимума довела биолошка контрола *A. fabae* преко *A. matricariae.*

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