J. Agr. Sci. Tech. (2016) Vol. 18: 1257-1266

Demography of the Bird Cherry-oat Aphid, (*Rhopalosiphum padi* L.) (Hemiptera: Aphididae) on Different Barley Varieties

L. Karami[1], M. Amir-Maafi[2], S. Shahrokhi[2*], S. Imani[1], and M. Shojai[1]

ABSTRACT

Life table parameters of the bird cherry-oat aphid, (*Rhopalosiphum padi* L.) were determined on different barley (*Hordeum vulgare* L.) varieties. Experiments were carried out under laboratory condition of 26±1ºC, 65±5% RH and photoperiod of 16:8 (L:D) hours. Newborn first instar nymphs of the same age were reared on the leaves of six barley varieties using leaf cages. Nymphal development time, mortality, longevity and adult fecundity were recorded daily. Nymphal survivorship varied from 71% to 88% on the varieties tested. The results revealed significant effect of experimental varieties on demographic statistics of *R. padi*. The intrinsic rate of natural increase r_m, ranged between 0.318 and 0.366 female/female/day; the range of other life table parameters was from 1.37 to 1.44 day^{-1} for finite rate of increase λ, 43.83 to 60.65 female/female/generation for net Reproductive rate R_0, 1.89 to 2.17 days for Doubling Time *DT* and 11.19 to 11.86 days for mean generation Time *T*. In conclusion, analysis of biological parameters indicated Valfajr and Fajr30 as relatively less susceptible varieties to *R. padi*, while Reihan03, Kavir and Zarjow were considered as relatively more susceptible and Nosrat was placed in the same statistical group with other varieties.

Keywords: Barley, Integrated pest management, Life table, Plant resistance.

INTRODUCTION

The bird cherry-oat aphid, *Rhopalosiphum padi* (L.) (Hemiptera: Aphididae) is a cosmopolitan polyphagus species and widely distributed in tropical and subtropical regions (Blackman and Eastop, 2000). This aphid is considered as a major pest of numerous grains and can be one of the predominant aphids on cereal crops (Wiktelius and Ekbom, 1985; Leather *et al.,* 1989; Elliott *et al.,* 1994; Baily, 2007; Hill, 2008). *R. padi* is classified as a heteroeicious species, and colonizes on cultivated grains in most parts of Iran in spring and early winter (Rezvani, 2001).

This aphid can cause serious problems on cereals including wheat, corn, barley, sorghum, rye, brome, Fescue, medlar and stone fruits (e.g. apple and plum) as well (Modarres Awal, 2002, Robinson, 1992). Feeding on phloem of grains, *R. padi* causes economic yield loss and consequently reduces yield components including seed and spikelet numbers. It causes severe infestations on plants both by direct feeding and by transmitting *Barley Yellow Dwarf Virus* (BYDV) (Pike and Schaffner, 1985; Kieckhefer and Gellner, 1992; Kieckhefer *et al.,* 1995; Jimenez-Martinez *et al.,* 2004; Fabre *et al.,* 2006; Borer *et al.,* 2009; Wang *et al.,* 2015).

According to the researches done on insect biology and life table, host plant varieties

[1] Department of Entomology, Science and Research Branch, Islamic Azad University (IAU), Tehran, Islamic Republic of Iran.
[2] Iranian Research Institute of Plant Protection, Agricultural Research, Education and Extension Organization (AREEO), Tehran, Islamic Republic of Iran.
[*] Corresponding author; email: shahrokhi1349@gmail.com

[DOR: 20.1001.1.16807073.2016.18.5.22.8]

can remarkably influence biological characteristics such as mortality, development, fecundity and reproductive capacity (Bernardi *et al*., 2012; Golawska, 2010; Golizadeh *et al*., 2009; Madahi and Sahragard, 2012; Mirmohammadi *et al.,* 2009; Tsai and Wang, 2001, Naseri *et al*., 2014); therefore the use of insect-resistant varieties may be an effective control strategy against the aphid as it is not only sustainable, but also cost-effective (Žanić *et al*., 2013; Elek *et al.,* 2009; Kellner *et al.,* 2010; Ozgokce and Altihan, 2005).

Knowledge of biology and population growth parameter is important for establishing management strategies for pest control. Life tables are well- established methods for understanding the effect of different factors on the growth, survival, reproduction and increase rate of an insect population (Obopile and Ositile, 2010). Life table parameters, specifically the intrinsic rate of natural increase r_m, illustrate the measure of plant resistance level to insects, so that higher values of plant resistance can be led to lower values of r_m. In other words, data obtained through life table studies depicts the host plant's suitability in relation to different species of plant pests (Rago and Dorazio, 1984; Dixon, 1987).

The main objective of this study was to estimate the life table parameters of *R. padi* on six commercial barley varieties and to determine susceptibility or resistance of the varieties, as there is no detailed information on these matters in Iran.

MATERIALS AND METHODS

Plant Rearing

Experiments were conducted during 2013 at Iranian Research Institute of Plant Protection, Tehran. To carry out the trials, seeds of six different barley (*Hordeum vulgare* L.) varieties including Kavir, Nosrat, Fajr30, Reihan03, Valfajr and Zarjow were obtained from Seed and Plant Improvement Institute and were sown in 15-cm diameter plastic pots filled with a mixture of sand, clay and peat moss. Pots were kept in a greenhouse at 25±5Cº, 60-70% RH with ambient light. After reaching two to three leaf stages, the seedlings of cultured plants in the greenhouse were transferred to the growth chamber at 26±1 ºC, 60±5% RH, a light: dark cycle of 16:8 hour and watered as needed.

Aphid Source

The aphids used in this study were originally collected during spring and summer of 2012 from infested barley fields in Karaj, Alborz province. The identity of *R. padi* was confirmed by A. Rezvani at the Iranian Research Institute of Plant Protection. To prevent maternal effects (Dixon *et al*., 1982), aphids were reared on seedlings of each variety for at least three generations before being used in the experiments in a growth chamber under the above- mentioned conditions.

Experiments

To evaluate the effects of barley varieties on biological characteristics and life table parameters, about 50 adult apterous females from the stock colony were picked randomly and transferred to the plastic leaf cages using a camel-hair brush. After four hours, adults and all but one newborn nymph in each clip cage were removed. For each variety tested in this work, 30 newly emerged nymphs were selected as a cohort. Nymphs were monitored at 24 h intervals to record nymphal developmental time and exuviae were considered as molting indicator. By reaching maturity and commencing reproduction, adult mortality and fecundity were recorded by daily counting of the offspring. This process was carried out until the death of all adults. Age-specific survival l_x and fecundity m_x were used to calculate life table parameters including intrinsic rate of natural increase r_m, net Reproductive rate

R_0, Doubling Time *DT*, mean generation Time *T* and finite rate of increase λ, on different barley varieties tested (Maia *et al*., 2000).

Data Analysis

Data on biological characteristics of *R. padi* including development time of immature stages, longevity and fecundity on different barley varieties were tested for normality using skewness and kurtosis test by Univariate procedure. GLM procedure was applied for analysis of variance and means were grouped by Tukey test using SAS statistical software (SAS Institute, 1989). Life table parameters concerning intrinsic rate of natural increase r_m, net Reproductive rate R_0, Doubling Time *DT*, mean generation Time *T* and finite rate of increase λ on six barley varieties were also estimated according to Maia *et al.* (2000) using SAS statistical software. Jackknife method was used for estimation of standard errors and then multiple comparisons of pseudo-values were performed using Sidak's procedure in which critical *P* values for two-tailed *t*-test (γ_T) were calculated and compared with the observed *P* values. The equation used for calculating the two-tailed *t*-test *P* values was: $(1-\gamma_T)^K = (1-\frac{\alpha}{2})$, where α is the probability level (5% or 1%) and *K* is all possible pairs with *G* groups of treatments and is calculated as $K = G\,(G-1)/2$ (Maia *et al*., 2000).

RESULT AND DISCUSSION

Development of Immature Stages

According to Table 1, the average development time of immature stages on the experimental varieties was significantly different (F= 8.55; df= 5, 406; P<0.0001). The aphids reared on Kavir, Fajr30 and Valfajr were indicated to have significantly longer developmental time (6.67, 6.64 and 6.61 days, respectively) than on Zarjow and Nosrat (6.10 and 6.09 days, respectively).

Table 1. Developmental time of different stages, longevity and total number of offspring. per female (Mean±SE) of *Rhopalosiphum padi* on six barley varieties at 26±1°C.[a]

Variety	1st Instar	2nd Instar	3rd Instar	4th Instar	Combined nymphs	Longevity (Day)	Mean No. Offsp/Female
Rihane03	2.13±0.06[a]	1.51±0.06[ab]	1.38±0.05[a]	1.30±0.05[a]	6.34±0.09[ab]	21.44±1.070[a]	70.48±3.686[a]
Zarjow	2.00±0.07[a]	1.56±0.06[ab]	1.36±0.06[a]	1.28±0.05[a]	6.10±0.08[b]	21.90±1.061[a]	68.35±3.613[ab]
Kavir	2.08±0.07[a]	1.74±0.07[a]	1.60±0.07[a]	1.33±0.05[a]	6.67±0.09[a]	20.57±0.821[a]	67.85±3.250[ab]
Nosrat	2.05±0.06[a]	1.41±0.06[b]	1.43±0.06[a]	1.23±0.05[a]	6.09±0.09[b]	19.45±0.799[a]	55.95±2.946[b]
Valfajr	2.12±0.07[a]	1.63±0.06[ab]	1.50±0.05[a]	1.33±0.06[a]	6.61±0.09[a]	20.31±1.045[a]	64.31±3.307[ab]
Fajr30	2.00±0.07[a]	1.62±0.06[ab]	1.56±0.06[a]	1.38±0.06[a]	6.64±0.08[a]	21.72±0.799[a]	61.33±2.992[ab]

[a] Means with the same letters in each column are not significantly different (P< 0.05).

Development time of 1st, 3rd and 4th instar nymphs was not significantly different on the experimental barley varieties. Therefore, it seems that variations of the time needed for the development of immature stages on the experimental barley varieties were due to differences in 2nd instar developmental period ($F= 2.82$; $df = 5, 482$; $P= 0.016$) (Table 1).

Nymphal survivalship from first instar to adult was approximately gauged the most for Reihan03 (88%), followed by Nosrat (84%), Zarjow (81%), Kavir (80%), Fajr30 (76%) and Valfajr (70%), respectively.

Biology 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 denoted by many researchers (Jimenez-Martinez *et al*., 2004; Zarpas *et al.,* 2006; Davis and Radcliffe, 2008; Mirmohammadi *et al*., 2009; Descamps and Chopa, 2011). It is worth noting that there is a wide range of host plants for bird cherry-oat aphid among cereals; however, there is no detailed information concerning the effect of common barley varieties on the performance of *R. padi* in Iran.

The findings gained in this study indicated that host plant had a profound effect on developmental time of the bird cherry-oat aphid. The time needed for the development of immature stages on the experimental barley varieties was remarkably longer than those reported by Elliott *et al*. (1989) (4.66 days) and Asin and Pons (2001) (5.4 days) on barley and corn, respectively. In contrast, the time was shorter based on the findings of Auad *et al*. (2009) when *R. padi* was reared on signal grass (7.13 days).

Longevity, Survival and Fecundity

The varieties had no significant influence on adult longevity; however, the mean number of offspring per female was affected by host plant varieties ($F= 1.81$; $df= 5, 136$; $P< 0.05$). According to Table 1, means for the total number of offspring per female was significantly higher on Reihan03 than Nosrat.

Comparing the age-specific fecundity and survival curves, experimental varieties had different age-specific fecundity rates with the highest amount on Reihan03. Bird cherry-oat aphid produced the most offspring during the first days of reproduction period on all varieties, so that the highest fecundity was observed at ages 8-10 on all barley varieties (Figure1).

R. padi showed similar mortality trends on barley varieties (Figure 1). According to Akcakaya *et al.* (1999), there are three types of age-specific survival curves. In the first type, mortality is low in early and middle ages, followed by a rapid increase in later ages. In type III, the mortality is high in early ages, and then it occurs slowly. Type II is an intermediate between types I and III, where roughly constant mortality rate occurs over a lifespan. However, in some cases, age-specific survival curve may be a combination of 2 or 3 types of these curves. In the present study, *R. padi* showed a combination of type I and type III age--specific survival curves on the experimental barley varieties. However, it was close to type II on Reyhan03. Mortality was high in early stages and also increased rapidly after the ages of 20-25, while most nymphs were produced until the mentioned ages (91.46, 91.26, 89.56, 89.01, 88.72 and 88.16% on Kavir, Reyhan03, Zarjow, Valfajr, Fajr30 and Nosrat, respectively) (Figure 1).

Host plant quality can affect insects' growth and reproduction and shorter developmental time represents the appropriateness of the host plants (van Lenteren and Nodus, 1990). Significant effect of barley varieties was observed on reproduction of *R. padi*; however, there was no direct correlation between reproduction and adult longevity ($r= 0.002$, $P= 0.98$).

The longevity of bird cherry-oat aphid ranged between 19.45 and 21.90 days, while it was less for the same species reared on

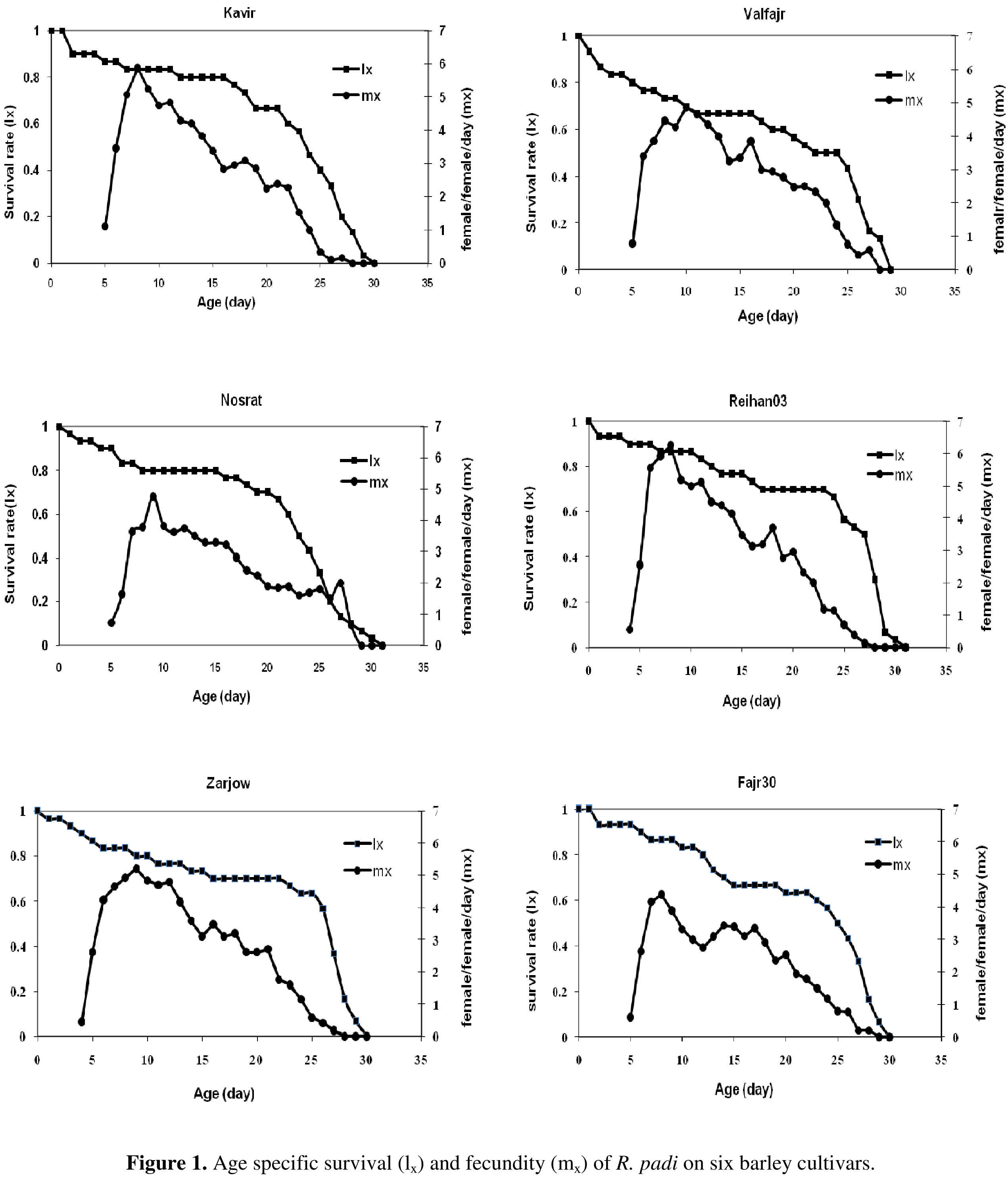

Figure 1. Age specific survival (l_x) and fecundity (m_x) of *R. padi* on six barley cultivars.

wheat (Jimenez-Martinez *et al*., 2004) and more compared to the ones reported by Elliott *et al*. (1989) (8.53 days at 24-28ºC).

Life Table Parameters

Table 2 represents true calculations in comparison to the Jackknife estimates and their respective 95% Confidence intervals (CI) for R_0, r_m, λ, T and DT. Results revealed that the values estimated by Jackknife were the same as or similar to those obtained by true calculation (Table 2) and so, it was an appropriate method to estimate the variances for fecundity life table parameters in the present study. According to Maia *et al.* (2000), in the case of skewed distribution of fecundity in which some females have little or no oviposition or a few lay very high numbers of eggs, Jackknife is not an appropriate method for variance estimation. Negative estimates may also be produced for *Ro* in extreme cases, indicating unsuitability of Jackknife method in such situations (Maia *et al*., 2000).

Table 2. True calculations, Jackknife estimates and their associated 95% CI for fecundity life table parameters of *Rhopalosiphum padi* on six barley varieties.[a]

Parameter	Variety	True calculation	Jacknife estimate	95% CI
R_0 (Female/-Female/Generation)	Reyhan03	60.65[a]	60.65±3.28	53.89-67.41
	Zarjow	53.69[ab]	53.69±2.71	48.07-59.31
	Kavir	52.63[ab]	52.63±2.51	47.42-50.60
	Nosrat	46.20[b]	46.20±2.12	41.79-50.60
	Valfajr	43.98[b]	43.98±2.44	38.89-49.08
	Fajr30	43.83[b]	43.83±2.30	39.04-48.63
r_m(Female/Female/Day)	Reyhan03	0.366[a]	0.366±0.004	0.357-0.375
	Zarjow	0.350[a]	0.350±0.005	0.339-0.361
	Kavir	0.348[a]	0.348±0.004	0.338-0.357
	Nosrat	0.340[ab]	0.340±0.008	0.322-0.358
	Valfajr	0.318[b]	0.318±0.005	0.306-0.330
	Fajr30	0.319[b]	0.318±0.005	0.307-0.330
λ (Day^{-1})	Reyhan03	1.44[a]	1.44±0.006	1.42-1.45
	Zarjow	1.42[a]	1.41±0.007	1.40-1.43
	Kavir	1.41[a]	1.41±0.006	1.40-1.43
	Nosrat	1.40[ab]	1.40±0.01	1.38-1.43
	Valfajr	1.37[b]	1.37±0.007	1.35-1.39
	Fajr30	1.37[b]	1.37±0.007	1.35-1.39
T (Day)	Reyhan03	11.19[a]	11.20±0.21	10.75-11.65
	Zarjow	11.35[a]	11.36±0.23	10.88-11.84
	Kavir	11.37[a]	11.38±0.19	10.97-11.79
	Nosrat	11.24[a]	11.25±0.31	10.60-11.89
	Valfajr	11.86[a]	11.87±0.26	11.31-12.43
	Fajr30	11.84[a]	11.85±0.28	11.25-12.45
DT (Day)	Reyhan03	1.89[b]	1.89±0.02	1.84-1.93
	Zarjow	1.97[b]	1.97±0.02	1.91-2.03
	Kavir	1.98[b]	1.99±0.02	1.93-2.04
	Nosrat	2.03[ab]	2.03±0.05	1.92-2.14
	Valfajr	2.17[a]	2.17±0.03	2.09-2.25
	Fajr30	2.17[a]	2.17±0.03	2.09-2.25

[a] Means with the same letters in each column are not significantly different (P< 0.05).

[DOR: 20.1001.1.16807073.2016.18.5.22.8]

According to Table 2, aphids showed the same mean generation time on the varieties tested, statistically. However, variety had a significant influence on the other population growth parameters studied. Aphids reared on Reihan03, Zarjow and Kavir had the highest values of R_0, r_m, λ and the lowest *DT*. However, the lowest values of R_0, r_m, λ observed on Fajr30 and Valfajr resulted in the highest population doubling time of the aphid on them. The suitability of different host plant varieties is marked in life table parameters; alongside these, the intrinsic rate of natural increase is of great importance and known as a comprehensive factor which can be applied as an indicator of population growth potential and host plant resistance. The influential factors on this parameter are developmental time, reproduction and survivorship (Rago and Dorazio, 1984; Dixon, 1987). In the present study, higher values for R_0, r_m, λ and lower ones for *DT* on Reihan03, Zarjow and Kavir was mainly due to lower immature stages of mortality and higher reproduction of the aphid on these varieties.

The calculated r_m ranged between 0.318 and 0.366 (female/female/day) on experimental varieties in the current study which was comparable with the results of Elliott *et al.* (1989) (0.34) on barley; however, it was reported 0.2 to 0.28 by Auad *et al.* (2009) on signal grass and 0.45 on corn by Asin and Pons (2001). Moreover, comparing the results of aphids fed on different host plants; natural rate of increase grows on high quality hosts (Dixon, 1987).

The finite rate of increase λ indicates the daily percentage of population growth which is of great importance to estimate the aphid compatibility with the host plant. Compared with Auad *et al*. (2009), findings of the present study demonstrated that finite rate of increase for *R. padi* on the experimental varieties was more than the amount on signal grass (1.32 day^{-1}). Differences in life table parameters of *R. padi* 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). The parameters' variations in different studies could also be under the influence of the local climatic conditions which disparate geographical populations are adapted to (Campbell *et al.*, 1974, Hutchinson and Hogg, 1984).

In conclusion, considering r_m, λ and *DT* values, Reihan03, Zarjow and Kavir have been recognized as the most suitable varieties for *R. padi* population growth. Poor performance of the *R. padi* was observed on Valfajr and Fajr30 and the aphid is likely to have less population growth on the mentioned varieties in the field condition.

With regard to inordinate intake of pesticides against aphids which is noxious to natural enemies, human and environmental health as well as the emergence of resistance, using resistant or relatively less susceptible varieties may be a feasible alternative or complementary method to chemical control of *R. padi* in Iran. The resistance or less susceptibility of the host plant can be of substantial contribution in decreasing population growth rate of pests and act as the integrated complementing management scheme. The outcome of the present paper is likely to provide required information to anticipate the population growth trend and consequently to organize the integrated pest management project.

ACKNOWLEDGEMENTS

We greatly appreciate the assistance of the Iranian Research Institute of Plant Protection and Islamic Azad University of Tehran, Science and Research Branch in supporting this project and Seed and Plant Improvement Institute for providing seeds.

REFERENCES

1. Akcakaya, H. R., Burgman, M. A. and Ginzburg, L. R. 1999. *Applied Population Ecology Principles and Computer Exercises RAMAS Ecolab2.0.* Sinauer Associates, Inc. Publishers Sunderlands, Massachusetts.

2. Asin, L. and Pons, X. 2001. Effect of High Temperature on the Growth and Reproduction of Corn Aphids (Homoptera: Aphididae) and Implications for Their Population Dynamics on the Northeastern Iberian Peninsula. *Environ. Entomol.*, **30**: 1127-1134.
3. Auad, A. M., Alves, S. O., Carvalho, C. A., Silva, D. M., Resende, T. T. and Verissimo, B. A. 2009. The Impact of Temperature on Biological Aspects and Life Table of *Rhopalosiphum padi* (Hemiptera: Aphididae) Fed with Signal Grass. *Fla. Entomol.*, **92**: 569-577.
4. Baily, P. 2007. Pests of Field Crops and Pastures Identification and Control. CSIRO Publishing, Oxford, UK, 520 PP.
5. Bernardi, D., Garcia, M. S., Botton, M. and Nava, D. E. 2012. Biology and Fertility Life Table of the Green Aphid, *Chaetosiphon fragaefolli* on Strawberry Cultivars. *J. Insect. Sci.,* **12**: 1-8.
6. Blackman, R. L. and Eastop, V. F. 2000. *Aphids on the World's Crops. An Identification and Information Guide*. 2nd Edition, John Wiley and Sons, Chichester, 414 PP.
7. Borer, E. T., Adams, V. T., Engler, G. A., Adams, A. L., Schumann, C. B. and Seabloom, E. W. 2009. Aphid Fecundity and Grassland Invasion: Invader Life History is the Key. *Ecol. Appl.,* **19:** 1187-1196.
8. Campbell, A., Frazer, B. D., Gilbert, N., Gutierrez, A. P. and Mackauer, M. 1974. Temperature Requirements of Some Aphids and Their Parasites. *J. Appl. Ecol.,* **11:** 431-438.
9. Davis, J. A. and Radcliffe, E. B. 2008. Reproduction and Feeding Behavior of *Myzus persicae* on Four Cereals. *J. Econ. Entomol.*, **101:** 9-16.
10. Decamps, L. R. and Chopa, C. S. 2011. Population Growth of *Rhopalosiphum padi* (Homoptera: Aphididae) on Different Cereal Crops from the Semiarid Pampas of Argentina under Laboratory Conditions. *Chi. J. Agric. Res.,* **71:** 390-394.
11. Dixon, A. F. G. 1987. Cereal Aphids as an Applied Problem. *Agr. Zool. Rev.*, **2**: 1-57.
12. Dixon, A. F. G., Chambers, R. J. and Dharma, T. R. 1982. Factors Affecting Size in Aphids with Particular Reference to the Black Bean Aphid, *Aphis fabae*. *Entomol. Exp. Appl.,* **32:** 123-128.
13. Elek, H., Werner, P., Smart, L., Gordon-Weeks, R., Nádasy, M. and Pickett, J. 2009. Aphid Resistance in Wheat Varieties. *Commun. Agric. Appl. Biol. Sci.,* **74**: 233-241.
14. Elliott, N. C., Hein, G. L. and Shepard, B. M. 1994. Sampling Arthropod Pests of Wheat and Rice. In: *"Handbook of Sampling Methods for Arthropods in Agriculture"*, (Eds.): Pedigo, L. P. and Buntin, G. D.. CRC Press, Boca Raton, USA, PP. **627-666**.
15. Elliott, N. C. and Kieckhefer, R. W. 1989. Effects of Constant and Fluctuating Temperatures on Immature Development and Age-specific Life Tables of *Rhopalosiphum padi* (L.) (Homoptera: Aphididae). *Can. Entomol.,* **121**: 131-140.
16. Fabre, F., Pierre, J. S., Dedryver, C. A. and Plantegenest, M. 2006. Barley Yellow Dwarf Disease Risk Assessment Based on Bayesian Modeling of Aphid Population Dynamics. *Ecol. Model.,* **193**: 457-466.
17. Golizadeh, A., Kamali, K., Fathipour, Y. and Abbasipour, H. 2009. Life Table of the Diamondback Moth, *Plutella xylostella* (L.) (Lepidoptera: Plutellidae) on Five Cultivated Brassicaceous Host Plants. *J. Agri. Sci. Techn.,* **11**: 115-124.
18. Golawska, S. 2010. Effect of Various Host-plants on the Population Growth and Development of the Pea Aphid. *J. Plant. Protect. Res.,* **50**, 224-228.
19. Hill, D. S. 2008. *Pests of Crops in Warmer Climates and Their Control.* Springer Science, Business Media, UK, 708 PP.
20. Hutchinson, W. D. and Hogg, D. B. 1984. Demographic Statistics for the Pea Aphid (Homoptera: Aphididae) in Wisconsin and a Comparison with other Populations. *Environ. Entomol.,* **13**: 1173-1181.
21. Jimenez-Martinez, E. S., Bosque-Perez, N. A., Berger, P. H. and Zemetra, R. S. 2004. Life History of the Bird Cherry-oat Aphid, *Rhopalosiphum padi* (Homoptera: Aphididae), on Transgenic and Untransformed Wheat Challenged with *Barley Yellow Dwarf Virus. J. Econ. Entomol.,* **97**: 203-212.
22. Kellner, M., Brantestam, A. K., Ahman, I. and Ninkovic, V. 2010. Plant Volatile-induced Aphid Resistance in Barley Cultivars is Related to Cultivar Age. *Theor. Appl. Genet.,* **121**: 1133-1139.
23. Kieckhefer, R. W. and Gellner, J. L. 1992. Yield Losses in Winter Wheat Caused by

Low Density Cereal Aphid Populations. *Agron. J.*, **84**: 180–183.
24. Kieckhefer, R. W., Gellner, J. L. and Riedell, W. E. 1995. Evaluation of the Aphid-day Standard as a Predictor of Yield Loss Caused by Cereal Aphids. *Agron. J.,* **87**: 785–788.
25. 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.
26. Leather, S. R., Walters, K. F. A. and Dixon, A. F. G. 1989. Factors Determining the Pest Status of the Bird Cherry-oat Aphid, *Rhopalosiphum padi* (L.) (Hemiptera: Aphididae), in Europe: A Study and Review. *Bull. Entomol. Res.,* **79**: 345–360.
27. Madahi, K. and Sahragard, A. 2012.Comparative Life Table of *Aphis pomi* (Hemiptera: Aphididae) on Two Host Plants *Malus pumila* L. and *Chaenomeles japonica* under Laboratory Conditions. *JCP,* **1**: 321-330.
28. Maia, A. H. N., Luiz, A. J. B. and Campanhola, C. 2000. Statistical Inference on Associated Fertility Life Table Parameters Using Jackknife Technique: Computational Aspects. *J. Econ. Entomol.,* 93, 511-518.
29. 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.
30. Modarres Awal, M. 2002. *List of Agricultural Pests and Their Natural Enemies in Iran*. 3th Edition, Ferdowsi University Press, 429 PP.
31. Naseri, B, Golparvar, Z., Razmjou, J. and Golizadeh, A. 2014. Age-stage, Two-sex Life Table of *Helicoverpa armigera* (Lepidoptera: Noctuidae) on Different Bean Cultivars. *J. Agr. Sci. Tech.*, **16**: 19-32.
32. Obopile, M. and Ositile, B. 2010. Life Table and Population Parameters of Cowpea Aphid, *Aphis craccivora* Koch (Homoptera: Aphididae) on Five Cowpea *Vigna unguiculata* (L. Walp.) Varieties*. J. Pest. Sci.,* **83**: 9-14.
33. Ozgokce, M. S. and Altihan, R. 2005. Biological Features and Life Table Parameters of the Mealy Plum Aphid *Hyalopterus pruni* on Different Apricot Cultivars. *Phytoparasitica,* **33**: 7-14.
34. Pike, K. S. and Schaffner, R. L. 1985. Development of Autumn Populations of Cereal Aphids, *Rhopalosiphum padi* (L.) and *Schizaphis graminum* (Rondani) (Homoptera: Aphididae) and Their Effects on Winter Wheat in Washington State. *J. Econ. Entomol.,* **78**: 676– 680.
35. Rago, P. J. and Dorazio, R. M. 1984. Statistical Inference in Life-table Experiments: the Finite Rate of Increase. *Can. J. Fish. Aquat. Sci.,* **41**:1361-1374.
36. Rezvani, A. 2001. *Key to the Aphids (Homoptera: Aphidinea) in Iran.* 1st Edition, Agricultural Research, Education and Extension Organization, Ministry of Jihad-e-Agriculture, 304 PP. (in Persian).
37. Robinson, J. 1992. Modes of Resistance in Barley Seedlings to Six Aphid (Homoptera: Aphididae) Species. *J. Econ. Entomol.* **85**: 2510-2515.
38. SAS Institute. 1988. *SAS/ STAT Users̓ Guide*, *Release 6.03 Editions*. SAS Institute, Cary, NC, USA.
39. 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.
40. van Lenteren, J. C and Noldus, L.P.J. J. 1990. Whitefly-plant Relationship: Behavioral and Ecological Aspects. In "*Whiteflies: Their Bionomics, Pest Status and Management*", (Ed.): Gerling, D.. Intercept, Andover, England, PP. 47-89.
41. Wang, H., Wu, K., Liu, Y., Wu, Y. and Wang, X. 2015. Integrative Proteomics to Understand the Transmission Mechanism of *Barley Yellow Dwarf Virus-GPV* by Its Insect Vector *Rhopalosiphum padi. Sci. Rep.,* **5**:10971.
42. Wiktelius, S. and Ekbom, B. S. 1985. Aphids in Spring Sown Cereals in Central Sweden: Abundance and Distribution 1980–1983. *Z. Angew. Entomol.,* **100**: 8–16.
43. Žanić, K., Ban, D., Gotlin Čuljak, T., Goreta Ban, S., Dumičić, G., Haramija, J. and Žnidarčič, D. 2013. Aphid Populations (Hemiptera:Aphidoidea) Depend of Mulching in Watermelon Production in the Mediterranean Region of Croatia. *Span. J. Agric. Res.*, 11(4): 1120-1128.
44. Zarpas, K. D., Margaritopoulos, J. T., Stathi, L. and Tsitsipis, J. A. 2006. Performance of Cotton Aphid *Aphis gossypii* (Hemiptera; Aphididae) Lineages on Cotton Varieties. *Int. J. Pest Manage.,* **52**: 225-232.

دموگرافی شتهٔ برگ برنج *Rhopalosiphum padi* L. (Hemiptera: Aphididae) روی واریته‌های مختلف جو

ل. کرمی، م. امیرمعافی، ش. شاهرخی، س. ایمانی، و م. شجاعی

چکیده

پارامترهای جدول زندگی شته (*Rhopalosiphum padi* L.) روی ارقام مختلف جو بررسی شد. آزمایش در آزمایشگاه موسسه تحقیقات گیاه‌پزشکی کشور با دمای ۱±۲۶ درجه سلسیوس، رطوبت نسبی ۵±۶۵ درصد و دوره نوری ۱۶ ساعت روشنایی و ۸ ساعت تاریکی انجام شد. برای این منظور پوره‌های سن یک تازه متولد شده و هم‌سن با استفاده از قفس برگ به تفکیک روی برگ‌های شش رقم جو پرورش داده شدند. طول دورهٔ رشدی سنین مختلف پورگی، تلفات، طول عمر و باروری حشرات کامل حاصل با آماربرداری روزانه ثبت شد. بقای پوره‌ها روی ارقام مورد بررسی از ۷۱ درصد تا ۸۸ درصد متغیر بود. ارقام جو از نظر پارامترهای رشد جمعیت شته *R. padi* تفاوت معنی‌داری نشان دادند. نرخ ذاتی افزایش جمعیت شته از ۰/۳۱۸ (ماده/ماده/روز) روی رقم والفجر تا ۰/۳۶۶ (ماده/ماده/روز) روی رقم ریحان۰۳ متغیر بود. همچنین کمترین و بیشترین مقادیر پارامترهای نرخ متناهی افزایش جمعیت، نرخ خالص تولید مثل، میانگین مدت زمان یک نسل و مدت زمان دو برابر شدن جمعیت روی ارقام جو به‌ترتیب ۱/۳۷ و ۱/۴۴ (در روز)، ۴۳/۸۳ و ۶۰/۶۵ (ماده/ماده/نسل)، ۱۱/۱۹ و ۱۱/۸۶ روز و ۱/۸۹ و ۲/۱۷ روز به‌دست آمد. با توجه به نتایج به‌دست آمده، والفجر و فجر۳۰ نسبت به سایر رقم ها حساسیت کمتری نسبت به شته برگ برنج نشان دادند و ریحان۰۳، کویر و زرجو حساسیت بیشتری داشتند. همچنین رقم نصرت تفاوت معنی‌داری با سایر رقم‌ها نداشت.

[DOR: 20.1001.1.16807073.2016.18.5.22.8]