J. Crop Prot. 2013, 2 (3): 331-341

The Effect of Wheat Cultivars on Biological Attributes of Bird Cherry-Oat Aphid, *Rhopalosiphum padi* (Homoptera: Aphididae)

Jabraeil Razmjou* and Ali Golizadeh

Department of Plant Protection, Faculty of Agriculture, University of Mohaghegh Ardabili, P. O. Box 179, Ardabil, Iran.

Abstract: The Bird cherry-oat aphid, *Rhopalosiphum padi* (L.) is a serious threat to several cereal crops. Host-plant resistance to this aphid could be especially valuable in cereal crops pest management. Therefore, we evaluated the development, survivorship, reproduction and population growth parameters of *R. padi* as resistance indices among six wheat cultivars, including Gaskojen, Tajan, Falat, Saysonz, Kras and Sardari at 25 °C under laboratory conditions. The development time and fecundity of aphid differed significantly among the tested wheat cultivars. The r_m values were highest for aphids reared on Sardari and lowest on Gaskojen and intermediate on Tajan, Saysonz and Kras cultivars. Aphid showed the longest development time and the lowest fecundity, reflecting in the lowest r_m value on Gaskojen cultivar. Consequently, Gaskojen showed more positive characteristics and was relatively not susceptible cultivar that could be considered for planning a comprehensive IPM program of *R. padi*.

Keywords: Biological attributes, plant resistance, *Rhopalosiphum padi*, wheat cultivar

Introduction

Wheat, *Triticum aestivum* L. (Poaceae), is the most important cereal cultivated widely in Iran. According to the Iranian Ministry of Jihad-e-Agriculture's reports, it is planted on more than 7,200,000 ha of land in this country. Cereal aphids can cause serious problem in wheat growing areas (Dixon 1987). Various aphids in Iran, including The bird cherry-oat aphid, *Rhopalosiphum padi* (Homoptera: Aphididae), at high population levels can considerably reduce the quantity and quality of cereal crops.

The bird cherry-oat aphid, *R. padi* is usually part of a complex of cereal aphids that infest small grains. It is recognized as a serious insect pest of cereals nearly worldwide and is one of the main vectors of *Barley yellow dwarf virus* (BYDV) which can cause disease and further yield loss in small grains (McGrath and Bale 1990; Bauske *et al.,* 1997; Herbert *et al.,* 1999; Riedell *et al.,* 1999; Blackman and Eastop 2000; Chapin *et al.,* 2001). *R. padi* has become one of the most important pests of cereals in Europe including England, Scandinavian countries and some areas of Turkey (Leather *et al.,* 1989; Blackman and Eastop 2000; Legrand and Barbosa 2000). This aphid causes severe damage in cereal-producing countries (Papp and Mesterházy 1993). In Iran, *R. padi* is one of the most abundant and economically important aphids on wheat (Taheri *et al.,* 2010), damaging hosts both by direct feeding (sucking the sap) and depriving the nutrients of plant which causes 40–60 % yield loss and by transmitting BYDV which is able to cause a yield loss of up to

Handling Editor: Dr. Yaghoub Fathipour

* **Corresponding author**, e-mail: razmjou@uma.ac.ir
Received: 2 November 2012; Accepted: 18 May 2013

85% (Papp and Mesterházy 1993; Stern 1967). Controlling the aphid populations can prevent damage, reduce frequency of BYDV, and sustain yield of small grains (Power and Gray 1995). Hence, strategies to manage *R. padi* should be defined.

Various chemical, biological, and cultural control strategies could be used for limitation of cereal aphid infestations (Holtzer *et al.,* 1996; Brewer and Elliott 2004). As is known, the application of chemical pesticides has resulted in the subsequent harmful effects such as development of resistance to chemical insecticides, health hazards from residues and in declining the natural enemies' populations (e. g., Llanderal-Cazares *et al.,* 1996; Bielza 2008; Saleem *et al.,* 2008). To reduce pesticides, destructive effects, scientists are endeavoring to find alternative safe procedures for pest control in the field. Improving host plant resistance is a desirable and suitable approach for limiting aphid populations because it is a cost-effective, safe and environmentally sound strategy and decreases dependence on chemical insecticides (Panda and Khush 1995; Robinson *et al.,* 1991; Webster et al., 1991; Hesler et al 1999; Li *et al.,* 2004; Razmjou and Golizadeh 2010). Plants vary in morphological characteristics, nutritional values and secondary metabolites. These traits can influence the survival, development, and fecundity of aphids (Weathersbee and Hardee 1994; Cisneros and Godfrey 2001; Tsai and Wang 2001). Poor nutritional quality of a host plant can reduce the fecundity and increase the immature developmental time of a pest (Legrand and Barbosa 2000).

Therefore, our objective in this study was to determine the development, longevity and reproductive potential of apterous viviparous aphid in relation to wheat cultivars.

Materials and Methods

This study was conducted during 2009 in the laboratory of plant protection department, University of Mohaghegh Ardabili, Ardabil, Iran.

Rearing of aphid colony

The original aphid colonies used in the experiments were collected from wheat field in the Research Station, Faculty of Agriculture (Babelan Research Station), University of Mohaghegh Ardabili, Ardabil in October 2009. The colonies were established on wheat seedlings cv Hirmand in wood-framed cages for preventing from infestation by other insects in the greenhouse.

Plant material and initial test

The seeds of wheat cultivars used in this study were obtained from the Agriculture and Natural Resources Research Institute of Moghan, Ardabil province, Iran. The six *T. aestivum* cultivars used in this study were selected on the basis of a preliminary evaluation in another experiment in the greenhouse. For this purpose, about 23 common wheat cultivars were used in preliminary experiment and all cultivars were planted in 12-cm plastic pots in greenhouse. About 10 potted plants of each cultivar were used for experiment. Each potted plant was confined inside a cylindrical transparent cage (10 cm diameter × 20 cm height) top of which were covered with fine mesh cloth to prevent escape. All plants were infested at two-leaf growth stage with two adult aphids. After 24 hour, the adults were removed and only three newly born nymphs maintained on each potted plant. After two weeks, all remaining nymph and adults on potted plants were counted and based on aphid density on each cultivar, three relatively resistant cultivars (Gaskojen, Saysonz and Sardari) and three relatively susceptible cultivars (Kras, Tajan and Falat) were selected for the following main experiments. Seeds of the six selected cultivars were sown in 12-cm plastic pots filled with proper field soil. The plant rearing was carried out at 25 ± 5 °C, 60 ± 10% R. H. and a photoperiod of (approximately) 10: 14 h (L: D) with ambient light in a greenhouse. Overall, 120 potted plants were used in the experiment.

Development and mortality

All experiments were conducted in a growth chamber under conditions of 25 ± 1 °C, 60 ±

10 % R. H. and a photoperiod of 16: 8 h (L: D). All aphids used in the experiments were apterous viviparous adults of similar size. For evaluation of developmental duration and survivorship of immature stages, fecundity and adult longevity, adult apterous aphids were randomly selected from the rearing colonies and placed on the potted plant using a fine-hair brush. All plants were infested at two-leaf growth stage. Each potted plant was confined inside a cylindrical transparent cage (10 cm diameter × 20 cm height) top of which was covered with fine mesh cloth to prevent escape and parasitism. Before using the plants in the experiments, they were checked and cleaned from aphids and other pests if required (Razmjou *et al.,* 2009). Aphids were then permitted to produce nymphs for 24 hours. After this time, the adults were removed and only a cohort of three newly born nymphs were maintained on each potted plant for determining nymphal biological parameters (Razmjou *et al.,* 2006). Overall 20 potted plants of each wheat cultivar were used for experiments. Development and survival rate of 60 nymphs were assessed on each cultivar.

Reproduction and biological attributes

After maturity and at the beginning of reproduction, only one newly emerged adult aphid was selected and maintained on each potted plant confined inside a cylindrical transparent cage as mentioned above. Then, mortality and fecundity of this apterous aphid was recorded and offspring were removed from each plant daily until the death of the adult aphid for insuring an effective monitoring of the aphid's lifespan. In this way we evaluated the fecundity of 18-20 adult aphids per each cultivar. The reproductive period, post-reproductive period, adult longevity and age-specific fecundity were determined. The intrinsic rate of increase (r_m), mean generation time (T), finite rate of increase (λ), doubling time (DT) and net reproduction rate (R_0) were calculated using Carey's formulae (Carey 1993).

Statistical analysis. Effect of wheat cultivars on the developmental time, reproduction period and adult longevity were analyzed with one-way ANOVA. If significant differences were detected, multiple comparisons were made using the SNK procedure ($P < 0.05$). Statistical analysis was performed using the SPSS v. 13.0 statistical program (SPSS, 2004). Differences in R_0, T, λ, DT and r_m values were tested for significance by estimating variances through the Jackknife procedure (Meyer *et al.,* 1986; Maia *et al.,* 2000). Algorithms for jackknife estimation of the means and variances are described only for r_m. Similar procedures were used for the other parameters (R_0, T, λ and DT). In the first step, life table parameters were estimated by Carey's equations considering the survival and reproduction data for all the n females ($r_{m\,(all)}$). Then this procedure was repeated for n times, each time excluding a different female (data of n-1 females, $r_{m\,(j)}$). The pseudo-values are calculated for each parameter for n samples using the following equation:

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

After calculating the n pseudo-values for r_m, jackknife estimate of the mean ($r_{m(mean)}$) and standard error ($SEr_{m(mean)}$) were calculated by equations in Maia *et al.,* (2000) using the SAS System ver. 8.2. (SAS Institute, 1989). The mean values of (n-1) jackknife pseudo-values for each cultivar were subjected to analysis of variance using the SPSS statistical programs.

Results

The results achieved in the experiments on biological attributes including nymphal mortality, developmental time of immature stages, adult longevity and fecundity as well as life table parameters of *R. padi* are presented in Tables 1 and 2, respectively.

Table 1 Developmental time, reproductive period, mean number of nymphs per aphid per day, adult longevity and mean nymphs per female of *Rhopalosiphum padi* reared on six wheat cultivars at 25 ºC.

Cultivars	Parameters				
	Developmental Time (d)	Fecundity	Reproductive period (d)	Mean number of nymphs/aphid/d	Adult Longevity (d)
Gaskojen	7.90 ± 0.06a	22.95 ± 2.56b	11.25 ± 1.56b	2.35 ± 0.19b	13.50 ± 1.98a
Tajan	7.40 ± 0.08c	37.35 ± 4.37a	14.30 ± 1.80ab	2.79 ± 0.14ab	16.30 ± 2.05a
Falat	7.60 ± 0.09abc	36.55 ± 3.38a	14.72 ± 1.56ab	2.64 ± 0.15ab	16.89 ± 1.96a
Saysonz	7.55 ± 0.11bc	39.95 ± 2.51a	18.00 ± 1.53a	2.39 ± 0.15b	19.95 ± 1.76a
Kras	7.79 ± 0.11ab	36.25 ± 3.85a	15.40 ± 1.81ab	2.51 ± 0.14b	17.25 ± 2.16a
Sardari	7.40 ± 0.08c	36.50 ± 3.63a	12.25 ± 1.26ab	3.14 ± 0.20a	14.15 ± 1.60a

For each parameter, differences between wheat cultivars were determined by SNK tests. Within columns, means followed by the same letter(s) are not significantly different (P > 0.05).

Table 2 Life table attributes of *Rhopalosiphum padi* reared on six wheat cultivars at 25 ºC.

Cultivars	Parameters				
	Net reproduction rate (R_0)	Intrinsic rate of increase (r_m)	Mean generation time (T)	Doubling time (DT)	Finite rate of increase (λ)
Gaskojen	18.68 ± 2.08b	0.253 ± 0.007c	11.57 ± 0.47a	2.73 ± 0.07a	1.288 ± 0.009c
Tajan	33.50 ± 3.92a	0.281 ± 0.008b	12.50 ± 0.56a	2.46 ± 0.07b	1.325 ± 0.010b
Falat	32.50 ± 3.00a	0.288 ± 0.006ab	12.11 ± 0.37a	2.41 ± 0.05bc	1.333 ± 0.008ab
Saysonz	33.28 ± 2.15a	0.279 ± 0.004b	12.55 ± 0.33a	2.48 ± 0.04b	1.322 ± 0.006b
Kras	32.55 ± 3.46a	0.273 ± 0.006b	12.76 ± 0.48a	2.53 ± 0.05b	1.314 ± 0.008b
Sardari	31.71 ± 3.16a	0.306 ± 0.008a	11.31 ± 0.46a	2.26 ± 0.06c	1.358 ± 0.011a

For each parameter, differences between wheat cultivars were determined by SNK tests. Within columns, means followed by the same letter(s) are not significantly different ($P > 0.05$).

Development and mortality

There were significant differences among developmental time of nymphs on wheat cultivars tested, and three statistical groups were observed for development time of bird cherry-oat on six wheat cultivars (F = 5.01, df = 5, 284, P = 0.000). The shortest and longest nymphal durations were observed on Tajan and Sardari (7.4 days) and Gaskojen (7.9 days), respectively (Table 1). The lowest survival rate from first instar nymphal to adult emergence was obtained on Gaskojen, and the lowest survival rate was observed on Tajan and Kras cultivars and the proportions of nymphal stages surviving to adulthood ranged from 0.81 to 0.89 on Gaskojen and Tajan-Kras wheat cultivars, respectively (Fig. 1). The age-specific survival rate (l_x) of *R. padi* on six wheat cultivars is shown in Fig. 1.

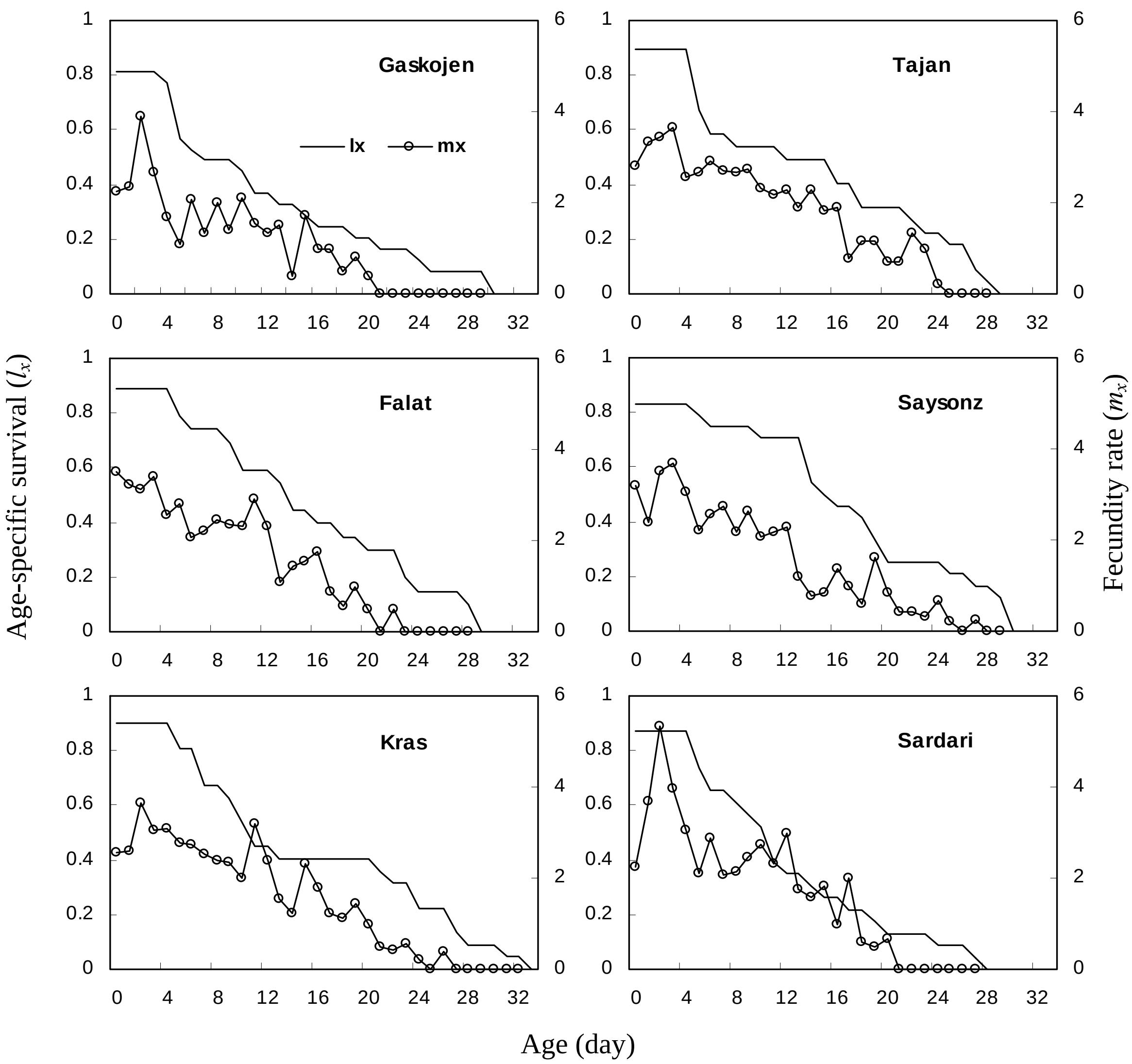

Figure 1 Age-specific survival (l_x) (adult stage) and fecundity rate (m_x) of *Rhopalosiphum padi* reared on six wheat cultivars at 25 ºC.

Adult longevity and fecundity

There were no significant differences in adult longevity of *R. padi* feeding on the wheat cultivars examined in this study (F = 1.48, df = 5, 117, P = 0.203). The reproduction period of the bird cherry-oat aphid significantly varied among the wheat cultivars (F = 2.26, df = 5, 117, P = 0.048) (Table 1) and this period on Saysonz cultivar was the longest. The total fecundities of adult also differed significantly among wheat cultivars tested (F = 3.09, df = 5, 117, P = 0.012) and ranged from 22.95 to 39.95 offsprings on Gaskojen and Saysonz, respectively. In addition, the mean number of nymphs per female per day of *R. padi* was significantly affected by wheat cultivars (F = 3.30, df = 5, 117, P = 0.008). Aphids reared on the Sardari cultivar produced the highest mean number of nymphs per female per day, whereas none of the other cultivars was significantly different from each other in the number of offspring per day (Table 1, Fig. 1). The age specific fecundity rate (m_x, female offspring per female per day) of *R. padi* on six wheat cultivars is shown in Fig. 1.

Life table parameters

Population growth parameters of viviparous apterous *R. padi* were significantly affected by wheat cultivars. The intrinsic rate of increase (r_m) value exhibited a significant difference on wheat cultivars (F = 6.98, df = 5, 117, P = 0.000). The highest intrinsic rate of increase for wheat cultivar occurred on Sardari, and it was significantly higher than that of all other cultivars. The r_m values of aphids reared on Gaskojen cultivar were the lowest, while aphids reared on Tajan, Falat, Saysons and Kras achieved intermediate values of r_m (Table 2). In addition, significant variation in the net reproductive rate (R_0) values of the aphid was observed among wheat cultivars (F = 3.65, df = 5, 117, P = 0.004). The R_0 values ranged from 18.68 to 31.71 offsprings/aphid. The aphids reared on Gaskojen showed the lowest R_0 value that was significantly different from that on the other cultivars (Table 2). The shortest and longest mean generation times (T) were found on Sardari and Kras, respectively, however, there was no significant difference among T of *R. padi* feeding on cultivars tested (F = 1.68, df = 5, 117, P = 0.146). A dissimilar trend was displayed for doubling time (DT) and its value exhibited a significant difference on wheat cultivars (F = 7.15, df = 5, 117, P = 0.000). The variations of the finite rate of increase (λ) were similar to intrinsic rate of increase and this parameter was significantly influenced by wheat cultivar (F = 6.93, df = 5, 117, P = 0.000) (Table 2).

Discussion

Understanding the life cycle traits of an insect pest on host plants is essential to the development of an effective integrated pest management (IPM) strategy. Hence, the knowledge of population growth parameters of any pest could be useful in designing of a comprehensive pest management program for its host plant. Host plant quality, typically a major determinant of pest performance, influences the growth and fecundity of herbivorous insects on both individual and population scales (Awmack and Leather 2002). The degree of resistance exhibited by a host plant cultivar against a particular herbivore can be measured by the variation in insect performance on that host. The life table parameters (especially intrinsic rate of increase) can be used commonly as measures of performance to assess the level of plant resistance to insect herbivores (Dixon 1987; Castle and Berger 1993; Ruggle and Guitierrez 1995; Golizadeh and Razmjou 2010).

The present experiments demonstrated that under the laboratory conditions used, performance of the bird cherry-oat aphid on different wheat cultivars was similar for some traits such as adult longevity, but differed significantly for others such as the nymphal development and mean reproduction periods, lifetime and daily fecundity among the six wheat cultivars tested. *R. padi* showed the shortest and longest development time on Gaskojen and Sardari cultivars, respectivly.

Another important biological parameter that determines the success or failure of an insect pest is fecundity. Both Shorter developmental time and greater total reproduction of insects on a host indicate greater suitability of a host plant (van Lenteren and Noldus 1990; Golizadeh and Razmjou 2010). The poor performance of aphids on Tajan cultivar was a result of both poor fecundities and longer developmental times. The lower nymphal survival on Gaskojen cultivar would also be a contributing factor. These effects of host plants can play a role in pest population dynamics by affecting immature and adult performance (Morgan *et al.,* 2001; Liu *et al.,* 2004). In current study, the total fecundity on Gaskojen cultivar was the lowest. The significant difference in developmental time on wheat cultivars in current study can be related to nutritional and defensive components or their interacting effects. van Emden and Bashford (1969) stated that variation in performance on different cultivars could be due to differences in plant quality, either reflected in differences in nutrients required by aphids or differences in the levels of secondary compounds.

The net reproductive rate is an important indicator of population dynamics (Richard 1961; Varley and Gradwell 1970; Liu *et al.,* 2004). The significant differences in R_0 values between cultivars reflects the significant difference in intrinsic rates of increase (r_m) among wheat cultivars. However, the mean generation time (T) displayed non-significant difference among cultivars examined. The mean r_m of aphids on Sardari was the greatest (0.306 offsprings/aphid/d), while that on Gaskojen was the poorest (0.253 offsprings/aphid/d) and those on others were intermediate. This parameter (r_m) is a useful tool to measure the influence of various environmental conditions including host plants on the development of an insect population (Aldyhim and Khalil 1993).

van Lenteren and Noldus (1990) stated that shorter developmental time and greater total fecundity on a host might be a reflection of the host plant suitability. Since intrinsic rate of increase (r_m) contributes to many factors (such as fecundity, survival and generation time) and adequately summarizes the physiological qualities of an animal in relation to its capacity to increase, it would be a most appropriate index to evaluate performance of an insect on different host plants and host resistance (Southwood and Henderson 2000). The developmental time, reproduction period, fecundity, survival rate, and population growth parameters especially intrinsic rate of increase could be regarded as susceptibility indices on host plants. Plants capable of antibiosis may cause reduced survival rate, reduced adult longevity, and fecundity, or they may cause prolonged developmental time and have an indirect effect by increasing the exposure of the insect to its natural enemies (Dent 2000).

In conclusion, our data presented in this work address new information on fecundity and development rates as well as demographic parameters of *R. padi* which obviously document that various wheat cultivars examined here differ considerably in terms of their quality as hosts for the bird cherry-oat aphid, an important pest of wheat. The Gaskojen wheat cultivar showed more positive characteristics compared with the other cultivars used in this study and this cultivar had the highest resistance against *R. padi*. It was the least favorable of the hosts evaluated for bird cherry-oat aphid as indicated by the long developmental time, somewhat low survival rate of immature stages and somewhat low reproductive rate resulting in a lower value of r_m on Gaskojen. These characteristics could cause reductions in fitness of bird cherry-oat aphid. Gaskojen as a relatively insusceptible host plant, therefore, can serve as an important tool for *R. padi* management with reduced input of insecticides.

Acknowledgments

The authors would like to thank the Agriculture and Natural Resources Research Institute of Moghan, for providing the seeds of different wheat cultivars tested in this study. We also gratefully acknowledge H. Tavakkoli and A. Fallahi (from University of Mohaghegh Ardabili) for their valuable help in the experiment. This work was financially supported by University of Mohaghegh Ardabili, Arabil, Iran.

References

Aldyhim, Y. N., and Khalil, F. 1993. Influence of temperature on population development of *Aphis gossypii* on *Cucurbita pepo.* Entomologia Experimentalis et Applicata, 67: 167-122.

Awmack, C. S., and Leather, S. R. 2002. Host plant quality and fecundity in herbivorous insects. Annual Review of Entomology, 47: 817-844.

Bauske, E. M., Bissonnette S. M., and Hewings, A. D. 1997. Yield loss assessment of barley yellow dwarf disease on spring oat in Illinois. Phytopathology, 81: 485-488.

Bielza, P. 2008. Insecticide resistance management strategies against the western flower thrips, *Frankliniella occidentalis*. Pest Management Science, 64: 1131-1138.

Blackman, R. L., and Eastop, V. F. 2000. Aphids on the World's Crops. An Identification and Information Guide. 2nd ed. John Wiley and Sons Ltd., London. 375 pp.

Brewer, M. J., and Elliott, N. C. 2004. Biological control of cereal aphids in North America and mediating effects of host plant and habitat manipulations. Annual Review of Entomology, 49: 219-242.

Carey, J. R., 1993. Applied Demography for Biologists, with Special Emphasis on Insects. Oxford University Press, Oxford. 206 pp.

Castle, S. J., and Berger, P. H. 1993. Rates of growth and increase of *Myzus persicae* on virus-infected potatoes according to type of virus-vector relationship. Entomologia Experimentalis et Applicata, 69: 51-60.

Chapin, J. W., Thomas, J. S., Gray, S. M., Smith D. M., and Halbert, S. E. 2001. Seasonal abundance of aphids (Homoptera: Aphididae) in wheat and their role as barley yellow dwarf virus vectors in the South Carolina coastal plain. Journal of Economic Entomology, 94: 410-421.

Cisneros, J. J., and Godfrey, L. D. 2001. Midseason pest status of the cotton aphid (Homoptera: Aphididae) in California cotton: is nitrogen a key factor? Environmental Entomology, 30: 501-510.

Dent, D., 2000. Host plant resistance. In Insect pest management (D. Dent, Ed.). 2nd ed. CABI Publishing, Wallingford, Oxfordshire, United Kingdom, pp. 123-179.

Dixon, A. F. G., 1987. Cereal aphids as an applied problem. Agricultural Zoology Review 2: 1-57.

Golizadeh, A., and Razmjou, J. 2010. Life Table Parameters of *Phthorimaea operculella* (Lepidoptera: Gelechiidae), Feeding on Tubers of Six Potato Cultivars. Journal of Economic Entomology, 103: 966-972

Halbert, S., and Voegtlin, D. 1995. Biology and taxonomy of vectors of barley yellow dwarf viruses. In Barleyy ellow dwarf 40 years of progress (C. J. D'Arcy and P. A. Burnett, eds.). APS Press, St. Paul, MN, pp. 217-258.

Herbert, D. A., Stromberg, E. L., Chappell, G. F., and Malone, S. M. 1999. Reduction of yield components by barley yellow dwarf virus in Virginia. Journal of Production Agriculture, 12: 105-109.

Hesler, L. S., Riedell, W. E., Kieckhefer, R. W., Haley S. D., and Collins, R. D. 1999. Resistance to *Rhopalosiphum padi* (Homoptera: Aphididae) in wheat germplasm accessions. Journal of Economic Entomology, 92: 1234-1238.

Holtzer, T., Anderson, R. L., McMullen, M. P., and Peairs, F. B. 1996. Integrated pest management of insects, plant pathogens, and weeds in a dry land cropping system. Journal of Production Agriculture, 9: 200-208.

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. Bulletin of Entomological Research, 79: 345-360.

Legrand, A., and Barbosa, P. 2000. Pea aphid (Hom.: Aphididae) fecundity, rate of increase, and within plant distribution unaffected by plant morphology. Environmental Entomology, 29: 987-993.

Li, Y., Hill, C. B., and Hartman, G. L. 2004. Effect of three resistant soybean genotypes on the fecundity, mortality, and maturation of soybean aphid (Homoptera: Aphididae). Journal of Economic Entomology, 97: 1106-1111.

Liu, Z., Li, D., Gong, P., and Wu, K. 2004. Life table studies of the cotton bollworm, *Helicoverpa rmigera* (Hu¨ bner) (Lepidoptera: Noctuidae), on different host plants. Environmental Entomology, 33: 1570-1576.

Llanderal-Cazares, C., Lagunes-Tejada, A., Carrillo-Sanchez, J. L., Sosa-Moss, C., Vera-Graziano, J. and Bravo-Ojica, H. 1996. Susceptibility of *Phthorimaea operculella* (Zeller) to insecticides. Journal of Entomological Science, 31: 420-426.

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

McGrath, P. F., and Bale, J. S. 1990. The effects of sowing date and choice of insecticide on cereal aphids and barley yellow dwarf virus epidemiology. Annals of Applied Biology, 117: 31-43.

Meyer, J. S., Igersoll, C. G., MacDonald, L. L. and Boyce, M. S. 1986. Estimating uncertainty in population growth rates: Jackknife vs. Bootstrap techniques. Ecology. 67: 1156-1166.

Morgan, D., Walters, K. F. A. and Aegerter, J. N. 2001. Effect of temperature and cultivar on pea aphid, *Acyrthosiphon pisum* (Hemiptera: Aphididae) life history. Bulletin of Entomological Research, 91: 47-52.

Panda, N., and Khush, G. S. 1995. *Host plant resistance to insects*. CAB International, Oxon, United Kingdom. 431 pp.

Papp, M., and Mesterházy, A. 1993. Resistance to bird cherry-oat aphid (*Rhopalosiphum padi* L.) in winter wheat varieties. Euphytica. 67: 49-57.

Powell, G., and Hardie, J. 2001. The chemical ecology of aphid host alternation: How do return migrants find the primary host plant? Applied Entomology and Zoology, 36: 259-267.

Power, A. G., and Gray, S. M. 1995. Aphid transmission of barley yellow dwarf viruses: interactions between virus, vectors, and host plants. In Barley yellow dwarf 40 years of progress (C. J. D'Arcy and P.A. Burnett, eds.), ARS Press, St. Paul, MN, pp. 259-289.

Razmjou, J., and Golizadeh, A. 2010. Performance of corn leaf aphid, *Rhopalosiphum maidis* (Fitch) (Homoptera: Aphididae) on selected maize hybrids under laboratory conditions. Applied Entomology and Zoology, 45: 267-274.

Razmjou; J., Moharramipour S., Fathipour Y., and Mirhoseini, S. Z. 2006. Effect of cotton cultivar on performance of *Aphis gossypii* (Homoptera: Aphididae) in Iran. Journal of Economic Entomology, 99: 1820-1825.

Razmjou, J., Tavakkoli, H., and Fallahi, A. 2009. Effect of soybean cultivar on life history parameters of *Tetranychus urticae* Koch (Acari: Tetranychidae). Journal of Pest Science, 82: 86-92.

Richard, O. W., 1961. The theoretical and practical study of natural insect populations. Annual Review of Entomology, 6: 147- 162.

Riedell, W. E, Kieckhefer, R. W., Haley, S. D., Langham, M. A. C., and Evenson, P. D. 1999. Winter wheat responses to bird cherry-oat aphid and barley yellow dwarf virus infection. Crop Science, 39: 158-163.

Robinson, J., Vivar, H. E., Burnett, P. A., and Calhoun, D. S. 1991. Resistance to Russian wheat aphid (Homoptera: Aphididae) in barley genotypes. Journal of Economic Entomology, 84: 674-679.

Ruggle; P.; and Gutierrez; A. P. 1995. Use of life tables to assess host plant resistance in alfalfa to *Therioaphis trifolii* f. *maculate* (Homoptera: Aphididae): hypothesis for maintenance of resistance. Environmental Entomology, 24: 313-325.

Saleem, M. A., Ahmad, M., Aslam, M., and Sayyed, A. H. 2008. Resistance to selected organochlorin, organophosphate, carbamate and pyrethroid, in *Spodoptera litura* (Lepidoptera: Noctuidae) from Pakistan. Journal of Economic Entomology, 101: 1667-1675.

SAS Institute, 1989. Release 8.02. SAS Institute, Cary, NC.

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

Southwood, T. R. E., and Henderson, P. A. 2000. Ecological methods. 3rd ed. Blackwell, Oxford, United Kingdom. 575 pp.

SPSS Inc, 2004. SPSS base 13.0 user's guide. SPSS Inc., Chicago, IL.

Stern, V. M., 1967. Control of the aphids attacking barley and analysis of yield increases in the Imperial Valley, California. Journal of Economic Entomology, 60: 485-490.

Taheri, S.Razmjou, J. and Rastegari, N. 2010. Fecundity and Development Rate of the Bird Cherry-oat Aphid, *Rhopalosiphum padi* (L.) (Hom.: Aphididae) on Six Wheat Cultivars. Plant Protection Science, 2: 72-78.

Tsai, J. H., and Wang, J. J. 2001. Effects of host plant on biology and life table parameters of *Aphis spiracola* (Hom.: Aphididae). Environmental Entomology, 30: 44-50.

van Emden, H.F., 1991. The role of host plant resistance in insect pest mis-management. Bulletin of Entomological Research, 81: 123-126.

van Emden, H. F., and Bashford, M. A. 1969. A comparison of the reproduction of *Brevicoryne brassicae* and *Myzus persicae* in relation to plant age and leaf amino acids. Entomologia Experimentalis et Applicata, 14: 349-360.

van Lenteren, J. C., and Noldus, L. P. J. J. 1990. Whitefly plant relationships, behavioral and ecological aspects. In White flies: their bionomics, pest status and management intercept (D. Gerling ed.). Andover, Hamshire, United Kingdom, pp. 47-89.

Varley, G. C., and Gradwell, G. R. 1970. Recent advance in insect population dynamics. Annual Review of Entomology, 15: 1-24.

Weathersbee III, A. A., and Hardee, D. D. 1994. Abundance of cotton aphids and associated biological control agents on six cotton cultivars. Journal of Economic Entomology, 87: 258-265.

Webster, J. A., Baker, C. A. and Porter, D. R. 1991. Detection and mechanisms of Russian wheat aphid (Homoptera: Aphididae) resistance in barley. Journal of Economic Entomology, 84: 669-673.

اثر برخی از ارقام گندم روی ویژگی‌های زیست‌شناسی شته برگ یولاف (*Rhopalosiphum padi* L.)

جبرائیل رزمجو[1] و علی گلی‌زاده[2]

گروه گیاه‌پزشکی دانشگاه محقق اردبیلی، اردبیل، ایران
* پست الکترونیکی نویسنده مسئول مکاتبه: razmjou@uma.ac.ir
دریافت: ۱۲ آبان ۱۳۹۱؛ پذیرش: ۲۸ اردیبهشت ۱۳۹۲

چکیده: شته برگ یولاف، *Rhopalosiphum padi* (L.) خطر بسیار جدی برای بسیاری از غلات است. مقاومت گیاهان میزبان به این شته می‌تواند به‌ویژه در مدیریت آفات این محصولات ارزشمند باشد. به‌همین دلیل، در این تحقیق طول دوره‌ی پورگی، بقاء، تولید مثل و پارامترهای رشدی جمعیت *R. padi* به‌عنوان شاخص‌های مقاومت، بر روی شش رقم گندم شامل کاسکوژن، تجن، فلات، سایسونز، کراس و سرداری در دمای ۲۵ درجه‌ی سلسیوس تحت شرایط آزمایشگاهی مورد ارزیابی قرار گرفت. طول دوره‌ی پورگی و باروری شته‌ها در نتیجه‌ی تغییرات زیاد در پارامترهای رشدی جمعیت از قبیل نرخ ذاتی افزایش، نرخ خالص تولید مثل، نرخ متناهی افزایش و مدت زمان دو برابر شدن جمعیت به‌طور معنی‌داری بین رقم‌های گندم مورد آزمایش، متفاوت بود. مقادیر r_m برای شته‌های پرورش یافته روی رقم سرداری بیشترین و برای رقم کاسکوژن کمترین و برای شته‌های پرورش یافته روی ارقام تجن، سایسونز و کراس متوسط بود. شته‌ها بیشترین طول دوره‌ی پورگی، کمترین باروری و کمترین مقدار r_m را روی رقم کاسکوژن نشان دادند. در نتیجه این رقم دارای ویژگی‌هایی است که می‌تواند به‌عنوان یک رقم نسبتاً غیرحساس در طراحی یک برنامه‌ی جامع برای مدیریت تلفیقی شته‌ی برگ یولاف مدنظر قرار گیرد.

واژگان کلیدی: ویژگی‌های زیستی، مقاومت گیاهی، *Rhopalosiphum padi*، رقم گندم