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Short Paper

Duration of life stages and fecundity of *Diuraphis noxia* (Hemiptera: Aphididae) on six wheat cultivars

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Abstract: The Russian wheat aphid (RWA), *Diuraphis noxia* has been known as a major pest of small grains, particularly wheat, worldwide. This study evaluated the biological responses of RWA to six wheat cultivars including Yavarus, Pishgam, Aadl, Omid, Darab 2 and Sepahan. The experiment was conducted under greenhouse conditions of 25 ± 2 °C, 55 ± 10 % R. H. and a photoperiod of 16:8 (L: D) h. Resistance or susceptibility of cultivares against the aphid nymphal development time, adult fecundity, daily reproduction, total longevity and adult longevity were investigated. The ANOVA of the data indicated that there were significant differences ($P < 0.05$) among cultivars regarding duration of nymphal development time, fecundity and daily reproduction. The longest mean nymphal development time was obtained on Omid and Sepahan, and the shortest on Yavarus. The highest and the lowest total fecundity were observed on Yavarus and Omid, respectively. Also, the highest and the lowest mean offspring produced per female per day (daily reproduction) was observed on Yavarus and Omid, respectively. On the whole, Yavarus appeared to be susceptible to the Russian wheat aphid while Omid was resistant.

Keywords: wheat, Diuraphis noxia, resistance

Introduction

The Russian wheat aphid (RWA), Diuraphis noxia (Mordvilko), has become one of the most important pests of cereal crops in many wheat-growing areas of the world. It was first reported in 1900 from the Mediterranean region and Southern Russia (Elsidaig and Zwer, 1993). It has also been reported from North and South Africa, Central Asia and the Middle East (Blackman and Eastop, 1984); Mexico (Robinson, 1993); U.S.A. (Kindler and Springer, 1989; Archer and Bynum, 1992) and Canada (Jones *et al*., 1989; Kindler and Springer, 1989).

This aphid feeds on wheat, barley, rye, triticale, oat and a number of grass weeds, amongst which barley, wheat and triticale are highly susceptible to its attack, with oat and rye showing less susceptibility (Melaku *et al*., 1993; Webster *et al*., 1993). Its damage pattern differs from those of the other cereal aphids so that one can identify its occurrence by means of the resulting damage. White or yellow longitudinal bands appear on the leaves due to the feeding effects and injection of salivary toxins which, in colder climates, become red or pinkish due to the existing anthocyanic pigments. The individual aphids feed on the upper surfaces of curled leaves. Young plants become stunted under heavy

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aphid attack and prepanicle infestations can result in curling of the flag leaves and panicle deformations (Jones *et al*., 1989; Kindler and Hammon, 1996). RWA can also be damaging as a vector of plant pathogenic viruses including Barley Yellow Dwarf, Barley brome mosaic, and Barley stripe mosaic (Storlie *et al*., 1993).

The amount of insect damage is different in different regions and in different years according to the host, climatic conditions, host plant conditions and may reach one hundred percent (Najafi Mirak *et al*., 2004; Shekarian *et al*., 2001; Randolpha *et al*., 2005). Hughes and Maywald (1990) stated that this insect can cause the loss of 80 % in wheat yield and 100 % in barley yield of the infected farms.

Plant resistance has been considered as an especially useful way to control *D. noxia*, because the aphid's habit of feeding within rolled wheat leaves may limit the effectiveness of contact insecticides and some natural enemies (Burd *et al*. 1993; Haile *et al*. 1999). Akhtar *et al*. (2010) have evaluated antibiosis resistance of 10 wheat cultivars/lines on *Rhopalosiphum padi* (Linnaeus) fecundity. Results showed that this aphid had the least fecundity on the cultivars Diamond and Wafaq-2007 and had the highest fecundity on the line of V-00125. Özder (2005) examined the nymphal development time and fecundity of Sitobion avenae (Fabricius) on 9 wheat cultivars. Results showed that nymphal development time was variable between 5.75 to 7.2 days and the highest fecundity was observed on Sana cultivar. Foster *et al*. (1988) studied longevity and fecundity *R. padi* on 5 wheat cultivars and 1 oat cultivar. Results showed that this aphid had the highest longevity and fecundity on the oat cultivar.

Since food is one of the effective factors in the growth and development of insects, type and quality of food can affect their growth and reproduction. Therefore in this study, the effect of some wheat cultivars on duration of life stages and fecundity of *D. noxia* was studied to determine the resistant and susceptible cultivars.

Materials and Methods

Insect Rearing

The RWA was collected from the Urmia wheat fields and transferred to the laboratory for morphological identification according to the relevant sources (Blackman and Eastop, 1984). To provide aphid for infecting plants and creating a pure population, aphids were reared on the Mahdavi cultivar (susceptible cultivar).

Plants

Wheat cultivars used in this study were the six wheat cultivars including Darab 2, Omid, Aadl, Sepahan, Pishgam, Yavarus. The seeds of these cultivars were obtained from Department of Plant Breeding, Faculty of Agriculture, Urmia University. The experimental plants were kept under greenhouse conditions of 25 ± 2 ºC, 55 ± 10 % relative humidity and a 16: 8 (L: D) h photoperiod.

Experiments

Five seeds of each wheat cultivar were sown in plastic pots 7cm in diameter and 8 cm in height. The used soil was a mixture of field soil, sand and manure at a rate of 2:1:1. Nymphal development time, adult fecundity, daily reproduction, total longevity and adult longevity were measured according to Webster *et al*. (1994) method with slight modification. Four pots were used for each wheat cultivar. When seedlings attained a height of 5-6 cm, five seedlings of each cultivar were reduced to one per pot. One adult aphid was released on each seedling and then each pot was covered with transparent plastic cage of 30 cm height having mulincloth on top. When these aphids started reproduction on seedling, all the nymphs were removed except one, this nymph was allowed to grow on test cultivars until it was mature and started reproduction parthenogenetically. Number of nymphs

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reproduced daily was counted and they were removed from each seedling until the aphid stopped reproduction and died.

Statistical Analysis

Experiments were designed based on completely randomized design. Statistical analysis of data was performed using SAS statistical package (Version 9.1) and mean comparisons were done by Tukey test at 5 % level.

Results

Statistical analysis of data showed significant differences of nymphal development time among the six wheat cultivars ($F = 3.86$, $df = 5, 18$, $P < 0.05$) (Table 1). The longest nymphal development time was 8.50 days in Sepahan and Omid cultivars and the shortest was 7.00 days in Yavarus cultivar.

Table 1 Duration (days) (Mean ± SE) of different life stage and fecundity of *Diuraphis noxia* on six wheat cultivars.

Parameters	Cultivars					
	Omid	Aadl	Darab 2	Sepahan	Pishgam	Yavarus
Nymphal development time	8.50 ± 0.57 a	8.25 ± 0.50 ab	8.25 ± 0.50 ab	8.50 ± 0.75 a	7.75 ± 0.50 ab	7.00 ± 0.18 b
Total longevity	39.75 ± 7.41 a	44.00 ± 4.08 a	34.25 ± 4.50 a	39.75 ± 6.70 a	39.50 ± 6.40 a	44.50 ± 3.00 a
Adult longevity	31.25 ± 7.18 a	35.75 ± 4.57 a	26.00 ± 4.24 a	31.25 ± 6.18 a	31.75 ± 6.13 a	37.50 ± 2.64 a
Total fecundity	24.00 ± 0.81 c	41.00 ± 9.55 b	37.50 ± 7.14 bc	37.50 ± 7.93 bc	39.50 ± 5.74 bc	61.75 ± 7.93 a
Daily reproduction	1.40 ± 0.19 c	1.74 ± 0.17 bc	2.02 ± 0.20 ab	1.79 ± 0.12 bc	1.89 ± 0.14 bc	2.51 ± 0.43 a

*The means followed by same letter(s) in each row are not significantly different at $P < 0.05$ (Tukey test).

Statistical analysis showed significant differences among the mean total number of offspring produced by *D. noxia* on six wheat cultivars ($F = 11.80$, $df = 5, 18$, $P < 0.05$). RWA had the lowest fecundity on the Omid cultivar with average number of 24 nymphs and had the greatest fecundity on the Yavarus cultivar with average of 61.75 nymphs (Table 1).

There was significant difference among the six wheat cultivars on the basis of the mean aphid offspring produced per female per day (daily reproduction) ($F = 9.42$, $df = 5, 18$, $P < 0.05$). The highest and the lowest number of offspring produced per female were observed on Yavarus and Omid, respectively (2.51 and 1.40 nymph per day, respectively) (Table 1).

Statistical analysis of data showed no significant differences in the total longevity ($F = 1.77$, $df = 5, 18$, $P < 0.05$) and adult longevity ($F = 2.24$, $df = 5, 18$, $P < 0.05$) among the tested cultivars (Table 1).

Discussion

The results of these experiments showed that the host plant has a significant effect on nymphal development time, total fecundity and daily reproduction. In this study, the longest nymphal development time was observed in Sepahan and Omid cultivars. These results are in accordance with Baker *et al*., (1992) who showed that resistant cultivars and lines can cause delayed aphids maturation time. However, Kazemi *et al*. (2002) reported that there were no significant differences in RWA nymphal development time in five wheat cultivars (Sabalan, Sardari, Alvand, Zarin and Alamut) and that the aphid nymphal development time was reported between 8 to 8.53 days on these cultivars. The different results of this study with results of other researchers can be due to differences in the cultivars, the difference between aphid population and the rearing conditions, especially temperature. Change in temperature

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by changing host plant quality directly (Harrington *et al*., 2001) and indirectly (Veteli *et al*., 2002), can affect the susceptibility of plants against herbivores.

In the experiments the lowest total fecundity and daily reproduction were obtained on omid cultivar. The low fecundity of aphid on Omid may be due to the poor food quality in this cultivar. Rassoulian and Doulati (1996) showed in their research that there were significant differences among Argentina, Zarandi Dastjerdi, Rashidi, Shahi, Azar, new Aadl, old Aadl, Naz, Sephideh, Darab and Ghods wheat cultivars regarding mean total number of offspring produced by *D. noxia*. So that the lowest number of nymphs was on the Shahi and Sephideh cultivars and the highest on the new Aadl and old Aadl cultivars. Also, in the study of Kazemi *et al*. (2002) the highest fecundity of *D. noxia* was on the Alvand cultivar with 28.26 offspring and the least number was on the Sardari cultivar with 21.58 nymphs. In the research conducted by Moharamipour *et al*. (2003), the least RWA daily reproduction was in C-A/23 wheat line (1.6 nymphs per day) and the highest daily reproduction in Shole wheat cultivar (2.5 nymphs per day). Differences in reproductive parameters of the pest on the six tested wheat cultivars could be the result of differences in quality and quantity of nutrients for insect growth and development.

In this study, host plants had no effect on the total longevity and adult longevity of *D. noxia*. Randolph *et al*. (2005) and Rassoulian and Doulati (1996) obtained similar results. Shahrokhi *et al*. (2010) showed there were statistical differences among Mahdavi, Kavir, Tabasi, Azadi, Ghods and Nik Nejad wheat cultivars regarding to *Schizaphis graminum* (Rondani) total longevity, as the highest total longevity was on the Mahdavi and Tabasi cultivars. In contrast Fattah-Al-Husseini *et al*. (2011) showed there were no significant differences on the S. graminum adult longevity on Pishtaz, Shiraz, Chamran, Mahdavi and Marvdasht wheat cultivars. Taheri *et al*. (2010) reported that there was a significant difference in the *R. padi* adult longevity on Chamran, Shiraz, Marvdash, Darab 2, Ghods and Nik Nejad wheat cultivars, so that the longest and the shortest adult longevity was observed on Nik Nejad and Darab 2, respectively.

van Emden and Bashford (1969) found that the differences in aphid activity on different cultivars could be related to differences in host quality, quantity and type of secondry compounds and that the food insect feeds on can directly affect its survival and reproduction.

The calculation of nymphal development time, adult fecundity, daily reproduction, total longevity and adult longevity indicated that Yavarus with highest adult fecundity and daily reproduction and shortest nymphal development time was the most susceptible cultivar to RWA. Conversely, Omid cultivar showing the lowest total and daily fecundity rate and the longest nymphal development time of the aphid was the most resistant cultivar. In general, a high level of resistance in Omid compared with the other cultivars may decrease the population density of *D. noxia* on wheat and also result in suppression of cereal viruses thereby reducing the pesticide application in wheat fields of Iran.

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طول مدت مراحل زندگی و باروری شته روسی گندم (*Diuraphis noxia* (Hemiptera: Aphididae روی شش رقم گندم

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چکیده: شته روسی گندم به عنوان یکی از آفات بسیار مهم غلات دانه ریز، به ویژه گندم در سرتاسر جهان شناخته شده است. این شته علاوه بر تغذیه مستقیم از گیاه، با انتقال عوامل بیماری‌زای گیاهی، باعث ایجاد خسارت زیادی شده و یکی از مهم‌ترین عوامل کاهش عملکرد گندم است. در این مطالعه ویژگی های زیستی شته روسی روی شش رقم گندم یاواروس، پیشتاز، عدل، امید، داراب ۲ و سپاهان مورد ارزیابی قرار گرفت. آزمایش‌ها در شرایط گلخانه با دمای ۲±۲۵ درجه سلسیوس، رطوبت نسبی ۱۰±۵۵ درصد و دوره‌ی نوری ۱۶ ساعت روشنایی و ۸ ساعت تاریکی انجام شد. در این پژوهش به منظور تعیین میزان مقاومت یا حساسیت ارقام در مقابل شته، طول دوره‌پورگی، میزان باروری شته‌ها، تولید مثل روزانه هر شته‌ی ماده‌ی بالغ، طول عمر کل و طول عمر حشرات بالغ مورد بررسی قرار گرفت. نتایج حاصل از تجزیه واریانس داده‌ها نشان داد که از نظر طول دوره‌ی پورگی، قدرت باروری شته‌ها و میزان تولید مثل روزانه هر شته‌ی ماده‌ی بالغ، اختلاف معنی‌داری در سطح پنج درصد بین ارقام وجود داشت. بر این اساس بیشترین طول دوره‌ی پورگی مربوط به شته‌های پرورش یافته روی ارقام امید و سپاهان و کمترین طول دوره پورگی مربوط به رقم یاواروس بود. بیشترین و کمترین میزان باروری به ترتیب روی ارقام یاواروس و امید مشاهده گردید. همچنین بیشترین تعداد پوره‌ی تولید شده هر شته بالغ ماده در هر روز روی رقم یاواروس و کمترین آن روی رقم امید دیده شد. نتیجه بررسی‌ها و محاسبات مربوطه نشان داد که در بین ارقام مورد مطالعه، رقم یاواروس به شته‌ی روسی حساس تر بوده و رقم امید در مقایسه با سایر ارقام مقاوم‌تر می‌باشد.

واژگان کلیدی: گندم، شته روسی گندم، مقاومت

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