

**LABORATORY ASSESSMENT OF HOST PLANT RESISTANCE  
OF DIFFERENT WHEAT VARIETIES TO THE ENGLISH GRAIN  
APHID, *SITOBION AVENAE* F. (HOMOPTERA: APHIDIDAE)  
AT THE STEM ELONGATION GROWTH STAGE**

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**[Kazemi, M. H. 2014. Laboratory assessment of host plant resistance of different wheat varieties to the English grain aphid, *Sitobion avenae* F. (Homoptera: Aphididae) at the stem elongation growth stage. Munis Entomology & Zoology, 9 (2): 756-760]**

**ABSTRACT:** The English grain aphid is regarded as one of the most important pests of small grain cereals, especially wheat varieties in many parts of the world. The pest has extended its distribution throughout the wheat fields of Iran and in particular the East Azarbaijan province. Five modern Iranian wheat varieties, namely Alamoot, Alvand, Zarrin, Sabalan and Sardari, which are the most extensively cultivated in the province, were used in laboratory screening tests for assessment of their antibiosis resistance to the aphid at the stem elongation growth stage. This work was carried out under greenhouse conditions of  $24.2 \pm 4.5$  °C temperature,  $55.7 \pm 4.6\%$  R.H. and 16:8 (L: D) light regime. The probable antibiosis was assessed by studying the nymphal survival rate; mean developmental time and adult fecundity (total no. of progeny/ female produced within the first 10 and 15 days of reproductive stage) calculating the relevant intrinsic rate of natural population increase ( $r_m$  value). The ANOVA of the data indicated that regarding duration of nymphal development time, adult fecundity and also  $r_m$  values, there were significant differences ( $p < 0.01$ ) between the varieties. Based on this, the highest ( $7.70 \pm 0.47$ ) and lowest ( $5.75 \pm 0.44$ ) mean nymphal development time was calculated on Alvand and Sabalan respectively. The greatest ( $59.35 \pm 2.60$  &  $88.15 \pm 4.81$ ) and the least ( $38.30 \pm 2.20$  &  $58.60 \pm 3.42$ ) numbers of progeny produced per female within the first 10 and 15 days of larviposition period was observed on Sabalan and Sardari respectively. Moreover, the highest  $r_m$  value ( $0.4120 \pm 0.0074$  &  $0.4140 \pm 0.0073$ ) obtained for individuals reared on Sabalan, with the lowest ( $0.2620 \pm 0.0034$  &  $0.2670 \pm 0.0025$ ) being on Alvand. The present study indicated that at the stem elongation stage, Sabalan appeared to be more susceptible to the aphid whilst Alvand was more resistant and Sardari, Alamoot and Zarrin were regarded as intermediate among the others.

**KEY WORDS:** Resistance, wheat, English grain aphid.

The English grain aphid is regarded as one of the most important and periodical pests of small grain cereals, especially wheat varieties in many parts of the world, particularly Europe, Asia, tropical and subtropical areas (George & Gair, 1979; Lowe, 1984). The pest was first reported in Iran by Farahbakhsh (1961) and has extended its distribution throughout the wheat fields of Iran and in particular the East Azarbaijan province. This aphid causing direct feeding damages on the winter wheats in the spring by considerable reduction in crop yields (Hein et al., 1996), and can also be damaging as a vector of plant pathogenic viruses, such as Barley yellow Dwarf Virus (Markkula & Rouka, 1972; Vickerman & Wratten, 1979; Holland & Thomas, 1997). During the last 30 years, there has been a great deal of research seeking resistance to aphids in wheat varieties by the author and other experts in Iran. Only varying degrees of partial resistance have been reported, particularly in Moghan 2 and Ommid cultivares to *Rhopalosiphum padi* (L.) (Kazemi, 1988; Kazemi & van Emden, 1992) and in Alvand and Zarrin to *Diuraphis noxia* (mordvilko) (Kazemi et al., 2001a,b). This

aphid feeds on wheat, barley, oat, rye and a number of grass weeds (Blackman & Eastop, 2000).

Based on the occurrence of the aphid in Iran, and also due to the highest level of infestation which has been observed in wheat fields of East Azarbaijan province in recent years, the present study was aimed at evaluating the rate of "antibiosis" resistance to the aphid, at stem elongation stage of Alamoot, Alvand, Azrrin, Sabalan and Sardari varieties, for which, the highest acreages are being devoted in wheat planting areas of the province (Kazemi et al., 2001; Kazemi, 2010).

## MATERIALS AND METHODS

**Plant and aphid culture:** Vernalised seeds of five wheat varieties namely, Alamoot, Alvand, Zarrin, Sabalan and Sardari were evaluated at their stem elongation growth stage (30-49) against the English grain aphid, *Sitobion avenae* (Zadoks et al., 1974). The seeds of the varieties were obtained from the Agricultural-Jahad organization of East Azarbaijan province. The aphid clones were collected from the Marand wheat fields and transferred to the laboratory for morphological identification according to the relevant sources (Blackman & Eastop, 2000). Stock cultures of aphids were reared under glasshouse conditions on Barley plats (var. Makuie) which are highly susceptible to the aphid (Robinson, 1992) and kept in a 150×100×100 cm screen cage. The seeds were then put in a jar fully covered with aluminium foil and containing a few drops of distilled water and vernalized in the refrigerator at 3-5°C for eight weeks (Kay et al., 1981; Kazemi, 1988). Eight seeds of each variety were sown in 20 cm diameter plastic pots at a depth of 3 cm and thinned to four plants per pot after germination (van Emden et al., 1991). A total of 15 pots were devoted to each variety. The soil used, was a mixture of garden soil, sand and compost at a rate of 3:1:1 obtained from Khalate-pooshan agricultural experiment station.

**Plant infestation:** Aphids reared on the stock culture individually were confined in clip cages on the upper leaves of experimental plants (Kazemi, 1988). Since the culture plant may influence the performance and preferences of the aphids, they were reared on the experimental plants for at least one generation before the main experiments. For the main experiments, one adult apterous aphid from the appropriate culture was confined in a clip cage on the upper leaf of the experimental plant. After 24 hours, the adult was removed, and one newly born nymph was retained to develop to an adult and reproduce (Kazemi & van Emden, 1992). The position of the cages was changed once every three to four days to avoid local leaf damage. The experimental plants were kept under glasshouse conditions of 24.2±4.5°C temperature, 55.7±4.6% relative humidity and a 16:8 (L:D) light regime. The experimental design was a completely randomized block design with five treatments (varieties) and each variety with 20 replicates using individual clip-on leaf cages as experimental units, set up on the last fully grown leaves of the main plants. In order to determine the maturation time and survival rate of encaged progeny, each individual nymph was allowed to develop into an adult. The fecundity of the resultant adults was determined by daily counts of their progeny between 9 and 11 a.m. for periods of 10 and 15 days. All progenies were removed from caged leaves after completion of the counts. To calculate the daily intrinsic rate of natural increase ( $r_m$  value), nymphal survival on each variety (age specific survival rate:  $l_x$ ), developmental time and daily fecundity of individual aphids (age specific fecundity:  $m_x$ ) were used in the equation  $\sum -r_m l_x m_x = 1$  (Birch, 1948), using van Emden's STATSPAK version 8.00 based on Mallard Basic.

## RESULTS AND DISCUSSION

**Development time and survival rate of nymphs:** The ANOVA of the data obtained on duration of developmental period indicated that there were significant differences between treatment means. Comparisons made between treatment means using Duncan's multiple range test showed significant differences ( $P < 1\%$ ). Data presented in table 1 shows that the highest and lowest nymphal survival rate occurred on Sabalan, Sardari, Zarrin, Alamoot and Alvand varieties respectively. Also the highest and lowest growth index "GI" [more suitable measurement of insect growth on susceptible and resistant plants (Saxena et al., 1974)], belong to Sabalan (15.65) and Alvand (6.49) respectively (Table 1). The effects of feeding on various wheat varieties on survival rate of *Sitobion avenae* and *Metopolophium dirhodum*, *Rhopalosiphum paid* and *Diuraphis noxia*, have been investigated by the works of Sotherton & van Emden (1982), Kazemi & van Emden (1992), Kazemi, Talebi-Chaichi, Shakiba & Mashhadi Jafarloo (2001a,b) and Kazemi (2010) respectively. Obviously, determining the nature of the effects of defence mechanisms (Physical and Chemical) at the host plants on the survival rate of the aphid requires further complementary studies.

**Fecundity:** The ANOVA of obtained data indicated significant differences ( $P < 1\%$ ) in mean fecundity of the aphid on five wheat varieties within 10 and 15 day periods of larviposition (Table 2). The highest fecundity within the two periods was recorded on Sabalan, indicating its sensitivity to the English grain aphid. Although the aphid produces more progeny and shows the highest population density at the ear emergence stage, but Appablaza and Robinson (1967), Lowe (1984) and Kazemi (2010) have noticed certain differences between the aphid population density at the seedlings and tillering growth stages of the plant. They reported that resistant variety has the lowest aphid progeny on the plant. The results of our studies confirm the findings of Appablaza & Robinson, Low and Kazemi. The least progeny produced within the first 10 and 15 days of larviposition periods were observed on Sardari and Zarrin, whilst Alamoot and Alvand were intermediate between Sabalan and Sardari at the end of 15 day larviposition period.

**The Intrinsic rate of natural increase ( $r_m$  value):** Data indicated significant differences between  $r_m$  values at  $P \leq 1\%$  (Table 3). Based on the aphid's intrinsic rate of increase within 10 and 15 day periods of rearing on test varieties, Sabalan had the highest  $r_m$  value at both rearing periods and are thus regarded as the most susceptible variety. Alvand had the lowest  $r_m$  values and are considered to be resistant. Sardari, Zarrin and Alamoot seem to be partially resistant varieties.

## CONCLUSION

The result of this experiment showed that the factor of growth index of the varieties varies between 6.49 to 15.65, which means Alvand, Alamoot and Zarrin had the highest resistant effect on the aphid whilst Sabalan and Sardari had the lowest effect on the aphid respectively. Also survival rate of the aphid has shown the same results with Alvand and Alamoot being resistant and Sabalan and Sardari being the susceptible varieties between the cultivars. The 10 and 15 days fecundity results showed the varies ranking of the varieties with Sabalan having the highest number of fecundity and Sardari and Zarrin having the lowest ones which means that Sardari and Zarrin were resistant to the aphid and Sabalan was

susceptible. The intrinsic rate of natural population increase ( $r_m$  value) is considered as one of the most important factors of antibiosis resistance of different plant cultivars to insect pests. Sabalan had the highest  $r_m$  value whilst Alvand had the lowest value indicating the susceptibility of Sabalan to the aphid and the resistance of Alvand to this pest. The results of this study indicated that at stem elongation growth stage, amongst the varieties studied, Alvand was the resistant variety to the English grain aphid with Sabalan being the most susceptible one, while the other varieties Sardari, Alamoot and Zarrin appeared to be the intermediate varieties respectively. With extension of the studies to all phenological stages of the test varieties, it is hoped that inclusion of the pest management program would be a valuable tool toward lowering the damage potential of this aphid.

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Table 1. Mean development time, survival rate and growth index of nymphs of English grain aphid on five wheat varieties under greenhouse conditions.

Variety	Mean development time (days) X±S.D.	Survival rate (%)	Growth index
Sardari	6.5 ± 0.513 c+	80.8	12.3
Sabalan	5.75 ± 0.444 d	90.0	15.65
Zarrin	7.6 ± 0.503 a	70.0	9.21
Alvand	7.7 ± 0.470 a	50.0	6.49
Alamoot	7.25 ± 0.444 b	65.0	8.97

+ Means followed by a similar letter are not significantly different at a level of 1%.

Table 2. Mean fecundity of adult apterae of English grain aphid within 10 and 15 day periods of rearing on five wheat varieties.

Variety	10 day	15 day
	X±S.D.	X±S.D.
Sardari	38.30 ± 2.203 e+	58.60 ± 3.424 e
Sabalan	59.35 ± 2.601 a	88.15 ± 4.815 a
Zarrin	42.85 ± 2.925 d	61.25 ± 3.024 d
Alvand	48.15 ± 2.134 c	72.20 ± 2.984 c
Alamoot	53.25 ± 1.997 b	78.55 ± 2.544 b

+ Means followed by a similar letter in each column are not significantly different at a 1% level.

Table 3. Intrinsic rate of increase of the English grain aphid in rearings on five wheat varieties for 10 and 15 day periods under greenhouse conditions.

Variety	Intrinsic rate of increase ( $r_m$ values)	
	10 day period	15 day period
	X±S.D.	X±S.D.
Sardari	0.316 ± 0.0068 b+	0.320 ± 0.0063 b
Sabalan	0.412 ± 0.0074 a	0.414 ± 0.0073 d
Zarrin	0.284 ± 0.0058 d	0.287 ± 0.0053 d
Alvand	0.262 ± 0.0034 e	0.267 ± 0.0025 e
Alamoot	0.308 ± 0.0036 c	0.312 ± 0.0034 c

+ Means followed by a similar letter in each column are not significantly different at a 1% level.