ANTIBIOSIS RESISTANCE TO THE APHID, *SITOBION AVENAE* F. (HOMOPTERA: APHIDIDAE) IN DIFFERENT WINTER WHEAT CULTIVARS

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ABSTRACT: The nymphal survival rate; mean development time; adult fecundity (total number of progeny/female produced within the first 10 and 15 days of reproductive stage) and calculating the relevant intrinsic rate of natural population increase (r_m value) was measured on five modern Iranian wheat cultivars at the tillering growth stage. 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 Azarbaidjan province. The wheats were of Iranian origin, winter cultivars and hexaploid types, namely Alamoot, Alvand, Zarrin, Sabalan and Sardari, which are the most extensively cultivated in the province. The experiment was carried out under greenhouse conditions of 24.2±4.5°C temperature, 55.7±4.6%R.H. and 16:8(L: D) light regime. Aphids which had already been reared on the respective varieties for at least one generation were transferred to the experimental plants. 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 (8.70±0.47) and lowest (6.60±0.50) mean nymphal development time was calculated on Zarrin and Sardari respectively. The greatest (75.55±3.30 and 52.60±2.28) and the least (41.55±2.65 and 27.60±2.28) numbers of progeny produced per female within the first 10 and 15 days of larviposition period was observed on Alvand and Sabalan respectively. Moreover, the highest r_m value (0.3340±0.0052 and 0.3304±0.0051) obtained for individuals reared on Alvand, with the lowest (0.2444±0.0089 and 0.2379±0.0093) being on Sabalan. Sabalan showed some resistance to the aphid in comparison with the other varieties at the tillering stage, while Zarrin, Sardari and Alamoot were regarded as partially resistant varieties, whilst Alvand appeared to be more susceptible one.

KEY WORDS: Antibiosis, Plant resistance, *Sitobion avenae*, wheat cultivars.

During the last 25 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 cultivars to *Rhopalosiphum padi* (L.) (Kazemi, 1988; Kazemi & van Emden, 1992) and in Alvand and Zarrin to *Diuraphis noxia* (Mordvilko) (Kazemi et al., 2001a,b). 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 Azarbaidjan 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 (Vickerman & Written, 1979; Holland & Thomas, 1997; Markkula & Rouka, 1972). The 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 Azarbaidjan province in recent years, the present study was aimed at evaluating the rate of "antibiosis" resistance to the aphid, at tillering growth 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).

MATERIALS AND METHODS

Plant and aphid culture: Vernalised seeds of five wheat varieties namely, Alamoot, Alvand, Zarrin, Sabalan and Sardari were evaluated at their tillering growth stage (21-29) 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 Azarbaidjan 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 plants (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 alumininum 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 Enden, 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: 1x), developmental time and daily fecundity of individual aphids (age specific fecundity: mx) were used in the equation

$\sum e^{-r_m} {}_{1x}m_x = 1$ (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 Alamoot, Alvand, Zarrin, Sabalan and Sardari 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 Alvand (11.64) and Zarrin (8.62) respectively (table 1). The effects of feeding on various wheat varieties on survival rate of *Sitobion avenae* and *Metopolophium dirhodum, Rhopalosiphum padi* and *Diuraphis* noxia, have been investigated by the works of Sotherton & van Emden (1982), Kazemi & van Emden (1992) and Kazemi, Talebi-Chaichi, Shakiba & Mashhadi Jafarloo (2001a and 2001b) 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 Alvand, 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) and Lowe (1984) 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 and Lowe. The least progeny produced within the first 10 and 15 days of larviposition periods were observed on Sabalan and Sardari, whilst Alamoot and Zarrin were intermediate between Alvand and Sabalan 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≤1%. Based on the aphid's intrinsic rate of increase within 10 and 15 day periods of rearing on test varieties, Alvand had the highest r_m value at both rearing periods and are thus regarded as the most susceptible variety. Sabalan had the lowest r_m values and are considered to be resistant. Alamoot, Sardari and Zarrin seem to be partially resistant varieties (Table 3).

CONCLUSION

The results of this experiment showed that the factor of growth index of the varieties varies between 8.62 to 11.64, which means Sabalan, Zarrin and Sardari had the highest resistant effect on the aphid whilst Alamoot and Alvand had the

lowest effect on the aphid respectively. Also survival rate of the aphid has shown the same results with Sardari and Sabalan being resistant and Alamoot and Alvand being the susceptible varieties between the cultivars. The 10 and 15 days fecundity results showed the same ranking of the varieties with Alvand having the highest number of fecundity and Sardari and Sabalan having the lowest ones which means that Sardari and Sabalan were resistant to the aphid and Alvand 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. Alvand had the highest r_m value whilst Sabalan had the lowest value indicating the susceptibility of Alvand to the aphid and the resistance of Sabalan to this pest. The results of this study indicated that at tillering growth stage, amongst the varieties studied, Sabalan was the resistant variety to the English grain aphid with Alvand being the most susceptible one, while the other varities Alamoot, Sardari and Zarrin appeared to be the intermediate varieties respectively. With extension of the studies to the other phenological stages of the test varieties, it is hoped that inclusion of the pest management program would be a valuable tool twoards 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 green house conditions.

Variety	Mean development time (days) $\overline{X} \pm S.D$	Survival rate (%)	*Growth index*
Sardari	6.6 ±0.50 c+	60.0	9.09
Sabalan	7.5 ± 0.51 b	65.0	8.67
Zarrin	8.7 ± 0.47 a	75.0	8.62
Alvand	7.3 ± 0.47 b	85.0	11.64
Alamoot	8.4 ± 0.50 a	90.0	10.71

+ 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 $\overline{X} \pm S.D$	15 day $\overline{X} \pm S.D$
Sardari	29.85±2.35 d +	43.85±2.87 d
Sabalan	27.60±2.28 d	41.55±2.65 d
Zarrin	36.50±4.14 c	53.10±4.88 c
Alvand	52.60±2.28 a	75.55±3.30 a
Alamoot	45.90±2.92 b	67.00±3.51 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 reavings on five wheat varieties for 10 and 15 day periods under greenhouse conditions.

	Intrinsic rate of increase (r_m values)	
Variety	10 day period $\overline{X} \pm S.D.$	15 day period $\overline{X} \pm S.D.$
Sardari	0.2622±0.0109 c+	0.2676±0.0109 c
Sabalan	0.2379±0. 0093 e	0.2444±0.0089 e
Zarrin	0.2513±0.0079 d	0.2562±0.0078 d
Alvand	0.3306±0.0051 a	0.3340±0.0052 a
Alamoot	0.2929±0.0062 b	0.2963±0.0058 b

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