FIELD ASSESSMENT OF ANTIBIOSIS RESISTANCE OF DIFFERENT WHEAT CULTIVARS TO THE RUSSIAN WHEAT APHID, *DIURAPHIS NOXIA* (MORDVILKO) (HOM.:APHIDIDAE) AT STEM ELONGATION GROWTH STAGE

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ABSTRACT: The Russian Wheat Aphid is one of the most important cereal pests in the world. Due to the economic importance of this aphid in most parts of the world and also in Iran, certain studies have been directed towards the introduction of resistant cultivars. In the present study, the resistance associated with antibiosis was sought out at stem elongation growth stage in Alamoot, Alvand, Zarrin, Sabalan and Sardari, the most extensively planted wheat varieties in East Azarbaijan province of Iran. Antibiosis was determined by studying the percentage nymphal survival rate, their development time, fecundity of the first 10 and 15 days of reproductive period, growth index and calculating the relevant intrinsic rate of natural population increase (r_m value). ANOVA of data indicated that, regarding the development time of nymphs, fecundity and r_m values, there were significant differences between the varieties. The highest and lowest mean survival rate of nymphs also was observed in rearings on Sabalan and Alvand with 77.78 and 66.67 percent respectively. Comparisons of means using Duncan's multiple range test, showed significant differences (p<%5) in aphid r_m values between the varieties. Sabalan had the highest r_m value thus regarded as the susceptible variety, while Alvand and Zarrin had the lowest r_m values and thus seem to be partially resistant varieties.

KEY WORDS**:** Antibiosis, Host plant resistance, Russian Wheat Aphid, Wheat varieties.

The Russian Wheat Aphid, which is the fauna of the palaearctic region, has been reported as a native pest of Russia, Iran, Afghanistan and Mediteranean border countries (Rafi et al., 1993). This pest was first reported by Mordvilko in 1990 from barley fields in southern Russia and then its population was established in the west (Blackman & Eastop, 1984; Stoetzel, 1987; Kazemi et al., 2001a,b). 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 antocyanic pigments. The individual aphids feed on the upper surfaces of curled leaves. Young plants become stunted under heavy aphid attacks and prepanicle infestations can result in curling of the flag leaves and panicle deformations (Jones et al., 1989; Kindler & Hammon, 1996; Kazemi et al., 2001a).

In recent years, the Russian Wheat Aphid, has been included worldwidely in the list of the important pests of cereals, particularly wheat cultivars. Its damage losses in United States of America during years 1986-1989 was estimated more than 650 million dollars (Kindler et al., 1992). The importance of this aphid in its native regions, especially in dry years, is high (Souza et al., 1991), but in the opinion of Burd et al. (1993), this aphid can disturb the plant physiological patterns even in low populations. Archer and Bynum (1992) noted that the losses due to feeding damage of this pest on the crop in spring at the 29-60 phenological growth stages (Zadoks et al., 1974) for one percent of plant contamination by the aphid, was evaluated as 0.46-0.48 percent. The Russian Wheat Aphid can also be damaging as a vector of plant pathogenic viruses including Barley Yellow Dwarf Virus (BYDV), Barley Stripe Mosaic Virus (BSMV) and Sugarcane Mosaic Virus (SCMV) (Damsteegt et al., 1992). Also it has been reported that, the susceptibility of the winter wheat to the cold weather, increases due to feeding of this aphid, and therefore leads to indirect crop losses. In recent years, due to the economic importance of this aphid in most parts of the world certain studies have been directed towards the introduction of resistant varieties (Du Toit, 1989; Kindler & Springer, 1989; Webster, 1990; Quick et al., 1991; Kindler et al., 1992; Smith et al., 1992; Robinson, 1993; Webster et al., 1993; Rafi et al., 1996 and Kazemi et al., 2001a,, 2007). Based on the observations made during this investigation, the highest level of aphid infestation has been observed in wheat fields of Tabriz, Ahar and Kaleybar areas of East Azarbaijan province of Iran (Kazemi et al., 2001a,b, 2007). Thus, the present study was aimed at evaluating the existance of any resistance at the stem elongation growth stage of Alvand, Alamoot, Zarrin, Sabalan and Sardari wheat varieties (which have been showed already some resistant and susceptible pattern to the aphid) to which, the highest acreages are being devoted in the wheat planting areas of the province, in the field conditions.

MATERIALS AND METHODS

Plant and aphid culture

The degrees of resistance of five wheat varieties (Alvand, Alamoot, Zarrin, Sabalan and Sardari) were evaluated at their stem elongation growth stage (30-32) against the Russian Wheat Aphid, *Diuraphis noxia* (Zadoks et al., 1974). The seeds of the Sardari variety were obtained from the Institute for Dry Farming Studies and those of the remaining varieties from the Agricultural Organization of East Azarbaijan province. The aphid clones were collected from the Kaleybar wheat fields and transferred to the laboratory for morphological identification according to the relevant sources (Blackman & Eastop, 1984; Stoetzel, 1987). Stock cultures of aphids were reared under glasshouse conditions on Durum plants which are highly susceptible to the aphid (Formusoh et al., 1992) and kept in a germinator under 19-24^{o}C and 14: 10 (L: D) light regim. The seeds of each variety were sown in a 200 square meters of Khosrov-shahr Agricultural Research Station wheat fields (with 180 Kg/ha).

Plant infestation

Aphids reared on the stock culture were individually confined in a large 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 trained 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 design was a completely randomized block design with five treatments (varieties) and each variety with 15 replicates using individual clip-on leaf cages as experimental units, set up on the last fully grown leaves of the main plants when the first node of the plant stem was visible from the beginning of May. 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 the progeny 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: lx), developmental time and daily fecundity of individual aphids (age specific fecundity: m_x) were used in the equation $\Sigma e^{-r_m} l_x m_x=1$ (Birch, 1948), using van Emden's STATSPAK version 8.00 based on Mallard Basic. Percentage of nymphal survival rate divided by the mean nymphal developmental time was used to calculate the Growth Index (GI) (Smith et al., 1994).

RESULTS AND DISCUSSION

Maturation time and survival rate of nymphs

The data obtained on duration of developmental period indicated that there were significantal differences between treatment means. Comparisons made between treatment means using Duncan's multiple range test showed significant differences (P ≤ 5%). The data presented in Table 1 show that the highest and lowest development time occurred on the Alvand and Sabalan varieties respectively. Also the highest and lowest nymphal survival rate was seen on Sabalan and Alvand varieties respectively. Combination of these two parameters namely Growth Index (GI), demonstrates differences between the varieties, and due to a low GI on Alvand compared to the other varieties, Alvand is a resistant variety and Sabalan is a susceptible one. So the effect of aphid feeding on the resistant varieties, leads to increase in the nymphal maturation time and decrease in survival rate of the insects.

Fecundity

Comparisons made on mean fecundity (Table 2) indicated significant differences (P ≤ 5%) in the mean fecundity of the aphid on five wheat varieties within the two 10 and 15 day periods. The highest mean fecundity within the first 10 day periods of larviposition was recorded on Sabalan and the least progeny produced within the first 10 days of larviposition was observed on Zarrin, Sardari and Alvand.The trend of fecundity within the 15 day period of larviposition was more or less the same as within the first 10 days of reproduction.Trends in the aphid's larviposition on five wheat varieties within 10 and 15 day periods (Kazemi & van Emden, 1992; Kazemi et al., 2001a) have been shown as daily cumulative means in Figure 1. It is obvious that, from the beginning of the reproductive period, the rate of larviposition remained more or less the same on all varieties. However, there were remarkable deviations in fecundity on the Sabalan, Zarrin and Alamoot varieties which continued until the end of the 15-day period, whilst changes in the larviposition rate on three other varieties (Alvand, Zarrin and Sardari) followed the same pattern. However, at the end of the larviposition periods, the highest mean fecundity was observed on Sabalan and the lowest mean fecundity on Zarrin, Sardari and Alvand. The results of larviposition trend, indicating Sabalan suitability for aphid feeding or its higher susceptibility to the aphid, whilst Sardari, for lowest larviposition of the aphid on it, to be a resistant one between the wheat varieties. The other varieties, especially at the end of 15 day periods of larviposition, showed no significant differences between them and were placed in one group. Kazemi et al. (2001b) studying the susceptibility of *Diuraphis noxia* at stem elongation stage under laboratory conditions on mentioned wheat varieties, have noticed certain differences and same larviposition trend on the varieties.

The intrinsic rate of natural population increase (r_m value)

Data indicated significant differences between r_m values at $P \leq 5\%$. Based on the aphid's intrinsic rate of increase within 10- and 15- day periods of rearing on tested varieties, Sabalan had the highest r_m value for both rearing periods and are thus regarded as the most susceptible variety. Alvand and Zarrin had the lowest r_m values and are considered to be resistant varieties. Sardari and Alamoot seem to be partially resistant (Table 3).

CONCLUSION

The results and statistical analysis indicate that, at the stem elongation stage in field conditions, amongst the varieties studied, Sabalan appeared to be more susceptible one to the Russian wheat Aphid, because of having the highest aphid fecundity and r_m value. Alvand and Zarrin appeared to be more resistant varieties, because of showing both the lowest aphid fecundity and r_m values. The varieties, Alamoot and Sardari seem to be partially resistant. With the extension of the studies to the other phenological stages of the test varieties and under different experimental conditions, (Kazemi et al., 2001a,b, 2007) it is hoped that inclusion of the probable "antibiosis" program would be a valuable tool towards lowering the damage potential of this aphid.

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Table 1. Mean maturation time and survival rate of Russian Wheat Aphid nymphs of five wheat varieties under field conditions.

Variety	Mean maturation time (day) $(\overline{X} \pm SD)$	Survival rate (%)	Growth Index
Alamoot	13.13 ± 0.64 bc*	70.37	5.36
Alvand	13.73 ± 0.59 a	66.67	4.86
Zarrin	13.47 ± 0.64 ab	70.37	5.23
Sabalan	12.67 ± 0.82 d	77.78	6.14
Sardari	12.93 ± 0.70 cd	74.07	5.73

* Means followed by a similar letter are not significantly different at a level of 5%.

Table2. Mean fecundity of adult apterae of Russian Wheat Aphid within 10 and 15 day periods of rearing on five wheat varieties.

Variety	10 day ($\overline{X} \pm SD$)	15 day ($\overline{X} \pm SD$)
Alamoot	23.67 ± 6.18 b*	31.33 ± 9.61 ab
Alvand	21.33 ± 6.00 c	30.20 ± 8.91 bc
Zarrin	20.07 ± 5.50 c	28.73 ± 8.36 bc
Sabalan	26.20 ± 6.95 a	33.33 ± 11.17 a
Sardari	20.60 ± 5.94 c	28.60 ± 8.41 c

* Means followed by a similar letter in each column are not significantly different at a 5% level

Table 3. Intrinsic rate of increase (r_m values) of the Russian Wheat Aphid in rearing on five wheat varieties for 10 and 15 day periods under field conditions.

Variety	10- day period ($\overline{X} \pm SD$)	15- day period ($\overline{X} \pm SD$)
Alamoot	0.1536 ± 0.014 b*	0.1586 ± 0.014 b
Alvand	0.1377 ± 0.014 d	0.1444 ± 0.014 c
Zarrin	0.1407 ± 0.014 d	0.1478 ± 0.014 c
Sabalan	0.1712 ± 0.015 a	0.1747 ± 0.015 a
Sardari	0.1485 ± 0.015 c	0.1556 ± 0.013 b

* The means followed by similar letter in each column are not significantly different at a 5% level.

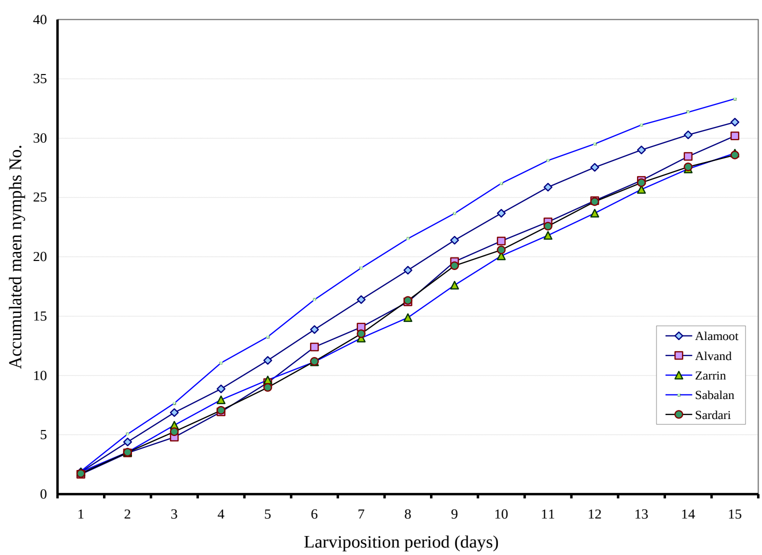

Figure 1. Daily cumulative means of larviposition within 10 and 15 day periods on five wheat varieties at stem elongation.