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Population Dynamics of Aphids (Aphididae: Homoptera) on Different Wheat Cultivars and Response of Cultivars to Aphids in Respect of Yield and Yield Related Parameters

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Abstract.- To see the population dynamics and to evaluate the resistance ability of seven wheat cultivars (Inqilab-91, Fakhar-e-Sarhad, Bakhtawar-92, Nowshera-96, Khyber-87, Suleman-96 and Tatara) against aphid, an experiment was conducted at Agriculture Research Institute, Tarnab, Peshawar. The aphid attack started in mid January on the wheat cultivars and increased gradually with the growth of plant. The highest aphid population 8.2 aphids tiller^{-1}) was recorded on Khyber-87 which was significantly more than the other tested cultivars. Tatara with 6.85 aphids tiller^{-1}, although, had significantly low number of aphids than Suleman-96 and Khyber-87 was statistically similar in aphid population with any other tested cultivar. In cultivar Tatara, the spiklet spike^{-1} were significantly more than Inqilab-91 which may be because of its resistance to this insect pest. Khyber-87 and Nowshera-96 had significantly more number of seed spike^{-1} as compared to the other tested wheat cultivars. The length of spike tiller^{-1} and the height of tiller plant^{-1} in all seven wheat cultivars were not affected by aphids. The weight of 1000 grain of seed and overall yield was statistically similar among these wheat cultivars.

Keywords: Aphid, wheat varieties, host plant resistance.

INTRODUCTION

Wheat *(Triticum aestivum* L.) is a convenient nutritious and economical source of food. It provides about 20% of the world's food calories and is a food for nearly 40% of the world's population. In many countries more wheat is consumed per capita than other foods (Wiese, 1987). In 2001, the leading wheat producing countries were India, China, Russian Federation, U.S.A., Australia, Canada, Turkey, and Pakistan (Anonymous, 2001). In Pakistan, wheat is the most important single crop. Although, in Pakistan wheat is grown on a fair percentage of the total cultivated area, it is still struggling hard to become self-sufficient in wheat production. Numerous factors are responsible for the low yield of wheat in Pakistan. Beside, the lack of modern agronomic practices, insect pests play important role in reducing the yield/hectare. Most of these pests belong to eight major orders Orthoptera, Hemiptera, Coleoptera, Diptera, Lepidoptera, and Hymenoptera in the class Insecta and mites in the class Arachinda (Hatchett and Webster, 1987). Among the sap sucking arthropods, aphids are the most widely distributed group. Aphids pierce and suck sap from leaves, stems, and less frequently the developing kernels of wheat. Some inject toxic substances that destroy plant tissue while some are vectors of viruses that may cause widespread losses exceeding those attributed to the direct feeding damage (Gair *et al.*, 1983). Several control methods have been evolved for the control of aphids. These include cultural, physical, mechanical, biological, chemical, and host plant resistance. Mostly aphid's population is kept below the economic injury level by the combination of naturally occurring population regulating factors. But some times, the aphids can be extremely injurious if present in large number and chemicals have to be used for control (Hatchett and Webster, 1987).

In order to combat with the increasing resistance development in the aphid against pesticides and also to reduce the pesticides load on

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the environment, adoption of Integrated Pest Management (IPM) strategies are needed. Host plant resistance is an important part of IPM for aphids. A population of *Sitobion avenae* on wheat is often effectively controlled by natural enemies in Europe and with positive interaction between natural enemies and host plant resistance. In resistant wheat cultivars, dihydroxy phenols are associated with feeding deterrence to the *Rhopalosiphum padi* and *S. avenae* (Leszcynski, 1985).

The present studies were therefore, undertaken to know the response of different wheat cultivars with respect to aphid attack.

MATERIALS AND METHODS

Population dynamics of aphids on different wheat cultivars

In order to evaluate different wheat varieties for their resistance against aphids, an experiment was conducted at Agricultural Research Institute Tarnab, Peshawar. Seven commercial wheat varieties (Inqilab-91, Khyber-87, Baktawar-92, Nowshera-96, Sulaiman-96, Fakhar-e-Sarhad and Tatara) were used in this study. The seed of the mentioned cultivars were obtained from CCRI. Pirsabak, Nowshera and were sown on November 16, 2003. The experiment was laid out in Randomized Complete Block Design. Each treatment was replicated three times and distance between replicates was kept 1.5 m. Each variety was sown in plot measuring 5x6 m (30 sq m).There were 16 rows in each plot and row to row distance was kept 36 cm. A uniform agronomic practices were applied to each plot. Each plot was divided in to two sub-plots. One sub-plot in each plot and each replicate was sprayed with Supracide @ of 1.5 ml 1 lit^{-1} of water and or Methamedophos @ 2 ml 1 lit^{-1} of water at the interval of 15 days, in order to ensure the complete control of aphids throughout the crop season. The other subs-plot was left untreated (control) for the comparison of yield and other yield related parameters (spikelets $spike^{-1}$, number of seed $spikeler^{-1}$, number of tillers $plant^{-1}$, 1,000 grains weight etc.). The spray was made with 10 ltrs. capacity hand operated knap sack sprayer. Wooden slices were used during spray to avoid the insecticidal drift to the untreated plot. The data was recorded fortnightly beginning with 4rth week of germination of the crop till the maturity of crop. Four plants in each untreated plots were randomly selected and aphids were counted on one tiller $plant^{-1}$. The data was recorded at weekly interval. The data was analyzed with analysis of Variance (ANOVA) and means separated with Least Significant Difference Test (LSD).

Effect of aphids on the yield and yield related parameters

Yield and other yield related parameters *i.e.*, height of plants, number of spikes $plant^{-1}$, number of spikelets $spike^{-1}$, length of tiller $plant^{-1}$ and 1000 grain weight etc were recorded at the end of the experiments in both treated and untreated plots. In this regard 5 tillers per plant were randomly selected and the mean of the 5 selected plants was taken. To see the difference between treated and untreated plots, the data taken on the above parameters were statistically analyzed and the means separated with Least Significance Difference Test.

RESULTS

Varietal resistance of wheat cultivars against aphid

The attack of aphids on different wheat varieties started on 17-01-2002. The aphid population increased gradually with the growth of plants. It is obvious, that aphid multiplication rate was slower during vegetative growth stage (Table I). However, a continuous increase in the population was observed. The overall mean aphid density $tiller^{-1}$ on different wheat varieties indicated that highest population of 8.42 aphids $tiller^{-1}$ was recorded on variety Khyber-87 which were significantly more than the aphid population $tiller^{-1}$ in Suleman-96, Nowshera-96, Bakhtawar, Fakhar-e-Sarhad, Inqilab-91, and Tatara with 6.85, 6.28, 6.08, 5.83, 5.15, and 5.01 aphids $tiller^{-1}$, respectively. The aphid density $tiller^{-1}$ in Inqilab-91, Tartara, Fakhar-e-Sarhad, Nowshera-96, and Bakhtawar-92 were statistically similar to each other. Tatara with 5.01 aphid $tiller^{-1}$ were significantly different at $\alpha = 0.05$ to the 6.85 aphids $tiller^{-1}$ in wheat variety Suleman-96.

Spikelets $spike^{-1}$ assessment

The cultivar Tatara showed maximum number (19.80 and 19.27) spikelets spike^{-1} both in the treated and untreated plots, respectively. The spikelets spike^{-1} in the treated plot of Tatara were statistically similar to the lowest number (18.30) spikelets spike^{-1} in Inqilab-91. However, the 19.27 spikelets spike^{-1} in the untreated plot of Tatara cultivar were significantly different from 17.33 spikelets spike^{-1} in the untreated plot of Inqilab-91. This significant difference may be because of the test insect (Table II).The number of spikelets spike^{-1} in the treated and untreated plots of all the other cultivars were statistically similar. The number of spikelets spike^{-1} loss and Percent spikelets spike^{-1} loss in the rest of the test cultivars were not significantly different from each other.

Table I.- Aphids population tiller^{-1} plant^{-1} on various wheat cultivars at different time intervals.

Varieties	Aphids density on different dates													Means
	17/1	24/1	½	8/2	17/2	23/2	1/3	8/3	15/3	23/3	30/3	6/4	15/4	
Inqilab-91	1. 58	2.00	3.67	4.08	6.92	9.50	16.17	10.00	8.50	2. .25	1. 08	0.17	0.00	5.15c
Fakhar-e-Sarhad	1. 42	4.00	4.00	4.50	6.17	10.42	15.67	18.92	6.92	2.50	1. 08	0.25	0.00	5.83bc
Bakhtawar-92	0.75	1. 50	4.25	5.00	9.92	13.83	18.08	13.50	8.17	2.67	1. 08	0.17	0.17	6.08bc
Nowshera-96	1. 50	2.67	3.92	4.58	11.75	17.33	16.83	14.17	5.15	2.25	0.92	0.25	0.25	6.28bc
Khyber-87	2.00	2.33	4.92	10.50	9.25	13.75	14.67	25.08	20.92	4.00	1. 42	0.17	0.17	8.42a
Suleman-96	0.92	2.42	4.00	4.42	9.92	12.92	18.33	20.17	10.58	3.83	1.17	0.25	0.17	6.85b
Tatara	1. 58	2.58	3.08	3.67	6.92	8.67	18.33	13.00	4.00	1. 83	1.17	0.33	0.00	5.01c

Each value is a mean *of* 3 replications. Means followed by similar letters are not significantly different with each other at $\alpha = 0.05$. LSD = 1.394.

Table II.- Effect of aphids on the number of spikelets spike^{-1}

Cultivars	Spikelets spike^{-1}		Spikelets pike^{-1} loss	Percent spikelets spike^{-1} difference
	Treated	Untreated		
Inqilab-91	18.30ABC	17.33C	0.97	5.30
Fakhar-e-Sarhad	18.70ABC	17.77BC	0.93	4.98
Bakhtawar-92	19.40AB	18.33ABC	1.07	5.52
Nowshera-96	19.53AB	18.87ABC	0.68	3.48
Khyber-87	19.33AB	18.30ABC	1.03	5.33
Suleman-96	19.00ABC	18.27ABC	0.73	3.84
Tatara	19.80A	19.27AB	0.53	2.68
Means	19.151	18.306	0.85	4.375

Each value is a mean of 3 replications Mean followed by the same letters are not significantly different at $\alpha = 0.05$

Number of seeds spike^{-1} assessment

The number of seed spike^{-1} in each tested variety were statistically similar in treated and untreated plots. In the untreated plots, Khyber-87, and Nowshera with 52.53 seed spike^{-1} and 48.93 seed spike^{-1}, respectively, although, statistically similar to each other, they were significantly better in the number of seed spike^{-1} to the rest of the tested varieties (Table III). The 0.027 percent seed spike^{-1} loss in variety Suleman-96 indicated its resistance to the test insect. The significant difference in the number of seed spike'! among the cultivars may be because of their genetic make up which remained in the untreated plot also.

Length of spike tiller^{-1} (cm) assessment

The maximum length (15.92 cm) of spike tiller^{-1} was recorded in variety Suleman-96 and the minimum length (14.67cm) of spike tiller^{-1} was recorded in Tatara. The untreated cultivar Suleman-

96 showed a difference of 1.19 cm due to aphid attack indicating 7.47% decrease in length of spike tiller^{-1}. Maximum decrease of 1.42 cm (9.68%) in length of spike tiller^{-1} was recorded in Tatara

Table III.- Effect of aphids on the number of seeds spike^{-1}.

Cultivars	Number of seeds spike^{-1}		Seeds spike^{-1} loss	Percent seeds spike^{-1} difference
	Treated	Untreated		
Inqilab-91	35.27C	35.00C	0.27	0.77
Fakhar-e-Sarhad	37.80 BC	37.07BC	0.73	1.93
Bakhtawar-92	39.97 A	39.23BC	0.74	1.851
Nowshera-96	49.83A	48.93A	0.9	1.836
Khyber-87	53.20A	52.53A	0.8	1.503
Suleman-96	36.08 BC	36.07C	0.01	0.027
Tatara	42.23B	41.90B	0.33	0.781
Means	42.054	41.37	0.54	1.242

Each value is a mean of 3 replications. Means sharing common characters between rows are non-significant at α = 0.05. LSD = 5.358

Table IV.- Effect of aphids on the length of spike tiller^{-1} (cm).

Cultivars	Length of seeds spike tiller^{-1} (cm)		Spike tiller^{-1} (cm) loss	Percent seeds spike tiller^{-1} difference
	Treated	Untreated		
Inqilab-91	15.47AB	14.42ABC	1.05	6.78
Fakhar-e-Sarhad	14.75ABC	13.90BC	0.85	5.76
Bakhtawar-92	15.08ABC	13.68C	1.4	9.28
Nowshera-96	14.83ABC	14.33BC	0.5	3.37
Khyber-87	15.02ABC	14.33BC	0.69	4.59
Suleman-96	15.92A	14.73ABC	1.19	7.47
Tatara	14.67ABC	13.25C	1.42	9.68
Means	15.105	14.091	1.01	6.70

Each value is a means of 3 replications. Means sharing common characters are not significantly different at α = 0.05. LSD = 1.515

Table V.- Effect of aphids on the height of tillers plant^{-1}.

Cultivars	Height tiller plant $^{-1}$ (cm)		Tiller plant^{-1} (cm) loss	Percent seeds tiller plant^{-1} difference
	Treated	Untreated		
Inqilab-91	91.33A	90.00ABC	1.33	1.456
Fakhar-e-Sarhad	88.75ABC	87.33C	1.42	1.6
Bakhtawar-92	89.10ABC	88.33BC	0.77	0.86
Nowshera-96	89.37ABC	87.33BC	1.17	1.307
Khyber-87	88.37BC	87.33BC	1.04	1.176
Suleman-96	90.67AB	89.17ABC	1.5	1.65
Tatara	90.17AB	89.67ABC	0.5	0.555
Means	89.698	88.59	1.104	1.229

Each value is a means of 3 replications. Means sharing common characters are not significantly different at α = 0.05. LSD = 2.799

followed by 1.4 cm (9.28%), 1.19 cm (7.47%), 1.05 cm (6.78%), 0.85 cm (5.762%), and 0.69 cm (4.59%) in Bakhtawar-92 Suleman-96, Inqilab-91, Fakhar-e-Sarhad, and Khyber-87, respectively (Table IV). Overall results showed 6.704% mean decrease in the length of spike tiller^{-1} in all entries, where the means were not significantly different with one another at a = 0.05.

Height of tiller plant^{-1} loss assessment

The maximum 91.33 cm height of tiller plant^{-1}

was recorded in variety Inqilab-91 and the minimum 88.37 cm height of tiller planr1 was found in variety Khyber-87. However, the untreated variety Inqilab-91 showed a difference of 1.33 cm due to aphid attack indicating 1.46 % decrease in the height of tiller plant^{-1}. Maximum decrease in height of tiller plant^{-1} was recorded in Suleman-96 with 1.5 cm (1.65%), followed by Fakhar-e-Sarhad with 1.42 cm (1.6%), Inqilab-91 with 1.33 cm (1.456%) Nowshera-96 with 1.17 cm (1.307%), Bakhtawar-92 with 0.77 cm (0.86%) and Tatara with 0.5 cm (0.55%) (Table V). The overall mean decrease of 1.104 cm (1.229%) in height of tillers plant^{-1} in all entries were not significantly different at $\alpha = 0.05$.

Table VI.- Effect of aphids on 1000 grains weight (gm).

Cultivars	1000 grain weight (gm)		1000 grain weight (gm)	Percent 1000 grain weight difference
	Treated	Untreated		
Inqilab-91	39.13 A	38.03A	1.1	2.81
Fakhar-e-Sarhad	39.26A	38.74A	0.52	1.325
Bakhtawar-92	38.28A	37.98A	0.3	0.78
Nowshera-96	38.44 A	37.98A	0.46	1.197
Khyber-87	37.14A	36.81A	0.33	0.88
Suleman-96	39.23A	38.36A	0.87	2.22
Tatara	38.08A	37.70A	0.38	0.99
Means	38.508	37.94	0.565	1.457

Each value is a means of 3 replications. Means sharing common characters are not significantly different at $\alpha = 0.05$. LSD = 3.752

Table VII.- Effect of aphids on the yield (kg ha^{-1}).

Cultivars	Grain yield (kg ha^{-1})		Grain yield loss (kg)	Percent yield difference
	Treated	Untreated		
Inqilab-91	5688A	5532A	156	2.74
Fakhar-e-Sarhad	5164A	4889A	275	5.33
Bakhtawar-92	5689A	5533A	156	2.74
Nowshera-96	5155A	4973A	182	3.53
Khyber-87	5867A	5510A	357	6.08
Suleman-96	5332A	5155A	177	3.32
Tatara	5472A	5332A	140	2.56
Means	5480.19	5274.86	206.14	3.76

Each value is a means of 3 replications. Means sharing common characters are not significantly different at $\alpha = 0.05$. LSD = 1262

Assessment of 1000 grain weight and overall yield

The weight of 1000 grain between treated and untreated plots of each variety and among the all tested varieties were statistically similar at a = 0.05 (Table VI). The small non-significant difference in the 1000 grain weight may be due to aphid attack but negligible.

Yield of cultivars as affected by the attack of aphids

At the end of the season, the yield in the treated and untreated sub-plots of the same cultivar as well as the yield in the different cultivars was statistically similar at $\alpha = 0.05$ (Table VI). A negligible variation in the yield of cultivars may be due to their genetic make up. The mean percent yield difference of 5.33 and 6.08 in the treated and untreated plots of Fakhar-e-Sarhad and Khyber-87, respectively, seems to be because of the aphid attack but without any significant impact.

DISCUSSION

Many research workers have studied the resistant ability of plants against their insect pests. Published information reveals that aphids are

serious pests of wheat crop (EL Bouhssini *et al.*, 2000). They have also been implicated in the transmission of BYDV disease of wheat (Capsicaneo and Gilet, 1996). In the present study, the increase in population was gradual from vegetative growth stage to inflorescence. Similar results were also observed by Hussein (1993). According to him a maximum abundance of each aphid species occurred at the beginning of flowering period, after which the population fell rapidly. Rustamani *et al.* (1999) observed that the infestation of aphids appeared during the 3rd week of December on all wheat varieties. The increase in population was gradual during vegetative growth stage but the aphids multiplied rapidly during the reproductive stage. The variation in the aphid density tiller^{-1} in different varieties could be the resistance response of these varieties to aphids attack. Our results favor the findings of Xiang (1999) who found that wheat varieties did not obviously affect the mortality of nymphal aphids, but significantly affected the development duration of nymphal aphids and the longevity and fecundity of adults. Similarly Havlickova (1989) found significant differences in the number of nymphs produced by the alates on tested cultivars. The percent reduction in spikelets spike^{-1} and seed spike^{-1} in the present study were not significantly different at different levels of probability may be because of the use of different varieties in the experiment. In contrast to our results, Rustamani (1999) observed that the agronomical characteristics such as plant height, number of spikelets spike^{-1} and number of grains spike^{-1} were variable with the tested varieties. Our results also disagree the results of Elmali and Toros (1997) who recorded 10.16% average loss in 1000 grain weight; However, they found that some yield and morphological characteristics (fertile spikelets spike^{-1}, grain spike^{-1}, plant height and spike length) were not. affected. The 6.70% reduction in the length of spike tiller^{-1} and 1.22% reduction in the length of tiller plant^{-1} because of the aphid infestation were not significantly different among the tested cultivars. Elmali and Toros (1997) observed that due to aphid infestation in winter wheat, some yield and morphological characteristics (fertile spikelets spike^{-1}, grains spike^{-1}, plant height and length of spike tiller^{-1} were not affected. Bakhait *et al.* (1989) found that the cultivars with high yielding ability were susceptible to aphid infestation. The percent reduction in 1000 grains weight and yield in the present study due to aphid attack was statistically similar. Our results favor the findings of Khan (2000), Zeb (2001), and Imran (2001) who observed non-significant yield losses in different wheat cultivars because of the aphids attack in N.W.F. Province. Insecticide used in this experiment was only used to completely stop the attack of the aphids which could be very correctly compared with yield and yield related parameters as affected by the aphid attack in the untreated plot of the same cultivar as well as of the different cultivars, though, Usually in wheat against aphids hot water treatment is made. It is evident from the results that aphids have no significant impact on the tested seven wheat cultivars.

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