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Varietal screening of advance wheat genotypes against wheat aphids and association of natural enemies

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Abstract
Aphid is destructive pest of wheat which is staple food crop of Pakistan. Eleven wheat genotypes (FSD-08, V-11098, NIBGE gandum-3, shafaq 2006, V-13372, Punjab-2011, V-12304, 11C023, V-13005, V-13016, V-12120) were studied using the Randomized Complete Block Design during the year 2015-2016. The results revealed that shafaq 2006 and V-12120 were more susceptible with 10.22 and 9.90 aphids per tiller and minimum infestation was observed on the Punjab-2011 and 11C023 i.e 5.72 and 5.99 aphid per tiller respectively. When the peak season observations were analyzed slight changes occur in the peak population of aphid among all wheat genotypes. The most susceptible genotypes were Shafaq 2006 and V-12304 with 18.63 and 18.23 aphids per tiller while the wheat genotypes were tolerant 11C023 and Punjab 2011 with 9.99 and 10.47 aphids per tiller. Population of natural enemies varied on each genotypes and showed the negative impact on wheat aphid's population.

Keywords: Wheat, aphids, population dynamics, varietal screening

1. Introduction
Wheat is the major food crop of all over the world population. About two billions people (36% population of the world) used wheat as staple crop. Globally people get 55% carbohydrates and 20% food calories from wheat [13]. Wheat is also major staple food crop of Pakistani people and gets more than seventy percent calories and protein from wheat during their average diet [15]. In 2013 and 2014 the area of cultivation of wheat was 215,489,485 ha and 220,417,745ha respectively. Worldwide the production of wheat during 2013 is 670,875,110 million tonnes. But China ranks first by producing wheat 120,580,000 million tonnes from top wheat production countries are Russia, France, India, China, and USA [7]. Wheat has the largest area under cultivation 9180 thousand hectares in Pakistan. The yield of wheat was 25.478 million tonnes during 2015. It shares 2.0 percent in the GDP and 10.0 percent in the agriculture. In 2013-14 the production is high (26.979 million tonnes) as compared to 2015 (1.9% decrease) due to some environmental factors at the harvesting stage during may and April rainfall occurs that favors the wheat rust and smut disease and also effect on grain formation. Another reason is area under cultivation of wheat decreased a little bit (0.2%) due to shifting of cropping pattern towards vegetables [6].
Many insect pests attack the wheat crop from sowing up to harvesting and then in stores also. The most dangerous pest is aphid [11]. The most prevalent species of aphids in Punjab are *Rhopalosiphum padi* S. *Schizaphis graminum* R., *Rhopalosiphum maidis* F. and *Sitobion avenae* F. [17]. Among these the most destructive aphid is *Schizaphis graminum* and has a wide range of host at least 60 species in which barley, sorghum, corn and wheat included [12]. Aphid suck the cell sap from the leaves, stems and spikes and also inject the saliva that is toxic [16]. It also favors the growth of fungus that causes the diseases of wheat [18]. It has been reported that 15 aphids per plant cause more than thirty percent of yield loss of wheat crop [21]. In 2004 eleven varieties/lines of wheat were checked against wheat aphid and PND-1 found to be most susceptible and Inqlab-91 found to be tolerant [10]. In 2010 conducted a study to assess the yield loss caused by wheat aphid. Maximum aphid infestation occur in commercially growing wheat variety Punjnad-1 having grain yield 2470kg per hector. Minimum aphid infestation occur on wheat genotype V-4012 with yield 3751kg per hectare that was almost statistically similar with V-2237 [4].

Different methods adopted to manage the aphid population below the ETL level without affecting the natural environment and beneficial organisms. A studied was done during 2002-4 in china on biological control of wheat aphid by using mites. To increase their effectiveness wheat is growing on strips with alfalfa (*Medicago sativa*) crop. Due to this the larval and egg densities of Allothrombium ovatum increases ultimately aphid parasitism increases as compared to wheat growing in a monoculture system. The parasitism of *A. ovatum* is more on alate aphids than apterous aphids so, dispersal increases and decreases the aphid population on wheat. [23]. Khan *et al*., (2015) reported that application of micro and macro nutrients enhance the host plant resistance in plants. The minimum aphid infestation was observed on the second treatment ('Blossom Plast' and 'Spring Up' as seed treatment and 'Super Flor' as foliar treatment) [19]. The host plant resistance is an important technique among these methods to keep the aphid population below the ETL level and host plant resistance can easily be recognized from various wheat genotypes [22]. Fecundity rate and reproduction greatly affected by the host plant variety [27]. By using various assays identified the type and level of tolerance/ resistance in the wheat varieties/lines against wheat aphids [32]. The current study was carried out to check the aphid population pressure on different genotypes of wheat so that the comparatively less susceptible/tolerant wheat varieties/lines could be screened out for general cultivation and to reduce losses caused by this insect pest.

2. Materials and Methods

An experiment was conducted to screen out the varieties of wheat against aphid, at the Entomological Research Institute in Ayub Agriculture Research Institute Faisalabad. Eleven wheat genotypes (FSD- 08, v-11098, NIBGE gandum-3, shafaq 2006, v-13372, Punjab-2011, v-12304, 11C023, v-13005, v-13016, v-12120) were used in this study. These varieties were sown in lines by hand pulled drill on November 23, 2015. The experiment was conducted in Randomized Complete Block Design having three replicates. The plot size was 5m x 6m. In each plot uniform agronomic practices were applied. The data regarding aphid was recorded from December 30, 2015 to March 16, 2016 at weekly interval on per tiller basis for aphids. Ten randomly selected tillers from each plot were observed to record the aphid population. Also count the sryphid fly and coccenillid beetles per five plants from each treatment plot.

2.1 Statistical Analysis

At the end of the experiment, the data were analyzed statistically (analysis of variance ANOVA) by using the statistix8.1 software and means were compared by using LSD test.

3. Results

During the season the dominant population of *Rhopalosiphum padi* L. at tillering stage and *Sitobion avenae* F. during earing stage. The aphid population become visible in the last week of December and gradually increased on all the wheat genotypes. Data on overall average aphid population reveals that shafaq 2006 and V-12120 had maximum aphid population 10.22 and 9.90 respectively while the minimum aphid population 5.72/tiller was recorded on 11C023 and it was statistically similar with FSD-08, V-11098, V-1305, V-13372, V-1306 and Punjab 2011 (Table-2). During the first week of January aphid population increases little bit but also statistically similar. During the last week of January the aphid infestation minimum aphid infestation observed on 11C023 and maximum on Nibge Gandum-3 genotypes. Aphid population varies with time to time on the first week of January and the second week of January maximum population observed on genotypes V-1372 (3.0 aphid per tiller), Nibge gandum-3 (7.4 aphids per tiller) respectively. During these two weeks minimum aphid infestation observe on genotypes shafaq 2006 (1.1 aphids per tiller), V-1108 (2 aphids per tiller) respectively and statistically similar for all varieties (Table-1).

The aphid population varied according to the passage of time from first week of January to the second week of February, but statistically similar for all the varieties (Table-1). The data reveal that during the second week of February to third week of March peak period of an aphid population started. During the last week of February and first week March maximum aphid infestation was observed on genotypes V-12304 (48 aphids per tiller), V-12120 (36 aphids per tiller) and minimum aphid infestation on Punjab 2011 (16.23 aphids per tiller), 11C023 (14.33 aphids per tiller) (Table-1).

Table 1: Mean aphid population week wise on the wheat genotypes

Wheat Genotypes	Dates of observations									
Treatments	**30/12/15**	**6/1/2016**	**28-1-2016**	**2/2/2016**	**9/2/2016**	**16/2/2016**	**23/2/2016**	**3/3/2016**	**8/3/2016**	**16/3/2016**
Fsd-08	0.067^{A}	0.000^{C}	0.500^{B}	1.467^{AB}	3.033^{AB}	5.833^{BC}	39.000^{ABC}	18.500^{BC}	4.4667^{CD}	3.8667^{ABC}
V-11098	0.000^{A}	0.133^{ABC}	0.900^{B}	1.200^{B}	2.000^{B}	6.533^{ABC}	24.833^{ABC}	25.767^{ABC}	9.7000^{AB}	5.1333^{ABC}
Nibge gandum-3	0.000^{A}	0.133^{ABC}	2.300^{A}	1.733^{AB}	7.433^{A}	6.467^{ABC}	35.600^{ABC}	14.300^{C}	7.5000^{ABC}	5.1667^{ABC}
Shafaq-2006	0.167^{A}	0.167^{AB}	1.167^{AB}	1.100^{B}	6.433^{AB}	10.867^{AB}	44.200^{AB}	30.833^{AB}	4.7000^{CD}	2.5333^{BC}
V-13372	0.167^{A}	0.200^{A}	0.800^{B}	3.300^{A}	3.400^{AB}	4.800^{BC}	17.667^{C}	18.233^{BC}	8.5333^{ABC}	7.3000^{A}
Punjab-2011	0.000^{A}	0.167^{AB}	0.633^{B}	2.333^{AB}	6.267^{AB}	5.833^{BC}	16.233^{C}	19.567^{BC}	6.2667^{ABCD}	2.0333^{C}
V-12304	0.000^{A}	0.100^{ABC}	1.033^{B}	1.700^{AB}	3.767^{AB}	12.933^{A}	48.733^{A}	18.433^{BC}	5.5000^{BCD}	5.5333^{ABC}
11C023	0.000^{A}	0.033^{BC}	0.400^{B}	1.533^{AB}	2.900^{AB}	7.800^{ABC}	23.167^{BC}	14.733^{C}	3.2333^{D}	3.4333^{ABC}
V-13005	0.033^{A}	0.133^{ABC}	1.167^{AB}	2.367^{AB}	4.100^{AB}	7.367^{ABC}	22.000^{BC}	20.700^{BC}	8.4000^{ABC}	6.7333^{AB}
V-13016	0.000^{A}	0.200^{A}	0.733^{B}	2.100^{AB}	3.800^{AB}	3.833^{C}	16.533^{C}	21.067^{BC}	8.5667^{ABC}	5.3000^{ABC}
V-12120	0.033^{A}	0.067^{ABC}	1.300^{AB}	2.667^{AB}	5.167^{AB}	11.367^{AB}	28.767^{ABC}	36.033^{A}	9.8000^{A}	3.8333^{ABC}
LSD values	0.23	0.15	1.24	1.90	4.62	6.5672	25.095	14.263	4.2457	4.4389

Each value is mean of 3 replications. Means having different letters show that statistically different from each other and means sharing same letters are not significantly different from each other by Fisher's LSD test at P= 0.05.

During the month of January, February, March maximum aphid infestation was observed on genotypes NIBGE gandum-3, V-1204, V-12120 (0.81, 16.79, 16.56 aphids per tiller) and minimum aphid infestation on genotypes Fsd-08, V-13016, 11C023 (0.19, 6.6, 7.1 aphids per tiller) respectively (Table-2).

Table 2: mean population of wheat aphid month wise, whole season and during peak period

Wheat Genotypes	Jan	Feb	March	Whole Season	Peak Period
Fsd-08	0.1867^{B}	12.337^{AB}	8.947^{BC}	7.673^{CD}	14.333^{BC}
V-11098	0.3433^{B}	8.643^{B}	13.533^{AB}	7.620^{CD}	14.393^{BC}
NIBGE gandum-3	0.8100^{A}	12.810^{AB}	8.987^{BC}	8.063^{BC}	13.807^{CD}
Shafaq-2006	0.4967^{AB}	15.653^{A}	12.687^{AB}	10.217^{A}	18.627^{A}
V-13372	0.3867^{AB}	7.293^{B}	11.357^{BC}	6.440^{CD}	11.307^{CD}
Punjab-2011	0.2667^{B}	7.670^{B}	9.290^{BC}	5.933^{D}	9.987^{D}
V-12304	0.3767^{B}	16.787^{A}	9.820^{BC}	9.773^{AB}	18.227^{AB}
11C023	0.1433^{B}	8.853^{B}	7.137^{C}	5.723^{D}	10.473^{CD}
V-13005	0.4433^{AB}	8.960^{B}	11.943^{ABC}	7.300^{CD}	13.040^{CD}
V-13016	0.3100^{B}	6.570^{B}	11.647^{BC}	6.213^{CD}	11.060^{CD}
V-12120	0.4700^{AB}	11.993^{AB}	16.557^{A}	9.903^{AB}	17.960^{AB}
LSD values	0.4308	6.3969	4.8504	1.9944	3.9618

Each value is mean of 3 replications. Means having different letters show that statistically different from each other and means sharing same letters are not significantly different from each other by Fisher's LSD test at P= 0.05.

While minimum population on the variety Punjab-2011 that was 9.99 that was statistically similar with 11C023, V-13016, V-13005, V-13372 and NIBGE gandum-3 that was 10.47, 11.06, 13.04, 11.31, 13.80 respectively (Table-2). After the third week of March, 2016 a sudden decline in the aphid population was observed due to heavy rain, sudden increases in temperature and maturity of the crop. During the peak period the maximum population observed on the shafaq 2006 that was 18.63 aphid per tiller that was statistically similar with the variety V-12304, V-12120 with 18.23 and 17.96 aphid per tiller (Table-2).

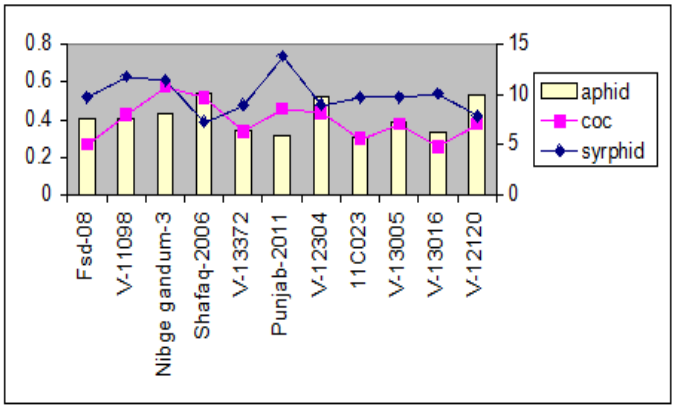

Fig 1: Relationship between coccennillid beetles, syrphid fly and aphid population

Strong natural enemies of wheat aphid syrphid fly and lady beetles was observed on all wheat genotypes. Data revealed that as the population of natural enemies increased population of wheat aphids decreased gradually (Fig-1) and ultimately having a positive impact on the yield. Population of natural enemies showed variation from genotypes to genotypes of wheat crop. Maximum population of syrphid flies observed on the genotypes Punjab-2011 while least population was observed on V-12120. In case of lady beetles (Cocenellids) maximum population was observed Nibge gandum-3 and minimum population on Fsd-08. Further investigation was required to determine how natural enemies' wheat aphids showed a variation on all genotypes of wheat crop.

4. Discussion

During January to 2nd week February population of aphids was not high because in the early growth stages the aphid does not capable to reproduce [2]. This may also be the reason that at that stage the quality of food different. The quantity and quality of food changes with the passage of growth of plants which definitely affect the distribution, reproduction, longevity, development speed and the survival of the insect [34]. During the second week of February to third week of March peak period of an aphid population started there are many reasons for this, one is that at milking stage the food quality good and surplus for the reproduction and growth of the aphid [29]. Aslam *et al*. conducted a study to check the effect of different sowing dates on aphid population. The best suitable sowing dates for wheat in regarding to aphid 25 November timely sowing because at late sowing the aphid infestation is more severe and cause huge economic loss [9]. Another factor is temperature [31]. Temperature 7.7 ^{0}C to 25.2 ^{0}C is favourable for the development of aphid [14], and the optimum temperature is 23.44 ^{0}C [24]. The mean maximum temperature during February was 24.6 ^{0}C and during March 27.8 ^{0}C in the Faisalabad.

The natural enemies, relative humidity and daily temperature also affect the aphid population [1]. Another factor was Syrphid fly larvae, Coccinellid beetles and their larvae in the field that feed on the aphid and also reduce the population at maturity stage [28].

Our findings confirmed the previous work of the scientists that the Punjab 2011 was a resistant variety against aphid and observed low population as compared to other varieties however they used different varieties of wheat with Punjab 2011 but our findings were against the work of Muhammad Saleem [26] who found the shafaq 2006 as resistant in 2010.But the trend of aphid infestation on shafaq genotype was totally changed so, now the most resistant varieties/lines of wheat against aphids are Punjab 2011 and 11C023.

5. Conclusion

The present experiment revealed that the aphid population was minimum during the month of February and maximum during the month of March. According to the data variety/lines shafaq 2006, V-12304, V-1220 were highly susceptible to aphid attack and the variety/lines V-11098,

FSD-08, NIBGE gandum-3 were moderately susceptible. The variety/lines V-13005, V-13372, V-13016 was moderately resistant and the variety/lines Punjab-2011 and 11C023 were resistant to aphid attack from the varieties/lines that were evaluated during the crop season 2015-16. Natural enemies of wheat aphid's lady beetles and syrphid flies showed a negative association with wheat aphids and their population vary between all genotypes.

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