Research Article

Incidence of Different Aphid Species on Various High Yielding Wheat Varieties

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Abstract | Wheat (*Triticum aestivum* L.) is a major crop with one of the largest area under cultivation playing a significant role in economic stability of Pakistan. Among other pests aphid is a major one which contributes towards low yield on wheat farms. Different wheat developmental periods, i.e., seedling (SS), tillering (TS), stem elongation (SES), heading (HS), dough (DS) and ripening (RS) were studied. Through evaluating, seven varieties i.e. Sahar-2006, Faisalabad-2008, Punjab-2011, Galaxi-2013, Gold-2016, Fakhr-e-Bhakkar-2017 and Bhakkar Star-2018 the most susceptible wheat stage against the infestation of aphid was investigated. Exploring most susceptible wheat stage was conducted through most common aphid species, i.e., *Rhopalosiphum padi*, *Schizaphis graminum*, *Sitobion avenae* on different varieties. Results indicated that heading and dough stages (Standard Weeks 10 and 11) were most susceptible developmental periods with average 10.56 and 8.36, 21.98 and 18.65 aphids per tiller during 2018 and 2019, respectively. *R. padi* was most dominant from mid-January to mid-April with maximum population of 100, 84.33, 44.31 and 1.64 % in 2018 as well as 100, 89.78, 22.08, and 0.29 % in 2019. *S. graminum* 12.97, 46.93, 64.74% in 2018 as well as 4.53, 42.00, 49.50 % in 2019. It was most dominant from 1st week of February to1st week of April. *S. avenae* population was 2.70, 8.75, 33.62 % in 2018 as well as 00.00, 15.13, 56.56 % during months of February, March and April, respectively. *S. avenae* was most dominant from 4th week of March to 2nd week of April during both years. Faisalabad-2008 and Sahar-2006 were most prone to aphid attach having maximum aphid populations during 2017-19. Fakhr-e-Bhakkar-2017 depicted minimum average aphid susceptibility having population of 2.94, 2.58 and 3.08 per tiller during years 2017, 2018 and 2019, respectively.

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Introduction

Wheat (*Triticum aestivum* L.) is healthy and efficient cereal crop, elementary food and economical source of staple food in the whole world (Khan *et al*., 2000). It feeds more than 35% of the world population (Khakwani *et al*., 2012) including Pakistan where it subsidizes more than 70 % share in total grain consumption. Wheat has been cultivated on 8.7 million hectares with production of 24.2 million tons in Pakistan. It shares 10.1 % to the value added in agriculture as well as 2.2 % towards GDP (Ahmad *et al*., 2015). Food demand of the 40 % world's people is met by wheat, therefore it is incessant need of obtaining higher grain yield for growing population of the world. In 100 g seed, it has 326-335 calories, 4.3-5.3 mg niacin, 0.11-0.12 mg riboflavin, carbohydrate 69.1-75.4, protein 9.4-14.0 g, fat 1.2-2.5 g, ash 1.7

g, calcium 36-46 mg, fiber, 3.0-4.3, potassium 370-435 mg, thiamine 0.43-0.66 and 11.57-14.0 g water (Ken, 2004). Wheat production of Pakistan is still below than other advanced agricultural countries and various elements are responsible for this including abiotic factors as well as low yielding varieties (Khan *et al*., 2012). Also injudicious use of irrigation and fertilizers (Kibe *et al*., 2006), sowing date (Aheer *et al*., 1993), weeds (Memon *et al*., 2013) and insect pests (Khattak *et al*., 2007). Among these factors insect pests have their significant role in reducing yield whereas aphids are major and serious pests of wheat crop (EL Bouhssini *et al*., 2000). *Rhopalosiphum padi, Schizaphis graminum*, *Sitobion avenae* and *Rhopalosiphum maidis* are the most abundant species infesting wheat crop in Pakistan (Shah *et al*., 2006). These have become regular pest of wheat in Pakistan and act as vectors for the transmission of BYDV (Barley Yellow Dwarf Virus) disease of wheat (Capsicaneo and Gilet, 1996). They suck sap from leaves and shoot that result in curling, chlorosis, distortion and stunted growth (Akhter and Khaliq, 2003). These insects reproduce very rapidly under favourable conditions on leaves, stems and inflorescence causing significant decrease in wheat yield. They cause 35-40 % loss directly by sucking sap, and 20-80 % loss indirectly by transmission of viral and fungal diseases (Rossing *et al*., 1994). *R. padi* damages cereals by sucking the sap and depriving the plant of nutrients at their two leaf stages leading to 40-60% yield loss (Taheri *et al*., 2010). It causes yield losses up to 600 kg/ha in wheat (Hallqvist, 1991). *S. graminum* also causes 30 % yield losses in unsprayed field of wheat crop (Kannan, 1992). *S. avenae* reduce yield by 20-30% during outbreaks. Single aphid can cause 2.20 % loss in grain yield and at the level of 15 aphid per plant 30-40 % yield losses has been reported. (Kiechkhefer and Gellner, 1992). The current study was carried out to investigate the most susceptible wheat developmental stage during aphid infestation, in regard to dominancy and feeding habit of three aphid specie i.e. *R. padi, S. graminum* and *S. avenae*. Estimates of the losses caused by these aphids was also investigated in order to device suitable IPM techniques for control recommendations. Susceptibility levels of different approved varieties was also investigated.

Materials and Methods

Experiment was conducted in the fields of Arid Zone Research Institute, Bhakkar (BK) under RCBD with five replications. Seven wheat variety i.e. Sahar-2006, Faisalabad-2008, Punjab-2011, Galaxi-2013, Gold-2016, Fakhr-e-Bhakkar-2017 and Bhakkar Star-2018 were grown since mid November during 2017-19 for the study. Uniform agronomic practices were applied to all the sown replicates. Different wheat stages i.e. seedling (SS), tillering (TS), stem elongation (SES), heading (HS), dough (DS) and ripening (RS) were examined critically to record the infestation of aphid over time, exploring most susceptible stage. Wingless aphids were counted on per tiller basis by examining visually. Dominancy and feeding habit of three most common aphid specie i.e. *Rhopalosiphum padi, Schizaphis graminum* and *Sitobion avenae* were studied on the different phases of wheat growth during several months during 2018-19. Population on the wheat tillers was counted by shaking aphids off a white paper. Three species were identified on the basis of morphological characters and counted separately. Data was subjected to statistical analysis (α-0.05) and analysis of variance was computed using window based computer program Statistic 8.1 at 5 % level of significance. Tukey HSD test was applied to determine pair wise comparison of the means.

Results and Discussion

The experiment was carried out during years 2018 and 2019 to evaluate most susceptible developmental stages of wheat crop against aphid infestation. Several stages were studied, i.e., seedling, tillering, stem elongation, heading, dough and ripening developmental stages. The highest population of 10.56 and 21.98 aphid per tiller were recorded during standard week 10 and 11 coinciding with heading and dough stage, respectively (Figure 1). All the stages were significantly different from each other regarding aphid population where heading, stem elongation and dough stages had maximum infestation with aphid (Figures 1 and 2). Traces of aphid population on plants were found during the last week of December and up to the beginning of January in 2018. During 2019 highest population of 8.36 and 18.65 aphid per tiller were recorded on same standard week 10 and 11 corresponding to heading and dough stage, respectively (Figure 2). All the stages were significantly different from each other regarding aphid population. These findings confirmed previous results by Rustamani *et al*. (1999) where thus observed that the infestation of aphid appeared during the 3rd week of December. Population of aphids was at high level during the

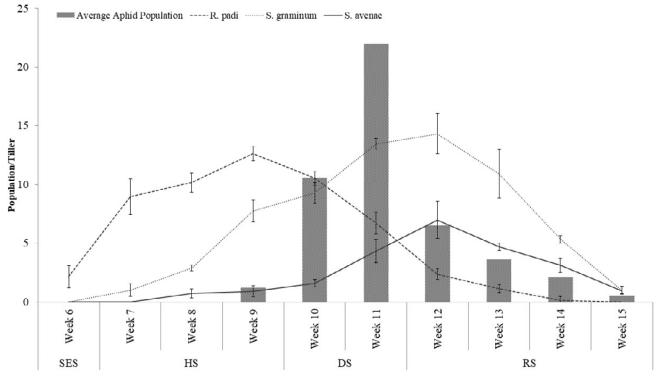

Figure 1: *Incidence of different wheat aphid species over time during 2018.*

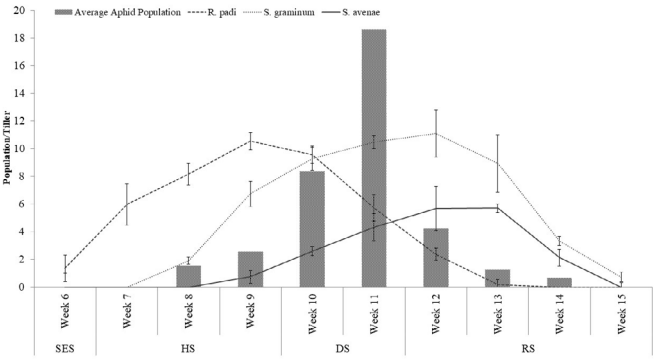

Figure 2: *Incidence of different wheat aphid species over time during 2019.*

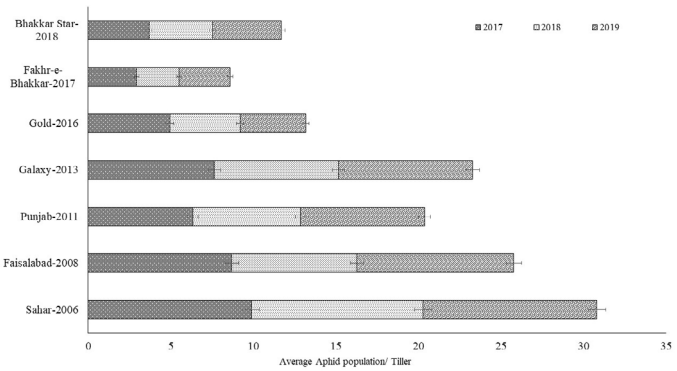

Figure 3: *Incidence of different wheat aphid species on different approved varieties during 2017-19.*

February till the 15th of the March and it decreased abruptly and disappeared after the 1st week of April. Our study has found the increase in population trend from tillering stage towards the heading stage (Figures 1 and 2). Similar results were found by Hussein (1993), where abundance of each aphid specie was found at the start of the flowering period and after this population fell abruptly. Maximum abundance of each aphid specie occurred at the beginning of flowering period which fell rapidly after. Many other scientists who have worked on the biology of wheat aphid. Such as Khan *et al.* (2012), Karimullah and Ahmad (1989), Aheer *et al.* (2007), Wains *et al.* (2008) and Iqbal *et al.* (2008), found highest peaks of aphid population during March. Singh *et al.* (2001) found highest such peaks during 2nd week of January and Ahmad *et al.* (2015) found highest peaks during 4th week of February. Ozder (2002) found highest aphid population peaks at milking stage during 3rd week of March. Rehman *et al.* (2016), Nawaz (2000), Keickhefer *et al.* (1994), Keickhefer and Gellner (1992) and Rustamani *et al.* (1999) reported highest peaks at heading or earing stage. Wheat has three major infesting aphid species i.e. *Rhopalosiphum padi*, *Schizaphis graminum*, and *Sitobion avenae* with varying periods of infestation. *R. padi* was curliest specie which appeared from February till 2nd and 1st week of April (Table 1). Population increased gradually with time and reached at its peaks on 1st week of March (12.65/tiller, Standard week 9). *S. graminum* appeared from 3rd and 4th week of February. Its population reached at its peaks during 4th week of March (Standard week 12) with population 14.33 per tiller (Table 1). Similarly *S. avenae* appeared during 4th week of February and 1st week of April with peaks during last week of March (6.99/tiller, Standard week 12) and 1st week of April (4.77/tiller) till during 3rd week of April (3.13/tiller) and 2nd week of April (0.98/tiller) as shown in Figure 1 during 2018. Whereas during 2019 *R. padi* appeared from January till 2nd and 1st week of April. Population increased gradually with time and reached at its peaks on 1st week of March (10.55/tiller, Standard week 9). *S. graminum* appeared from 3rd and 4th week of February and its population reached peaks during 4th week of March 11.10/tiller (Standard week 12). Similarly, *S. avenae* appeared during 4th week of February and lasts till 1st week of April (Figures 1 and 2) with peaks during last week of March (5.69/tiller, Standard week 12) 1st week of April (5.77/tiller) till during 3rd week of April (2.13/tiller) and 2nd week of April (0.00/tiller). *R. padi* was the 1st specie which appeared the wheat crop and fed mostly on the leaves and shoots (Table 1). *S. graminum* was appeared after the *R. padi* and fed mostly on the shoots and ears (Table 1). *S. avenae* appeared after the both of above species and remained mostly on flowers/ears (Table 1). This study was confirmed earlier work by Jarosik *et al.* (2003) who reported that *R. padi* and *S. avenae* are most destructive species on winter wheat where *R. padi* mostly feed on leaves and ears while *S. avenae* infesting ears. They found *R. padi* was dominant from mid-February to mid-March, *S. graminum* was dominant during month of March and *S. avenae* during mid-March till1st week of April. This study also confirmed reported by Shahzad *et al.* (2013) who observed two species, i.e., *R. padi* and *S. graminum* on

wheat crop where *S. graminum* was dominant over *R. padi* on the last week of March. Incidence of the three species was observed in order *R. padi* > *S. graminum* > *S. avenae* (Table 1). Maximum percent population of *R. padi* was 100 and 100, 84.33 and 89.78, 44.31 and 22.08, 1.68 and 0.29 during 2018 and 2019, respectively during the months of January, February, March and April (Table 1). Maximum percent population of *S. graminum* was 12.97 and 4.53, 46.93 and 49.50, 64.74 and 42.00 during 2018-19, respectively during the months of January, February, March and April (Table 1). Similarly, maximum percent population of *S. avenae* was 2.70 and 0.00, 8.75 and 15.13, 33.62 and 56.56 during 2018 and 2019, respectively during the months of January, February, March and April (Table 1). Aphid infestations showed different levels on different approved varieties. Old varieties had higher infestation levels as compared to the new approved varieties (Figure 3). There were progressive trends of aphid populations every year. Aphid per tiller population on Sahar-2006 was 9.89, 10.39, 10.54, Faisalabad-2008 8.69, 7.59, 6.51, Punjab-2011 6.34, 6.52, 7.51, Galaxy-2013 7.65, 7.52, 8.12, Gold-2016 4.95, 4.26, 3.98, Fakhr-e-Bhakkar-2017 2.94, 2.58, 3.08 and Bhakkar Star-2018 3.69, 3.84, 4.18 during 2017, 2018 and 2019, respectively (Table 1). Faisalabad-2008 and Sahar-2006 were most susceptible to aphid attach having maximum aphid populations during three years. Ahmad *et al.* (2015) reported Faisalabad-2008 and Punjab-2011 as highly susceptible to aphid having high seasonal average. But Iqbal *et al.* (2018) reported Faisalabad-2008 as moderately resistant while Sahar-2006 susceptible variety to aphid attack. This difference may be due to varied environmental conditions at different experimental sites.

Table 1: *Percent population abundance of different species during 2018-19.*

2018					
Species	**December**	**January**	**February**	**March**	**April**
R. padi	0.00	100.00	84.33	44.31	1.64
S. graminum	0.00	0.00	12.97	46.93	64.74
S. avenae	0.00	0.00	2.70	8.75	33.62
CV (%)	0.00	43.24	18.8	18.7	18.1
P value		P<0.74	P<0.041	P<0.056	P<0.055
2019					
R. padi	0.00	100.00	89.78	22.08	0.29
S. graminum	0.00	0.00	4.53	49.50	42.00
S. avenae	0.00	0.00	0.00	15.13	56.56
CV (%)	0.00	43.01	13.1	16.4	14.6
P value		P<1.54	P<0.051	P<0.006	P<0.000

Conclusion and Recommendations

Dough and ripening stages are the most susceptible growth periods for the aphid attacks during mid-February to mid-March. *R. padi* was found dominant during stem elongation stage, whereas *S. graminum* feed on dough and ripening stages, while *S. avenae* was most destructive specie during ripening stage. Sahar-2006 was found most susceptible, while Fakhr-e-Bhakkar was moderately resistant to aphid attack. This report will be helpful to devise a management strategy for the control of each aphid specie presented.

Novelty Statement

The current study conducted to determine the optimal lines spacing for enhancing the production in Pakistan. The recommended line spacing was 30cm to harvest maximum lentil yield the province of Sindh.

Author's Contribution

Muhammad Ramzan: Conceived the idea.
Muneer Abbas: Prepared manuscript, data collection, management of manuscript and analysis.
Sohail Abbas: Data collection.
Niaz Hussain: Technical input.
Muhammad Aslam: Proof read.
Javed Anwar Shah: Introduction.
Muhammad Irshad: Proof read, review of literature.
Mudassar Khaliq: Review of literature

Conflict of interest

The authors have declared no conflict of interest.

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