Screening the best adopted wheat cultivars resistant against wheat aphids

M. Farhan Ali, Fahad Hassan, M. Waheed Shah, M. Awais, Jamil Ijaz, M. Usman, M. Faheem Dastgeer, Shafqat Ijaz

Department of Entomology, University of Agriculture, Faisalabad, Pakistan.
*Corresponding author's email: awaisentomologist@gmail.com

Abstract: The planned study was conducted with the objectives to find varietal resistance against aphid (*Shizaphis graminum* Rond) on wheat. Four wheat cultivars i.e. Galaxy-2013, Punjab-2011, Ujala-2016 and Sehar-2006 were sown under randomized complete block design (RCBD) in last week of November with net plot size (1.2m×8m); at Entomological research Area University of agriculture, Faisalabad. Recommended agronomic practices were carried out during experiment. Aphid population density per plant was recorded on weekly basis. Aphid infestation started during last week of January, reached to its peak in mid-March and vanished up to 2nd week of April. Maximum aphid population recorded statistically was 81.43 aphids per plant. In four wheat cultivars Galaxy-2013 came out as most resistant with minimum infestation i.e.59.4 aphids per plant and Sehar-2006 most susceptible with 81.4 aphids per plant. Punjab-2011 and Ujala-2016 were moderately resistant. Galaxy-2013 was most productive in grain yield (5.42 t ha^{-1}) followed by Punjab-2011 (5.17 t ha^{-1}), Sehar-2006(4.88 t ha^{-1}) and Ujala-2016(4.55 t ha^{-1}). Maximum grain yield losses were recorded by Sehar-2006 i.e. 9.3% and Punjab-2011 suffered minimum grain yield losses (4.7%) as compared to control.

[M. Farhan Ali, Fahad Hassan, M. Waheed Shah, M. Awais, Jamil Ijaz, M. Usman, M. Faheem Dastgeer, Shafqat Ija. **Screening the best adopted wheat cultivars resistant against wheat aphids.** *Rep Opinion* 2019;11(5):1-12]. ISSN 1553-9873 (print); ISSN 2375-7205 (online). http://www.sciencepub.net/report. 1. doi:10.7537/marsroj110519.01.

Key words: Screening, wheat cultivars, resistant, aphids

1. Introduction

Wheat (*Triticumaestivum L.*) is important cereal crop which belongs to poaceae (Graminae) family. Since ancient times, its grains have been used by humans to meet dietary requirements and straw for animal feed. The wheat grain constitutes about 68% carbohydrates, 15.4% protein, 12.2% dietary fiber and 1.9% fat. A common man meets 60% of his food requirement from wheat utilization. Wheat straw is important part of animal feed especially during dry spells and forage shortage (Shrivastava*et al.,* 2010). It is a major crop with largest area under cultivation among the cereal crops in Pakistan and plays an important role in economic stability. It fulfills 70% of total food grain consumption in Pakistan (Anonymous, 2008-2009). Due to high nutrition value, it is used as staple food in more than one third population of the world. It is expected that wheat grain yield will touch 860 million tons per annum by 2030 (Tolmay, 2006).

Many factors are responsible for low yield of wheat in Pakistan in which insect pests play an important role (Hatchett and Webster, 1987). Insect pests like wheat aphid (*Schizaphisgraminum*) armyworm (*Helicoverpaarmigera*), termites (*Odontotermusobesus*), wheat weevil (*Tanymecusindicus*) and white ants (*Microtermesobesi*) attack wheat (Atwal and Dhaliwal, 1998). Hashmi *et al*. (1983) reported four aphid species which severely damage the wheat crop in Pakistan especially common green wheat aphid (*Shizaphisgraminum Rond*.) English grain ear aphid (*Sitobionavenae* F.) bird cherry-oat aphid (*Rhopalosiphumpadi* Sasatri) and Russian wheat aphid (*Diuraphisnoxia*). Geza (2000) on winter wheat found 29 aphid species among flying insects.

In order to reduce environment load by pesticides, integrated pest management (IPM) strategy is used in which host plant resistance and biological agents play an important role. In resistant wheat cultivars, host plant resistance is associated with dihydroxy phenols present in plants which cause feeding deterrence to aphids (Leszcynski, 1985). So it is better to utilize varietal resistance of wheat cultivars and judicial insecticides application against aphid (Iqbal *et al.,* 2008).

Khan *et al.* (2011) tested 5 wheat cultivars i.e. 99T007, BK-2002, TW0135, INQLAB and CHAKWAL-97 for resistance against aphids at Arid Zone Research Institute, Bhakar, Pakistan. Aphid population was highest in 4th week of April. INQLAB-91 appeared to be most resistant with mean aphid population (0.35 ± 0.01) and 99T007 most susceptible (0.95±0.02).

Tabasum*et al.* (2012) carried an experiment at university of Sargodha to check the sowing date effect and screening best adopted wheat lines against aphid (*Schizaphisgraminum* R.) on four wheat genotypes (Inqlab-91, Lasani-2002, V-02192 and Bhakar-2002)

during 2009-2010. It was observed that Inqalab-91 was least attacked and Bhakar-2002 was most susceptible among four genotypes.

Beside the cultural practices varietal resistance is also an important tool in insect pest management. The factors that are involved in resistance may be chemical or physical. Pakistan breeders focused their attention to increase the potential of yield and evolved a number of varieties of various crops with maximum yield. Abiotic factor like rainfall, temperature, relative humidity etc. extremely effected the population of wheat aphid (Aheer*et al*., 2007). The world population is increasing progressively with alarming rate, it is reported that it will reach up to eight billion in 2020. So, it will be difficult to feed all the people according to the need and it will create the problems of food security (Avis *et al.,* 2008). Yield losses due to wheat aphid boost the problem of food security. So, it is necessary to develop resistant varieties against wheat aphids to increase the crop yield to meet the food security.

2. Materials and methods

The experiment was conceded at the experimental area, Department of Entomology, University of Agriculture, Faisalabad under Randomized Complete Block Design (RCBD) with three treatments and three replications. A row-row distance of 22.5 cm was maintained. Each experimental unit had a net size of 1.2 m × 8 m. Agronomic practices were kept same for all the treatments. The seed of following wheat cultivars was collected from Ayub Agricultural Research Institute (AARI), Faisalabad and sown with single row drill.

Sr. No.	Cultivars
V1	Galaxy 2013
V2	Punjab 2011
V3	Ujala 2016
V4	Sehar 2006

Screening of wheat genotypes

Aphid population density counts

Data regarding aphid population were recorded 5±2 days interval started from last week of January till 1st week of April when aphid population was nil. Data regarding insecticides efficacy were recorded one day before spray and one, two, seven, and fourteen days after application of insecticides. Counting of aphid from wheat crop was done from 15 randomly selected plants from each treatment from base of plant up to top. The average population per plant was then calculated by the formula.

$$\text{Population density (P)} = \frac{To+T1+T2+T3}{4}$$

Where P is average population per plant

T1, T2, T3 and T0 = Aphids population density on randomly selected plants

Following observations were recorded during the study:

- Aphid population per plant.
- Grain yield per plot.

3. Statistical Analysis

Data collected on various attributes were statistically analyzed using fisher's analysis of variance technique using "DSAASTAT" statistical program (Onofri, 2007). Difference among treatments means was compared using Fisher's least significant test (LSD) at 5% probability level (Steel *et al.*, 1997). Graphical representation of the data was made and standard errors were computed using MS-Excel.

4. Results and discussion

The study was conducted on different cultivars of wheat to verify resistance and susceptibility against aphid depending upon population thickness noted under field conditions, effect of metrological factors, efficacy of insecticides against wheat aphid and their residual toxicity in wheat grains during 2018. The research was conducted in research area of Entomology, University of Agriculture Faisalabad. A number of cultivars were planted i.e. Galaxy-2013, Punjab-2011, Ujala-2016 and Sehar-2006 during third week of November in three repeats and treated with four insecticides. The results are termed below subsequent subdivisions.

Aphid Population dynamics

The data regarding aphid bulk per plant on several cultivar of wheat were observed on different dates of observation and data were analyzed statistically. Analysis of variance revealed significant variation. The means were compared by LSD test at probability ≤0.05 level. The results showed significant ($p \leq 0.05$) differences among various dates of observations and among genotypes. Regarding period of abundance of aphid population, results revealed that the population appeared during the last week of January which increased progressively and reached up to peak value during mid of March and extended to minimum through 1st week of April.

Aphid Population at 63 DAS

Mean aphid population in table (4.1a.) revealed that aphid first appeared on Sehar-2006 as compared to other cultivars i.e. Punjab-2011, Ujala-2016 and Galaxy-2013. Mean population on Sehar-2006 was 0.44 aphids per plant; however, no aphid was recorded on other cultivars.

Table: 4.1a. Mean comparison of data regarding aphid population in various cultivars of wheat at 63 DAS

Sr. #	Variety	Mean ± S.E
1	Galaxy 2013	0.00±0.00 b
2	Punjab 2011	0.00±0.00 b
3	Ujala 2016	0.00±0.00 b
4	Sehar 2006	0.44±0.03 a

Means sharing similar letters do not differ significantly.
LSD ($p \leq 0.05$) = 0.057

Table: 4.1b. Analysis of variance regarding aphid population in wheat cultivars at 63 DAS

Source of Variance	Sum Square	Degree of Freedom	Mean Square	F	Probability	Sig.
Blocks	0.01	2	8×10^{-4}	1		
Variety	0.25	3	0.083	100	1.64×10^{-5}	**
Residual	0.01	6	8×10^{-4}			
Total	0.26	11	0.023			

Ns = Non-significant * = $p \leq 0.05$ ** = $p \leq 0.01$

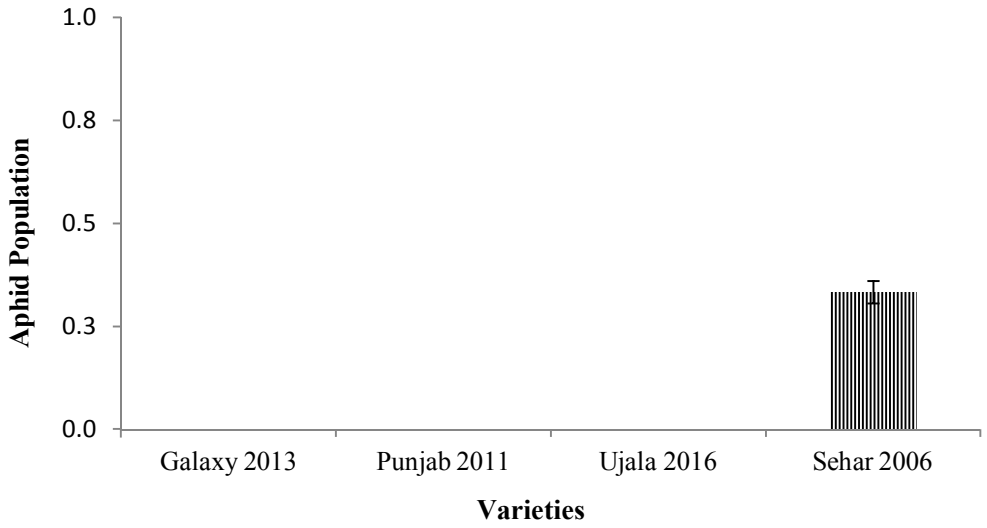


Fig. 4.1. Graphical presentation regarding aphid population on different wheat cultivars at 63 DAS.

4.1.2. Aphid Population at 70 DAS

The comparison of mean data presented that Galaxy-2013 possessed minimum population i.e. 0.39 aphids per plant; whereas, Sehar-2006 was most susceptible with 1.25 aphids per plant as shown in table (4.2a). Punjab-2011 and Ujala-2016 were statistically at par.

Table: 4.2a. Mean comparison of data regarding aphid population in various cultivars of wheat at 70 DAS

Sr. #	Variety	Mean ± S.E
1	Galaxy 2013	0.39±0.05 c
2	Punjab 2011	0.53±0.06 b
3	Ujala 2016	0.50±0.05 b
4	Sehar 2006	1.25±0.03 a

Means sharing similar letters do not differ significantly.
LSD ($p \leq 0.05$) = 0.18

Table: 4.2b. Analysis of variance regarding aphid population in wheat cultivars at 70 DAS

Source	S.S.	D.F.	M.S.	F	Prob.	Sig.
Blocks	0.02	2	0.01	1.26		
Variety	1.31	3	0.44	50.84	1×10^{-6}	**
Residual	0.05	6	0.01			
Total	1.39	11	0.13			

Ns = Non-significant * = $p\leq0.05$ ** = $p\leq0.01$

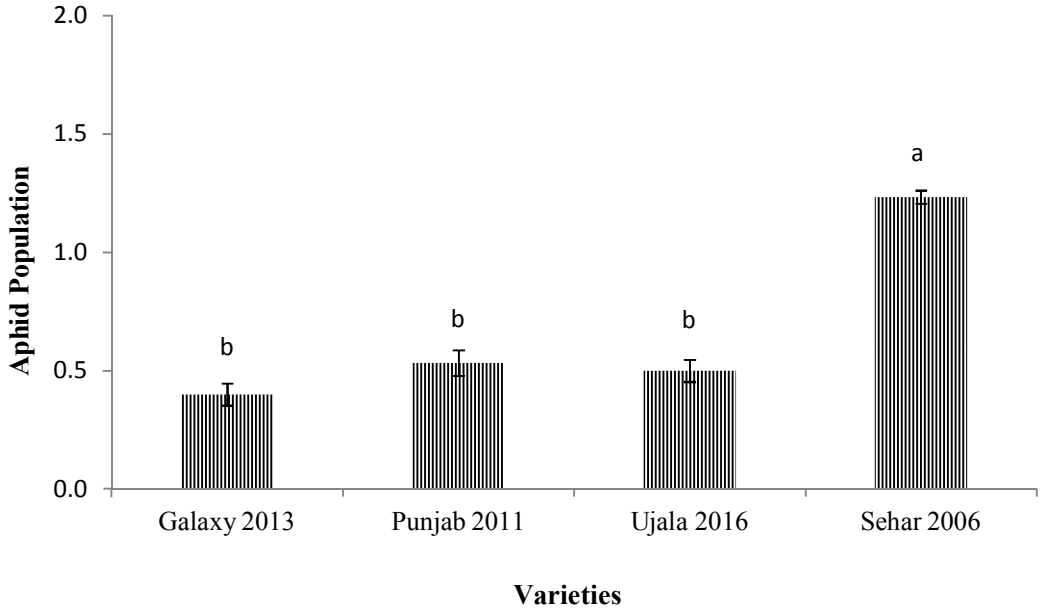


Fig: 4.2. Graphical presentation regarding aphid population on different wheat cultivars at 70 DAS.

4.1.3. Aphid Population at 77 DAS

It is evident from the results that mean comparison shows significant ($p\leq0.05$) difference among Galaxy-2013 and Sehar-2006 (Table: 4.3a.). Maximum aphid population appeared on Sehar-2006 i.e. 4.05 aphids per plant and Galaxy-2013 appeared most resistant with minimum aphid population i.e. 2.02 aphids per plant; however, Punjab-2011 and Ujala-2016 were not significantly ($p\leq0.05$) different from each other as shown in Fig. (4.3).

Table: 4.3a. Mean comparison of data regarding aphid population in various cultivars of wheat at 77 DAS

Sr. #	Variety	Mean ± S.E
1	Galaxy 2013	2.02±0.11 c
2	Punjab 2011	2.30±0.05 b
3	Ujala 2016	2.43±0.11 b
4	Sehar 2006	4.05±0.07 a

Means sharing similar letters do not differ significantly.
LSD ($p\leq0.05$) = 0.26

Table: 4.3b. Analysis of variance regarding aphid population in wheat cultivars at 77 DAS

Source	S.S.	D.F.	M.S.	F	Prob.	Sig.
Blocks	0.14	2	0.07	4.2		
Variety	7.36	3	2.45	147.2	5.2×10^{-06}	**
Residual	0.1	6	0.02			
Total	7.6	11	0.69			

Ns = Non-significant * = $p\leq0.05$ ** = $p\leq0.01$

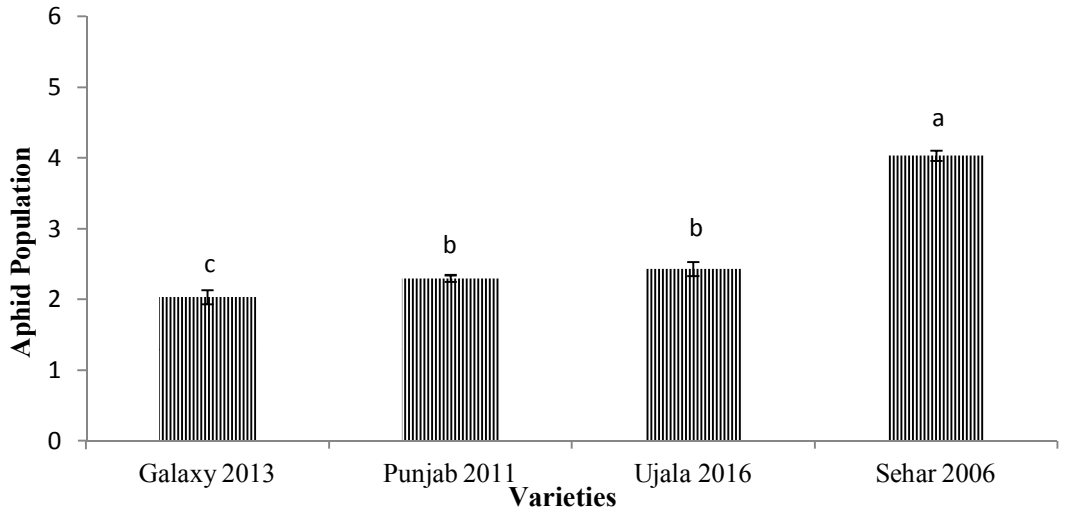


Fig. 4.3. Graphical presentation regarding aphid population on different wheat cultivars at 77 DAS

4.1.4. Aphid Population at 84 DAS

Results revealed that all wheat cultivars were not statistically at par with each other (Fig. 4.4). Galaxy-2013 was most resistant with minimum mean aphid population i.e. 13.53 aphids per plant and Sehar-2006 came out as most susceptible with mean aphid population i.e. 22.77 aphids per plant; nevertheless, Punjab-2011 and Ujala-2016 were not significantly ($p \leq 0.05$) different from each other as shown in the table (4.4a).

Table: 4.4a. Mean comparison of data regarding aphid population in various cultivars of wheat at 84 DAS

Sr. #	Variety	Mean ± S.E
1	Galaxy 2013	13.53±0.26 c
2	Punjab 2011	15.70±0.05 b
3	Ujala 2016	15.87±0.21 b
4	Sehar 2006	22.77±0.91 a

Means sharing similar letters do not differ significantly.
LSD ($p \leq 0.05$) = 1.89

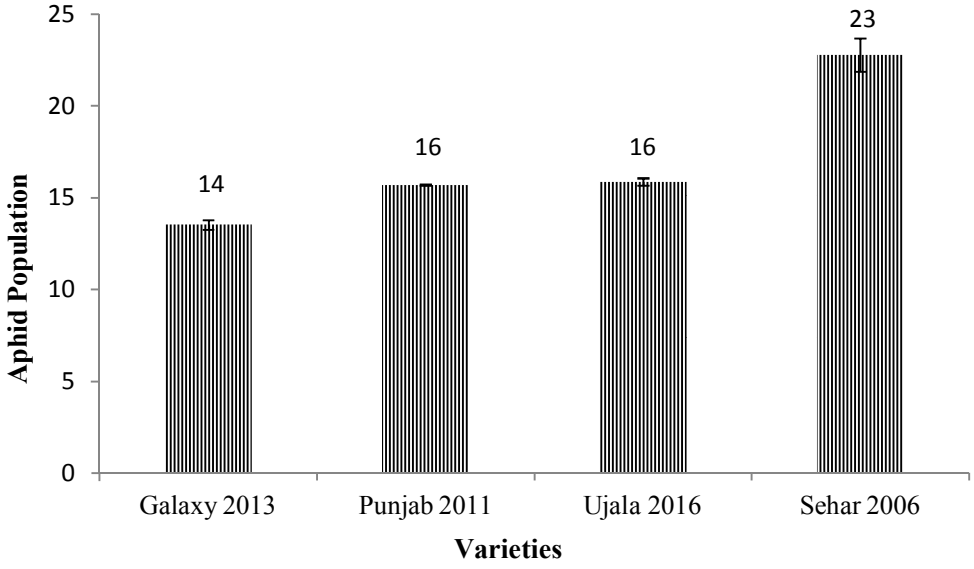


Fig. 4.4. Graphical presentation regarding aphid population on different wheat cultivars at 84 DAS

Table: 4.4b. Analysis of variance regarding aphid population in wheat cultivars at 84 DAS

Source	S.S.	D.F.	M.S.	F	Prob.	Sig.
Blocks	2.81	2	1.41	1.57		
Variety	144.73	3	48.24	53.72	9.9×10^{-05}	**
Residual	5.39	6	0.90			
Total	152.93	11	13.90			

Ns = Non-significant * = $p\leq0.05$ ** = $p\leq0.01$

4.1.5. Aphid Population at 91 DAS

Mean number of aphid population significantly differ from each other in all wheat cultivars (Fig. 4.5). The highest mean aphid population was recorded on Sehar-2006 i.e. 41.23 aphids per plant and lowest number of aphid population on Galaxy-2013 i.e. 22.53 aphids per plant. Punjab-2011 and Ujala-2016 were statistically at par with each other (Table 4.5a).

Table: 4.5a. Mean comparison of data regarding aphid population in various cultivars of wheat at 91 DAS

Sr. #	Variety	Mean ± S.E
1	Galaxy 2013	22.53±1.91 c
2	Punjab 2011	29.50±1.47 b
3	Ujala 2016	30.67±1.62 b
4	Sehar 2006	41.23±1.45 a

Means sharing similar letters do not differ significantly.
LSD ($p\leq0.05$) = 2.88

Table: 4.5b. Analysis of variance regarding aphid population in wheat cultivars at 91 DAS

Source	S.S.	D.F.	M.S.	F	Prob.	Sig.
Blocks	82.05	2	41.03	19.74		
Variety	536.30	3	178.77	86.03	2.5×10^{-5}	**
Residual	12.47	6	2.08			
Total	630.82	11	57.35			

Ns = Non-significant * = $p\leq0.05$ ** = $p\leq0.01$

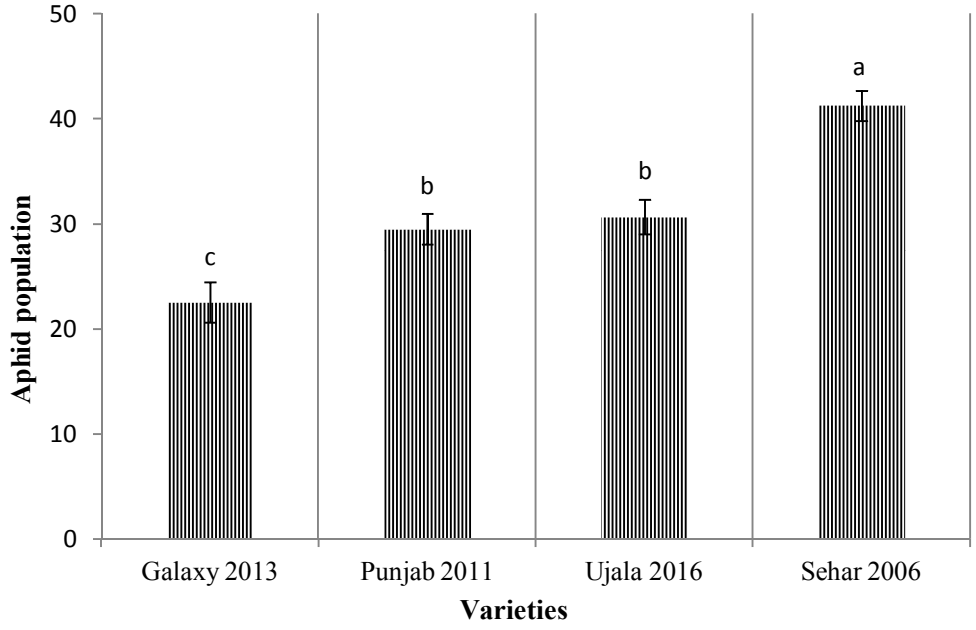


Fig. 4.5. Graphical presentation regarding aphid population on different wheat cultivars at 91 DAS

4.1.6. Aphid Population at 98 DAS

All four wheat cultivars were statistically different from each other in comparison of mean aphid population (Table 4.6a). Gradual increase in mean aphid population continued in last week of February with maximum mean aphid population on Sehar-2006 i.e. 52.83 aphids per plant and minimum mean aphid population in Galaxy-2013 i.e. 33.13 aphids per plant (Fig. 4.6).

Table: 4.6a. Mean comparison of data regarding aphid population in various cultivars of wheat at 98 DAS

Sr. #	Variety	Mean ± S.E
1	Galaxy 2013	33.13±1.34 c
2	Punjab 2011	47.43±2.67 ab
3	Ujala 2016	42.10±1.64 bc
4	Sehar 2006	52.83±1.74 a

LSD ($p \leq 0.05$) = 9.11

Table: 4.6b. Analysis of variance regarding aphid population in wheat cultivars at 98 DAS

Source	S.S.	D.F.	M.S.	F	Prob.	Sig.
Blocks	7.28	2	3.64	0.18		
Variety	634.34	3	211.45	10.17	9×10^{-4}	**
Residual	124.78	6	20.80			
Total	766.4	11	69.67			

Ns = Non-significant * = $p \leq 0.05$ ** = $p \leq 0.01$

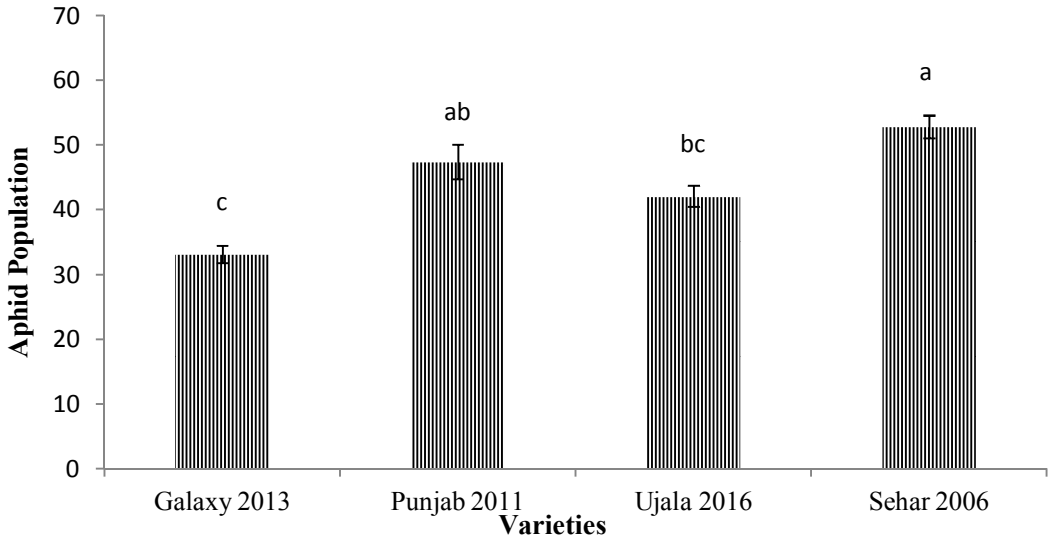


Fig. 4.6. Graphical presentation regarding aphid population on different wheat cultivars at 98 DAS

4.1.7. Aphid Population at 105 DAS

It is evident from the results that Sehar-2006 persistently appeared to be the most Susceptible wheat cultivar with highest mean aphid population i.e. 64.13 aphids per plant; however, in first week of March both Galxy-2013 and Ujala-2011 had minimum aphid population (Fig. 4.7).

Table: 4.7a. Mean comparison of data regarding aphid population in various cultivars of wheat at 105 DAS

Sr. #	Variety	Mean ± S.E
1	Galaxy 2013	43.57±1.29 c
2	Punjab 2011	55.90±0.69 b
3	Ujala 2016	48.23±1.68 c
4	Sehar 2006	64.13±1.06 a

Means sharing similar letters do not differ significantly.
LSD ($p \leq 0.05$) = 5.97

Table: 4.7b. Analysis of variance regarding aphid population in wheat cultivars at 105 DAS

Source	S.S.	D.F.	M.S.	F	Prob.	Sig.
Blocks	1.06	2	0.53	0.06		
Variety	732.19	3	244.06	27.26	6.8×10^{-5}	**
Residual	53.72	6	8.95			
Total	786.97	11	71.54			

Ns = Non-significant * = $p\leq0.05$ ** = $p\leq0.01$

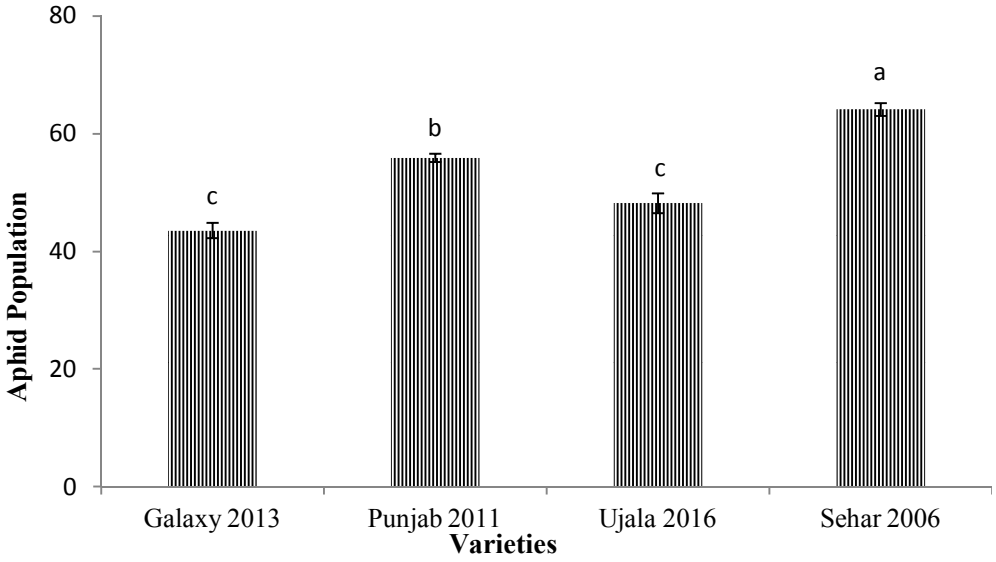


Fig. 4.7. Graphical presentation regarding aphid population on different wheat cultivars at 105 DAS

4.1.8. Aphid Population at 112 DAS

Result in table (4.8a) shows that aphid population reached to its peak in third week of March with maximum mean aphid population on the most susceptible wheat cultivar Sehar-2006 i.e. 81.43 aphis per plant as compared to Galaxy-2013 which appeared to be most resistant with 59.37 mean aphid population per plant; however, all four wheat cultivars were statistically different from each other (Fig. 4.8).

Table: 4.8a. Mean comparison of data regarding aphid population in various cultivars of wheat at 112 DAS

Sr. #	Variety	Mean ± S.E
1	Galaxy 2013	59.37±3.68 c
2	Punjab 2011	73.13±1.44 ab
3	Ujala 2016	70.93±2.93 b
4	Sehar 2006	81.43±1.43 a

LSD ($p\leq0.05$) = 9.65

Table: 4.8b. Analysis of variance regarding aphid population in wheat cultivars at 112 DAS

Source	S.S.	D.F.	M.S.	F	Prob.	Sig.
Blocks	95.98	2	47.99	2.06		
Variety	745.67	3	248.56	10.65	8.1×10^{-4}	**
Residual	140.01	6	23.33			
Total	981.66	11	89.24			

Ns = Non-significant * = $p\leq0.05$ ** = $p\leq0.01$

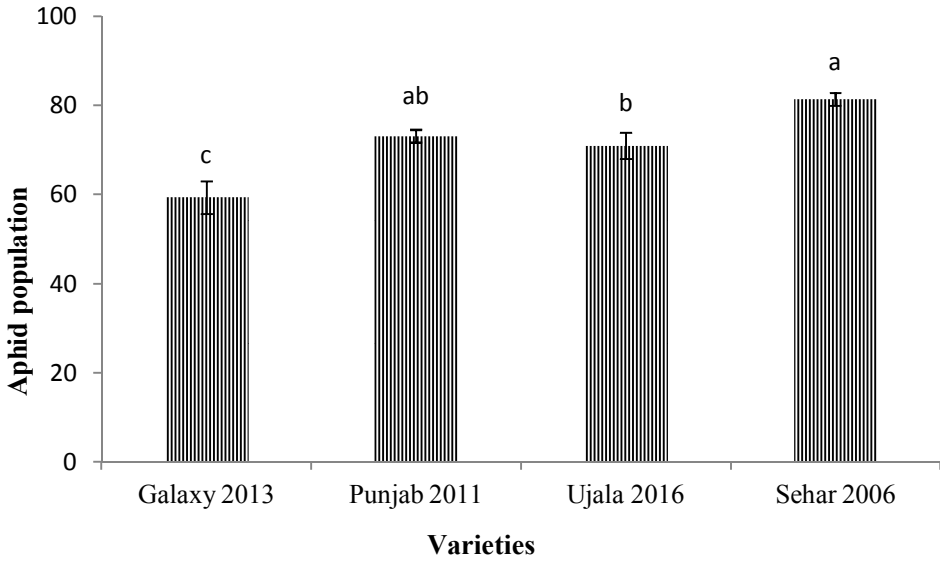


Fig. 4.8. Graphical presentation regarding aphid population on different wheat cultivars at 112 DAS

4.1.9. Aphid Population at 119 DAS

As evident from the data all wheat cultivars suffered certain level of infestation in third week of March. Sehar-2006 was statistically different with mean aphid population (56.93 aphids per plant) from other three wheat cultivars i.e. Galxy-2013, Punjab-2011 and Ujala-2016, which were statistically at par (Table 4.9a).

Table: 4.9a. Mean comparison of data regarding aphid population in various cultivars of wheat at 119 DAS

Sr. #	Variety	Mean ± S.E
1	Galaxy 2013	38.33±0.91b
2	Punjab 2011	37.67±1.74 b
3	Ujala 2016	40.53±1.91 b
4	Sehar 2006	56.93±2.41 a

Means sharing similar letters do not differ significantly.
LSD ($p \leq 0.05$) = 5.72

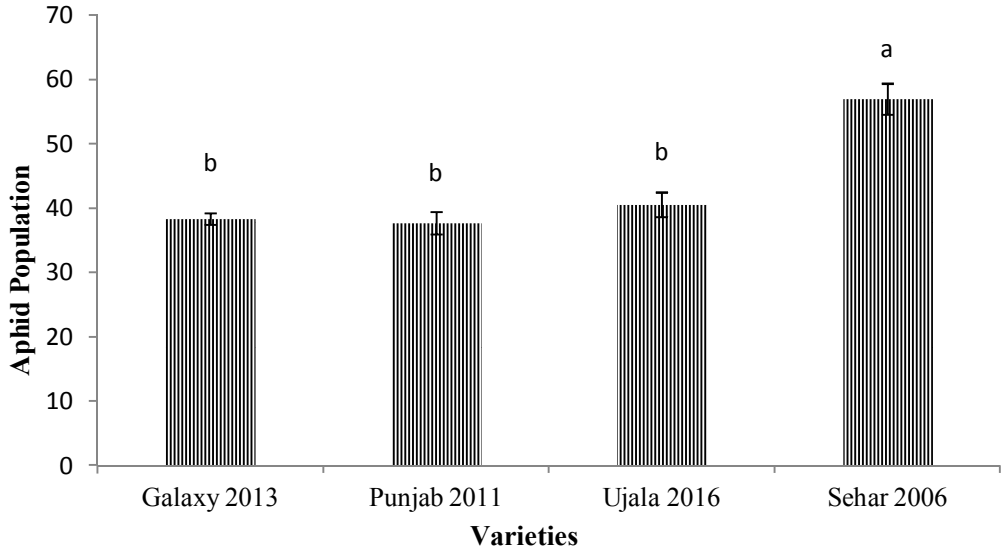


Fig. 4.9. Graphical presentation regarding aphid population on different wheat cultivars at 119 DAS

Table: 4.9b. Analysis of variance regarding aphid population in wheat cultivars at 119 DAS

Source	S.S.	D.F.	M.S.	F	Prob.	Sig.
Blocks	70.21	2	35.10	4.27		
Variety	749.72	3	249.91	30.39	5×10^{-4}	**
Residual	49.34	6	8.22			
Total	869.27	11	79.02			

Ns= Non-significant * = $p\leq0.05$ ** = $p\leq0.01$

4.1.10. Aphid Population at 126 DAS

The results (Table 4.10a) revealed that Sehar-2006 significantly differed from all other wheat cultivars regarding population of aphid. Punjab-2011, Ujala-2016 and Galaxy-2013 were statistically at par with each other (Fig. 4.10).

Table: 4.10a. Mean comparison of data regarding aphid population in various cultivars of wheat at 126 DAS

Sr. #	Variety	Mean ± S.E
1	Galaxy 2013	25.57±0.68 b
2	Punjab 2011	23.50±0.51 b
3	Ujala 2016	24.33±0.57 b
4	Sehar 2006	34.03±1.78 a

Means sharing similar letters do not differ significantly.
LSD ($p\leq0.05$) = 2.87

Table: 4.10b. Analysis of variance regarding aphid population in wheat cultivars at 126 DAS

Source	S.S.	D.F.	M.S.	F	Prob.	Sig.
Blocks	25.53	2	12.77	6.15		
Variety	212.41	3	70.80	34.13	3.6×10^{-4}	**
Residual	12.45	6	2.07			
Total	250.39	11	22.76			

ns= Non-significant * = $p\leq0.05$ ** = $p\leq0.01$

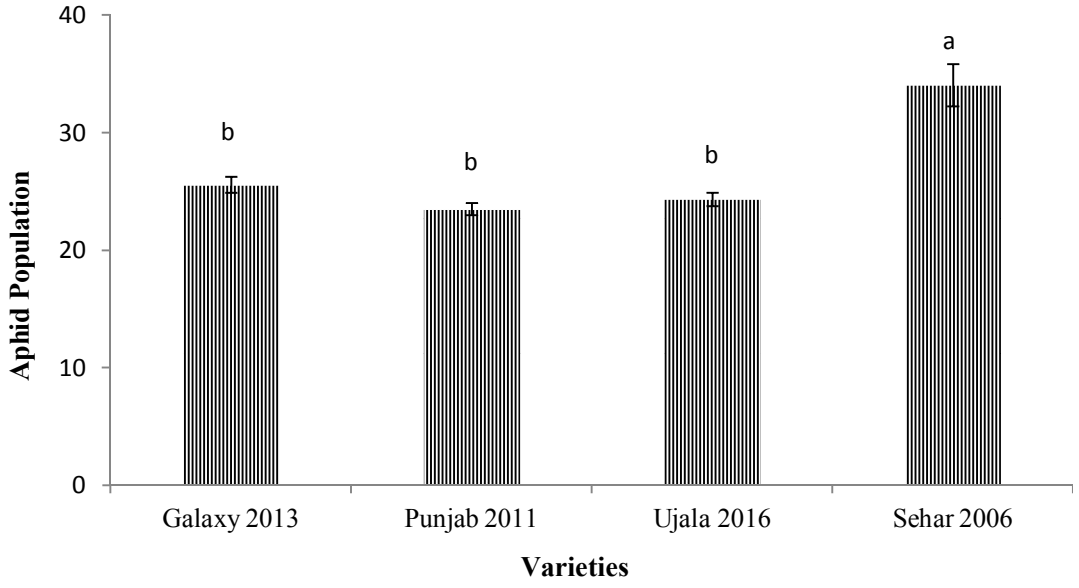


Fig. 4.10. Graphical presentation regarding aphid population on different wheat cultivars at 126 DAS

4.1.11. Aphid Population at 133 DAS

The comparison of mean data (Table 4.11a) shows that Sehar-2006 possessed maximum mean population i.e. 13.83 aphids per plant; whereas, Galaxy-2013, Punjab-2011 and Ujala-2016 were not significantly ($p\leq0.05$) different from each other.

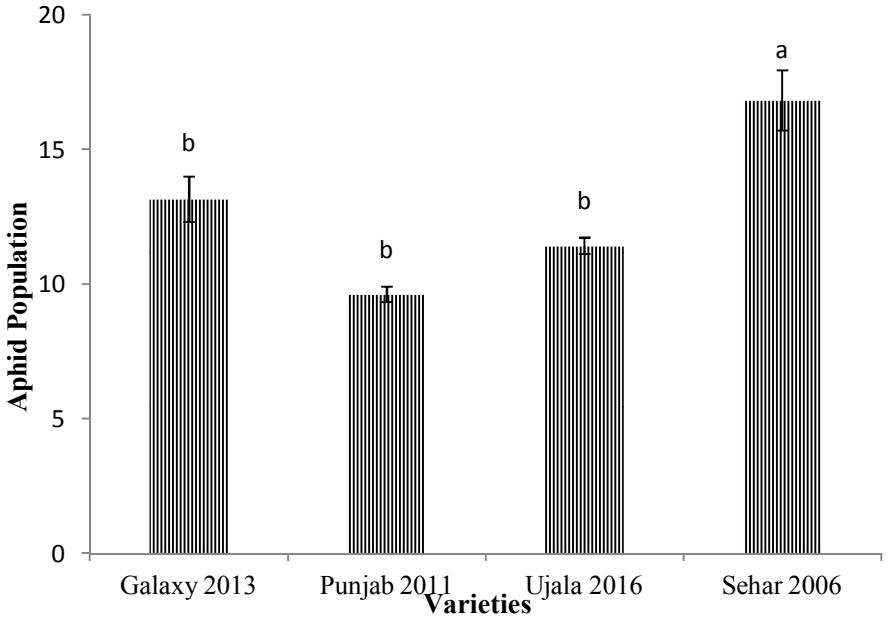
Table: 4.11a. Mean comparison of data regarding aphid population in various cultivars of wheat at 133 DAS

Sr. #	Variety	Mean ± S.E
1	Galaxy 2013	10.17±0.85 b
2	Punjab 2011	8.63±0.29 b
3	Ujala 2016	9.43±0.30 b
4	Sehar 2006	13.83±1.12 a

Means sharing similar letters do not differ significantly.
LSD ($p \leq 0.05$) = 2.38

Table: 4.11b. Analysis of variance regarding aphid population in wheat cultivars at 133 DAS

Source	S.S.	D.F.	M.S.	F	Prob.	Sig.
Blocks	10.75	2	5.37	3.77		
Variety	47.53	3	15.84	11.11	7.3×10^{-4}	**
Residual	8.56	6	1.43			
Total	66.84	11	6.08			



Ns= Non-significant * = $p \leq 0.05$ ** = $p \leq 0.01$

Fig. 4.11. Graphical presentation regarding aphid population on different wheat cultivars at 133 DAS

4.1.12. Aphid Population at 140 DAS

The comparison of mean aphid population shows that a sudden decline occurred in last week of March (Table 4.10a) and first week of April (Table 4.11a); however, aphid population eliminated up to 10th April (Table 4.12a). Mid of March appeared to be most satisfactory period for growth of aphid and displayed maximum aphid population. Sehar-2006 appeared to be most susceptible wheat cultivar and Galaxy-2013 most resistant against wheat aphid (*S. graminum*); nevertheless, Punjab-2011 and Ujala-2016 were statistically at par.

Table: 4.12a. Mean comparison of data regarding aphid population in various cultivars of wheat at 140 DAS

Sr. #	Variety	Mean ± S.E
1	Galaxy 2013	1.23±0.21 b
2	Punjab 2011	$0.10\pm8\times10^{-8}$ c
3	Ujala 2016	0.27±0.07 c
4	Sehar 2006	1.93±0.23 a

Means sharing similar letters do not differ significantly.
LSD ($p \leq 0.05$) = 0.68

Table: 4.12b. Analysis of variance regarding aphid population in wheat cultivars at 140 DAS

Source	S.S.	D.F.	M.S.	F	Prob.	Sig.
Blocks	0.18	2	0.09	0.78		
Variety	6.66	3	2.22	19.06	1.8×10^{-3}	**
Residual	0.70	6	0.12			
Total	7.54	11	0.69			

Ns= Non-significant * = $p\leq0.05$ ** = $p\leq0.01$

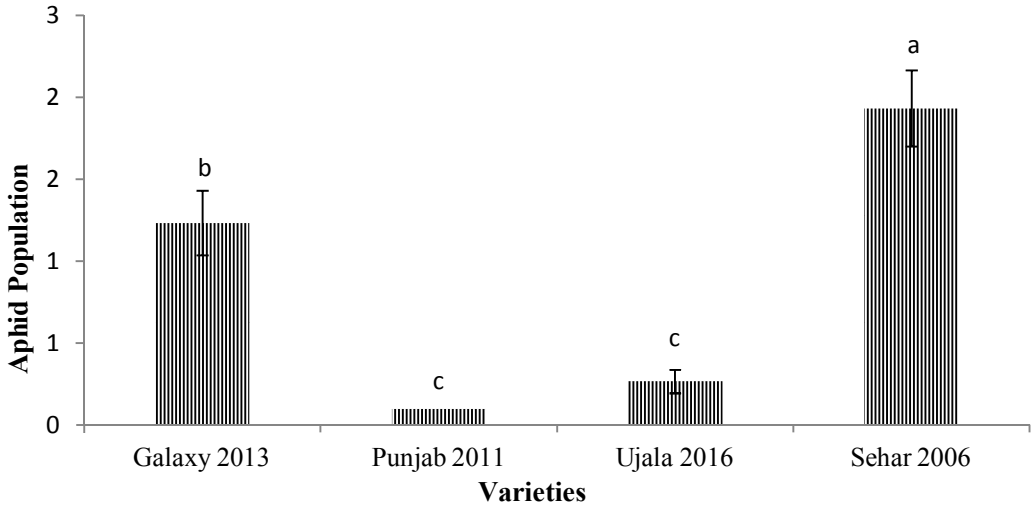


Fig. 4.12. Graphical presentation regarding aphid population on different wheat cultivars at 140 DAS

References

1. Aheer, G.M., M. Munir and A. Ali, 2007. Screening of wheat cultivars against aphids in ecological conditions of district Mandi Bahauddin. J. Agric. Res., 44: 55-58.
2. Atwal, A.S. and G, S. Dahliwal, 1998. Insect pests of Sauth Asia, p: 487. Kaiyant Publishers, Ludhiana, India.
3. Avis, T.J., V. Gravel, H. Antoun and R.J. Tweddell, 2008. Multifaceted beneficial effects of rhizosphere microorganisms on plant health and productivity. Soil Biol. Biochem., 40: 1733−1740.
4. Geza, K., 2000. Aphid flight and change in abundance of winter wheat pests. Archives Phytopathol. PI. Prot., 33: 361-373.
5. Hashmi, A.A., M.M. Hussain and M. Ulfat, 1983. Insect pest complex of wheat crop. Pak. J. Zool., 15: 169–76.
6. Iqbal, J., M. Ashfaq and A. Ali, 2008. Screening of wheat varieties/advanced lines against aphids. Pak. Entomol., 30(1): 77-81.
7. Khan, A.A., Arif, M.Tahir, M.Afzal, A. Khaliq, S. Yar Khan and I.Raza 2011. Effect of wheat cultivars on aphids and their predator populations. Afric. J. Biotech., 10(80): 18399-18402.
8. Lesezezynski, B., 1987. Use of plant resistance in insect pest management systems. In: Plant resistance to insect, a fundamental approach (ed. C.M. Smith), pp. 243-268. John Wiley and Sons, New York.
9. Shrivastava, B., S. Thakur, Y.P. Khasa, A. Gupte, A.K. Puniya and R.C. Kuhad. 2010. White-rot fungal conversion of wheat straw to energy rich cattle feed. Biodegradation. (DOI: 10. 1007/s10532-010-9408-2).
10. Tabasum, S., I.R. Noorka, M. Afzal and A. Ali, 2012. Screening best adopted wheat lines against aphid (*Schizaphis graminum* Rondani) population. Pak. Entomol., 34(1): 51-53.
11. Tolmay, V.L., F. Du Toit and C.M. Smith, 2006. Registration of seven Russian wheat aphid resistant near isogonics lines developed in south Africa. Crop sci., 46(4): 478-480.

4/25/2019