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Evaluation of different insecticides for the management of aphid (*Shizaphis graminum* Rond.) on *Triticum aestivum* L.

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ABSTRACT

The planned study was conducted with the objectives to find efficacy of three insecticides 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, 2018 with net plot size (1.2m×8m) at entomological research Area University of agriculture, Faisalabad. The treatments were T1=thiamethoxam, T2=imidacloprid, T3=carbosulfan, T4=acetamaprid and T5=control. Recommended agronomic practices were carried out during experiment. Data regarding efficacy were recorded 1, 2, 7 and 14 days after application. All four insecticides were effective and reduced aphid population significantly; however, imidacloprid proved to be the most effective with minimum aphid population (1.25 aphids per plant) and maximum percent mortality (97.13%).

Introduction

Wheat (*Triticum aestivum 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). 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 (*Schizaphis graminum*) armyworm (*Helicoverpa armigera*), termites (*Odontotermus obesus*), wheat weevil (*Tanymecus indicus*) and white ants (*Micro termes obesi*) attack wheat (Atwal and Dhaliwal, 1998). Aphids (Aphididae: Homoptera) as a sucking pest of various field crops, having scientific name (*Shizaphis graminum* Rond.), common names: wheat aphid, grain aphid, green bug and sometimes called as plant louse. Aphid is an important pest of wheat, barley, sorghum and corn with range of at least 60 plant species (Bowling *et al*., 1998). Although many insect pests in Pakistan attack wheat crop but aphid is the most damaging agent (Khan *et al*., 2011).

The damage due to aphid is reported in many fields as well as in horticultural crops. In Pakistan aphid is now introduced as regular pest of wheat due to dramatically increase in its population which is responsible in 50-70% reduction in weight grain per ear (Kuroli and Nemeth, 1987). Their population is increasing day by day and had attained the status of a regular pest in Pakistan. 72% losses due to aphid attack were attributed to the direct sucking and remaining 28 % loss was due to fungi (Rebbinge *et al*., 1981). Aphid effects wheat production adversely causing 35-40% direct and 20-80% indirect yield losses by transmission of viral and fungal diseases (Trdan & Mileroj, 1999). Aphid infestation starts in mid-January with maximum attack in 3rd and 4th week of February. Population density starts to decline in mid-march and diminish up-to 1st week of April (Tabasum *et al*., 2012). Various control methods including cultural, mechanical, physical, biological, chemical and host plant resistance are used to keep aphid population below economic

injury level. However, when aphid population is extremely injurious and in large number then chemical control is used (Hatchett and Webster, 1987). For the control of wheat insects pests like aphids which destroy crop by cell sap sucking, imidacloprid is being used to be useful chemical (Altman and Elbert, 1992).

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.

The experimentation was performed with the following aims.

•To evaluate efficacy of four synthetic insecticides against wheat aphids.

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.

Screening of wheat genotypes

The seed of following wheat cultivars was collected from Ayub Agricultural Research Institute (AARI), Faisalabad and sown with single row drill.

Insecticides/ Treatments

Following insecticides were used

Sr. #	Treatments	Manufacturing Company Name	Dose/Acre	
T1.	Thiamethoxam	Actara	250ml/acre	Syngenta
T2	Imidacloprid	Confidor	125ml/acre	Bayer
T3	Carbosulfan	Advantage	200ml/acre	FMC
T4	Acetamaprid	Mospilan	50 gm/acre	Arysta life science
T5	Control			

Insecticides were sprayed by knapsack hand sprayer when population of wheat aphids reached the economic threshold level (ETL). Before application, insecticides were dissolved in clean water to make solution on Wt./Vol. and vol. /vol. basis. Calculation of percent mortality was done by following formula.

$$\% \text{ Mortality} = \frac{\text{Pre treatment} - \text{post treatment}}{\text{Pre treatment}} \times 100$$

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

Statistical Analysis

Data collected on various attributes were statistically analyzed using fisher's analysis of variance technique using "DSAASTAT" statistical program (Onofri, 2007). Population means and overall means of predator and aphid population for whole growing season were calculated and then subjected to statistical analysis and DMR test at P=0.05 was applied to test the level of significant and correlation between pest population and treatments, as well as weather factors were also determined by the help of SPSS. 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.

Results and discussion

Efficacy of insecticides against wheat aphids

The data regarding population of aphids per plant in selected wheat cultivars influenced by various treatments at different dates of observations are given in the tables. The crop was treated with three synthetic insecticides compared with control (no insecticides application) when the pest understudy reached at the economic threshold level (ETL). The means were compared by LSD Test, at $P \leq 0.05$.

Aphid population 24 hours after spray

Results (Table1) regarding insecticides efficacy shows that all four insecticides i.e. thiamethoxam, imidacloprid, carbosulfan and Acetamaprid with mean aphid population 4.2, 3.3, 1.2 and 2.5 aphids per plant respectively, were not significantly different from each other 24 hours after spray; however, control came out with maximum aphid population i.e. 43.1 aphids per plant (Fig. 1**)**.

Table: 1. Mean aphid population on wheat cultivars influenced by different insecticides 24 hours after spray

	Galaxy 2013	Punjab 2011	Ujala 2016	Sehar 2006	Mean
Control	32.14 c	48.43 a	43.10 b	48.86 a	43.2 A
Thiamethoxam	3.83 de	4.57 d	3.83 de	4.14 de	4.2 B
Imidacloprid	3.07 de	2.97 de	3.07 de	4.23 de	3.3 B
Carbosulfan	1.00 de	1.47 de	0.77 e	1.67 de	1.2 B
Acetamaprid	3.15de	2.87de	1.12 de	3.2 de	2.5 B
Mean	8.63 C	12.04 AB	10.4 BC	12.4 A	

Means sharing similar letters do not differ significantly.

LSD variety ($p \leq 0.05$) = 2.29

LSD Insecticides ($p \leq 0.05$) = 1.83

LSD Variety × Insecticide ($p \leq 0.05$) = 3.68

Table: 2. Analysis of variance of insecticides efficacy on wheat cultivars 24 hours after spray

Source	S.S.	D.F.	M.S.	F	Prob.	Sig.
Replication	0.60	2	0.30	0.06	0.95	
Variety	228.74	3	76.25	14.44	3.7×10^{-4}	**
Error variety	31.68	6	5.28			
Insecticides	15080.00	3	5026.67	1054.76	0.00	**
Variety x Insecticides	420.17	9	46.69	9.80	4×10^{-6}	**
Residual	114.38	24	4.77			
Total	15875.56	47	337.78			

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

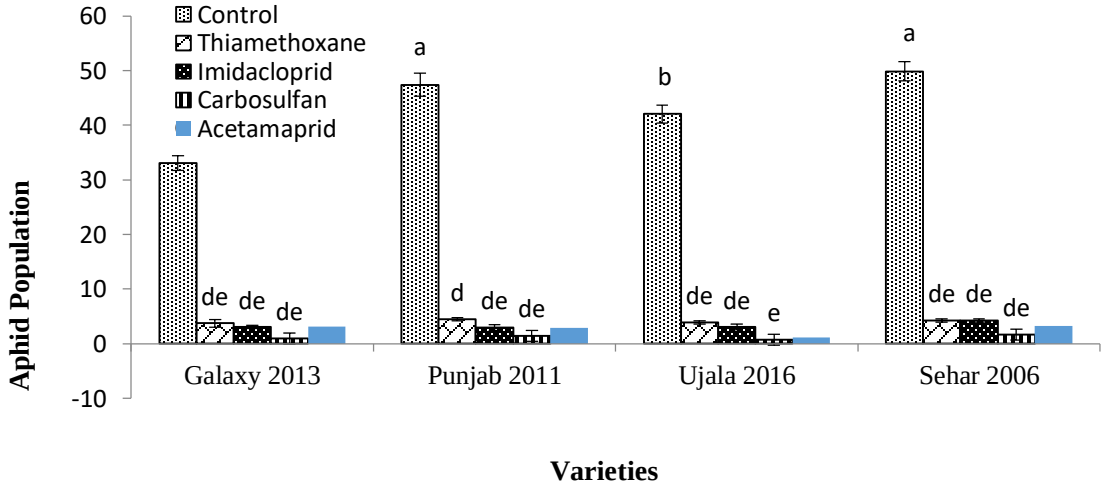

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Fig. 1. Graphical presentation regarding aphid population on different wheat cultivars 24 hours after insecticides application compared to control

Mortality (%) 24 hours after spray

The highest percentage mortality of aphids was observed in Carbosulfan (97.21% mortality of aphids) followed by Acetamaprid (93.01%) imidacloprid (92.40%) and thiamethoxam appeared to give minimum control and caused 89.65% mortality as shown in Fig. (2). There was almost no control in untreated plot.

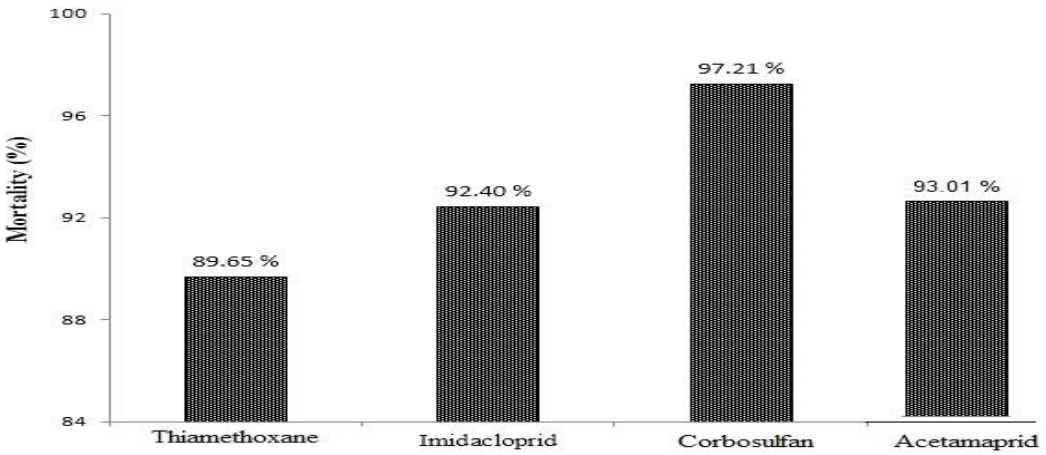


Fig. 2. Graphical presentation regarding %age mortality 24 hours after spray

Aphid population 48 hours after spray

Results revealed that all four insecticides were not statistically different from each other and control came out with maximum aphid population i.e. 44.78 aphids per plant (Table 3). Maximum mean aphid population appeared on Sehar-2006 i.e. 12.81 aphids per plant and minimum on Galaxy-2013 i.e. 8.69 aphids per plant.

Table: 3. Mean aphid population influenced by different insecticides on wheat cultivars 48 hours after spray

	Galaxy 2013	Punjab 2011	Ujala 2016	Sehar 2006	Mean
Control	34.07 d	48.00 b	43.40 c	53.67 a	44.78 A
Thiamethoxam	0.40 e	0.47 e	0.37 e	0.90 e	0.53 B
Imidacloprid	0.20 e	0.37 e	0.30 e	0.33 e	0.30 B
Carbosulfan	0.10 e	0.10 e	0.13 e	0.33 e	0.17 B
Acetamaprid	0.30e	0.27e	0.16e	0.31e	0.26 B
Mean	7.01 B	9.84 A	8.87 AB	11.10 A	

Means sharing similar letters do not differ significantly.

LSD variety ($p \leq 0.05$) = 2.26

LSD Insecticides ($p \leq 0.05$) = 1.70

LSD Variety × Insecticide ($p \leq 0.05$) = 3.40

Table: 4. Analysis of variance of insecticides efficacy on wheat cultivars 48 hours after spray

Source	S.S.	D.F.	M.S.	F	Prob.	Sig.
Replication	1.83	2	0.92	0.18	0.84	
Variety	167.32	3	55.77	10.80	0.01	**
Error variety	30.97	6	5.16			
Insecticides	17783.05	3	5927.68	1450.67	0.00	**

Variety x Insecticides	451.45	9	50.16	12.28	5×10^{-7}	**
Residual	98.07	24	4.09			
Total	18532.70	47	394.31			

Ns= Non-significant *=p≤0.05 **=p≤0.01

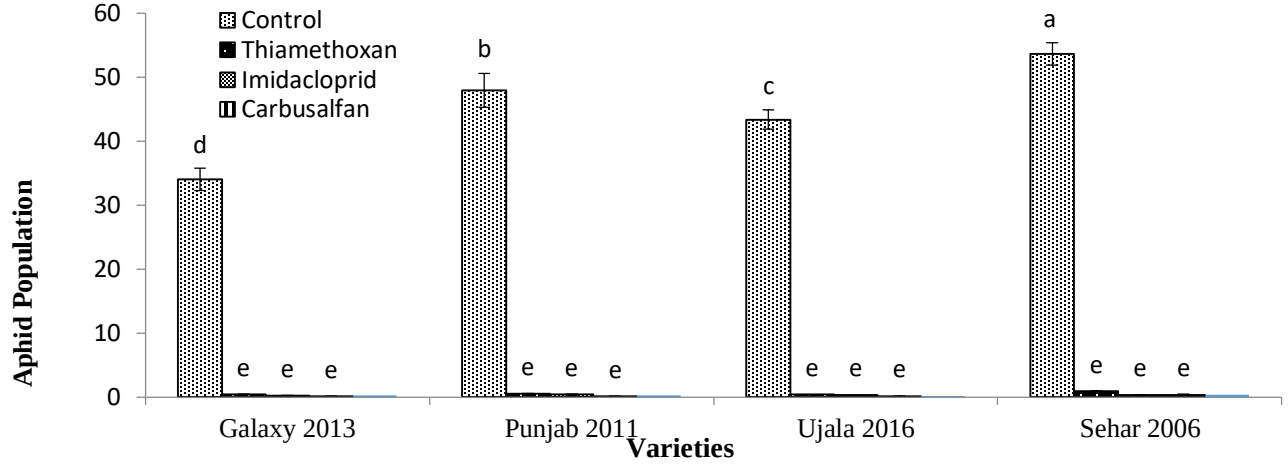


Fig. 3. Graphical presentation regarding aphid population on different wheat cultivars 48 hours after insecticides application compared to control

Mortality (%) 48 hours after spray

The highest percent mortality of aphids was observed by Carbosulfan (99.62% mortality of aphids) followed by Acetamaprid (99.32%) Imidacloprid (99.32%) and thiamethoxam appeared to give minimum control and caused 98.78% mortality as shown in Fig. (4). There was almost no control in untreated plot.

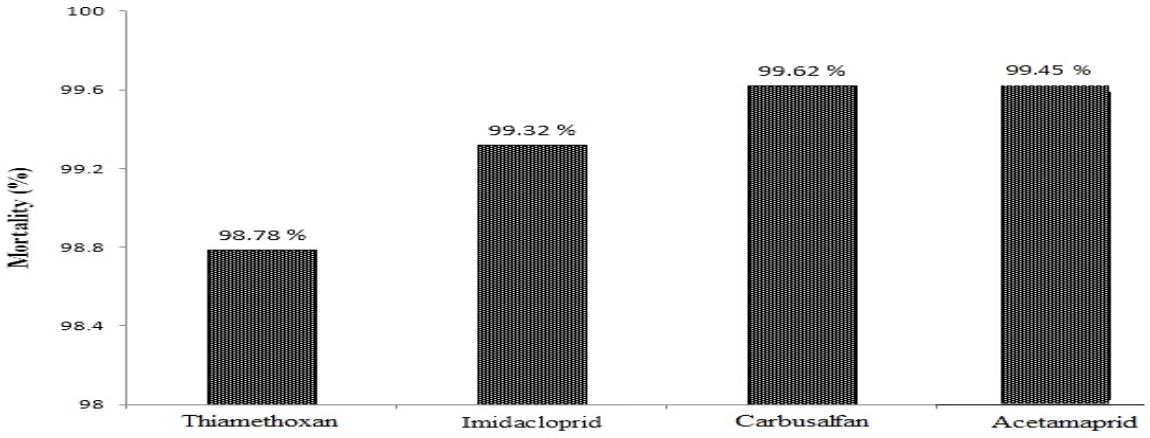


Fig. 4. Graphical presentation regarding %age mortality 48 hours after spray

Aphid population 07 days after spray

Variation in insecticides was non-significant; however all insecticides reduced aphid population and control came out as maximum aphid population i.e. 52.96 aphids per plant (Table 5). Carbosulfan reduced maximum mean aphid population i.e. 0.45 aphids per plant and thiamethoxam reduced minimum aphid population numerically. Sehar-2006 appeared most susceptible i.e. 16.92 aphids per plant and Galaxy-2013 most resistant i.e. 11.39 aphids per plant.

Table: 5. Mean aphid population influenced by different insecticides on wheat cultivars 07 days after spray

	Galaxy 2013	Punjab 2011	Ujala 2016	Sehar 2006	Mean
Control	43.57 d	55.90 b	48.23 c	64.13 a	52.96 A
Thiamethoxam	1.30 e	1.00 e	1.20 e	2.03 e	1.38 B
Imidacloprid	0.37e	0.37 e	0.53 e	0.77 e	0.51 B
Carbosulfan	0.33 e	0.33 e	0.40 e	0.73 e	0.45 B
Acetamaprid	0.31 e	0.35 e	0.41 e	0.81 e	0.47 B
Mean	9.17 C	12.00 B	10.15 BC	13.70 A	

Means sharing similar letters do not differ significantly.

LSD variety (*p≤0.05*) = 1.70

LSD Insecticides (*p≤0.05*) = 1.10

LSD Variety × Insecticide (*p≤0.05)* = 2.20

Table: 6. Analysis of variance of insecticides efficacy on wheat cultivars 07 days after spray

Source	S.S.	D.F.	M.S.	F	Prob.	Sig.
Replication	0.70	2	0.35	0.12	0.89	
Variety	207.98	3	69.33	23.75	9×10^{-4}	**
Error variety	17.52	6	2.92			
Insecticides	24509.25	3	8169.75	4791.84	0.00	**
Variety x Insecticides	526.70	9	58.52	34.33	0.00	**
Residual	40.92	24	1.70			
Total	25303.05	47	538.36			

Ns= Non-Significant *=*p≤0.05* **=*p≤0.01*

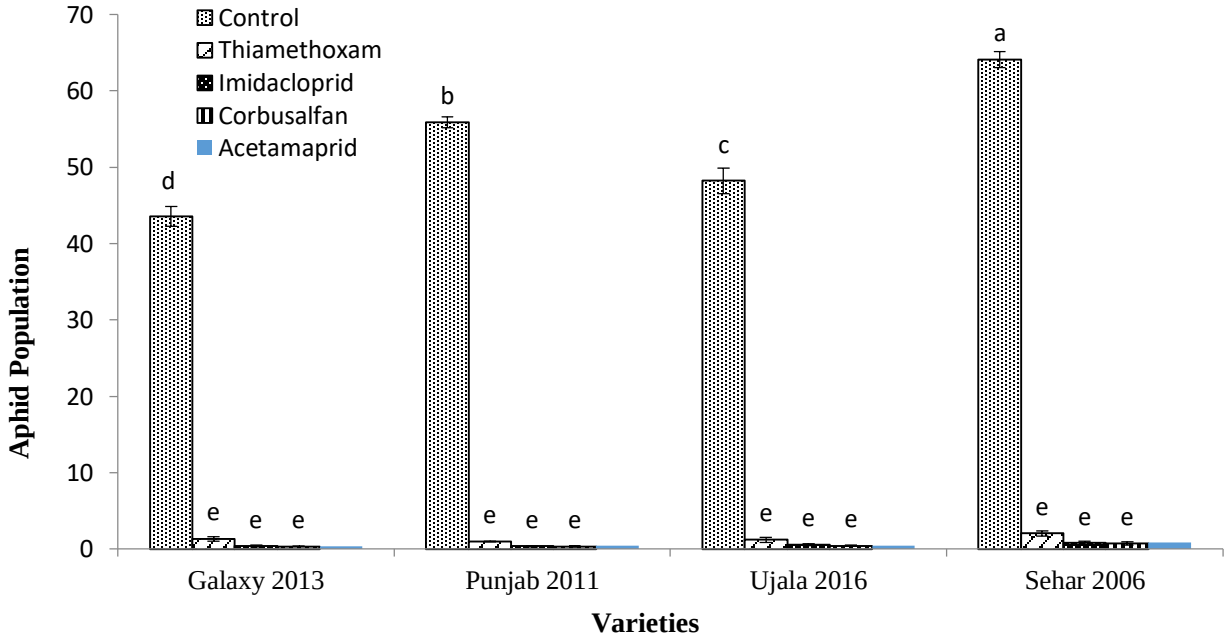


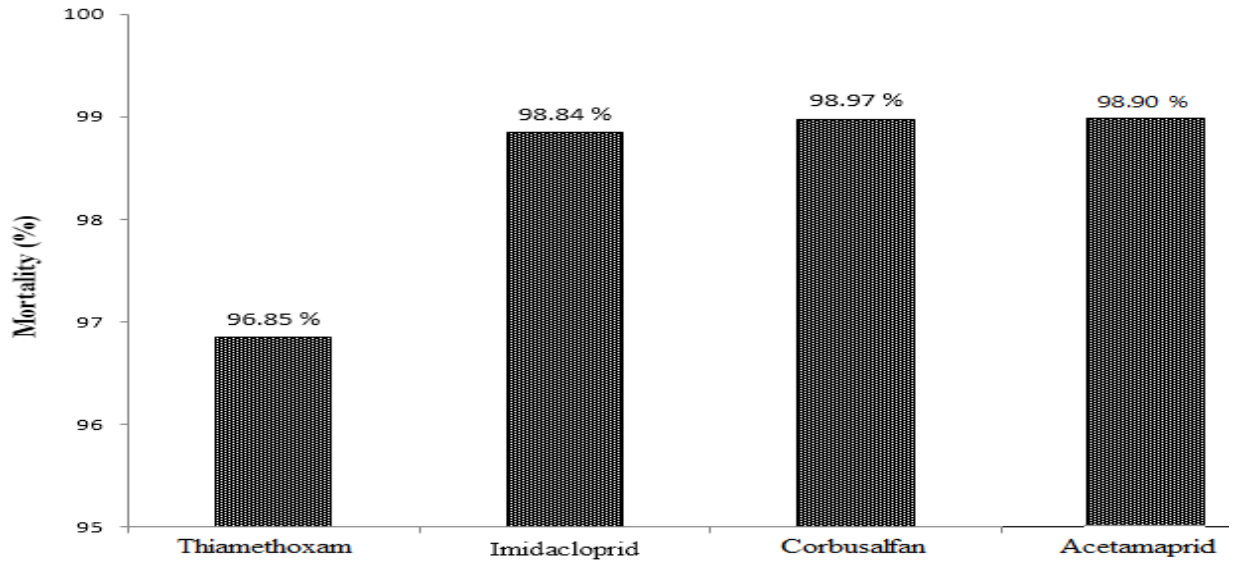
Fig. 5. Graphical presentation regarding aphid population on different wheat cultivars 07 days after insecticides application compared to control

Mortality (%) 07 days after spray

Carbosulfan, Acetamaprid and imidacloprid caused almost same %age mortality i.e. 98.97%, 98.90% and 98.84% and thiamethoxam appeared to give minimum control and caused 96.85% mortality as shown in Fig. (4.15b); nevertheless, all insecticides reduced aphid population. There was almost no control in untreated plot.

Fig.6. Graphical presentation regarding %age mortality 07 days after spray

Aphid population 14 days after spray



Numerically (Table 7) imidacloprid gave maximum control i.e. 5.67 aphids per plant as compared to Carbosulfan i.e. 3.16 aphids per plant and thiamethoxam i.e. 3.50 aphids per plant. All four insecticides were statistically at par with each other. Aphid population in varieties differed significantly, maximum on Sehar-2006 i.e. 23.13 aphids per plant and minimum on Galaxy-2013 i.e. 17.38 aphids per plant. Ujala-2016 and Punjab-2011 were statistically same (7).

Table: 7. Mean aphid population influenced by different insecticides on wheat cultivars 14 days after spray

	Galaxy 2013	Punjab 2011	Ujala 2016	Sehar 2006	Mean
Control	60.37c	74.13 b	71.93 b	82.43 a	72.22 A
Thiamethoxam	6.83 d	6.70 d	6.23 d	6.90 d	6.66 B
Imidacloprid	2.23 d	2.07 d	2.07 d	2.67 d	2.26 B
Carbosulfan	4.10 d	3.13 d	4.87 d	4.53 d	4.15 B
Acetamaprid	4.13 d	3.08 d	3.98 d	5.76 d	4.23 B
Mean	15.53 B	17.82 AB	17.81 AB	20.45 A	

Means sharing similar letters do not differ significantly.

LSD variety ($p \leq 0.05$) = 2.48

LSD Insecticides ($p \leq 0.05$) = 2.57

LSD Variety × Insecticide ($p \leq 0.05$) = 5.14

Table: 8. Analysis of variance of insecticides efficacy on wheat cultivars 14 days after spray

Source	S.S.	D.F.	M.S.	F	Prob.	Sig.
Replication	9.20	2	4.60	0.75	0.51	
Variety	198.91	3	66.30	10.76	0.01	**
Error variety	36.97	6	6.16			
Insecticides	41556.73	3	13852.24	1489.08	0.00	**
Variety x Insecticides	553.38	9	61.49	6.61	1×10^{-4}	**
Residual	223.26	24	9.30			
Total	42578.45	47	905.92			

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

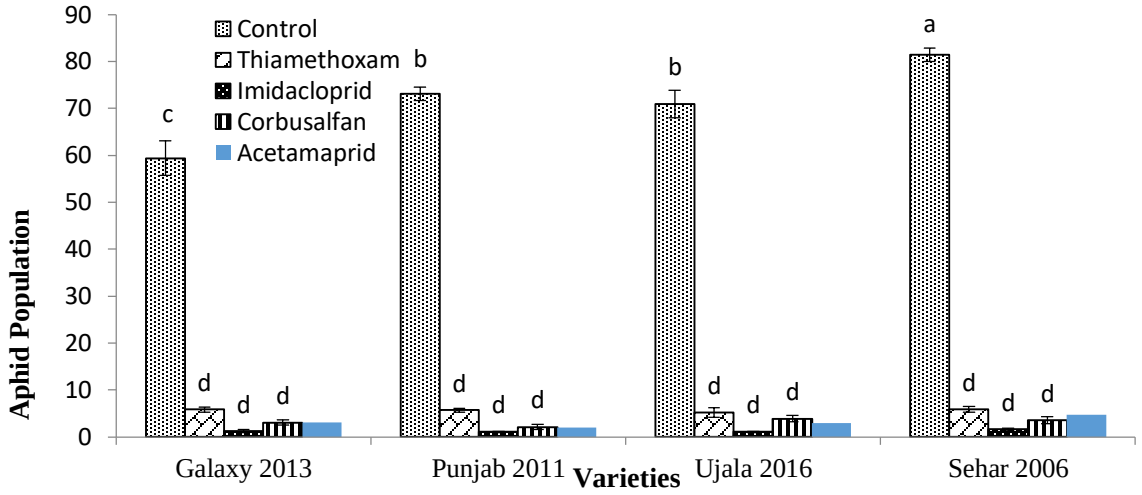


Fig. 7. Graphical presentation regarding aphid population on different wheat cultivars 14 days after insecticides application compared to control

Mortality (%) 14 days after spray

Overall, imidacloprid appeared to be most persistent as compared to Carbosulfan, Acetamaprid and thiamethoxam. Satisfactory control was observed by all four insecticides. Imidacloprid maintained highest %age mortality i.e. 97.13%; however, it was reduced in remaining insecticides 14 days after insecticides application (Fig 8).

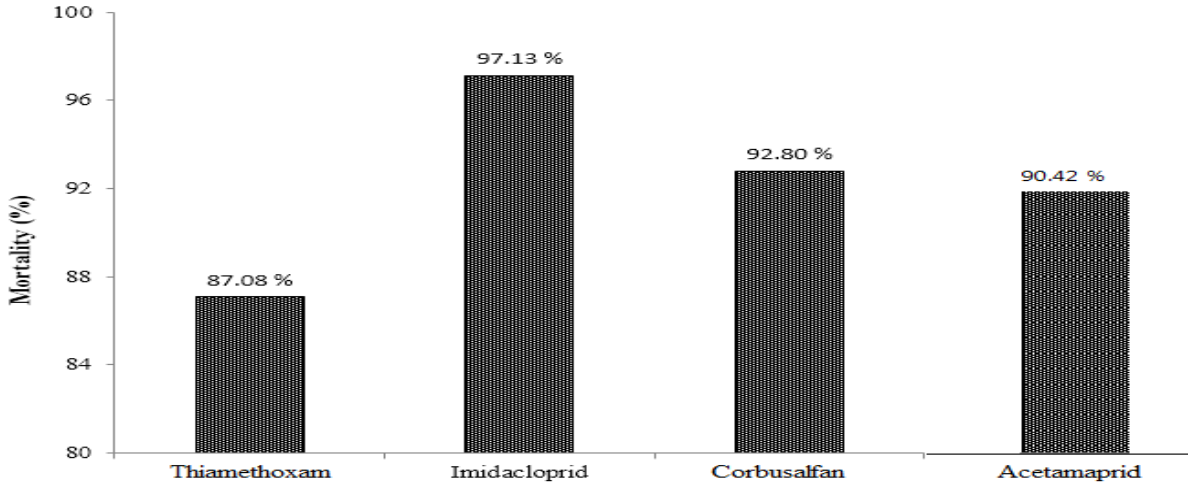


Fig. 8. Graphical presentation regarding %age mortality 14 days after spray

Author contributions

Ayesha Anwar[†] and Ali Khan[†] both contributed equally and both are first author, other authors helped in data compiling, statistical analysis and paper writing in this research work.

Conflicts of Interest

The authors declare no conflict of interest.

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