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MANAGEMENT OF WHEAT APHID *Schizaphis graminum* (RONDANI) (HOMOPTERA, APHIDIDAE) THROUGH VARIOUS CONTROL STRATIGIES AND THEIR EFFECT ON YIELD

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Abstract

Our research trial was comprised of two experiments. In first experiment, effect of various sowing dates ((S_1) 26th Oct, (S_2) 6th Nov, (S_3) 16th Nov 2021) on the population trend of wheat aphids (*Schizaphis graminum R.*) on selected varieties of wheat (Khyber-87, Uqab, Attahabib-10, Pirsabak-2019) were studied. In the second experiment the efficacy of various botanicals (Neem oil, Garlic Extract, Aleovera extract) and Imidacloprid was studied against wheat aphids (*Schizaphis graminum R.*) during 2021 on wheat variety Pirsabak-2019. Averaged over varieties, data regarding 1st sowing date showed that significantly lowest aphid plant^{-1} (1.39) and reached to its peak in the 9th week (14th February) with 80.21 aphid plant^{-1}. Averaged over weeks, lowest aphids' plant^{-1} (7.90) was recorded on Pirsabak-2019, while significantly highest number of aphid's plant^{-1} (42.06) was recorded on Khyber-87 variety. The interaction effect of weeks x varieties showed that statistically lowest aphids plant^{-1} (0) was recorded onPirsabak-2019 and Attahabib-10 in first week (20-Dec), while significantly maximum aphid plant^{-1} (147.76) was recorded in 9th week (14-Feb) on Khyber-87. Averaged over varieties, data regarding 2nd date of sowing date showed that aphids appeared in 1st week (02-Jan) by having 1.18 aphids plant^{-1} and peaked (89.57 aphid plant^{-1}) in the10th week (27th Feb) with significant difference. Interaction effect also showed that significantly minimum aphid plant^{-1} (0) was recorded on Pirsabak-2019 and Attahabib-10 in the first week (02-Jan), while significantly maximum aphid plant^{-1} (170.83) was recorded in10th week on Khyber-87. Averaged over varieties, data regarding 3rd date of sowing date showed that aphids appeared in 1st week (11th Jan) by having 0.91 aphids plant^{-1} and peaked (91.06 aphid plant^{-1}) in the9th week (7th March) with significant difference. Interaction effect showed that significantly minimum aphid plant^{-1} (0) was recorded on Pirsabak-2019 and Attahabib-10 in the first week (11th Jan), while significantly maximum aphid plant^{-1} (175.33) was recorded in 9th week on Khyber-87. Averaged over dates of sowing, data regarding the yield revealed that significantly maximum yield (3158 kg ha^{-1}) was obtained from Pirsabak-2019 and significantly minimum yield was obtained from Khyber-87 variety, with 2327 kg ha^{-1}. Averaged over varieties, data regarding the yield revealed that significantly maximum yield (2796 Kg ha^{-1}) was obtained from varieties sown on 26th October. Yield obtained from varieties sown on 6th (2695 Kg ha^{-1}) and 16th November (2667 Kg ha^{-1}) was not significantly different from each other. Interaction effect of varieties x date of sowing showed that significantly maximum yield (3256 Kg) was obtained from variety Pirsabak-2019 sown on 26th October and minimum from the variety Kyber-87 (2276 kg) sown on 16th November. Pesticides treated trial showed that, averaged over time intervals, significantly minimum mean population density (2.28 aphid plant^{-1}) was recorded from Imidacloprid treated plot and significantly maximum mean aphid population density (41.91 aphid plant^{-1}) was recorded from Control. Averaged over treatments, showed that significantly maximum mean population density (24.80 aphids plant^{-1}) was recorded 7th day of post treatment, while significantly minimum mean population density of aphid plant^{-1}

was recorded 24 hours of post treatment with 14.18 aphids plant^{-1}. The interaction effect of time intervals x pesticides revealed that significantly lowest population density (1.80 aphid plant^{-1}) was recorded on of efficacy of Imidacloprid treated plot, 24 hrs of the post treatment. And, maximum population density (46.44 aphid plant^{-1}) was recorded 7 days of the post treatment in the control plot. Results regarding the impact botanicals and Imidacloprid on the yield revealed that maximum yield was obtained from the Plot treated with Imidacloprid and minimum from the control. Similarly, the data regarding thousand grain weight revealed that that significantly maximum thousand grain weight was recorded in Imidacloprid treated plot and minimum in control. Overall, Pirsabak-2019 proved comparatively better variety among all the tested varieties against wheat aphids (*Schizaphis graminum R.*). Chemical (Imidacloprid) was statistically better as compared to botanicals (Neem oil, Garlic Extract, Aleovera extract).

Keywords: *Schizaphis graminum*, varietal response, botanical control, chemical control

Introduction

Wheat is the staple food of people in Pakistan and is being consumed @129 kg per capita/person annually. Wheat is an important cereal crop of Pakistan, as it is grown on 9 million hectares with almost 80% farmers grows this crop. During the year 2020-2021 wheat production reached to 27.5 million tons and cultivated on an area of 9.2 million/ha (Khan *et al*., 2011). Production of wheat is affected by various abiotic and biotic factors i.e., low yielding varieties, improper irrigation, fertilizer application, sowing time, weed and insect pests (Wains *et al*., 2010). Several insect pests causes damage to wheat crop, Among these insect pests, Aphids are developing as a potential pest causing more distortion in wheat crop (Khan *et al*., 2011), and are soft-bodied insects, order Hemiptera and super family-Aphidoidea. Body size of these insects ranging from about 1.5 mm to around 3.1 mm. Dominant species of wheat aphids are *S. graminum*, *R. padi*, *S. avenae*, *Diuraphisnoxia* (Mordvailko) and rose-grass aphid, *M. dirhodum* (Bospucperez and Schotzko, 2000). *Schizaphis graminum* in Pakistan is a severe insect pest. It's also a major pest of oats, barley, and sorghum, but it is the common species on Rabi wheat crop. It is most destructive in the winter and causes significant economic losses in the yield of wheat crop. It directly damages the crop by feeding on cell sap, as well as indirect damage via viral transmission and the growth of mold (brown rust) on their honey dew (Aslam *et al*., 2005). Aphid outbreaks are frequently favored by mild, dry winters and chill, dry springs. Among all insect pest, total of 29 aphid's species attack on the wheat varietys. Aphid can cause various damages to plant such has leaves curling, chlorosis, and leaves distortion which hinder the growth of the plant (Akhter and Khaliq, 2003). Heavy aphid infestation at the initial stage of the wheat crop can kill the plants however aphids feeding on plant result in poor root growth, resulting in damaging the number of tillers and grain yield (Russel, 2013). In Peshawar the aphid pest appeared from December to January. The peak population of aphid has been recorded during the month of February. Infestation of aphids decreases gradually towards the end of March very low members were recorded and at the end of April aphids vanished completely (Khan *at al.* 2006). This pattern is very much complicated as no single factor is responsible for decline the population from the field, however, may be due to natural enemies, temperature, humidity and stage of the crop. Keeping in view the above importance the current research is to examine the effect of different sowing dates of wheat varieties on aphid (*S. graminum* R.) population under field conditions ((S_1) 26th Oct, (S_2) 6th Nov, (S_3) 16th Nov, 2021), compare the impacts of

efficacy of botanical extracts and chemical pesticide against wheat aphid (*Schizaphis graminum* R.) and compute the yield and its related qualities from different treatments in wheat field.

Materials and Methods

This study is composed of two different experiments; first experiment was to determine effect of sowing dates on the population trend of wheat aphids (*Schizaphis graminum R.*) on selected varieties (Khyber-87, Uqab, Attahabib-10, Pirsabak-2019) of wheat. while in the second experiment comprised the efficacy of three bio pesticides (Neem oil, Garlic Extract,and Aleovera extract) compared to synthetic chemical (Imidacloprid 20% SL) were tested against (*Schizaphis graminum R.*) during 2021-2022 in NDF Malakander, The University of Agriculture Peshawar.

Experiment 1: Study population trend and using different sowing dates of selected wheat varieties against wheat aphid *S. graminum.*

In this experimental trial, three replications treatment^{-1} were used in Randomized Complete Block Design (RCBD). Four wheat varieties (Khyber-87, Uqab, Attahabib-10, and Pirsabak-2019) were sown though hand hoe on 3 different dates at an interval of 10 days i.e., (S_1) 26th Oct, (S_2) 6th Nov, (S_3) 16th Nov, 2021. These four varieties were used as treatments and blocks as replications. Each plot was 2.5m in width and 2m in length, 30cm distance was maintained between rows as well as one-meter separation between replications. All the agronomic practices were carried out and no pesticide was applied pre or post sowing (Zeb *et al.*, 2011).

Parameters:

1. Mean population trend of wheat aphids (*Schizaphis graminum R.*)

Data regarding population trend were recorded on weekly interval for 12 weeks in the field during cropping season. In each replication, for sampling five spots in one row foot were randomly selected and number of aphids was counted on leaves, stem and spikes through visual method in the field. Data was collected from whole plant during seedling stage while at maturity data was collected from leaves and spikes, respectively. The mean number of aphids plant^{-1} was calculated from each variety.

2. Yield

On maturity the crop was sickle harvested in 1m^2 area in the center of each plot. The bundles were properly tagged and allowed to sun drying for seven days. After threshing separately grain yield of each plot was converted to kg ha^{-1} by the formula;

$$yield(kg\ ha^{-1}) = \frac{yield\ kg\ per\ plot}{area\ harvested\ (m^2)}\ x\ 10{,}000m^2$$

Experiment 2: Efficacy of various botanicals and Imidacloprid against wheat aphid (*Schizaphis graminum R.*)

In this experiment, variety with minimum number of aphids per plants among the tested varietys were selected from first experiment was selected and sown at NDF Malakander, The University of Agriculture Peshawar. Current experiment was performed in Randomized Complete Block Design (RCBD)with three replications and five treatments *i.e.,* (T_1) Neem oil, (T_2) Garlic Extract, (T_3), Aleo vera extract, (T_4) Imidacloprid 20% SL and (T5) control in each replication. The total size of the experimental plot was (32m x 6m), with three rows of one meter each; row-row distance and plant-plant distances was 30 cm and 15 cm respectively, while plot to plot distance was kept 50 cm. All cultural and agronomic procedures, including weeding, thinning, and watering, were carried out evenly in all plots throughout the growing season. With a knapsack sprayer, a chemical (spray) was employed on or before reaching the ETL (Aslam *et al*., 2005)

Parameters:

1. Mean population density of aphids leaf^{-1} on different varieties of wheat

Application of treatments was done through knapsack hand sprayer when aphid population reached economic threshold level (ETL (35-40). Population density of aphids was recorded after 24, 48, 72 and 168 hours post application of treatments. For data collection, in each replication, from three different plant, five leaves were selected; number of aphids was counted and following formula was used to calculate their mean (Asim *et al.* 2019).

$$\text{Population density (P)} = \frac{T1 + T2 + T3 + T4 + T5}{5}$$

"P" signifies the average population density/plant, while T_1, T_2, T_3, T_4 and T_5 denotes time interval.

2. Thousand Grain Weight

Mature wheat varieties were harvested and threshed separately to record the data regarding thousand grain weights. These wheat samples were taken separately from each plot to calculate thousand grains by weighing on electric balance (Zeb *et al*. 2011).

3. Yield kg ha^{-1}

On maturity the crop was sickle harvested in $1m^2$ area in the center of each plot. The bundles were properly tagged and allowed to sun drying for seven days. After threshing separately grain yield of each plot was converted to kg ha^{-1} by the formula;

$$yield(kg\ ha^{-1}) = \frac{yield\ kg\ per\ plot}{area\ harvested\ (m^2)}\ x\ 10{,}000m^2$$

Statistical analysis

The data were analyzed using the STATISTIX software (8.1). Mean of all parameters were distinguished by least significant difference (LSD 0.05) approach.

Results

Mean population trend of wheat aphids (*Schizaphis graminum R.*) plant^{-1}

The analysis of variance for the population trend of wheat aphids (*Schizaphis graminum R.*) revealed significant effect ($P<0.05$) because of different wheat varieties and sowing dates. The information in Table 1 relates to the population trend of wheat aphids *(Schizaphis graminum* R.) on four different wheat cultivars sown at various dates. Mean values for varieties and sowing dates revealed significant difference. Significantly minimum aphid population (7.90 aphid plant^{-1}) was obtained from Pirsabak-2019, followed by Attahabib-10 (16.93 aphid plant^{-1}) and Uqab (23.78 aphid plant^{-1}), respectively. However, significantly maximum aphid population was obtained from Khyber-87 variety with 42.06 aphid plant^{-1}. Mean values for weeks also showed significant difference among various time interval, as aphids emerged initially on 20-December and peaked (80.21 aphid plant^{-1}) in the 9th week (14-Febraury), followed by 8th week (07-Feb) and 10th week (21-Feb) with 52.40 and 39.46 aphid plant^{-1}, respectively. Significantly lowest aphid plant^{-1} (1.39) was recorded on 20-December followed by 27-Dec (2.28 aphid plant^{-1}) and 03-Jan (2.93 aphid plant^{-1}) with no significant difference. The interaction effect of weeks and varieties was significant. Population of aphids was low during last weeks of December and starts building in the middle weeks of January. Statistically minimum aphids plant^{-1} was recorded from the interaction effect of wheat varieties such as Pirsabak-2019 and Attahabib-10 with first week (20-Dec) with no significant difference, while significantly maximum aphid plant^{-1} (147.76) was recorded from the interaction of 9th week with Khyber-87 variety followed by the interaction of 8th week x Khyber-87 and 9th week x Uqab with 95.90 and 90.94 aphids plant^{-1}, respectively. After 10th week, a sharp decline was observed in aphid population; however, the overall seasonal aphid population trend shows that wheat aphid significantly preferredKhyber-87 variety in the mid-week of February.

Table 1: Mean population trend of wheat aphids (*Schizaphis graminum R.*) plant^{-1} on four wheat varieties sown on 26th October, during 2021.

S. No.	Weeks	Wheat Varieties				Mean
		Khyber-87	Uqab	Attahabib-10	Pirsabak-2019	
1	20-Dec	0.48 stuv	3.08 stuv	0.00 v	0.00 v	1.39 h
2	27-Dec	2.96 stuv	2.20 stuv	2.68 stuv	1.30 tuv	2.28 h
3	03-Jan	4.48 rstu	2.11 stuv	4.01 rstu	1.13 uv	2.93 gh
4	10-Jan	4.96 rst	2.13 stuv	2.41 stuv	3.03 stuv	3.13 gh
5	17-Jan	29.36 i	18.11 l	13.38 no	2.46 stuv	15.83 g
6	24-Jan	38.19 g	14.21 mno	12.87 o	6.86 qr	18.03 e
7	31-Jan	68.94 d	32.53 hi	18.53 kl	7.20 qr	31.80 d
8	07-Feb	95.90 b	54.47 f	41.53 g	17.70 lm	52.40 b
9	14-Feb	147.76 a	90.94 c	59.20 e	22.93 j	80.21 a
10	21-Feb	68.62 d	38.09 g	34.27 h	16.86 lmn	39.46 c
11	28-Feb	32.20 hi	21.87 jk	11.74 op	13.38 no	19.79 e
12	07-Mar	8.85 pq	5.67 qrs	2.56 stuv	1.94 stuv	4.75 g
Mean		42.06 a	23.78 b	16.93 c	7.90 d	

Mean with different letters are significantly different at P≤ 0.05

LSD value for Varieties at p ≤ 0.05 = 1.0827
LSD value for Week at p ≤ 0.05= 1.8752
LSD for value interactions at p ≤ 0.05 = 3.7505

Mean population trend of wheat aphids (*Schizaphis graminum R.*) plant^{-1} on four wheat varieties sown on 6thNovember, during 2021

The analysis of variance for the population trend of wheat aphids (*Schizaphis graminum R.*) revealed significant effect (P<0.05) because of different wheat varieties and sowing dates. Table 2 provides information on the population trend of aphids (*Schizaphis graminum* R.) on four distinct wheat cultivars sowed at various dates. Mean values for

varieties and sowing dates revealed significant difference. Significantly minimum aphid population (9.19 aphid plant^{-1}) was obtained from Pirsabak-2019, followed by Attahabib-10 (12.05 aphid plant^{-1}) and Uqab (26.30 aphid plant^{-1}), respectively. However, significantly maximum aphid population was obtained from Khyber-87 variety with 47.99 aphid plant^{-1}. Mean values for weeks also showed significant difference among various time interval, as aphids emerged initially on 02-January and peaked (89.57 aphid plant^{-1}) in the 9th week (27-Febraury), followed by 8th week (20-Febraury) and 10th week (06-March) with 69.22 and 47.01 aphid plant^{-1}, respectively. Significantly lowest aphid plant^{-1} (1.18) was recorded on 02-January followed by 09-January (1.49 aphid plant^{-1}), 20-March (2.18 aphid plant^{-1}) and 16-January (2.44 aphid plant^{-1}) with no significant difference. The interaction effect of weeks x varieties was significant. Population of aphids was low during first weeks of January and starts building up rapidly in the first weeks of February. Statistically minimum aphids plant^{-1} was recorded from the interaction effect of wheat varieties such as Pirsabak-2019 and Attahabib-10 with first week (02-Jan), Second week (09-Jan) with no significant difference, while significantly maximum aphid plant^{-1} (170.83) was recorded from the interaction of 9th week with Khyber-87 variety followed by the interaction of 8th week x Khyber-87 and 9th week x Uqab with 148.73 and 91.40 aphids plant^{-1}, respectively. After 10th week, a sharp decline was observed in aphid population; however, the overall seasonal aphid population trend shows that wheat aphid significantly preferred Khyber-87 variety in the mid-week of February.

Table 2: Mean population trend of wheat aphids (*Schizaphis graminum R.*) plant^{-1} on four wheat varieties sown on 6thNovember, during 2021.

S. No.	Weeks	Wheat Varieties				Mean
		Khyber-87	Uqab	Attahabib-10	Pirsabak-2019	
1	02-Jan	2.76 rst	1.99 rst	0.00 t	0.00 t	1.18 i
2	09-Jan	3.76 rst	2.20 rst	0.00 t	0.00 t	1.49 i
3	16-Jan	6.74 opqrst	2.11 rst	0.92 st	0.00 t	2.44 i
4	23-Jan	12.55 mnop	3.03 rst	2.10 rst	1.20 st	4.72 hi
5	30-Jan	18.22 lm	8.11 nopqrs	3.67 rst	2.10 rst	8.02 gh
6	21-Jan	27.85 k	9.06 nopqr	2.93 rst	4.17 qrst	10.00 fg

7	06-Feb	37.62 hij	11.27 mnopq	4.76 qrst	6.86 opqrst	15.13 e
8	13-Feb	83.37 d	44.93 gh	14.56 mn	7.20 opqrst	37.52 d
9	20-Feb	148.73 b	77.72 de	32.72 jk	17.70 m	69.22 b
10	27-Feb	170.83 a	91.40 c	54.21 f	41.85 ghi	89.57 a
11	06-Mar	45.89 g	73.23 e	37.07 ij	31.84 jk	47.01 c
12	13-Mar	25.51 kl	13.80 mno	3.76 rst	6.66 opqrst	12.45 ef
13	20-Mar	5.63 pqrst	3.10 rst	0.00 t	0.00 t	2.18 i
Mean		47.99 a	26.30 b	12.05 c	9.19 d	

Mean with different letters are significantly different at P≤ 0.05

LSD value for Varieties at p ≤ 0.05 = 2.0412
LSD value for Week at p ≤ 0.05= 3.6798
LSD value for interactions at p ≤ 0.05 = 7.3595

Mean population trend of wheat aphids (*Schizaphis graminum R.*) on four wheat varieties sown on 16thNovember, during 2021

The analysis of variance for the population trend of wheat aphids (*Schizaphis graminum R.*) revealed significant effect (P<0.05) because of different wheat varieties and sowing dates. Table 3 illustrates the population trend of wheat aphids (*Schizaphis graminum* R.) on four distinct wheat varieties seeded on different dates. Among all the tested wheat varieties, mean values for varieties and sowing dates revealed significant difference. Significantly minimum aphid population (6.51 aphid plant^{-1}) was obtained from Pirsabak-2019, followed by Attahabib-10 (13.87 aphid plant^{-1}) and Uqab (25.93 aphid plant^{-1}), respectively. However, significantly maximum aphid population was obtained from Khyber-87 variety with 51.58 aphid plant^{-1}. Mean values for weeks also showed significant difference among various time interval, as aphids emerged initially on 11-January and peaked (91.06 aphid plant^{-1}) in the 9th week (07-March), followed by 8th week (28-Febraury), 7th week (21-Febraury) and 10th week (14-March) with 69.05, 36.85 and 36.67 aphid plant^{-1}, with no significant difference between 7th and 10th week, respectively. Significantly lowest aphid plant^{-1} (0.91) was recorded on 11-January followed by 28-March (1.00 aphid plant^{-1}), and 18-January (1.67 aphid plant^{-1}) with no significant

difference. The interaction effect of weeks x varieties was significant. Population of aphids was low during mid-weeks of January and starts building up rapidly in the last weeks of February. Statistically minimum aphids plant^{-1} was recorded from the interaction effect of wheat varieties such as Pirsabak-2019 and Attahabib-10 with first week (11-Jan), (18-March) and25-Jan x Pirsabak-2019 with no significant difference, while significantly maximum aphid plant^{-1} (175.33) was recorded from the interaction of 9th week with Khyber-87 variety followed by the interaction of 8th week x Khyber-87 and 9th week x Uqab with 150.90 and 94.19 aphids plant^{-1}, respectively. After 10th week, a sharp decline was observed in aphid population; however the overall seasonal aphid population trend shows that wheat aphid significantly preferred Khyber-87 variety in the last weeks of February and first weeks of March.

Table 3: Mean population trend of wheat aphids (*Schizaphis graminum R.*) on four wheat varieties sown on 16th November, during 2021.

S. No.	Weeks	Wheat Varieties				Mean
		Khyber-87	Uqab	Attahabib-10	Pirsabak-2019	
1	11-Jan	1.73 wxy	1.91 vwxy	0.00 y	0.00 y	0.91 i
2	18-Jan	3.74 stuvwx	2.02 vwxy	0.83 xy	0.00 y	1.67 i
3	25-Jan	7.14 qrs	3.86 rstuvwx	1.96 vwxy	0.92 wxy	3.47 h
4	01-Feb	18.93 kl	8.41 pq	3.48 tuwxy	2.38 vwxy	8.30 g
5	08-Feb	22.41 jk	11.31 op	6.23 qrstu	4.37 rstuvw	11.08 f
6	15-Feb	40.71 g	20.20 jkl	12.61 no	6.92 qrst	20.11 d
7	21-Feb	84.06 d	41.31 g	14.97 mn	7.09 qrs	36.85 c
8	28-Feb	150.90 b	76.22 e	31.75 hi	17.32 lm	69.05 b
9	07-Mar	175.33 a	94.19 c	65.65 f	29.08 i	91.06 a
10	14-Mar	76.55 e	39.24 g	23.51 j	7.36 qr	36.67 c
11	21-Mar	34.33 h	11.71 nop	5.38 qrstuv	2.73 uvwxy	13.54 e
12	28-Mar	3.16 uvwxy	0.83 xy	0.00 y	0.00 y	1.00 i
Mean		51.58 a	25.93 b	13.87 c	6.51 d	

Mean with different letters are significantly different at P≤ 0.05

LSD value for Varieties at $p \leq 0.05 = 1.0140$
LSD value for Week at $p \leq 0.05 = 1.75$
LSD value for interactions at $p \leq 0.05 = 3.5127$

Comparison of Yield kg ha^{-1} of four different wheat varieties sown on three different dates

The analysis of variance for yield kg ha^{-1} revealed significant effect (P<0.05) because of different wheat varieties and sowing dates. Data regarding the yield on four distinct varieties of wheat sown on different dates are given in Table 4. Among all the tested wheat varieties, mean values for varieties revealed significant difference as well as sowing dates. Significantly maximum yield (3158 kg ha^{-1}) was obtained from Pirsabak-2019, followed by Attahabib-10 (2821 kg ha^{-1}) and Uqab (2571 kg ha^{-1}), respectively. However,

significantly minimum yield was obtained from Khyber-87 variety with 2327 kg ha^{-1}, similarly, among sowing dates, significantly maximum yield (2796 kg ha^{-1}) was recorded from first Sowing date 1 (26th Oct) while significantly lowest yield (2667 kg ha^{-1}) was recorded from sowing date 3 (16th Nov). The interaction effect of sowing dates x varieties was significant. Significantly highest yield (3256kg ha^{-1}) was recorded from the interaction effect of Pirsabak-2019 with 1st sowing date followed by Pirsabak-2019 x 2nd sowing date and Pirsabak-2019 x 3rd sowing date with 3113 and 3107 kg ha^{-1}, respectively, although no significant difference was observed among these interactions. Statistically lowest yield (2276 kg ha^{-1}) was obtained from the interaction effect of Khyber-87 with 3rd sowing date followed by the interaction effect of Khyber-87 x 2nd sowing date and Khyber-87 x 1st sowing date with 2314 and 2391 yield kg ha^{-1}, respectively.

Table 4: Comparison of yield kg ha^{-1} of four different wheat varieties sown on three different dates.

Treatments	**Sowing Dates**			**Mean**
	26th Oct (1st)	6th Nov (2nd)	16th Nov (3rd)	
Khyber-87 (V_1)	2391 g	2314 gh	2276h	2327 d
Uqab (V_2)	2631 e	2570 ef	2513 f	2571 c
Attahabib-10 (V_3)	2905 c	2788 d	2771 d	2821 b
Pirsabak-2019 (V_4)	3256 a	3113 b	3107 b	3158 a
Mean	2796 a	2695b	2667b	

Mean with different letters are significantly different at P≤ 0.05

LSD value for Varieties at p ≤ 0.05 = 55.818
LSD value for Sowing Dates at p ≤ 0.05= 48.340
LSD value for interactions at p ≤ 0.05 = 96.680

Efficacy of various botanicals and Imidacloprid on the population density of wheat aphids (*Schizaphis graminum R.*) on wheat crop

A significant effect (P< 0.05) was found in the analysis of variance for the mean population density of wheat aphids (*Schizaphis graminum* R.) owing to different botanicals and imidacloprid. In Table 5, information is provided about the effectiveness of various

botanicals extracts and the insecticide imidacloprid on the mean population density of wheat aphids (*Schizaphis graminum* R.) on wheat crops. Among all the tested botanicals and Imidacloprid, mean values for population density of aphid revealed significant difference. Significantly minimum mean aphid population density (1.53 aphid plant^{-1}) was recorded from Imidacloprid treated plot, followed by Neem seed extract (13.78 aphid plant^{-1}) and Garlic extract (19.14 aphid plant^{-1}), respectively. However, significantly maximum mean aphid population density (41.91 aphid plant^{-1}) was recorded from Control followed by Aloe vera extract with 22.79 aphid plant^{-1}. Mean values for aphid population density per plant^{-1}during post treatment time interval also expressed considerable differences. Significantly minimum mean population density (14.18 aphid plant^{-1}) was recorded 24 hours post treatment followed by 48 hours (16.50 aphid plant^{-1}) and 72 hours (20.47 aphid plant^{-1}), respectively, however, significantly maximum mean population density of aphid plant^{-1} was recorded 7 days' post treatment with 24.80 aphid plant^{-1}, respectively. The interaction effect of time interval x treatments was significant. Significantly lowest population density was recorded during 24hrs (1.80 aphid plant^{-1}), 48hrs (1.86 aphid plant^{-1}), 72hrs (2.14 aphid plant^{-1}) and 7 days (3.34 aphid plant^{-1}) from the plants treated with Imidacloprid followed by Neem seed extract (5.97 aphid plant^{-1}) 24 hours post treatment time interval.In comparison with all treated plant, statistically highest population density of aphids during post treatment time interval was recorded from control (Untreated plants), such as maximum population density was recorded 7 days post treatment (46.44 aphid plant^{-1}) followed by 72hrs (43.67 aphid plant^{-1}), respectively. Untreated control plant was followed by Aloe vera treated plant with 31.70 aphid plant^{-1} 7 days' post treatment.

Table 5: Efficacy of various botanicals and Imidacloprid on the population density of wheat aphids (*Schizaphis graminum R.*)on wheat crop

Treatments	Time Interval				Mean
	24 hrs	48 hrs	72 hrs	7 days	
Neem seed extract (T_1)	5.97 l	8.11 k	11.03 j	16.01 i	13.78 d

Garlic extract (T_2)	12.20 j	15.01 i	21.80 h	27.55 f	19.14 c
Aloe vera extract (T_3)	15.61 i	19.13 h	24.72 g	31.70 e	22.79 b
Imidacloprid (T_4)	1.80 n	1.86 n	2.14 n	3.34 m	2.28 e
Control (T_5)	37.32 d	40.41 c	43.67 b	46.44 a	41.91 a
Mean	14.18 d	16.50 c	20.47 b	24.80 a	

Mean with different letters are significantly different at P≤ 0.05

LSD value for Treatments at p ≤ 0.05 = 0.8489
LSD value for Time interval at p ≤ 0.05= 0.7593
LSD value for interactions at p ≤ 0.05 = 1.1178

Efficacy of botanicals and chemical against wheat aphid (*Schizaphis graminum R.*) on yield kg ha^{-1} and thousand grain weights on wheat crop

The analysis of variance for yield and thousand grain weight displayed a substantial effect (P<0.05) due to botanicals and Imidacloprid on wheat crop. Final results regarding the efficacy of botanicals and Imidacloprid on the yield and thousand grains weight in wheat crop are given in Table 6. Among the tested botanicals and Imidacloprid, mean values for yield and thousand grains weight showed significant difference. Considerably minimum yield (3332 kg ha^{-1}) and thousand grains weight (53.37 gm) was noted from control followed by plants treated with Aloe vera extract (3372 kg ha^{-1}) (55.24 gm), respectively. Significantly, maximum yield (3733 kg ha^{-1}) and thousand grains weight (65.77 gm) was recorded from Imidacloprid treated plant followed by Neem seed extract treated plants with 3531 kg ha^{-1} yield and 61.44 grams thousand grains weight, respectively.

Table 6: Efficacy of botanicals and chemical against wheat aphid (*Schizaphis graminum R.*) on yield kg ha^{-1} on wheat crop

Varieties	Yield kg ha^{-1}	Thousand Grain Weight
Neem seed extract (T_1)	3531 b	61.44 b
Garlic extract (T_2)	3425 c	58.56 c

Aloe vera extract (T_3)	3372 d	55.24 d
Imidacloprid (T_4)	3733 a	65.77 a
Control (T_5)	3332 e	53.37 e
LSD	**58.432**	**2.2854**

Mean with different letters are significantly different at $P \leq 0.05$

Discussion

Our experimental trial contains two experiments; in the first experiment effect of several sowing dates on the population trend of wheat aphids (*Schizaphis graminum R.*) in different varieties of wheat were studied while in the second experiment the efficacy of various bio pesticides and chemicals were tested against wheat aphids (*Schizaphis graminum R.*) in various varieties of wheat during 2021-2022 in NDF Malakander, The University of Agriculture Peshawar. Data on the aphid population trend on four wheat types demonstrates that all wheat varieties were attacked by wheat aphids, however, Pirsabak-2019 was comparatively resistant while Khyber-87 was highly susceptible against wheat aphid. These results regarding Khyber-87 are in line with Inayatullah *et al.* (1993) who tested 439 varieties and reported that Khyber-87 belongs to susceptible group of wheat varieties. Similar results were also recorded by Zeb *et al.* (2011) who stated that highest yield (3048 kg ha^{-1}) and lowest aphid population was observed from Pirsabak-2019 variety, while lowest yield and highest aphid population density was recorded from Khyber-87 wheat variety. Our results regarding Pirsabak-2019 was not in conformity with Ali *et al.* (2015) who tested wheat varieties against wheat aphids and revealed Pirabak-2004 as susceptible variety. Iqbal *et al*. (2008) reported that Uqab variety of wheat is neither highly resistant nor highly susceptible, which are in agreement with our results and similar results regarding Uqab variety was also reported by Saleem *et al*. (2009). Our results show that aphid infestation started in mid-December and first week of January; these results are in agreement with Rustamani *et al.* (1999) who stated that aphid infestation started in the mid-weeks of December. Ahmad and Nasir (2001) reported similar outcomes and claimed that aphid population begins initially in the first week of January and peaked on 19th February, these results are in line with our results. However, it was reported by Aheer *et al.* (2007) that several abiotic factors such as temperature, humidity and rainfall plays a vital role in the population fluctuation of wheat aphid. Feng *et al.* (1992) have also observed the fluctuation in aphid population from one year to another. Biological and physical factors are the main cause of aphid population fluctuation and its densities on various varieties (Akhtar *et al*. 2009). The climatic conditions, natural enemies, host plant quality and agronomic practices affect the population dynamic of aphids (Brewer and Elliot, 2004), as well as the seasonal dynamics of aphid is also affected significantly by the morphological characters of plants (Markova and Tomchev, 2013). Our results regarding the use of botanicals and chemical shows that chemical control

(Imidacloprid) is the most effective treatment all tested treatments, as similar effectiveness of chemical was also reported by Khattak *et al.* (2007) who stated that chemical application reduces the aphid population significantly. Wains *et al*. (2010) reported that Imidacloprid is the most effective treatment against aphids by reducing the aphid population to almost zero level as the efficacy of chemical is almost 99% as compared to untreated control. Our results regarding efficacy of botanicals are in line with Mansoor *et al*. (2005) that plant extracts possess insecticidal properties such as repellent, antifeedant and killer as well as not hazardous for environment and human health. Ullah *et al.* (2022) who evaluated the efficacy of neem oil and reported that neem oil is effective against various insect pests due to the presence of a compound called *Azadirachtin,* this compound can act as antifeedant, sterilant and growth regulator against insect pest of various crops. Shah *et al*. (2017) tested efficacy of Imidacloprid, Neem seed extract and Moringa leaf extract and revealed that The most effective treatment for aphids was discovered to be imidacloprid, followed by neem seed extract, same results were also reported by Dougoud *et al*. (2019). Anwar *et al.* (2017) also revealed the efficacy of garlic extract against various insect pest of wheat crop due to presence of sulphur atoms in the form of thiosulfinates and disulfinates. Results regarding yield shows that aphid can cause serious damages to wheat which results in production losses, similar results were also recorded by Khan (2000) and Imran (2001) who reported the losses in yield due to wheat aphids in different areas of Khyber Pakhtunkhwa. Khan *et al*. (2006) evaluated the yield of several wheat varieties and revealed that Pirsabak-2019 gives significantly highest yield as compared to other wheat varieties. In our second experiment, it was recorded that yield and its components increases due to the application of botanicals and chemical; same results were also reported by Shahzad *et al*. (2013) that post spray, thousand grain weight and yield were significantly increased. Our results regarding yield are also in line with Zeb *et al*. (2011) who stated that significantly highest yield was recorded from Pirsabak-2019 while significantly lowest yield was recorded from Khyber-87 variety.

Conclusions and Recommendations

Pirsabak-2019 proved comparatively better variety as compared to Attahabib-10, Uqab and Khyber-87, as significantly lowest mean population of wheat aphids (*Schizaphis graminum R.*) with maximum yield. In term of chemical, Imidacloprid is better as compared to botanicals (Neem oil, Garlic Extract, Aleovera extract) as it reduced wheat aphid (*Schizaphis graminum R.*) population significantly and results in highest yield as compared to other treatments. Thus, Pirsabak-2019 is recommended as better wheat variety against wheat aphid (*Schizaphis graminum R.*) and Imidacloprid treatment is recommended for the effective control against wheat aphid infestation.

References

Aheer, G. M., M. Munir, and A. Ali. 2007. Impact of weather factors on population of wheat aphids at Mandi Baha-ud-Din district. J. Agric. Res. 45(1): 61-66.

Ahmad, F. and S. Nasir, 2001.Varietal resistance of wheat germplasmagainst wheat aphid (*Sitobion avenae* F.). Pakistan Entomol.,23: 5–7

Ali, S., S. Khalid, S. Ali, K. Akhtar, M.S. Khan, A. Ali, A. Samad, S. Hussain, S. Fahad, and F. Khan. 2015. Preferential Influence of Wheat Variety on the Distribution Pattern and Population Dynamics of Cereal Aphids and Their Natural Enemies in Peshawar Valley. Pak. J. Zool. 47(1): 223-233.

Akhter, I. H. and A. Khaliq. 2003. Impact of plant phenology and coccinellid predators on the population dynamics of rose aphid *Macrosiphum rosaeiformis* Das (Aphididae:Homoptera) on rose . Plant Sci. 2: 119-122.

Akhtar, N., N. Moin, G. Jilani, A.U. Mohsin, S. Yasmin, A. Tashfeen, M. Goraya, and I. Begum. 2009. Evaluation of resistance in wheat against *Rhopalosiphum padi* (L.)(Homoptera: Aphididae) under laboratory conditions. Pak. J. Agric. Res. 22(1/2): 67-72.

Anwar, A., E. Gould, R. Tinson, M. Groom and C. J. Hamilton. 2017. Think yellow and keep green-role of Sulfanes from garlic in agriculture. *Antioxidants (Basel)*, 6 (3): 1- 12.

Aslam, M., M. Razaq, W. Akhter, M. Faheem and F. Ahmad, 2005.Effect of sowing date of wheat on aphid (*Schizaphis gramium* R.) population. Pak Entomol., 27(1): 79-82.

Asim, M. A., A. Ali, S. Zulfiqar, H. E. Ali, A. Ali, A. Abdullah, M. I. Sarwar, M. Zia-ul-haq and M. U. Gulzar. 2019.Evaluation of different insecticides against wheat aphid. Int. J. Biol. Res. 2(1): 206- 218.

Bospucperez N. A and J. D. J. Schotzko.2000. Wheat variety, early plant growth stage and infestation density effects on Russain wheat aphid (Homoptera: Aphidae) population increase and plant damage. J. Entomol. Sci. 35:22-38.

Brewer, M. and N. Elliott. 2004. Biological Control of Cereal Aphids in North America and Mediating Effects of Host Plant and Habitat Manipulations. Annu. Rev. Entomol. 49(1): 219-242.

Dougoud, J., S. Toepfer, M. Bateman and W. H. Jenner. 2019. Efficacy of homemade botanical insecticides based on traditional knowledge- a review. Agronomy for Sustainable Development 39: 37.

Feng, M., J. Johnson, R. Nowierski.and S. Halbert. 1992. Population trends and biological aspects of cereal aphids (Homoptera: Aphididae), and their natural mortality factors on winter wheat in southwestern Idaho. Pan-Pac Entomol. 68(4): 248-260.

Imran, I. 2001. Screening of different wheat varieties against the resistance of aphids. M.Sc. thesis, Department of Entomology, NWFP Agriculture University, Peshawar, pp. 60-72.

Iqbal, J., M. Ashfaq. and A. Ali. 2008. Screening of wheat varieties/advanced lines against aphids. Pak. Entomol. 30(1): 77-81.

Khan, S. S. 2000.Impact of plant phonology of various wheat variety on aphid population and subsequent losses in wheat due to aphids. M.Sc. thesis, Department of Plant Protection, NWFP Agriculture University, Peshawar, pp. 51.

Khan, M., N. H. Shah, I.A. Inamullah, S. Rehman, N. Ahmad, M. Siddiq, F.U. Khan,.and I. Ali. 2006. Pirsabak-04: A New Wheat Variety for Normal and Late cultivation in the North West Frontier Province of Pakistan. Asian. J. Plant Sci. 5(2): 233-237.

Khan, A. A., A. M. Khan, H. M. Tahir, M.Afzal, A. Khaliq, S. Y. Khan and I. Raza. 2011. Effect of wheat varietys on aphids and their predator populations. Afr. J. Biotechnol.. 10(80): 18399-18402.

Khattak, M. K., Riazuddin and M. Inayatullah. 2007. Population Dynamics of Aphids (Aphididae: Homoptera) on Different Wheat Varietys and Response of Varietys to Aphids in Respect of Yield and Yield Related Parameters. Pakistan J. Zool., 39(2): 109-115.

Mansoor, H., M. Farooq, M. Sagheer, M. F. Iqbal and M. Tariq.2005. Residual persistence of Chlorpyrifos, Imidachloprid and Acephate in Brinjal fruit. Pak. Entomol.27(1):53- 55.

Markova, L., and N. Tomchev. 2013. Seasonal dynamics of cereal aphids and predators on various wheat varieties/lines (*Triticum aestivum* L.) 1st Global virtual conference. http://www.gv.conference.com

Russel, G.E. 2013.Plant breeding for pest and disease resistance: Studies in the agricultural and food sciences. Butterworths, London, pp. 485.

Rustamani, M.A., S. A. Sheikh, N. M. Memon, H. Leghari andM. H. Dhaunroo, 1999.Impact of wheat plant phonology on the development of green-bug, *Schizaphis graminum* (Rondani).Pakistan J. Zool., 31: 245-248.

Saleem, S., F. Ullah and M. Ashfaque. 2009. Population Dynamics and Natural Enemies of Aphids on Winter Wheat in Peshawar, Pakistan. Pak. J. Zool. 41(6): 505-513.

Shah, F. M., M. Razaq,A. Ali, P. Han and J. Chen. 2017. Comparative role of neem seed extract, moringa leaf extract and Imidacloprid in the management of wheat aphids in relation to yield losses in Pakistan. *PLoS One*, *12*(9), e0184639.

Ullah, M., F. Ullah, M. Khan, S. Ahmed, M. Jamil, S. Sardar, K. Tariq and N. Ahmed. 2022. Efficacy of various natural plant extracts and the synthetic insecticide cypermethrin 25EC against *Leucinodes orbonalis* and their impact on natural enemies in brinjal crop. Int. J. Trop. Insect. Sci. 42, 173–182

Wains, M. S., M. A. Ali, M. Hussain, J. Anwar, M. Zulkiffal and W. Sabir. 2010. Aphid dynamics in relation to meteorological factors and various management practices in bread wheat. J. Plant Prot. Res. 50 (3): 385-392.

Zeb, Q., H. Badshah, H. Ali, R. A., Shah, and M. Rehman. 2011. Population of aphids on different varieties/lines of wheat and their effect on yield and thousands grain weight. Sarhad J. Agric., 27(3): 443-450.