

Impact of nitrogenous fertilizer rates on *Schizaphis graminum* (Rondani) population dynamics in wheat (*Triticum aestivum* L.)

Muhammad Usama Intizar^{1*}, Muhammad Daud¹, Muhammad Nasir¹, Zunaira² and Hafiza Ayesha Jafar³

¹Department of Entomology, Bahauddin Zakariya University, Multan, Pakistan

²Department of Pathology and Biomedical Sciences, Muhammad Nawaz Shareef University of Agriculture, Multan, Pakistan

³Institute of Molecular Biology and Biotechnology, Bahauddin Zakariya University, Multan, Pakistan

*Corresponding author's email: usamaintizar898@gmail.com

Abstract

Sustainable wheat crop production for improved growth and yield depends on the balanced use of nitrogenous fertilizers. However, their inadequate usage often provides a favorable environment for the sucking insect pests like aphids to flourish. Field research was performed to assess the effect of elevated levels of nitrogenous fertilizer on *Schizaphis graminum* population in a randomized complete block design (RCBD) with four replications at the research farm area of the Faculty of Agricultural Sciences and Technology (FAS&T), Bahauddin Zakariya University, Multan. Five different doses of nitrogenous fertilizers, i.e., 0, 50, 75, 100, and 125 kg/acre, were used. The results revealed a significant correlation between the average number of *S. graminum* per plant and nitrogen fertilizer application in both years. Infestation by *S. graminum* nymphs reached its highest levels during the 2nd week of February and the 1st week of March during 2024

while in 2025 peak was observed in 2nd and 3rd week of February. The first peak recorded 17.8 nymphs/plant, while the second peak reached 16.9 nymphs/plant on February 12th during 2024. Similarly in 2025 first peak recorded 18.3 nymphs/plant, while the second peak reached 16.2 nymphs/plant on February 26th and 12th. The 2nd and 3rd week of February presence of *S. graminum* on wheat crops was observed from January 15th through April 9th, with the overall population peaking on February 26th at 18.3 nymphs/plant. The study further examined the influence of varying nitrogen application rates, specifically 0, 50, 75, 100, and 125 kg/acre, on the population density of *S. graminum*. Nitrogen levels had a statistically significant impact on both nymph and adult populations in both years. The lowest population densities were recorded at application rates of 0, 50 and 75 kg/acre. © 2026 The Author(s)

Keywords: *Aphis gossypii*, Nitrogen fertilizer, Pest management, Population fluctuation, Wheat

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Introduction

Wheat (*Triticum aestivum* L.), a member of the Poaceae family, is the main staple food crop of Pakistan (Anwaar et al., 2020). Being a staple food crop, it is a rich source of proteins, carbohydrates, fibers, lipids, vitamins, and minerals (Shewry & Hey, 2015; Gao et al., 2025). Unfortunately, the average wheat crop yield is lower than the developed nations Due to inadequate delivery of vital nutrients at proper stages (Ahmad et al., 1998; Wang et al., 2025), lack of information about varieties, edaphic features, mismanagement of farmers field operations and technology (Meena et al., 2013; Ullah et al., 2018), and availability and quality of irrigation water that limits the potential yield (Kumar et al., 2014). Furthermore, many insect pests which infest and inflict severe damage to wheat crop especially aphid (Aheer et al., 2008; Devi et al., 2026).

Aphids comprise of more than 4300 species, all of which are specialized to feed on plants phloem sap (Van

Emden, 2007). Out of these 92 species have been recorded in Pakistan (Irshad, 2001). There are 29 aphid species that damage the wheat crop (Ali & Ali, 2015) from which two aphid species *S. graminum* (Rondani) and *Rhopalosiphum padi* (L.) are more destructive globally (Inayatullah et al., 1993). Two species of aphid i.e. *Sitobion avenae* (Fabricius) and *R. padi* inflict severe damage to wheat crop in Pakistan (Ullah et al., 2020). Often the attack of pest occurs either individually or in groups on tillers, stems, kernels and leaves and the population density of aphid varies with the growing stages of wheat (Liu et al., 2015). Aphids have been implicated to cause a yield loss of 7.9-34.2% (Yahya et al., 2017). To attain higher crop yields, farmers intensively utilize nitrogenous fertilizers. Unfortunately, this practice has negative impact upon the wheat crop as it favors the high population density of aphid. Earlier studies have demonstrated that a relationship exists between the (higher dose) nitrogenous fertilizer application and wheat aphids (Draz et al., 2013). Aphids have a wide known host range including wheat, barley, oat, sorghum, maize and pasture grasses (Hughes & Maywald, 1990). It is extensively

distributed throughout the grain growing regions of Middle East, Russia, North-Western China, America, Europe, Africa, and Australia (Yazdani et al., 2018). Typically, aphids cause the direct damage to the wheat plant by sucking phloem sap from leaves and shoots that results in curling of leaves, chlorosis, and stunted growth (Muhammad et al., 2015; Atakan, 2026), and indirect damage by transmission of viral i.e., barley yellow dwarf virus (Jayasena & Randles, 1984) and fungal diseases i.e., development of mold (brown rust) on their honey dew (Marzocchi & Nicoli, 1991; Atakan, 2026). The direct yield losses by sucking the sap of infested plant may vary from 35-40% and in case of indirect losses of 20-80% by transmission of viral and fungal diseases (Kieckhefer & Gellner, 1992). Small, soft-bodied insects (1.2–2.2 mm long), typically pale to dark green or yellow. They have distinctive dark, tube-like structures (cornicles) on their rear and can be winged or wingless (Lagos-Kutz et al., 2014).

Nitrogenous fertilization is an essential agronomic technique that is widely employed to boost crop yields (Xu et al., 2020; Naz et al., 2026). But on the other side, it is one of the major nutrients which reduces the yield of wheat crop if not applied in proper amounts (Kutman et al., 2011). Some authors have studied the relationship between nitrogenous fertilizer levels and aphid infestation. They concluded that inappropriate levels of nitrogenous fertilizer facilitate heavy infestation of *S. graminum* on wheat crop and a positive connection between nitrogenous fertilizer levels and aphid population prevails (Draz et al., 2013; Naz et al., 2026). Increasing levels of nitrogenous fertilizer generally increases the quality of amino acids in the plant phloem sap and subsequently affects the aphid population (Nowak & Komor, 2010; Rostami et al., 2012). Therefore, the present study was laid out to investigate the relationship between the rates of nitrogenous fertilizer application and aphid population on wheat crop.

Materials and Methods

Experimental design and plot layout

The research was performed to assess the effect of elevated levels of nitrogenous fertilizer on the population of *S. graminum* at the research farm area of FAST, Bahauddin Zakariya University, Multan, Pakistan. The experiment was conducted during the wheat growing season, with environmental conditions recorded from January to April. The experiment was laid out in a randomized complete block design (RCBD) consisting of five nitrogen treatments, with one treatment assigned to each plot in each of four blocks, giving a total of 20 experimental plots. Each experimental plot measured 12 m × 12 m. The wheat variety 'Fakhar-E-Bhakkar' was used in the experiment.

Wheat was sown using a hand drill with rows spaced 10 cm apart. The recommended seed rate was 50 kg acre⁻¹.

Fertilizer treatments and application

All phosphatic and potassium fertilizers were applied at sowing in the form of diammonium phosphate (DAP) and sulphate of potash (SOP), respectively. Nitrogen fertilizer was applied in the form of urea containing 46% N. Five nitrogen treatments were evaluated: 0, 50, 75, 100, and 125 kg urea acre⁻¹. The specified amount of urea was divided into two equal applications. Half of the respective urea dose was applied at sowing, while the remaining half was applied 25 days after sowing. The nitrogen rates in this experiment refer to the quantity of urea fertilizer applied per acre.

Irrigation and meteorological conditions

The wheat field was irrigated with groundwater using a tube well at 25, 45, and 60 days after sowing. All other general crop management practices in the research farm area were carried out as usual. From January to April 2024, the average temperature ranged from 15 to 27°C, while relative humidity ranged from 48 to 79%. During the corresponding period in 2025, the average temperature ranged from 13 to 32°C, and relative humidity ranged from 33 to 68% (<https://www.timeanddate.com/weather/pakistan/multan/historic?month=4&year=2025>) (accessed on 15 April 2025). The average rainfall from January to April 2024 ranged from 1.6 to 12.2 mm. During January to April 2025, average rainfall ranged from 0 to 11.7 mm (<https://climateyearbook.com/locations/multan/2025>) (accessed on 15 April 2025).

Data collection and analysis

The data recording of aphid population/plant on weekly basis started on wheat crop was under infestation. For each sampling, twenty wheat plants/replicate were randomly selected, and *S. graminum* population was directly counted on plant leaves and later individuals appearing on spikes were also counted. All the recorded data was transformed into a weekly basis, and the pooled data was subjected to statistical analysis using the programme Statistix 8.1 and the means were compared using Tukey's test.

Results

Population fluctuation of *S. graminum*

The outcomes of this study revealed a significant relation of aphid population per plant with the elevated levels of nitrogenous fertilizer. The average weekly population of *S. graminum* nymphs was recorded in the wheat crop from January 15th to April 9th at weekly intervals. The data indicated that *S. graminum* appeared after one month of sowing date.

The numbers of nymphs and adults of *S. graminum* increased to 0.1 nymphs/plant, 0.2 adult/plant on January 22nd, 29th January and reach its maximum on March 5th and 12th February (17.8 nymph/plant, 16.9 adult/plant) (Table 1). The activity period of *S. graminum* on wheat plant started on 15th January and extended to April 9th with a peak of activity during 2nd week of February and first week of March (Fig. 1 & 2). The maximum population was 17.8 aphids/plant on 5th March (Table 1). An analysis of the data within each week indicated that the population of *S. graminum* was low in the beginning of the season. Furthermore, *S. graminum* nymphs/plant fluctuated from 0.1 to 17.8, and adults fluctuated from 0.2 to 16.9 across all the treatments in 2024 (Table 1 & 2). During the data recording period peak population of *S. graminum* nymphs and adults were observed in February and March. Importantly, highest peak of nymphal population was noted on 12th February, and 5th March at the highest used dose of nitrogenous fertilizer. Like this, lowest peak of *S. graminum* nymphs/plant were found on 15th January and 9th April at 0kg (control) of nitrogenous fertilizer treatment (Fig. 1). However, adult population peaks were also observed on 12th February at 125 kg/acre and lowest peak was noted on 9th April at 0 kg/acre (control) (Fig. 2). *S. graminum* adults were the predominant as compared to

nymphs in our results (Fig. 2) whereas it was found in large numbers 16.9, 16.8 and 14.4/plant on February 12th, March 5th and March 12th, respectively (Fig. 2).

S. graminum nymphs/plant fluctuated from 0.1 to 18.3 and adults fluctuated from 0.2 to 16.3 across all the treatments in 2025 (Table 3 & 4). During the data recording period peak population of *S. graminum* nymphs and adults were observed in February. Importantly, highest peak of nymphal population was noted on 12th and 26th February at the highest used dose of nitrogenous fertilizer.

Similar to this, lowest peak of *S. graminum* nymphs/plant were found on 15th January and 9th April at 0 kg (control) of nitrogenous fertilizer treatment (Fig. 3). However, adult population peaks were also observed on 26th February at 125 kg/acre and lowest peak was noted on 9th April at 0 kg/acre (control) (Fig. 4). *S. graminum* nymphs were the predominant as compared to adults in our results of 2025 (Fig. 3 & 4). The maximum mean population of *S. graminum* nymphs was observed in 125 kg/acre dose of nitrogenous fertilizer while lowest population was observed in 0 kg/acre dose of nitrogenous fertilizer during both years. Similar trend was observed in *S. graminum* adult population in which highest mean population was observed in 125 kg/acre dose whereas minimum population was observed in 0 kg/acre dose in both years (Fig. 5).

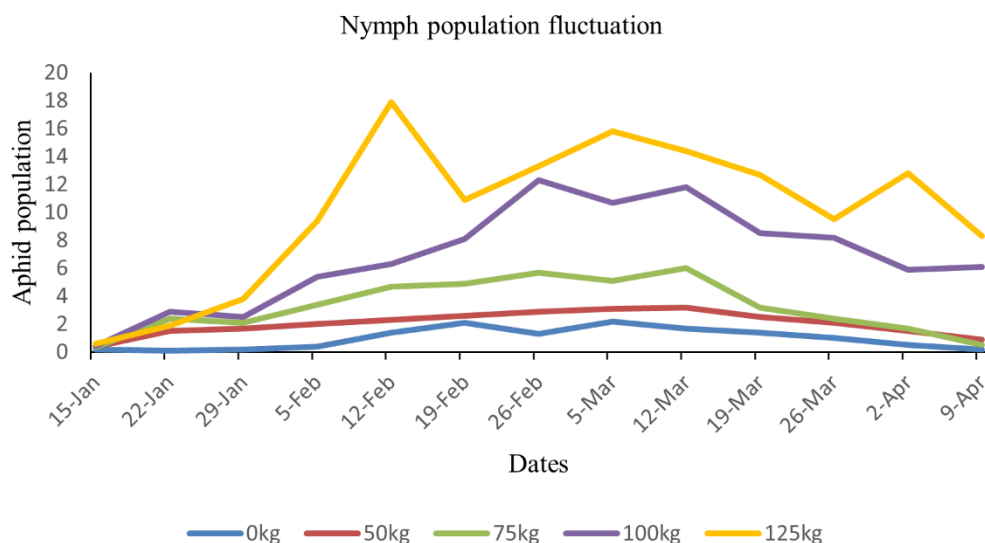


Fig. 1 Population fluctuation of *A. gossypii* nymphs on wheat at different doses during 2024

Effect of various rates of nitrogen fertilizer on *S. graminum* population in wheat

The data in Table 1 & 2 revealed significant difference ($p < 0.05$) in population of *S. graminum* on wheat plants fertilized with various levels of nitrogen fertilizer in both

years. The maximum population of aphid nymphs was recorded on the plants treated with maximum rates of nitrogen fertilizers (125 kg/acre) whereas the mean number of nymph/plant reached 17.8 followed by the wheat plant that received 100 kg/acre (12.3 nymphs/plant). After that, the population declined for next two treatments to record 4.7 and

3.2 nymphs/plant when the wheat plant received 75 and 50 kg/acre in 2024, respectively (Table 1). The mean number of *S. graminum* adults on wheat plants was significantly high in the wheat plant fertilized by 125 kg/acre nitrogen fertilizer during 2024 (Table 2) whereas the mean number of adult/plant reached 16.9 adult/pant. Followed by the plants that fertilized by 100 kg/acre, whereas the mean number of adult/plant reached to 12.3 adults/plant, then the plant fertilized by 75 kg/acre whereas the mean number of adult/plant recorded 4.7 adult/plant. The lowest infestation by *S. graminum* was noticed in wheat plant fertilized by 50 kg/acre (3.2 adult/plant) during 2024 (Table 2). The maximum population of aphid nymphs was recorded on the plants treated with maximum rates of nitrogen fertilizers (125 kg/acre) whereas the mean number of nymph/plant

reached 18.3 followed by the wheat plant that received 100 kg/acre (12.4 nymphs/plant). After that, the population declined for next two treatments to record 7.3 and 4.1 nymph/plant when the wheat plant received 75 and 50 kg/acre during 2025, respectively (Table 3). The mean number of *S. graminum* adults on wheat plants were significantly high in the wheat plant fertilized by 125 kg/acre nitrogen fertilizer during 2025 (Table 4) whereas the mean number of adult/plant reached 16.3 adult/pant. Followed by the plants that fertilized by 100 kg/acre, whereas the mean number of adult/plant reached to 12.5 adult/plant, then the plant fertilized by 75 kg/acre whereas the mean number of adult/plant recorded 4.7 adult/plant. The lowest infestation by *S. graminum* (3.6 adult/pant) was noticed in wheat plant fertilized by 50 kg/acre during 2025 (Table 4).

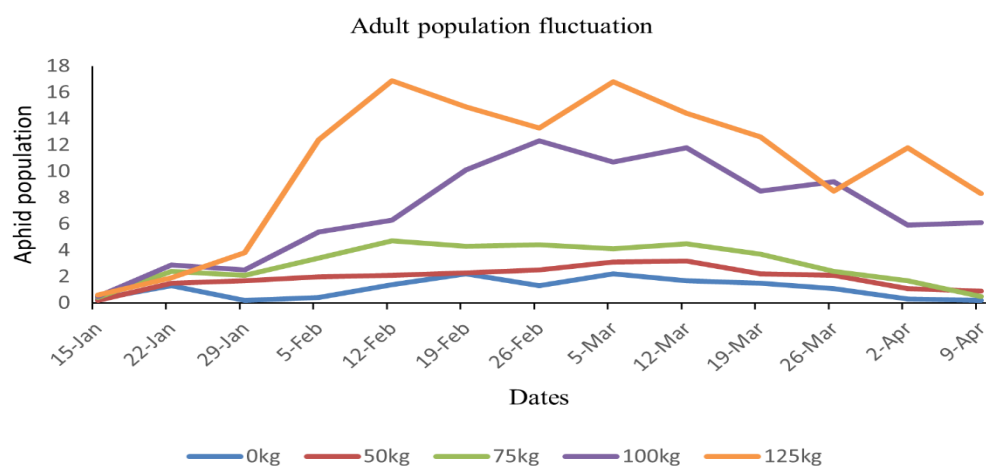


Fig. 2 Population fluctuation of *S. graminum* adults on wheat plants at different doses during 2024

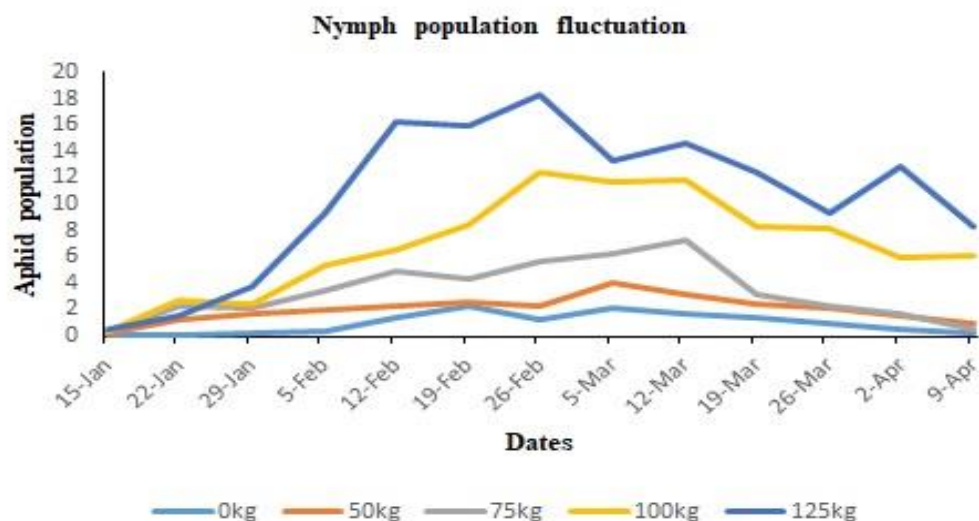


Fig. 3 Population fluctuation of *S. graminum* nymphs on wheat at different doses during 2025

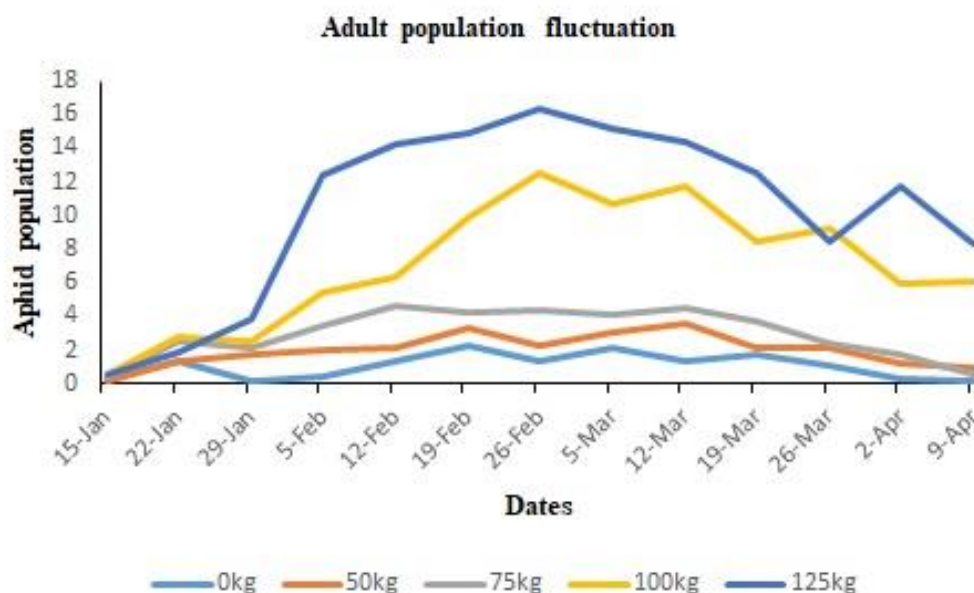


Fig. 4 Population fluctuation of *S. graminum* adults on wheat at different doses during 2025

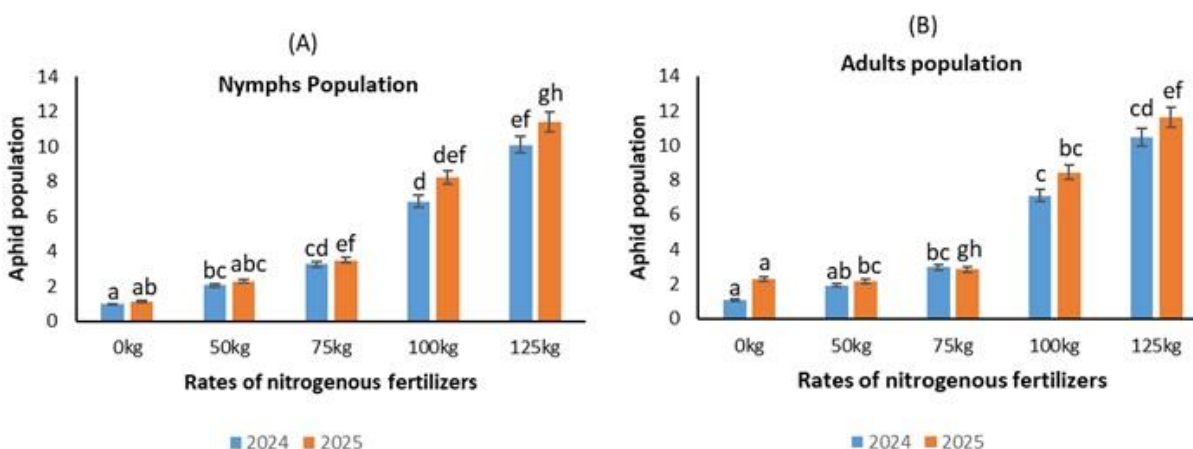


Fig. 5 Mean population of *S. graminum* (A) nymphs/plant (B) adult/plant after treatment with different doses of nitrogenous fertilizers during 2024 and 2025. Different letters represent significant differences ($p < 0.05$) among treatments. Different colors of bars indicate the years.

Effect of various rates of nitrogen fertilizer on *S. graminum* population in wheat

The data in Table 1 & 2 revealed significant difference ($p < 0.05$) in population of *S. graminum* on wheat plants fertilized with various levels of nitrogen fertilizer in both years. The maximum population of aphid nymphs was recorded on the plants treated with maximum rates of nitrogen fertilizers (125 kg/acre) whereas the mean number of nymph/plant reached 17.8 followed by the wheat plant that received 100 kg/acre (12.3 nymphs/plant). After that, the population declined for next two treatments to record 4.7 and 3.2 nymphs/plant when the wheat plant received 75

and 50 kg/acre in 2024, respectively (Table 1). The mean number of *S. graminum* adults on wheat plants was significantly high in the wheat plant fertilized by 125 kg/acre nitrogen fertilizer during 2024 (Table 2) whereas the mean number of adult/plant reached 16.9 adult/pant. Followed by the plants that fertilized by 100 kg/acre, whereas the mean number of adult/plant reached to 12.3 adults/plant, then the plant fertilized by 75 kg/acre whereas the mean number of adult/plant recorded 4.7 adult/plant. The lowest infestation by *S. graminum* was noticed in wheat plant fertilized by 50 kg/acre (3.2 adult/plant) during 2024 (Table 2). The maximum population of aphid nymphs was recorded on the plants treated with maximum rates of nitrogen fertilizers (125 kg/acre)

whereas the mean number of nymph/plant reached 18.3 followed by the wheat plant that received 100 kg/acre (12.4 nymphs/plant). After that, the population declined for next two treatments to record 7.3 and 4.1 nymph/plant when the wheat plant received 75 and 50 kg/acre during 2025, respectively (Table 3). The mean number of *S. graminum* adults on wheat plants were significantly high in the wheat plant fertilized by 125 kg/acre nitrogen fertilizer during

2025 (Table 4) whereas the mean number of adult/plant reached 16.3 adult/pant. Followed by the plants that fertilized by 100 kg/acre, whereas the mean number of adult/plant reached to 12.5 adult/plant, then the plant fertilized by 75 kg/acre whereas the mean number of adult/plant recorded 4.7 adult/plant. The lowest infestation by *S. graminum* (3.6 adult/pant) was noticed in wheat plant fertilized by 50 kg/acre during 2025 (Table 4).

Table 1 Effect of the elevated levels of nitrogenous fertilizer on wheat aphid population (Average number of nymphs/plant) in different treatments during 2024

Nitrogen rates*	Date							Mean ± SE
	15 Jan	22 Jan	29 Jan	5 Feb	12 Feb	19 Feb	26 Feb	
0 kg (Control)	0.2±0.01a	0.1±0.03	0.2±0.01	0.4±0.01	1.4±0.1	2.1±0.3a	1.3±0.1a	0.81 ± 0.30
50	0.4±0.03b	1.5±0.1c	1.7±0.1c	2±0.1b	2.3±0.3b	2.6±0.4b	2.9±0.5b	1.91 ± 0.31
75	0.37±0.04c	2.4±0.5c	2.1±0.2c	3.4±0.15c	4.7±0.11c	4.9±0.11c	5.7±0.13cd	3.37 ± 0.71
100	0.42±0.08d	2.9±0.2d	2.5±0.3d	5.4±0.11d	6.3±0.14c	8.1±0.18c	12.1±0.24d	5.39 ± 1.48
125	0.6±0.03e	1.9±0.1e	3.8±0.7ef	9.4±0.12e	15.9±0.13e	10.9±0.31e	13.3±0.44e	7.97 ± 2.24

*Nitrogen rates are expressed in kg/acre; Jan = January; Feb = February; LSD (0.05) = 0.0432; Data are presented as mean ± standard error (SE). Means within each column (date) followed by the same lowercase letter are not significantly different at $p \leq 0.05$, as determined by Tukey's Honestly Significant Difference (HSD) test after a significant one-way Analysis of Variance (ANOVA). The Tukey HSD values provided represent the minimum difference required between two means for them to be considered statistically significant. Mean separation was applied separately for each sampling date and for the overall seasonal mean.

Table 1 Continued

Nitrogen rates*	Date						Mean ± SE
	5 Mar	12 Mar	19 Mar	26 Mar	2 Apr	9 Apr	
0 kg (Control)	2.2±0.3a	1.7±0.1a	1.4±0.1a	1±0.1a	0.5±0.02a	0.2±0.03a	1.17 ± 0.31
50	3.1±0.3c	3.2±0.5bc	2.5±0.3bc	2.1±0.2b	1.5±0.3b	0.9±0.04b	2.22 ± 0.37
75	5.1±0.6c	6±0.9cd	3.2±0.5d	2.4±0.4d	1.7±0.2d	0.5±0.02d	3.32 ± 0.87
100	10.7±0.21cd	11.8±0.13cd	8.5±0.17d	8.2±0.16d	5.9±0.13d	6.1±0.11d	8.53 ± 0.99
125	17.8±0.34f	14.4±0.31f	12.7±0.25ef	9.5±0.21e	12.8±0.19ef	8.3±0.14e	12.58 ± 1.47

*Nitrogen rates are expressed in kg/acre; Mar = March; Apr = April; LSD (0.05) = 0.0432; Data are presented as mean ± standard error (SE). Means within each column (date) followed by the same lowercase letter are not significantly different at $p \leq 0.05$, as determined by Tukey's Honestly Significant Difference (HSD) test after a significant one-way Analysis of Variance (ANOVA). The Tukey HSD values provided represent the minimum difference required between two means for them to be considered statistically significant. Mean separation was applied separately for each sampling date and for the overall seasonal mean.

Table 2 Effect of the elevated levels of nitrogenous fertilizer on wheat aphid population (Average number of adults/plant) in different treatments during 2024

Nitrogen rates*	Date							Mean ± SE
	15 Jan	22 Jan	29 Jan	5 Feb	12 Feb	19 Feb	26 Feb	
0 kg (Control)	0.3±0.02a	1.3±0.1a	0.2±0.03b	0.4±0.04b	1.4±0.1a	2.2±0.2a	1.3±0.1a	0.96 ± 0.27
50	0.2±0.04ab	1.5±0.2ab	1.7±0.2ab	2±0.1a	2.1±0.3a	2.3±0.4a	2.5±0.02a	1.76 ± 0.29
75	0.4±0.08ab	2.4±0.4a	2.1±0.1a	3.4±0.5bc	4.7±0.5b	4.3±0.6b	4.4±0.7b	3.10 ± 0.60
100	0.5±0.09b	2.9±0.6c	2.5±0.2b	5.4±0.9c	6.3±0.8b	10.1±0.11b	12.3±0.17b	5.71 ± 1.43
125	0.6±0.05c	1.9±0.4cd	3.8±0.3c	12.4±0.19c	16.9±0.21c	14.9±0.34cd	13.3±0.37cd	7.69 ± 2.41

*Nitrogen rates are expressed in kg/acre; Jan = January; Feb = February; LSD (0.05) = 0.0227; Data are presented as mean ± standard error (SE). Means within each column (date) followed by the same lowercase letter are not significantly different at $p \leq 0.05$, as determined by Tukey's Honestly Significant Difference (HSD) test after a significant one-way Analysis of Variance (ANOVA). The Tukey HSD values provided represent the minimum difference required between two means for them to be considered statistically significant. Mean separation was applied separately for each sampling date and for the overall seasonal mean.

Table 2 Continued

Nitrogen rates*	Date						Mean ± SE
	5 Mar	12 Mar	19 Mar	26 Mar	2 Apr	9 Apr	
0 kg (Control)	2.2±0.3b	1.7±0.4a	1.5±0.5a	1.1±0.5a	0.3±0.3a	0.2±0.03	1.17 ± 0.32
50	3.1±0.6a	3.2±0.3a	2.2±0.5a	2.1±0.4b	1.1±0.1bc	0.9±0.05	2.10 ± 0.39
75	4.1±0.3b	4.5±0.3b	3.7±0.2bc	2.4±0.2b	1.7±0.1b	0.5±0.09	2.82 ± 0.63
100	10.7±0.9b	11.8±0.13b	8.5±0.15c	9.2±0.17c	5.9±0.13c	6.1±0.7	8.70 ± 0.97
125	16.8±0.31cd	14.4±0.27d	12.6±0.21d	8.5±0.19d	11.8±0.16d	8.3±0.11cd	12.07 ± 1.36

*Nitrogen rates are expressed in kg/acre; Mar = March; Apr = April; LSD (0.05) = 0.0227; Data are presented as mean ± standard error (SE). Means within each column (date) followed by the same lowercase letter are not significantly different at $p \leq 0.05$, as determined by Tukey's Honestly Significant Difference (HSD) test after a significant one-way Analysis of Variance (ANOVA). The Tukey HSD values provided represent the minimum difference required between two means for them to be considered statistically significant. Mean separation was applied separately for each sampling date and for the overall seasonal mean.

Table 3 Effect of the elevated levels of nitrogenous fertilizer on wheat aphid population (Average number of nymphs/plant) in different treatments during 2025

Nitrogen rates*	Date						
	15 Jan	22 Jan	29 Jan	5 Feb	12 Feb	19 Feb	26 Feb
0 kg (Control)	0.1±0.02a	0.1±0.01ab	0.2±0.05ab	0.4±0.03a	1.4±0.1a	2.3±0.3a	1.2±0.5a
50	0.2±0.03b	1.3±0.1a	1.7±0.1cd	2±0.3bc	2.3±0.1b	2.6±0.5b	2.3±0.2b
75	0.34±0.1c	2.3±0.3c	2.1±0.3ef	3.4±0.2de	4.9±0.3c	4.4±0.2cd	5.6±0.12c
100	0.4±0.3d	2.7±0.2d	2.5±0.6e	5.4±0.3f	6.6±0.7de	8.5±0.6ef	12.4±0.21de
125	0.5±0.1e	1.6±0.5e	3.8±0.2g	9.4±0.5gh	16.2±0.8f	15.9±0.8gh	18.3±0.32fg
							Mean±SE

*Nitrogen rates are expressed in kg/acre; Jan = January; Feb = February; LSD (0.05) = 0.0432; Data are presented as mean ± standard error (SE). Means within each column (date) followed by the same lowercase letter are not significantly different at $p \leq 0.05$, as determined by Tukey's Honestly Significant Difference (HSD) test after a significant one-way Analysis of Variance (ANOVA). The Tukey HSD values provided represent the minimum difference required between two means for them to be considered statistically significant. Mean separation was applied separately for each sampling date and for the overall seasonal mean.

Table 3 Continued

Nitrogen rates*	Date						
	5 Mar	12 Mar	19 Mar	26 Mar	2 Apr	9 Apr	Mean±SE
0 kg (Control)	2.2±0.3ab	1.7±0.2a	1.4±0.1b	1±0.05a	0.5±0.02ab	0.2±0.03a	1.17±0.32
50	4.1±0.8cd	3.2±0.2bc	2.4±0.5cd	2.1±0.2b	1.5±0.6bbc	0.9±0.3c	2.37±0.48
75	6.3±0.16ef	7.3±0.5cd	3.2±0.1e	2.3±0.1c	1.7±0.3ef	0.5±0.7ef	3.55±1.00
100	11.7±0.12gh	11.8±0.22ef	8.3±0.9f	8.2±0.7de	5.9±0.9e	6.1±0.5e	8.67±1.06
125	13.3±0.27h	14.7±0.25fg	12.4±0.21gh	9.3±0.19f	12.8±0.12g	8.3±0.9gh	11.80±1.03

*Nitrogen rates are expressed in kg/acre; Mar = March; Apr = April; LSD (0.05) = 0.0432; Data are presented as mean ± standard error (SE). Means within each column (date) followed by the same lowercase letter are not significantly different at $p \leq 0.05$, as determined by Tukey's Honestly Significant Difference (HSD) test after a significant one-way Analysis of Variance (ANOVA). The Tukey HSD values provided represent the minimum difference required between two means for them to be considered statistically significant. Mean separation was applied separately for each sampling date and for the overall seasonal mean.

Table 4 Effect of the elevated levels of nitrogenous fertilizer on wheat aphid population (Average number of adults/plant) in different treatments during 2025

Nitrogen rates*	Date						
	15 Jan	22 Jan	29 Jan	5 Feb	12 Feb	19 Feb	26 Feb
0 kg (Control)	0.3±0.01a	1.3±0.2ab	0.2±0.01a	0.4±0.03ab	1.4±0.02	2.3±0.5a	1.3±0.4a
50	0.2±0.04b	1.4±0.2bc	1.7±0.03bc	2±0.1bc	2.1±0.2	3.3±0.6bc	2.3±0.2b
75	0.4±0.06c	2.5±0.4c	2.1±0.1cd	3.4±0.3c	4.7±0.3	4.3±0.2c	4.4±0.3c
100	0.5±0.03d	2.8±0.3de	2.5±0.4ef	5.4±0.6de	6.3±0.8	9.9±0.13de	12.5±0.14de
125	0.6±0.02ef	1.9±0.1f	3.8±0.2gh	12.4±0.12f	14.3±0.11	14.9±0.13fg	16.3±0.15f
							Mean±SE

*Nitrogen rates are expressed in kg/acre; Jan = January; Feb = February; LSD (0.05) = 0.0227; Data are presented as mean ± standard error (SE). Means within each column (date) followed by the same lowercase letter are not significantly different at $p \leq 0.05$, as determined by Tukey's Honestly Significant Difference (HSD) test after a significant one-way Analysis of Variance (ANOVA). The Tukey HSD values provided represent the minimum difference required between two means for them to be considered statistically significant. Mean separation was applied separately for each sampling date and for the overall seasonal mean.

Table 4 Continued

Nitrogen rates*	Date						
	5 Mar	12 Mar	19 Mar	26 Mar	2 Apr	9 Apr	Mean±SE
0 kg (Control)	2.1±0.2ab	1.3±0.1a	1.8±0.1b	1.1±0.2ab	0.3±0.05ab	0.2±0.02a	1.13±0.30
50	3.1±0.5bc	3.6±0.3b	2.2±0.3cd	2.1±0.5b	1.2±0.02cd	0.9±0.01b	2.18±0.43
75	4.1±0.2cd	4.5±0.2c	3.7±0.3ef	2.4±0.1c	1.7±0.1e	0.5±0.1cd	2.82±0.63
100	10.7±0.11ef	11.8±0.13d	8.4±0.7g	9.2±0.9def	5.9±0.5fg	6.1±0.6e	8.68±0.95
125	15.2±0.19g	14.4±0.16ef	12.6±0.13h	8.5±0.12g	11.8±0.9h	8.3±0.8fg	11.80±1.30

*Nitrogen rates are expressed in kg/acre; Mar = March; Apr = April; LSD (0.05) = 0.0227; Data are presented as mean ± standard error (SE). Means within each column (date) followed by the same lowercase letter are not significantly different at $p \leq 0.05$, as determined by Tukey's Honestly Significant Difference (HSD) test after a significant one-way Analysis of Variance (ANOVA). The Tukey HSD values provided represent the minimum difference required between two means for them to be considered statistically significant. Mean separation was applied separately for each sampling date and for the overall seasonal mean.

Discussion

Wheat is the 2nd most cultivated crop all over the world after maize (Breitkreuz et al., 2020; Gao et al., 2025)

which fulfills the food demand of 35% of humans (Miedaner et al., 2020). Globally, numerous factors, including poor irrigation, unpredictable changes in the environment (Kirby et al., 2017), uneven application of fertilizers (Wu et al., 2019), and incidences of diseases and insect pests like aphids, have

been cited to impose challenges in achieving higher crop yields. The field experiment was laid out to assess how elevated levels of nitrogenous fertilizer applied to wheat crop affected the population dynamics of *S. graminum*. In the past various researchers studied the variation of cereal aphids in wheat fields and most of them attributed the role of abiotic factors in their population fluctuation (Wains et al., 2010). While others described the impact of nitrogenous fertilizer (Rostami et al., 2012; Wagan et al., 2015; Naz et al., 2026) and irrigation levels (Foote et al., 2017) on aphid population. The nitrogenous fertilizers affect the host plant characters like increased tiller number, aboveground dry biomass (Walker et al., 2017; Xu et al., 2020), grain or whole plant nitrogen content and grain nitrogen level correlates closely with levels of the nutrients in the flag leaf on which the aphid was feeding (Gao et al., 2025).

Our results demonstrated significant surge in *S. graminum* population in highest used dose of nitrogen fertilizer. Similar results reported by Slman (2002) in which significant increase in the incidence of aphids was recorded with the increasing application of nitrogenous fertilizer. The application of nitrogenous fertilizer not only improves wheat yield (Belete et al., 2018; Xu et al., 2020) but also enhances the nitrogen contents (proteins) of the leaves (Bentz et al., 1995) that results in the production of a lush green crop. Subsequently, the vigorous growth of the wheat crop attracts heavy infestation of pests especially the wheat aphids (Ahmed et al., 2007). Interestingly, the piercing sucking insect pests like aphids rely on phloem sap, which is abundant in nutrients like nitrogen, to meet their dietary demands (Nowak & Komor, 2010; Hölttä et al., 2013). In this study two peaks of wheat aphids population were noted in the treatment where nitrogenous fertilizer was applied at the rate of 125 kg/acre as compared to the other treatments (Fig. 1 & 2). To this extent the findings agree with the earlier work of different researchers (Wagan et al., 2015; Awadalla et al., 2017; Mousa et al., 2019). These researchers explained the highest used dose of nitrogenous fertilizer vigor the population of aphid in wheat crop. In addition to some authors also mentioned that the variation in the population of wheat aphid might be due to the prevalence of different species (Honěk, 1991).

In the current study, the population density of *S. graminum* varied significantly across plants treated with different nitrogen doses. This finding aligns with the observations of Kumar et al. (1998), who reported the highest *S. graminum* infestation under conditions of elevated nitrogen application. The application of high doses of nitrogen fertilizer often results in the production of lush, vigorous plant growth, which may enhance the attractiveness of plants to herbivorous pests. Additionally, increased fertilizer levels can influence crop phenology and contribute to greater susceptibility to sucking insect pests (Ahmed et al., 2007). Supporting these observations,

Brodbeck et al. (2001) noted that populations of western flower thrips, *Frankliniella occidentalis*, were markedly higher on tomato plants receiving elevated nitrogen inputs. Jahn (2004) emphasized that nutrient supplementation through soil application promotes the development of broader, more succulent, and tender foliage, providing favorable sites for oviposition and influencing pest reproduction, longevity, and overall biological performance. In a related study, Tabikha (2002) evaluated the impact of six nitrogen fertilizer levels (ammonium sulfate 20% at rates of 100, 200, 300, 400, 500, and 600 kg/feddan) on the infestation intensity of *Aphis gossypii* in squash. Statistical analysis of the data revealed no significant differences in mean aphid population densities among the varying nitrogen levels over the study period.

Gash (2012) reported the effects of various rates of nitrogenous fertilizer on wheat aphids and demonstrated an increase in dose of the nitrogenous fertilizer caused a surge in wheat aphid population from 1.9-2.4 nymphs/day. Based on literature, it is possible that an increase in nitrogen fertilization might have enhanced the quality of amino acids in phloem sap, which directly affected the behavior of aphid population. Similarly to our study, Wagan et al. (2015) examined the effects of various doses of nitrogenous fertilizer on population of *S. graminum*. Three different doses of urea were applied in three different farms connected to each other. The results indicated that the aphid population increased with high dose of nitrogen while it decreased correspondingly. The aphid population varied from the lowest dose (100 kg/acre) to highest dose (200 kg/acre) from 2.11 to 9.16/plant. The maximum dose of used nitrogen fertilizer produced the lush green crop which might have attracted the more sucking pest like aphids and affected the quality and quantity of the crop.

Another research study was conducted by Awadalla et al. (2017) who evaluated the influence of nitrogenous fertilizer levels on the population density of aphid i.e., *R. padi*. For this purpose, four doses of nitrogenous fertilizer i.e., 0 kg, 90 kg, 150 kg, 200 kg/acre were used in two successive seasons. The results showed that statistically a significant relationship existed between the increasing levels of nitrogenous fertilizers application and aphid population density. The highest average number of *R. padi* was recorded on nitrogen dose of 200 kg with an average of 342.5 ± 95.7 and 236.2 ± 56.9 individual. While the lowest average number of aphids was recorded on nitrogen rates of 0 kg with an average of 259.4 ± 79 and 79.7 ± 47 individuals. Mousa et al. (2019) described the effect of application of nitrogenous fertilizer and drought stress on cereal aphid. Four different treatments of nitrogenous fertilizer were taken in RCBD with split plots and three replicates. The results illustrated that the number of wheat aphids was low in the beginning of the cropping season. However, it increased with high dose of nitrogenous fertilizer and drought. Typically, the excessive use of nitrogenous fertilizer produces the plants with prolific foliage and attracts the more sucking pests. The authors concluded that an increase in the dose of nitrogenous fertilizer might have increased the concentration of nitrogen in the phloem sap which was more nutritional to aphid. Asghar et

al. (2019) performed a trial to evaluate the impact of nitrogenous fertilizer application on the population dynamics of wheat aphid. For this goal, four treatments were taken in a split manner. The results indicated that the aphid population in the first split was low where less urea was used and high in the third split. Split application of urea resulted in a greenish crop which was more susceptible to the sucking pests like aphids. Nevertheless, among various split applications, nitrogen in two doses i.e., half at sowing and another half at 1st irrigation produced better outcomes in terms of aphid infestation and also helped to boost grain yield.

Conclusion

The population dynamics of *S. graminum* on wheat are closely linked to the nitrogen application rates. The activity of *S. graminum* was noted during mid-January to early April and high population in the middle of February and early March. The data found that there was a definite correlation among the rise in nitrogen levels and the density of *S. graminum*. It was discovered that nitrogen applications that were higher than 100 kg/acre were found to encourage a larger population of both the nymphs and adults. However, application rate of 50 and 75 kg/acre was always related to a low level of infestation.

Declarations

i. Ethics approval and consent to participate

Ethical approval and informed consent were not required for this study as it did not involve human participants, human data, or animals.

ii. Consent for publication

Consent for publication is not applicable.

iii. Data availability

All data generated or analyzed during this study are included in this article.

iv. Competing interests

Authors have declared that no competing interests exist.

v. Authors' contributions

M.U.I. conceptualized the study, developed the methodology, conducted the investigation, curated and analyzed the data, prepared the visualizations, and wrote the first draft; M.D. contributed to methodology, data collection, and validation; M.N. contributed to investigation, data curation, and formal analysis; Z. conducted the literature review and contributed to investigation and visualization; H.A.J. supervised the study, administered the project, and contributed to validation and critical revision. All authors read and approved the final manuscript.

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viii. SDGs addressed

Zero Hunger (SDG 2), Responsible Consumption and Production (SDG 12), Life on Land (SDG 15)

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References

- Aheer, G. M., Ali, A., & Ahmad, M. (2008). Abiotic factors effect on population fluctuation of alate aphids in wheat. *Journal of Agricultural Research*, 46(4), 367-371. <https://doi.org/10.58475/6fb60f23>
- Ahmad, N., & Muhammad, T. (1998). Fertiliser, plant nutrient management, and self-reliance in agriculture. *The Pakistan Development Review*, 37(4, Part II), 217-233.
- Ahmed, S., Sabir, S., & Ali, C. M. (2007). Effect of different doses of nitrogen fertilizer on sucking insect pests of cotton, *Gossypium hirsutum*. *Journal of Agricultural Research*, 45(1), 43-48. <https://doi.org/10.58475/r1hq431>
- Ali, A., & Ali, H. (2015). Population dynamics of cereal aphids in wheat crop at District Swabi. *International Journal of Agriculture and Environmental Research*, 1(1), 25-31.
- Anwaar, H. A., Perveen, R., Mansha, M. Z., Abid, M., Sarwar, Z. M., Aatif, H. M., & Khan, K. A. (2020). Assessment of grain yield indices in response to drought stress in wheat (*Triticum aestivum* L.). *Saudi Journal of Biological Sciences*, 27(7), 1818-1823. <https://doi.org/10.1016/j.sjbs.2019.12.009>
- Asghar, M., Baig, M. M. Q., Chaudhary, S., Waqar, M. Q., & Ali, M. A. (2019). Impact of split application of urea on the management of wheat aphid. *International Journal of Environmental Science and Technology*, 5, 3623-3629.
- Atakan, E. (2026). Abundance patterns of the wheat aphid, *Sitobion avenae* (F.) (Homoptera: Aphididae) and beneficial insects in wheat field. *Journal of Agricultural Sciences*, 32(2), 375-384. <https://doi.org/10.15832/ankutbd.1743480>
- Awadalla, S. S., Beleh, S. B., & Mansour, M. R. (2017). Influence of nitrogen and potassium fertilization levels on the population density of the bird cherry oat aphid,

- Rhopalosiphum padi* Linnaeus (Homoptera: Aphididae). *Journal of Plant Protection & Pathology*, 8(2), 87-89.
- Belete, F., Dechassa, N., Molla, A., & Tana, T. (2018). Effect of nitrogen fertilizer rates on grain yield and nitrogen uptake and use efficiency of bread wheat (*Triticum aestivum* L.) varieties on the Vertisols of central highlands of Ethiopia. *Agriculture & Food Security*, 7(1), 1-12. <https://doi.org/10.1186/s40066-018-0231-z>
- Bentz, J., Reeves, J. I., Barbosa, P., & Francis, B. (1995). Within-plant variation in nitrogen and sugar content of poinsettia and its effects on the oviposition pattern, survival, and development of *Bemisia argentifolii* (Homoptera: Aleyrodidae). *Environmental Entomology*, 24 (2), 271-277.
- Breitkreuz, C., Buscot, F., Tarkka, M., & Reitz, T. (2020). Shifts between and among populations of wheat rhizosphere *Pseudomonas*, *Streptomyces* and *Phyllobacterium* suggest consistent phosphate mobilization at different wheat growth stages under abiotic stress. *Frontiers in Microbiology*, 10, 3109. <https://doi.org/10.3389/fmicb.2019.03109>
- Brodbeck, B. V., Stavisky, J., Funderburk, J. E., Andersen, P. C., & Olson, S. M. (2001). Flower nitrogen status and populations of *Frankliniella occidentalis* feeding on *Lycopersicon esculentum*. *Entomologia Experimentalis et Applicata*, 99(2), 165-172. <https://doi.org/10.1046/j.1570-7458.2001.00814.x>
- Devi, S. S., Vairam, N., Mavilashaw, V. P., Thamizharasu, T., & Murugan, N. (2026). Contemporary insights into wheat aphid biology, ecological drivers and integrated pest management in indian wheat production. *Uttar Pradesh Journal of Zoology*, 47(6), 107-118.
- Draz, K. A., Darwish, A. A., & Tabikha, R. M. (2013). Effect of different rates of nitrogen fertilizer on infestation level with piercing sucking insect pests of tomato crop, *Lycopersicon esculentum* L. *Journal of Agricultural & Environmental Sciences*, 12(3), 20-32.
- Foot, N. E., Davis, T. S., Crowder, D. W., Bosque-Pérez, N. A., & Eigenbrode, S. D. (2017). Plant water stress affects interactions between an invasive and a naturalized aphid species on cereal crops. *Environmental Entomology*, 46(3), 609-616. <https://doi.org/10.1093/ee/nvx071>
- Gao, Y., Li, H., & Lu, Y. (2025). Bottom-up effects of nitrogen fertilizer on cotton growth and population expansion of *Aphis gossypii* (Hemiptera: Aphididae). *Journal of Economic Entomology*, 118(3), 1225-1234. <https://doi.org/10.1093/jee/toaf080>
- Gash, A. F. (2012). Wheat nitrogen fertilisation effects on the performance of the cereal aphid *Metopolophium dirhodum*. *Agronomy*, 2(1), 1-13. <https://doi.org/10.3390/agronomy2010001>
- Hölttä, T., Kurppa, M., & Nikinmaa, E. (2013). Scaling of xylem and phloem transport capacity and resource usage with tree size. *Frontiers in Plant Science*, 4, 496. <https://doi.org/10.3389/fpls.2013.00496>
- Honěk, A. (1991). Nitrogen fertilization and abundance of the cereal aphids *Metopolophium dirhodum* and *Sitobion avenae* (Homoptera, Aphididae). *Journal of Plant Diseases & Protection*, 98(6), 655-660. <https://www.jstor.org/stable/43386788>
- Hughes, R. D., & Maywald, G. F. (1990). Forecasting the favourableness of the Australian environment for the Russian wheat aphid, *Diuraphis noxia* (Homoptera: Aphididae), and its potential impact on Australian wheat yields. *Bulletin of Entomological Research*, 80(2), 165-175. <https://doi.org/10.1017/S0007485300013389>
- Inayatullah, C., Ehsan-Ul-Haq, M. N., & Chaudhry, M. F. (1993). Incidence of greenbug, *S. graminum* (Rondani) (Homoptera: Aphididae) in Pakistan and resistance in wheat against it. *International Journal of Tropical Insect Science*, 14(2), 247-254. <https://doi.org/10.1017/S1742758400014697>
- Irshad, M. (2001). Aphids and their biological control in Pakistan. *Pakistan Journal of Biological Sciences*, 4(5), 537-541.
- Jahn, G. C. (2004). Effect of soil nutrients on the growth, survival and fecundity of insect pests of rice: an overview and a theory of pest outbreaks with consideration of research approaches. *International Organization for Biological Control Bulletin*, 27(1), 115-122.
- Jayasena, K. W., & Randles, J. W. (1984). Patterns of spread of the non-persistently transmitted bean yellow mosaic virus and the persistently transmitted subterranean clover red leaf virus in *Vicia faba*. *Annals of Applied Biology*, 104(2), 249-260. <https://doi.org/10.1111/j.1744-7348.1984.tb05609.x>
- Kieckhefer, R. W., & Gellner, J. L. (1992). Yield losses in winter wheat caused by low-density cereal aphid populations. *Agronomy Journal*, 84(2), 180-183. <https://doi.org/10.2134/agronj1992.00021962008400020011x>
- Kirby, M., Mainuddin, M., Khaliq, T., & Cheema, M. J. M. (2017). Agricultural production, water use and food availability in Pakistan: Historical trends, and projections to 2050. *Agricultural Water Management*, 179, 34-46. <https://doi.org/10.1016/j.agwat.2016.06.001>
- Kumar, B. A., Kumar, M. S. Ali, & Parsad, J. (1998). Effect of different levels of nitrogen on the incidence of mustard aphid (*Lipaphis erysimi* Kalt.). *Shashpa*, 5(1), 111-112.
- Kumar, P., Sarangi, A., Singh, D. K., & Parihar, S. S. (2014). Wheat performance as influenced by saline irrigation regimes and cultivars. *Journal of AgriSearch*, 1(2), 66-72.
- Kutman, U. B., Yildiz, B., & Cakmak, I. (2011). Effect of nitrogen on uptake, remobilization and partitioning of zinc and iron throughout the development of durum wheat. *Plant & Soil*, 342(1), 149-164. <https://doi.org/10.1007/s11104-010-0679-5>

- Lagos-Kutz, D., Favret, C., Giordano, R., & Voegtlin, D. J. (2014). Molecular and morphological differentiation between *Aphis gossypii* Glover (Hemiptera, Aphididae) and related species, with particular reference to the North American Midwest. *ZooKeys*, 459, 49-72. <https://doi.org/10.3897/zookeys.459.7850>
- Liu, H., Tian, H. Q., Li, Y. F., & Zhang, L. (2015). Comparison of four Adaboost algorithm based artificial neural networks in wind speed predictions. *Energy Conversion & Management*, 92, 67-81. <https://doi.org/10.1016/j.enconman.2014.12.053>
- Marzocchi, L., & Nicoli, G. (1991). The principal pests of wheat. *Informatore Fitopatologico*, 41, 29-33.
- Meena, B. L., Singh, A. K., Phogat, B. S., & Sharma, H. B. (2013). Effects of nutrient management and planting systems on root phenology and grain yield of wheat (*Triticum aestivum*). *Indian Journal of Agricultural Sciences*, 83(6), 627-632.
- Miedaner, T., Akel, W., Flath, K., Jacobi, A., Taylor, M., Longin, F., & Würschum, T. (2020). Molecular tracking of multiple disease resistance in a winter wheat diversity panel. *Theoretical & Applied Genetics*, 133(2), 419-431. <https://doi.org/10.1007/s00122-019-03472-4>
- Mousa, K. M., Gawad, A. A., Shawer, D. M., & Kamara, M. M. (2019). Drought stress and nitrogen fertilization affect cereal aphid populations in wheat fields. *Journal of Plant Protection and Pathology*, 10(12), 613-619.
- Muhammad Faheem, M. F., Asif Sajjad, A. S., & Shafique, R. M. (2015). Balanced use of fertilizers can reduce aphid infestation and improve yield in wheat crop. *Asian Journal of Agriculture & Biology*, 3, 50-55.
- Naz, S., Mumtaz, T., Hussain, D., Saleem, M., Tariq, Z., & Arshad, E. (2026). Population fluctuations of wheat aphids (Hemiptera: Aphididae) in response to weather variations. *International Journal of Tropical Insect Science*. doi:10.1007/s42690-026-01928-x
- Nowak, H., & Komor, E. (2010). How aphids decide what is good for them: experiments to test aphid feeding behaviour on *Tanacetum vulgare* (L.) using different nitrogen regimes. *Oecologia*, 163(4), 973-984. <https://doi.org/10.1007/s00442-010-1652-y>
- Rostami, M., Zamani, A. A., Goldasteh, S., Shoushtari, R. V., & Kheradmand, K. (2012). Influence of nitrogen fertilization on biology of *Aphis gossypii* (Hemiptera: Aphididae) reared on *Chrysanthemum indicum* (Asteraceae). *Journal of Plant Protection Research*, 52(1), 118-121. <https://doi.org/10.2478/v10045-012-0019-2>
- Shewry, P. R., & Hey, S. J. (2015). The contribution of wheat to human diet and health. *Food & Energy Security*, 4(3), 178-202. <https://doi.org/10.1002/fes3.64>
- Slman, F. A. A. (2002). Influence of some agricultural practices on the infestation of wheat crop by cereal aphids in upper Egypt. *The Journal of Agricultural Science*, 33, 1-12.
- Tabikha, R. M. (2002). Ecological and taxonomical studies on aphid species on vegetable crops in El-Behera Governorates. M.sc. Thesis, Faculty of Agriculture, Alexandria University, Egypt, 193.
- Ullah, F., Gul, H., Said, F., Ali, A., Tariq, K., Zaman, M., & Song, D. (2020). Population dynamics of wheat aphids *Rhopalosiphum padi* (Linnaeus) and *Sitobion avenae* (Fabricius) at District Mardan, Khyber Pakhtunkhwa Pakistan. *Pure & Applied Biology*, 9(1), 27-35. <http://dx.doi.org/10.19045/bspab.2020.90004>
- Ullah, I., Ali, N., Durrani, S., Shabaz, M. A., Hafeez, A., Ameer, H., & Waheed, A. (2018). Effect of different nitrogen levels on growth, yield and yield contributing attributes of wheat. *International Journal of Science & Engineering Research*, 9(9), 595-602.
- Van Emden, H. F. (2007). 17 Host-Plant Resistance. Aphids as crop pests, 447. <https://doi.org/10.1079/9780851998190.0000>
- Wagan, T. A., Brohi, R., Hamada, C., Tunio, S. K., & Wagan, Z. A. (2015). Effect of different nitrogen fertilizer levels on aphid population and its natural enemies in winter grown wheat. *Wudpecker Journal of Agricultural Research*, 4(4), 61-65.
- Wains, M. S., Ali, M. A., Hussain, M., Anwar, J., Zulkiffal, M., & Sabir, W. (2010). Aphid dynamics in relation to meteorological factors and various management practices in bread wheat. *Journal of Plant Protection Research*, 50, 3. <http://dx.doi.org/10.2478/v10045-010-0065-6>
- Walker, C., Armstrong, R., Panozzo, J., Partington, D., & Fitzgerald, G. (2017). Can nitrogen fertiliser maintain wheat (*Triticum aestivum*) grain protein concentration in an elevated CO₂ environment?. *Soil Research*, 55(6), 518-523. <https://doi.org/10.1071/SR17049>
- Wang, Y., Di, B., Sun, Z., Sonali, Donovan-Mak, M., Chen, Z. H., & Wang, M. Q. (2025). Multi-omics and physiological analysis reveal crosstalk between aphid resistance and nitrogen fertilization in wheat. *Plant, Cell & Environment*, 48(3), 2024-2039. <https://doi.org/10.1111/pce.15282>
- Wu, W., Ma, B. L., Fan, J. J., Sun, M., Yi, Y., Guo, W. S., & Voldeng, H. D. (2019). Management of nitrogen fertilization to balance reducing lodging risk and increasing yield and protein content in spring wheat. *Field Crops Research*, 241, 107584. <https://doi.org/10.1016/j.fcr.2019.107584>
- Xu, A., Li, L., Xie, J., Wang, X., Coulter, J. A., Liu, C., & Wang, L. (2020). Effect of long-term nitrogen addition on wheat yield, nitrogen use efficiency, and residual soil nitrate in a semiarid area of the loess plateau of China. *Sustainability*, 12(5), 1735. <https://doi.org/10.3390/su12051735>

- Yahya, M., Saeed, N. A., Nadeem, S., Hamed, M., & Shokat, S. (2017). Role of wheat varieties and insecticide applications against aphids for better wheat crop harvest. *Pakistan Journal of Zoology*, 49(6), 2217-2225. <http://dx.doi.org/10.17582/journal.pjz/2017.49.6.2217.2225>
- Yazdani, M., Baker, G., DeGraaf, H., Henry, K., Hill, K., Kimber, B., & Nash, M. A. (2018). First detection of Russian wheat aphid *Diuraphis noxia* Kurdjumov (Hemiptera: Aphididae) in Australia: a major threat to cereal production. *Austral Entomology*, 57(4), 410-417. <https://doi.org/10.1111/aen.12292>



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