



Research Article

Evaluation of Different Wheat Genotypes for Resistance Against Green Bug (*Schizaphis graminum* Rodani) (Homoptera: Aphididae)

Mohammad Zubair¹, Khwaja Junaid^{1*}, Asad ur Rahman¹, Mehran Ullah², Shabir Ahmed¹, Ijaz Ullah¹, Rahim Shah¹ and Gul Raiz¹

¹Department of Plant Protection, Faculty of Crop Protection sciences, The University of Agriculture, Peshawar, Pakistan; ²Department of Agriculture, Faculty of Environmental Sciences, King Abdulaziz University, Jeddah, Saudi Arabia.

Abstract | An Initial screening of wheat genotypes against greenbug (*Schizaphis graminum*) revealed differential responses, with fourteen classified as susceptible, four as moderately resistant, and two exhibiting clear resistance. Antixenosis assay conducted on six selected genotypes at 12, 24, and 48-hour intervals revealed no significant differences in greenbug attraction or avoidance among the tested genotypes. In the antibiosis assessment, the genotype 'Tatara-98' demonstrated relatively higher resistance, exhibiting the lowest intrinsic rate of increase ($rm = 0.135$) among the seven wheat genotypes examined. Tolerance was assessed through the tolerance index (TI), where genotype 'MPT-V33' showed the highest tolerance with the lowest TI value (0.250), while 'Tatara-98' was found to be the least tolerant (TI = 0.507). None of the tested wheat genotypes exhibited complete immunity to greenbug infestation. Although antixenosis resistance was absent, while notable antibiosis and tolerance responses were recorded. Resistant and tolerant genotypes may play an important role in reducing insecticide usage and supporting future integrated pest management strategies.

Received | July 22, 2025; **Accepted** | January 16, 2026; **Published** | October 22, 2026

***Correspondence** | Khwaja Junaid, Department of Plant Protection, Faculty of Crop Protection sciences, The University of Agriculture, Peshawar, Pakistan; **Email:** Kjprr@aup.edu.pk

Citation | Zubair, Z., K. Junaid, A.U. Rahman, M. Ullah, S. Ahmed, I. Ullah, R. Shah and G. Raiz. 2027. Evaluation of different wheat genotypes for resistance against green bug (*Schizaphis graminum* rodani) (Homoptera: aphididae). *Sarhad Journal of Agriculture*, 43(1): 22-32.

DOI | <https://dx.doi.org/10.17582/journal.sja/2027/43.1.22.32>

Keywords | Aphid, Resistance, Susceptible, Genotypes, Antixenosis, Antibiosis



Copyright: 2027 by the authors. Licensee ResearchersLinks Ltd, England, UK.

This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

Introduction

Wheat (*Triticum aestivum* L.) is one of the most important cereal crops cultivated extensively across the globe (Farooq *et al.*, 2020). It serves as the primary dietary staple for nearly 40% of the global population, contributing around 20% of total caloric intake worldwide (Ahmad *et al.*, 2003; Giraldo *et al.*, 2019). In addition to human consumption, wheat byproducts such as bran and straw are utilized as

livestock feed and in various industrial processes (USDA, 2021). Globally, wheat is ranked as the second most cultivated grain crop after maize, with total production reaching approximately 757 million metric tons during 2019–2020 season (FAO, 2020). In Pakistan, wheat crop is cultivated across all four provinces, encompassing both irrigated and rain-fed (barani) areas. Punjab continues to be the top wheat-producing province in the country followed by Sindh, Khyber Pakhtunkhwa (KPK), and Balochistan,

respectively. According to the Pakistan Economic Survey (2020–21), the country ranks 4th in Asia and 10th globally among wheat-producing nations. During the 2021–22 growing season, wheat was cultivated on 8.98 million hectares, resulting in the production of 26.2 million tons wheat having average yield of 29196 kg ha⁻¹. In Khyber Pakhtunkhwa, 0.76 million hectares of area was cultivated to harvest 1.36 million tons of wheat, which was comparatively lower averaging 1791 kg ha⁻¹. The province contributed 5.1% of the total national wheat output. Of the total cultivated area in KP, rain-fed zones comprised 0.386 million hectares, producing 0.69 million tons, while irrigated regions covered 0.373 million hectares and yielded about 0.66 million tons (MNFSR, 2021–22). To meet the projected global food requirement, increase expected to rise by 50% to 100% by 2050, thus significant improvements in crop productivity are necessary (Elferink and Schierhorn, 2016). In Pakistan, wheat productivity remains below the global average due to various constraints, including utilization of less-productive genotypes and poor soil management, irrigation, and control of pest (Bajkani et al., 2025; Mukhtarullah and Akmal, 2016).

Several aphid species attack wheat in Pakistan, including greenbug (*Schizaphis graminum*), *Rhopalosiphum padi*, *Diuraphis noxia*, and *Sitobion avenae* (Shahid et al., 2012). Among these, *S. graminum* is identified as the most prevalent and damaging species, with potential to reduce yield by 30–40% (Hafeez et al., 2021). It is a key pest of wheat and other tiny grains including barley, oats, rye, rice, and sorghum (Vakhide and Safavi, 2014). This aphid specie damages host plants by extracting phloem sap and injecting toxic saliva, leading to chlorosis, reduced photosynthesis and stunted growth, while honeydew excretions foster sooty mold growth (Blanchard et al., 2022). The yield losses from greenbug feeding are estimated at 35–40%, while indirect effects primarily through virus and fungal transmission result in total losses ranging from 20–80% (Aradottir and Crespo-Herrera, 2021).

These are tiny insects having soft bodies, typically measuring between 1.5–3.1 mm in length (Mushtaq et al., 2014). Their reproductive strategy includes parthenogenesis, enabling them to produce 3–6 offspring daily, while nymphal development period spans 5–10 days, and an individual can live up to 30 days (Stansly and McKenzie, 2008). In Khyber

Pakhtunkhwa, greenbugs are commonly observed on wheat during mid-January, with peak populations occurring by late February. Their numbers decline by the end of March and become nearly undetectable by April's end (Khan et al., 2006).

To mitigate aphid-induced yield losses, several pest management strategies are employed including mechanical, physical, cultural, chemical, biological, as well as host plant resistance methods (HPR). Biological control methods are generally considered safe for humans and the environment. Once successfully established, they often require minimal ongoing input and have a favorable cost-benefit ratio (Norris et al., 2003; Dent, 2003; Wright and Abrol, 2014).

Despite the advantages of non-chemical approaches, chemical pesticides are still commonly used to manage aphid populations. However, their excessive application poses environmental hazards and accelerates the development of resistance in pest populations (Ullah et al., 2022). In contrast, host plant resistance (HPR) provides an eco-friendly, cost-effective, and sustainable strategy to limit yield losses from pests. This approach is straightforward for farmers to adopt, requiring only the cultivation of resistant crop varieties. HPR is formally defined as a set of genetically inherited plant traits that reduce the suitability of the plant as a host for herbivores, thereby lowering damage compared to susceptible cultivars exposed to similar pest pressures (Moohkiah et al., 2022; Thorpe et al., 2016).

For the successful implementation of integrated pest management (IPM) methods, utilization of resistant varieties is essential. This method minimizes reliance on synthetic pesticides and mitigates their environmental and ecological impacts (Hatchett et al., 1987). Cultivating wheat varieties with inherent resistance to aphids is a critical component of IPM, as it contributes to suppressing aphid populations under field conditions (Khan and Port, 2008).

Materials and Methods

An experimental trial was carried out in 2024 to assess and categorize the resistance levels of selected wheat genotypes against greenbug aphids at the Department of Plant Protection, The University of Agriculture, Peshawar. Growth chambers were maintained at 20

$\pm 1^{\circ}\text{C}$ at night and $24^{\circ} \pm 1^{\circ}\text{C}$ during day, having a photoperiod of 10 hours dark with 14 hours of light (10:14 D: L).

Rearing of insect and plant cultivation

Greenbug aphids (*Schizaphis graminum*) were collected from infested wheat crops at the New Developmental Farm (NDF) of The University of Agriculture, Peshawar, and reared on Khaniwal wheat variety to establish a uniform colony. To maintain a continuous food supply for the insects, wheat seeds were sown every third day in Petri dishes and later transferred to pots to sustain aphid culture throughout the experimental period.

Initial screening

Twenty wheat genotypes (including 15CA73, AUP-40, AUP-94, AUP-83, Jm-1683, Jm-1215, My-902, My-409, My-1419, My-1416, My-2914, My-1501, Black Wheat, Hybrid-H1, Gulzar, Khaista, Wadan, among others) were subjected to a preliminary resistance screening. The genotypes were sown in rows (one seed per row) in a rectangular tray measuring 140 cm (L) $\times$ 37 cm (W) $\times$ 3 cm (H), with ten replications per genotype. Upon reaching the 2-leaf stage, ten greenbugs were released per seedling and damage was assessed after 15 days using a 0-9 visual rating system. A damage rating scale (DRS) was used to assign resistance levels: 0 for no damage and 9 indicating complete plant mortality. Genotypes having DRS values of 0–3 were considered resistant, 4–6 moderately resistance, and 7–9 susceptible (Akhtar *et al.*, 2011; Khan *et al.*, 2006).

Antixenosis evaluation

For assessing non-preference (antixenosis) resistance, each genotype's single seedling was grown in individual circular pots (3cm height $\times$ 22cm diameter). Each genotype was replicated ten times in completely randomized design (CRD). When seedlings attained 2-leaf stage, 50 aphids were introduced in the middle of every plot using a paper strip. The pots stayed enclosed in nylon mesh cages to prevent insect dispersal. Aphid numbers on each seedling were recorded after 12, 24, and 48-hour post-infestation to regulate any genotypic preference differences as per the method described by Flinn *et al.* (2001).

Antibiosis assessment

To determine antibiosis resistance, aphid reproductive performance was studied on each wheat genotype.

In each pot (8 cm diameter $\times$ 11.5 cm height), one seedling was grown, and each genotype was replicated ten times in a CRD layout. At the two-leaf stage, a cage was installed on the central part of the primary leaf using two pieces of plastic foam (0.9 cm thick, 2.54 cm internal diameter). Mesh of nylon was utilized for the airflow. Through the clips, a late instar aphid (P1) was enclosed inside the cage. The P1 aphid was monitored twice daily for progeny production. Upon producing the first progeny (F1), the mother was relocated and caged on a separate leaf of that plant. The duration in days (*d*) was recorded after the production of the F1 aphid. At the same time, the overall sum of aphids produced by the parent aphid (P1) was noted as *Md*. The intrinsic rate of increase (*rm*) was calculated by the equation propose by Birch (1948): $rm = 0.738 \times (\ln Md) / d$, where *Md* represents the total fecundity of the P1 aphid, and *d* is the time span (in days) required by the F1 to produce its first progeny. The coefficient 0.738 is the mean regression constant determined for four aphid species, as described by Wyatt and White (1977).

Tolerance measurement

Tolerance was determined by calculating proportional dry weight loss (DWT) and tolerance index (TI) following Reese *et al.* (1994). Following formula was used to calculate DWT: $DWT = [WC - WT] / WC \times 100$, where WC = Uninfected plant dry weight and WT = Aphid infested plant dry weight. TI was then derived as: $TI = DWT / \text{Overall aphid counts on the infested plant}$, to adjust for differences in infestation intensity.

Each genotype was grown in individual pots (11.5cm height $\times$ 8cm diameter), having replicated ten times. At two-leaf stage, they were matched in pairs according to their comparable size and vigor. From every pair, one plant was subjected to aphid infestation (20 greenbugs), while the other remained un-infested. Cages of nylon mesh were utilized to wrap and maintain the pots for 15 days.

After infestation, aphids were gathered from each affected plant onto a sheet of paper and their numbers were recorded. The aerial portions of both treated and untreated plants were cut at the soil surface and placed in pre-weighed aluminum foil packets. The roots were carefully washed to eliminate any soil and then sealed separately in foil packets. All plant materials were dried in an oven at 75°C for 48 hours. The final dry

mass was calculated by deducing the weight of the foil from the total measured weight.

Data analysis

Collected data were statistically evaluated using the software STATIX 8.1. Mean separation among treatments was performed using the Least Significant Difference (LSD) test at a significant level of 5% ($P < 0.05$).

Table 1: Preliminary screening of wheat genotypes for assessment of resistance.

Susceptible	Moderately resistant	Resistant
Black Wheat	MY-409	Khaista
AUP-83	MY-1501	Tatara-98
15CA-73	JM-1215	
JM-1683	MPT-V33	
MY-2914		
AUP-40		
MY-1419		
MY-902		
MY-1416		
Khaniwal		
Hybrid-H1		
AUP-94		
Wadan		
Gulzar		

Results

Preliminary assessment

In the initial screening phase, twenty pre-selected wheat genotypes were evaluated for their resistance using a visual Damage Rating Scale (Table 1). Of the tested entries, fourteen genotypes AUP-83, Black wheat, JM-1683, 15CA-73, AUP-40, MY-2914, MY-902, MY-1419, Khaniwal, MY-1416, AUP-94, Hybrid-H1, Gulzar and Wadan were classified as 'susceptible'. Four genotypes namely MY-1501, MY-409, MPT-V33 and JM-1215 exhibited partial resistance and were placed in the 'moderately resistant' group. Meanwhile, two genotypes, Tatara-98 and Khaista, were considered 'resistant' based on their visual damage scores. Susceptible genotypes were excluded from further evaluation, whereas the moderately resistant and resistant ones were retained for subsequent analysis to determine the resistance mechanisms.

Antixenosis assay

The antixenosis test examined greenbug preference and avoidance behavior on the selected wheat genotypes.

According to Table 2, no significant difference was recorded in greenbug infestation among genotypes at 12, 24 and 48 hours post infestation. After 12 hours, the lowest mean greenbug population was observed on MY-1501 and MY-409 (7.7 aphids per seedling), while the highest was recorded on JM-1215 (8.8 aphids per seedling). A similar trend persisted at the 24-hour mark, with JM-1215 again exhibiting the highest count (8.9), followed by MPT-V33 (8.4). Conversely, MY-1501 and Khaista had the lowest infestations (7.7), with MY-409 slightly higher at 7.8. At 48 hours, MY-1501 showed the fewest greenbugs (7.8), followed by Khaista and MY-409 (7.9), whereas JM-1215 had the highest (8.9), trailed by MPT-V33 (8.5) and Tatara-98 (8.3).

Table 2: Mean population density of greenbug on selected wheat genotypes at 12, 24 and 48 hours.

Genotypes	12 hours	24 hours	48 hours
Khaista	7.8	7.7	7.9
MY-1501	7.7	7.7	7.8
MPT-V33	8.5	8.4	8.5
MY-409	7.7	7.8	7.9
Tatara-98	8.0	8.2	8.3
JM-1215	8.8	8.9	8.9

Table 3: Means values of offspring produced (M_d), Pre-reproduction time (d) and rate of intrinsic natural increase (r_m) of greenbug on tested wheat genotypes

Genotypes	Total progeny produced (M_d)	Pre-reproduction time (d)	Rate of intrinsic increase (r_m)
Khaista	29.90 e	7.51 b	0.144 c
MY-1501	45.78 a	7.17 c	0.170 a
MPT-V33	41.16 b	6.84 e	0.173 a
MY-409	34.89 c	7.13 cd	0.159 b
Tatara-98	31.72 d	8.19 a	0.135 d
JM-1215	35.70 c	7.01 d	0.163 b
Khaniwal (Susceptible check)	40.56 b	6.83 e	0.172 a
LSD (0.05)	0.8990	0.1445	3.376

Means in a column followed by same alphabets are non-significant at 5% probability level.

Antibiosis assay

Seven wheat genotypes were tested for antibiosis, including Tatara-98 as a known resistant standard and Khaniwal as a known susceptible reference. Significant differences were observed in parameters such as total progeny count (M_d), pre-reproductive

period (days), and intrinsic rate of increase (rm) (Table 3). The lowest progeny count was recorded on Khaista (29.90), followed by Tatara-98 (31.72), while the highest was observed in MY-1501 (45.78), followed by MPT-V33 (41.16), with no statistical difference between the latter two.

Regarding the pre-reproductive period, greenbugs produced their first offspring fastest on Khaniwal (6.83 days), closely followed by MPT-V33 (6.84). The longest time was required on Tatara-98 (8.19 days), followed by Khaista (7.51 days). The intrinsic rate of increase (rm) varied significantly. The highest value (0.173) was observed on MPT-V33, followed closely by Khaniwal (0.172) and MY-1501 (0.170), with no significant difference among them. The lowest rm was recorded on Tatara-98 (0.135), followed by Khaista (0.144) and MY-409 (0.159). These findings suggest Tatara-98 has strong antibiotic effects, with Khaista showing moderate antibiosis based on rm comparisons.

Table 4: Mean of percent dry weight change (DWT) of shoot, root and total plant of tested genotypes of wheat against greenbug.

Mean percent plant dry weight change (DWT)			
Genotypes	Shoot	Root	Total plant
Khaista	49.89 a	40.0 a	89.90 a
MY-1501	36.33 c	24.38 c	60.71 c
MPT-V33	37.71 c	26.10 c	63.82 c
MY-409	43.81 b	35.44 b	79.25 b
Tatara-98	50.09 a	41.67 a	91.77 a
JM-1215	45.19 b	36.08 b	81.07 b
LSD (0.05)	3.4033	3.8406	5.9543

Means in a column followed by same alphabets are non-significant at 5% probability level.

Tolerance evaluation

Data on dry weight change (DWT) in shoot, root, and whole plant across the selected genotypes revealed significant differences (Table 4). Tatara-98 showed the highest shoot DWT (50.09), closely followed by Khaista (49.89), with no significant difference between them. On the other hand, MY-1501 (36.33) and MPT-V33 (37.71) showed the lowest shoot DWT. Root DWT followed a similar pattern, with the lowest values recorded in MY-1501 (24.38) and MPT-V33 (26.10), while Tatara-98 (41.67) and Khaista (40.0) showed the highest values with no statistical difference. A consistent trend was also seen

in total plant DWT, where Tatara-98 (91.77) ranked the highest, closely followed by Khaista (89.90). In contrast, MY-1501 (60.71) and MPT-V33 (63.82) recorded the lowest values.

Table 5: Mean values of tolerance index (TI) of shoot, root and total plant of the tested genotypes of wheat against greenbug.

Tolerance index (TI)			
Genotypes	Shoot	Root	Total Plant
Khaista	0.268 a	0.214 a	0.483 a
MY-1501	0.180 c	0.125 c	0.305 c
MPT-V33	0.147 d	0.103 d	0.250 d
MY-409	0.221 b	0.179 b	0.400 b
Tatara-98	0.277 a	0.230 a	0.507 a
JM-1215	0.230 b	0.187 b	0.418 b
LSD (0.05)	0.0187	0.0203	0.0342

Means in a column followed by same alphabets are non-significant at 5% probability level.

Tolerance Index (TI) for Shoots, Roots, and Whole Plant

The tolerance index (TI) also displayed significant variation among wheat genotypes in shoot, root, and total plant categories (Table 5). Tatara-98 had the highest shoot TI (0.277), closely followed by Khaista (0.268), with no significant difference between them. In contrast, MPT-V33 recorded the lowest shoot TI (0.147), followed by MY-1501 (0.180). For root TI, MPT-V33 had the lowest (0.103), followed by MY-1501 (0.125), both showing significant differences. The highest root TI was recorded on Tatara-98 (0.230), followed by Khaista (0.214), with no significant difference between them. Similarly, the total plant TI was highest in Tatara-98 (0.507), followed by Khaista (0.483), with comparable statistical results. Meanwhile, MPT-V33 had the lowest total plant TI (0.250). These results indicate that although MPT-V33 exhibited relatively higher tolerance among the tested entries, Tatara-98 demonstrated comparatively lower tolerance traits.

Discussion

Twenty wheat genotypes were evaluated under controlled laboratory conditions to determine their resistance against *Schizaphis graminum*. Using a damage rating scale (DRS), 'Khaista' and 'Tatara-98', were identified as resistant, while four genotypes 'MY-409', 'MY-1501', 'JM-1215', and 'MPT-V33' were categorized as moderately resistant. The remaining

fourteen genotypes, including 'Black Wheat', 'AUP-83', '15CA-73', 'JM-1683', 'MY-2914', 'AUP-40', 'MY-1419', 'MY-902', 'MY-1416', 'Khaniwal', 'Hybrid-H1', 'AUP-94', 'Wadan', and 'Gulzar', were found to be susceptible based on visual damage symptoms. A similar DRS approach was employed by [Akhtar et al. \(2013\)](#), who reported that among the wheat lines tested, two were susceptible, thirteen moderately resistant, and four resistant (NARC-09, Momal-2002, TD-1 and Zarlasta-99). Additionally, [Akhtar and Mujahid \(2006\)](#) evaluated sixteen wheat cultivars and found four to exhibit resistance, while twelve were categorized as moderately resistant. [Ahmad et al. \(2015\)](#) also confirmed significant variability in resistance among wheat genotypes. Srinivasan and Rakha (2019) had also utilized the Damage Rating Scale (DRS) method for the screening against greenbug.

Our results agree with the findings of [Iqbal et al. \(2018\)](#), who assessed nine different wheat accessions (Lassani-08, Faisalabad-08, Blue-silver, Miraj-08, Aas-11, Sahar-06, Pak-81, Millat-08, and Fareed-06), against *S. graminum* and revealed that only two of them (Lassani-08 and Faisalabad-08) were found resistant. While antixenosis test revealed that Millat-08 variety was highly preferred by insects as compared to other tested varieties. Similarly, [Aslam et al. \(2004\)](#) also screened 12 different wheat varieties including Punjab-96, Punjab-2333, Punjab, 2210, Punjab-2486, Punjab-2045, Punjab-2049, Punjab-2460, PND-01, BWP-97, MH-97, Iqbal-2000 and Inqalab-2000 against *S. graminum* and found that significantly lowest mean aphid population (6.90) was recorded on Inqalab-91 while highest mean population (21.80 aphids) was recorded from PND-01 wheat variety.

According to [Liu et al. \(2012\)](#), traits such as green spikes, stems, and glumes correlate positively with aphid resistance in wheat. Additionally, the degree of quantitative resistance in genotypes is influenced not only by environmental factors but also by polygenic traits, while aphid adaptability plays a pivotal role in determining host plant suitability ([Khanal et al., 2023](#); [Smith and Chuang, 2014](#)).

In the antixenosis assay, all the tested wheat genotypes showed significant preference for greenbug. These findings corroborate those of [Castro et al. \(2015\)](#) and [Junaid et al. \(2016\)](#), who also found no observable antixenosis resistance in wheat genotypes screened for

greenbug tolerance. Our results are also in conformity with [Weng et al. \(2004\)](#) who stated that greenbug preferred susceptible wheat varieties as compared to resistant but generally affected all the tested wheat varieties. However, [Akhtar and Yaqoob \(2006\)](#) noted that three wheat cultivars (MAW-I, BARS-I, and Faisalabad) were less attractive to aphids in their trials. The observed differences in preference may be associated with morphological or chemical traits inherent to specific host plants ([Dent, 1991](#)).

Antibiosis testing revealed statistically significant variations in resistance levels among the wheat genotypes. The genotype 'Khaista' showed unique antibiosis responses compared to the rest, based on its pre-reproductive duration (d) and total progeny count (Md). The intrinsic rate of increase (rm) on 'Khaista' was 0.144, which was relatively low, second only to the resistant standard genotype 'Tatara-98' with a rm value of 0.135. [Akhtar et al. \(2013\)](#) also investigated aphid fecundity on wheat genotypes and reported significantly higher reproduction on 'V00125', whereas 'Diamond' and 'Wafaq' supported the lowest fecundity. Our results are consistent with previous findings by [Lazzeri et al. \(2009\)](#); [Iqbal et al. \(2018\)](#) and [Zhang et al. \(2022\)](#) who also recorded substantial differences in antibiosis effects among wheat varieties.

Comparable outcomes were reported by [Goldasteh et al. \(2012\)](#), who assessed four wheat varieties for greenbug resistance. They recorded the highest rm value on 'Pastor' ($0.276 \pm 0.002 \text{ day}^{-1}$) and the lowest on 'Zegros' ($0.222 \pm 0.00 \text{ day}^{-1}$). These differences in fecundity across genotypes could be due to host plant chemistry, differing aphid biotypes, or variation in experimental conditions ([Anaii et al., 2018](#)). Additional influences on aphid reproduction include secondary metabolites and nutritional factors in the plant, which affect aphid survival, development, reproduction, and overall performance ([Filho et al., 2019](#); [Seo et al., 2020](#)).

In the tolerance assay, differences in proportional dry weight change (DWT) and tolerance index (TI) were observed among genotypes. The lowest DWT was recorded in 'MY-1501' (60.71%), indicating better maintenance of biomass under aphid pressure. Conversely, 'Tatara-98' exhibited the highest DWT (91.77%), followed by 'Khaista' (89.90%), suggesting greater biomass loss due to aphid feeding. Regarding

TI, the genotype 'MPT-V33'—recognized as a moderately resistant standard—demonstrated the lowest TI value (0.250), indicating higher tolerance relative to the other genotypes tested. Our findings are supported by earlier reports from [Junaid *et al.* \(2016\)](#) and [Khan *et al.* \(2010\)](#), who also identified 'MPT-V33' as relatively tolerant to aphid attack. Similar results were documented by [Akhtar *et al.* \(2009\)](#), [Akhtar *et al.* \(2013\)](#), and [Sulistyo and Inayati \(2016\)](#), where certain wheat genotypes exhibited enhanced tolerance.

Tolerance in host plants is believed to be associated with activation of the genetic makeup of the plant involved in biomass accumulation, regulation of photosynthesis, and cellular repair processes, which are triggered in response to aphid feeding ([Smith *et al.*, 2010](#)). The variability in tolerance responses across genotypes may be attributed to the presence of incomplete dominant resistance genes ([Yang *et al.*, 2017](#)) as well as foremost key resistance loci ([Hassan *et al.*, 2023](#)). Reproduction and development in the plants are severely affected by the presence of phenolic compounds in the plant tissues, thereby contributing to resistance mechanisms. As such, phenolic content plays a crucial role in defining aphid resistance in wheat cultivars ([Wu *et al.*, 2007](#)).

Conclusions and Recommendations

None of the genotypes screened in this study exhibited complete immunity to greenbug infestation, indicating the absence of highly resistant wheat varieties. Antixenosis resistance was absent among tested genotypes; however, 'Tatara-98' showed notable antibiotic resistance, while 'MPT-V33' demonstrated a strong tolerance response. Based on these findings, it is recommended that farmers consider cultivating resistant genotypes such as 'Tatara-98' and 'MPT-V33' to manage greenbug populations and reduce pesticide dependency. Further molecular studies are required to elucidate the genetic basis of resistance in these genotypes.

Acknowledgments

The authors express their gratitude to the Department of Plant Protection, The University of Agriculture Peshawar, for their valuable support and facilities throughout the experiment.

Novelty Statement

In this study different wheat genotypes were assessed for resistance against aphid infestation and the most resistant genotypes (Tatara-98 and MPT-V33) were recommended for commercial cultivation under the climatic conditions of Peshawar.

Author's contribution

Mohammad Zubair: Conducted the experiment, analyzed data.

Khwaja Junaid: Designed and supervised the experiment.

Asad ur Rahman: Maintained insect and plant culture.

Mehran Ullah: Wrote the manuscript.

Shabir Ahmed: Checked language of the manuscript.

Ijaz Ullah: Critically reviewed the manuscript.

Rahim Shah: Helped in data collection.

Gul Raiz: Analysed the data.

Generative AI or AI assisted technology statement

No AI technology has been used in this whole experimental research trial.

Conflict of Interest

Authors share no conflict of interest.

References

- Aheer, G.M., A. Ali and M. Ahmad. 2008. Abiotic factors effect on population fluctuation of alate aphids in wheat. *J. Agric. Res.*, 46 (4): 367-371.
- Ahmad, R. and A.S. Shaikh. 2003. Common weeds of wheat and their control. *Pak. J. Water Res.*, 7(1): 73-76.
- Ahmed, T., M. Aslam, M.W. Hussan and J. Iqbal. 2015. Aphids (*Schizaphis graminum* R.) infestation on different wheat (*Triticum aestivum* L.) varieties and their comparative yields. *J. Agric. Res.*, 53(2): 209-216.
- Akhtar, N. and M. Yaqoob. 2006. Patterns of resistance to *Schizaphis graminum* (Rondani) among rainfed National Uniform wheat varieties. *Pakistan J. Zool.*, 38(2): 153-157.
- Akhtar, N., A. Iqbal, H.I. Javed, J. Khan, M. Riaz, W.A. Gillani, T. Mahmood, A. Rasool and T. Yasmin. 2013. Evaluation of recommended wheat varieties for resistance against *Schizaphis*

- graminum* (Rodani) (Aphididae: Homoptera) under laboratory conditions. Pak. J. Agric. Res., 26: 321-327.
- Akhtar, N., N. Moin, G. Jillani, A.U. Mohsin, S. Yasmin, A. Tashfeen and I. Begum. 2009. Evaluation of resistance in wheat to aphids (Homoptera: Aphididae) under laboratory conditions. Pak. J. Agric. Res., 22(1-2): 67-72.
- Akhtar, N., W.A. Gillani, E.U. Haq, J. Khan, I. Begum, S. Yasmin and K. Saeed. 2011. Screening for resistance to aphid in barley. Pak. J. Agric. Res., 24: 1-4.
- Anaii, M.M., M.P. Yali and M.B.A. Kalae. 2018. Resistance of nine wheat cultivars and lines to greenbug, *Schizaphis graminum* (Rodani) in Iran. J. Agric. Sci. Technol., 20(6): 1173-1185.
- Aradottir, G.I. and L. Crespo-Herrera. 2021. Host plant resistance in wheat to barley yellow dwarf viruses and their aphid vectors: A review. Curr. Opi. Insect Sci., 45: 59-68. <https://doi.org/10.1016/j.cois.2021.01.002>
- Aslam, M., M. Razaq, F. Ahmad, M. Faheem, and W. Akhter. 2004. Population of aphid (*Schizaphis graminum* R.) on different varieties/lines of wheat (*Triticum aestivum* L.). Int. J. Agric. Biol., 6(6): 974-977.
- Bajkani, J.K., H. Amin, H.A. Samoon, F. Muhammad, N.A. Soomro, and S.P. Tunio. 2025. Impact Assessment of Zero Tillage Wheat Sowing Technology in the Rice-Wheat Farming System of Sindh Province. Res. J. Soc. Affair., 3(2): 413-423. <https://doi.org/10.71317/RJSA.003.02.0162>
- Blanchard, S., F. Verheggen, I. Van De Vreken, A. Richel, and C. Detrain. 2022. Combined elevation of temperature and CO₂ impacts the production and sugar composition of aphid honeydew. J. Chem. Ecol., 48(9): 772-781. <https://doi.org/10.1007/s10886-022-01385-z>
- Castro, A.M., A. Vasicek, M. Manifiesto, O. Giménez, M.S. Tacaliti, O. Dobrovolskaya, M.S. Röder, J.W. Snape and A. Börner. 2005. Mapping antixenosis genes on chromosome 6A of wheat to greenbug and to a new biotype of Russian wheat aphid. Plant Breed., 124: 229-233.
- Dent, D. 1991. Insect Pest Management. Wallingford, Oxon, UK: CAB International: 410.
- Dent, D.R., M. Holderness and J.G.M. Vos. 2003. Integrated pest management of CAB International. Integrated pest management in the global arena. Wallingford UK: CABI Pub. 493-499. <https://doi.org/10.1079/9780851996523.0493>
- Elferink, M. and F. Schierhorn. 2016. Global demand for food is rising. Can we meet it. Harv. Busi. Rev., 7(04): 2016.
- FAO. 2020. Food and Agriculture Organization.
- Farooq, M., M. Hussain, M.M. Habib, M.S. Khan, I. Ahmad, S. Farooq and K.H. Siddique. 2020. Influence of seed priming techniques on grain yield and economic returns of bread wheat planted at different spacings. Crop Past. Sci., 71(8): 725-738. <https://doi.org/10.1071/CP20065>
- Filho, J.E., L.E.D.M. Padua, G.L.F. Portela and F.D.M. Sousa. 2019. Thermal requirements and age-specific life tables of cowpea aphids in cowpea under natural field conditions. Arquivos do Instituto Biológico., 86: 50-201. <https://doi.org/10.1590/1808-1657000502018>
- Flinn, M., C.M. Smith, J.C. Reese and B. Gill. 2001. Categories of resistance to greenbug (Homoptera: Aphididae) biotype I in *Aegilops tauschii* germplasm. J. Econ. Entomol., 94(2): 558-563. <https://doi.org/10.1603/0022-0493-94.2.558>
- Flint, M.L. 2012. IPM in practice: principles and methods of integrated pest management. Uni. California Agric. Natural Resour., Vol. 3418.
- Giraldo, P., E. Benavente, F. Manzano-Agugliaro and E. Gimenez. 2019. Worldwide research trends on wheat and barley: A bibliometric comparative analysis. Agro., 9(7): 352. <https://doi.org/10.3390/agronomy9070352>
- Goldasten, S., A.A. Talebi and E. Rakhshani. 2012. Effect of four wheat cultivars on life table parameters of *Schizaphis graminum* (Hemiptera: Aphididae). J. Crop Prot., 1: 121-129.
- Hafeez, F., M. Abbas, K. Zia, S. Ali, M. Farooq, M. Arshad, and M. J. Ansari. 2021. Prevalence and management of aphids (Hemiptera: Aphididae) in different wheat genotypes and their impact on yield and related traits. PLoS one., 16(10): e0257952. <https://doi.org/10.1371/journal.pone.0257952>
- Haq, A., W. Murad and S. Ahmad. 2023. The impact of wheat resistance and bio-rational insecticides toxicity against cherry-oat aphid, *Rhopalosiphum padi* L. (Hemiptera:

- Aphididae). Turk. J. Zool., 47(1): 10-19. <https://doi.org/10.55730/1300-0179.3108>
- Hatchett, J.H., K.J. Starks and J.A. Webster. 1987. Insect and mite pests of wheat. Wheat Wheat Improv., 13: 625-675. <https://doi.org/10.2134/agronmonogr13.2ed.c34>
- Iqbal, M.A., M.W. Hassan, H.M. Rehman, M. Aslam, and M. Jamil. 2018. Evaluation of different wheat varieties for resistance against aphid, *Schizaphis graminum* R. (Homoptera: Aphididae) under laboratory conditions. Asian J. Agric. Biol., 6(04): 549-555.
- John, F., N.A. Saeed, S. Nadeem and M. Hamed. 2017. Integration of planting time and insecticide to manage aphid infestations in wheat for better crop productivity. Pak. J. Zool., 49: 1343-1351. <https://doi.org/10.17582/journal.pjz/2017.49.4.1343.1351>
- Junaid, K., S.A. Khan, I. Khan, S.R.A. Shah and Z. Khan. 2016. Study on different components of resistance in wheat genotypes to green bug (*Schizaphis graminum*) (Rondani). Pak. J. Zool., 48(4): 981-987.
- Khan, M. and G. Port. 2008. Performance of clones and morphs of two cereal aphids on wheat plants with high and low nitrogen content. Entomol. Sci., 11(2): 159-165. <https://doi.org/10.1111/j.1479-8298.2008.00262.x>
- Khan, S.A., F. Ullah, N. Hussain, A.U.R. Saljoqi, Y. Hayat and S. Sattar. 2006. Distribution pattern of the cereal aphids in the wheat growing areas of the North West Frontier Province (NWFP) of Pakistan. Sar. J. Agric., 22(4): 655.
- Khan, S.A., M. Murugan, S. Starkey, A. Manley and C.M. Smith. 2010. Inheritance and categories of resistance in wheat to Russian wheat aphid (Hemiptera: Aphididae) biotype 1 and biotype 2. J. Econ. Entomol., 102(4): 1654-1662. <https://doi.org/10.1603/029.102.0433>
- Khanal, N., C. Vitek, and R. Kariyat. 2023. The known and unknowns of aphid biotypes, and their role in mediating host plant defenses. Divers., 15(2): 186. <https://doi.org/10.3390/d15020186>
- Kolar, C.S., D.C. Chapman, W.R.C. Jr, C.M. Housel, J.D. Williams and D.P. Jennings. 2007. Bigheaded carps: a biological synopsis and environmental risk assessment.
- Hassan, H.M., A.A. Hadifa, S.A. El-Leithy, M. Batool, A. Sherif, I. Al-Ashkar, and A. Elsabagh. 2023. Variable level of genetic dominance controls important agronomic traits in rice populations under water deficit condition. Peer J., 11: e14833. <https://doi.org/10.7717/peerj.14833>
- Lazzari, S., S. Starkey, J. Reese, A. Ray-Chandler, R. McCubrey, and C. Michael Smith. 2009. Feeding behavior of Russian wheat aphid (Hemiptera: Aphididae) biotype 2 in response to wheat genotypes exhibiting antibiosis and tolerance resistance. J. Econ. Entomol., 102(3): 1291-1300. <https://doi.org/10.1603/029.102.0356>
- Liu, X.L., X.F. Yang, C.Y. Wang, Y.J. Wang, H. Zhang and W.Q. Ji. 2012. Molecular mapping of resistance gene to English grain aphid (*Sitobion avenae* F.) in Triticum durum wheat line C273. Theo. App. Genet., 124: 287-293. <https://doi.org/10.1007/s00122-011-1704-7>
- MNFSR (Ministry of National Food Security and Research), 2021-22. Government of Pakistan. Fruit, Vegetables and Condiments Statistics of Pakistan.
- Namara, L., K. Gauthier, L. Walsh, G. Thébaud, M. Gaffney and E. Jacquot. 2020. Management of yellow dwarf disease in Europe in a post-neonicotinoid agriculture. Pest Manage. Sci., 76(7): 2276-2285. <https://doi.org/10.1002/ps.5835>
- MNFSR. 2022. Ministry of National Food Security and Research. Govt. of Pak. Islamabad, Agriculture statistics. 2021-22.
- Mookiah, S., B. Sivasubramaniam, T. Thangaraj, and S. Govindaraj. 2022. Host plant resistance. In Molecular approaches for sustainable insect pest management (pp. 1-56). Singapore: Springer Singapore. https://doi.org/10.1007/978-981-16-3591-5_1
- Mukhtarullah, J.A. and M. Akmal. 2016. Yield comparison of some improved wheat varieties under different sowings dates as rainfed crops. Sar. J. Agri., 2: 89-95. <https://doi.org/10.17582/journal.sja/2016/32.2.89.95>
- Mushtaq, S., S. Akhtar, R.N. Rana, S. Maalik, and N. Ehsan. 2014. Developmental duration and predatory efficiency of *Episyrphus balteatus* on four aphid species in Pakistan. Int. J. Agric. Biol., 16(3): 259-268.
- Najafi, F., J. Razmjou, A. Golizadeh and A. Asadi. 2013. Resistance of Wheat Lines to Greenbug, *Schizaphis graminum* (Rondani) (Hemiptera: Aphididae). J. Entomol. Res. Soci., 15(1): 7-15.

- Norris, R.F., E.P. Caswell-Chen and M. Kogan. 2003. Concepts in integrated pest management. PES. 2021. Pakistan economic survey, Ministry of Finance, Govt. of Pakistan. Islamabad, Agriculture statistics of Pakistan. 2020-2021
- Reese, J.C., J.R. Schwenke, P.S. Lamont and D.D. Zehr. 1994. Importance and quantification of plant tolerance in crop pest management programs for aphids: greenbug resistance in sorghum. J. Agric. Entomol., 11(3): 255-270.
- Seo, B.Y., E.Y. Kim, J.J. Ahn, Y. Kim, S. Kang and J. K. Jung. 2020. Development, reproduction, and life table parameters of the foxglove aphid, *Aulacorthum solani* Kaltenbach (Hemiptera: Aphididae), on soybean at constant temperatures. Insect., 11(5): 296. <https://doi.org/10.3390/insects11050296>
- Shahid, S., A. Zia, N. Naeem and F. Naz. 2012. Bionomics of aphids and their parasitoid in selected wheat varieties grown under homologous ecological conditions. Pakistan J. Zool., 44: 1423-1430.
- Smith, C.M., X.M. Liu, L.J. Wang, M.S. Chen, S. Starkey and J. Bai. 2010. Aphid feeding activates expression of a transcriptome of oxolopin-based defense signals in wheat involved in resistance to herbivory. J. Chem. Ecol., 36: 260-271. <https://doi.org/10.1007/s10886-010-9756-8>
- Smith, C.M. and W.P. Chuang. 2014. Plant resistance to aphid feeding: behavioral, physiological, genetic and molecular cues regulate aphid host selection and feeding. Pest Manag. Sci., 70(4): 528-540. <https://doi.org/10.1002/ps.3689>
- Srinivasan, R. and M. Rakha. 2019. Resistance screening techniques for major insect and mite pests in vegetable crops. In Experimental techniques in host-plant resistance (pp. 83-95). Singapore: Springer Singapore. https://doi.org/10.1007/978-981-13-2652-3_11
- Stansly, P.A. and C.L. McKenzie. 2008. Fourth international Bemisia workshop international whitefly genomics workshop December 3-8, 2006, Duck Key, Florida, USA. J. Insect Sci., 8(1): 121-135. <https://doi.org/10.1673/031.008.0401>
- Sulistyo, A. and A. Inayati. 2016. Mechanisms of antixenosis, antibiosis, and tolerance of fourteen soybean genotypes in response to whiteflies (*Bemisia tabaci*). Biodiversitas J. Biol. Divers., 17(2): 447-453 <https://doi.org/10.13057/biodiv/d170207>.
- Thorpe, P.T., J.S. Pryke, and M.J. Samways. 2016. Review of ecological and conservation perspectives on future options for arthropod management in Cape Floristic Region pome fruit orchards. African Entomol., 24(2): 279-306. <https://doi.org/10.4001/003.024.0279>
- Ullah, M., I. Haq and S.A. Khan. 2022. Varietal preference and efficacy of various chemicals against red pumpkin beetle (*Aulacophora foveicollis* L.) (Coleoptera: Chrysomelidae) in different cucumber (*Cucumis sativus*) Cultivars. Int. J. Mol. Biol. Biochem., 5(1): 10-15. <https://doi.org/10.33545/26646501.2023.v5.i1a.33>
- Ullah, M., F. Ullah, M.A. Khan, S. Ahmad, M. Jamil, S. Sardar, 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(1): 173-182. <https://doi.org/10.1007/s42690-021-00528-1>
- USDA (United States Department of Agriculture), 2021. U.S. Department of Agriculture. Retrieved June 23, 2025, from <https://www.usda.gov/about-usda>
- Vakhide, N. and S.A. Safavi. 2014. Lethal and sublethal effects of direct exposure to acetamiprid on reproduction and survival of the greenbug, *Schizaphis graminum* (Hemiptera: Aphididae). Arch. Phytopathol. Plant Protect., 47(3): 339-348.
- Wains, M.S., M.W. Jamil, M.A. Ali, M. Hussain and J. Anwar. 2014. Germplasm screening and incorporation of aphid resistance in bread wheat (*Triticum aestivum* L.). J. Ani. Plant Sci., 23: 919-925.
- Wang, C.P., Q. Chen, K. Luo, H.Y. Zhao, G.S. Zhang and R. Tlali. 2011. Evaluation of resistance in wheat germplasm to the aphids, *Sitobion avenae* based on (Technique for Order Preference by Similarity to Ideal Solution) Topsis and cluster methods. Afr. J. Agric. Res., 6: 1592-1599.
- Webster, J.A. and C. Inayatullah. 1988. Assessment of experimental designs for green bug (Homoptera: Aphididae) antixenosis tests. J. Econ. Entomol. 81(4): 1246-1250. <https://doi.org/10.1093/jee/81.4.1246>
- Weng, Y., M. D. Lazar, G. J. Michels, and J. C.

- Rudd. 2004. Phenotypic mechanisms of host resistance against greenbug (Homoptera: Aphididae) revealed by near isogenic lines of wheat. J. Econ. Entomol., 97(2): 654-660. <https://doi.org/10.1093/jee/97.2.654>
- Wright, M.G. and D.P. Abrol. 2014. Integrated pest management-current concepts and ecological perspective. 267-281. <https://doi.org/10.1016/B978-0-12-398529-3.00015-4>
- Wu, B., T. Takahashi, T. Kashiwagi, S. Tebayash and C.S. Kim. 2007. New Flavonoid Glycosides from the Leaves of *Solidago altissima*. Chem. Pharm. Bull., 55: 815-816. <https://doi.org/10.1248/cpb.55.815>
- Wyatt, I.J. and P.F. White. 1977. Simple estimation of intrinsic increase rates for aphids and tetranychid mites. J. App. Ecol., 757-766. <https://doi.org/10.2307/2402807>
- Yang, J., S. Mezmouk, A. Baumgarten, E.S. Buckler, K.E. Guill, M.D. McMullen, and J. Ross-Ibarra. 2017. Incomplete dominance of deleterious alleles contributes substantially to trait variation and heterosis in maize. PLoS genetics., 13(9): e1007019. <https://doi.org/10.1371/journal.pgen.1007019>
- Zhang, K.X., H.Y. Li, P. Quandahor, Y.P. Gou, C.C. Li, Q.Y. Zhang, and C.Z. Liu. 2022. Responses of six wheat cultivars (*Triticum aestivum*) to wheat aphid (*Sitobion avenae*) infestation. Insect., 13(6): 508. <https://doi.org/10.3390/insects13060508>