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RESEARCHARTICLE

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Comparative Analysis of Morphological and Yield Traits in Wheat Genotypes

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Abstract

Wheat (*Triticum aestivum* L.) is a fundamental cereal crop, crucial for food security and economic stability globally, particularly in Pakistan, where it significantly contributes to the agricultural sector. This study aimed to evaluate ten wheat genotypes for their morphological traits and yield-related characteristics. The experiment was conducted in field area of Department of Plant Breeding and Genetics, UAF using a Randomized Complete Block Design (RCBD) with three replications, plant height, peduncle length, spike length, leaf area, number of tillers, grains per spike, and grain yield per plant were measured. Statistical analyses, including ANOVA and Tukey's mean comparison, indicated significant differences among the genotypes. Notably, Johar-2016 exhibited the highest plant height (105 cm), while Chakwal-50 recorded the lowest (89.67 cm). Aas-2011 showed maximum peduncle length (39.00 cm) and spike length (15.02 cm), with Maxi Pak-65 achieving the highest grains per spike (62.47). Correlation analysis revealed strong positive relationships among key traits, such as spike length and grain yield, emphasizing the interconnectedness of morphological and yield-related characteristics. Crucially, the 1000 grain weight (TGW) exhibits a strong positive correlation with yield, highlighting its significance in overall productivity, along with correlations with NGS and grain weight per spike (GWS). These findings underscore the importance of plant height, spike length, and grain weight as key contributors to enhancing grain yield. These findings provide valuable insights for breeding programs aimed at improving wheat cultivars in Pakistan.

KEYWORDS
Wheat, Morphological traits, 1000 grain weight, Yield, Correlation

1 | INTRODUCTION

Wheat is an essential cereal crop grown in temperate regions and used as food for human and livestock feed (Shewry, 2009). Wheat contributes 8.9% cost to the agriculture sector and 1.6% to the GDP, wheat crops expressed an increase in total production (29.69 million tons) but a reduction in the area under cultivation of wheat (9.033 thousand hectares) occurred during 2023-2024. It was due to the promotion of other competitive crops i.e. oil seeds however high-yielding varieties of wheat enhance the overall production (Government of Pakistan, 2023). By the trends of production of wheat in the past the production and area under cultivation of wheat crop in Pakistan for the year 2022 was estimated with the help of ARIMA model. It was observed that there would be an increase in production of wheat in upcoming years. It was also declared that it would be done by the participation of agricultural sector of Pakistan to introduce new production technologies in the farming community and support the government policies (Iqbal et al., 2005).

The major problems faced in the way of better production of wheat are unavailability of quality seeds for farmers, delayed planting of leaf, poor application of good quality fertilizers and late harvesting of summer crops like sugarcane, cotton and rice etc. These problems are due to the lack of awareness of farmers about new production technologies that should be used to enhance the productivity of wheat. The issues faced

by wheat productivity related to the poor seed, fertilizer, irrigation and harvesting techniques can be overcome by talking to the farmers and aware them about new harvesting strategies, proper guide line for application of fertilizer and required level of irrigation. It is also important to adopt new techniques in agricultural sector to produce high quality seeds (Hameed, 2013).

The objectives of this research are given as:

- To estimate the variation in morphological characters of different genotypes of bread wheat.

To estimate the correlation between morphological traits and yield of different genotypes of bread wheat.

2 METERIAL AND METHOD

The experimental design used for this research was Randomized Complete Block Design (RCBD). All ten genotypes were grown in RCBD and replications were considered. The required amount of fertilizer and irrigation was applied at suitable intervals. Field was fertilized with N: P: K 30:23:25 Kg/acre and irrigated by canal water. The harvesting of selected lines was done at the end of April 2020. The yield contributing traits of five plants from each replication of each treatment were measured during the suitable stages of crop and calculated their means for statistical analysis. The detailed measurements of all physical parameters were given as follows: The plant height of five selected plants from each replication of all treatments was measured in cm by using height measuring tape at the stage of maturity. Plant height was measured from the base to the top of plant. The mean of these five plants was calculated for statistical analysis. The area of leaf from five selected plants was measured by using scale at mature leaf stage in cm. For this purpose length and width of each leaf were measured and calculated the area by multiplying them. The mean of all five plants was calculated for further analysis. The peduncle length of five selected plants was measured in cm by using measuring scale at stage of maturity. The mean of all five plants was calculated for further analysis. The number of tillers per plant was counted from five randomly selected plants at green leaf stage.The mean of all five plants was calculated for further analysis. The number of spikelets per spike was counted from five random plants at mature spike stage. The mean of all five plants was calculated for further statistical analysis. The number of grains per spike from five spikes of different plants of all treatments was counted after harvesting of crop. The mean of all five plants was calculated for further statistical analysis. The spike length of five plants from all treatments was measured in cm by using a scale at the stage of mature spike.The mean of all five plants was calculated for further statistical analysis. The 1000 grains weight from all replications of different treatments was measured in grams by using a weighing balance after harvesting. The mean of all five plants was calculated for further statistical analysis. The grain weight per spike of five plants from each replication of all treatments was measured in grams by using a weighing balance after harvesting. The mean of all five plants was calculated for further statistical analysis. The grain yield per plant of five plants from all replications of each treatment was measured in grams by using a weighing balance after harvesting. The mean of all five plants was calculated for further statistical analysis.

Statistical analysis

The obtained data was subjected to analysis of variance (Steel et al. 1997) by using Statistix 8.1. Significant difference among treatments was determined by employing Tukey's test at 5% probability level. Correlation was performed to study the association among quality traits and yield of different genotypes (Pearson 1901).

3 RESULTS

Morphological Parameters

Analysis of variance exhibited that the plant height data was significantly different for all genotypes on the other hand plant height was non-significant among the replications (Table 1). The Tukey's mean comparison test was used to compare the plant height of 10 wheat genotypes. This test declared that the genotypes sharing or having the same alphabet were close or similar to each other and the genotypes that did not share the letter were quite different from others (Table 2). In the graphical representation, the means of all genotypes have been shown clearly. Johar-2016 showed the maximum mean value for plant height (105 cm) on the other hand Chakwal-50 gave the minimum value for plant height (89.67 cm). All other genotypes fall between 94.33 cm to 101.33 cm. The analysis of variance showed that the peduncle length of all genotypes of wheat was significantly different from each other (Table 1). The Tukey's mean comparison test was used to compare the peduncle length of 10 wheat genotypes. This test declared that the genotypes sharing or having the same alphabet were close or similar to each other and the genotypes that did not share the letter were quite different from others (Table 2). The maximum peduncle length was observed in Aas-2011 (39.00cm) which was very close to the peduncle length of Kohistan-97 (38.50 cm) and the minimum value was given by Chakwal-50 (29.69 cm). The spike length of randomly selected five plants was measured and passed their means through the analysis of variance that exhibited the difference among the spike

Table 1: MSS of morphological parameters of wheat genotypes.

S.O.V	D.F	PH	FLA	PL	NTPP	NSPS	NGPS	SL	1000 GW	GWPS	GYPP
Treatment	9	52.76**	74.49*	30.40**	7.04**	12.44*	110.76**	4.46*	31.66**	0.58**	78.83**
Block	2	4.03ns	0.01	0.04ns	0.06ns	0.05ns	0.00	0.01ns	0.11ns	0.01ns	0.10ns
Error	18	4.82	0.06	0.05	0.08	0.07	0.07	0.04	0.04	0.02	0.02
Total	29	29.00	29.00	29.00	29.00	29.00	29.00	29.00	29.00	29.00	29.00

Different values derived from ANOVA indicate significant differences at probability; ** = $p \leq 0.01$; * = $p \leq 0.05$; ns = Non-significant.
Abberviations: S.O.V: Source of variation, D.F: Degree of freedom, PH: Plant height, FLA: Flag leaf area, PL: Peduncle length, NTPP: Number of tillers per plant, NSPS: Number of spikelets per spike, NGPS: Number of grains per spike, SL: Spike length, 1000 WT: 1000 grain weight, GWPS: Grain weight per spike, GYPP: Grain yield per plant.

Table 2: Mean comparison of Morphological traits of wheat genotypes

Genotypes	PH	FLA	PL	NTPP	NSPS	NGPS	SL	1000 GW	GWPS	GYPP
Kohistan-97	96.19a	35.65a	38.50b	12.10a	21.23c	49.37a	12.58a	39.34c	2.19ac	28.88a
Chakwal-86	101.33b	41.10c	37.45c	10.23ac	22.13ac	52.53ac	13.70b	41.30d	1.88c	22.48c
Maxi Pak-65	96.20c	36.49b	32.66ac	13.37b	22.07d	62.47c	12.73c	37.61a	2.04bc	25.99ac
36 ESWYT-142	95.17ac	27.36ac	36.83a	11.03b	17.10ab	45.07d	11.93d	32.48ac	2.05c	18.27b
36 ESWYT-145	99.33b	30.02d	31.89ac	10.03bc	19.23c	56.67b	13.35ad	36.30b	2.04cd	18.09d
AAS-2011	99.00c	41.10ad	39.00b	8.10cd	21.47cd	50.03bd	15.02c	34.48c	2.30ad	17.20ad
CHAKWAL-50	89.67d	29.21c	29.69c	11.33d	18.90de	45.37bc	11.10cd	34.06b	1.57c	15.34cd
JOHAR-2016	105.00ac	34.16ac	38.03d	12.00ad	20.57e	55.67c	13.94ab	39.89bc	2.53bc	22.08a
AKBAR-2019	96.00b	31.15ab	36.47ad	9.27c	23.93d	58.37b	13.40e	40.31cd	2.89c	27.43d
ANAJ-2017	94.33d	29.01c	34.00cd	11.60b	22.77c	60.30c	11.34c	41.57ad	2.96d	29.01c

length of these ten genotypes that was significant (Table 1). For mean comparison of wheat genotypes Tukey's test was applied. By this comparison, it was concluded that the genotypes with the same letters have no difference in spike length on the other hand the genotypes with different letters have significant differences in their spike lengths (Table 2). The highest value for spike length 15.02 cm was observed in Aas-2011 and the minimum value of spike length 11.10 cm was showed by Chakwal-50.

The leaf area of five plants of 10 genotypes of bread wheat has been measured and analyzed by analysis of variance that showed a significant difference among all genotypes (Table 1). For the mean comparison of 10 bread wheat varieties Tukey's test was selected which exhibited that the varieties with similar letters have no difference in their leaf area but the genotypes with opposite alphabets showed a clear difference among the measurements of leaf area (Table 2). The wheat varieties Chakwal-86 and Aas-2011 gave the maximum mean value (41.10 cm^2) for leaf area on the other side 36 ESWYT-142 was present with the lowest leaf area (27.36cm^2). All remaining varieties fall between the range of 36.49 cm^2 and 29.01cm^2. The means of five randomly selected plants for several tillers was calculated and its significance level under Randomized complete block design analysis of variance and it was resulted that the number of tillers per plant was highly different for all genotypes (Table 1). The mean comparison for the number of tillers per plant was also done by Tukey's test and it was shown that the genotypes with the same alphabets and other genotypes that share the alphabet were statistically the same. On the other hand, the wheat varieties with separate letters were quite different from each other (Table 2).

It resulted that all varieties contained various numbers of spikelets per spike (Table 1). To compare the means of all genotypes Tukey's mean comparison test has been performed. This test showed that the varieties with the same letter were similar to each other or maybe statistically close to each other and the genotypes with the changed letter showed various results for several spikelets per spike (Table 2). Anaj-2017 contained the highest number of spikelets per spike (23.93) and 36 ESWYT-142 contained the lowest number of spikelets per spike (17.10). The RCBD analysis of variance showed that there was a significant difference in the number of grains per spike among all genotypes of wheat (Table 1). After the calculation of means Tukey's mean comparison test was practiced and it showed that the genotypes with opposite letters were quite different from each other and the genotypes that have similar letters had no noticeable difference in several grains per spike (Table 2). The highest number of grains per spike was observed in Maxi Pak-65 (62.47) and the lower number 0f grains per spike was present in 36 ESWYT-142 (45.07). The 1000 grain weight of 10 genotypes have been measured and exhibited it to the analysis of variance that gave the highly significant difference among all the genotypes with respect to the 1000 kernel weight (Table 1). The comparison of 1000 grain weight of all genotypes has been performed by Tukey's test. By this test it was observed that the genotypes sharing the alphabet were statistically closed to each other, the varieties that have the same letter were similar to each other and the wheat genotypes have different letters show variation among them (Table 2). The maximum 1000 grain weight was observed in Akbar-2019 (41.57g) and the minimum value was 36 ESWYT-142 (32.48g).

Table 3: Correlation analysis of morphological traits of wheat genotypes

	PH	NTP	LA	PL	SL	NSS	NGS	GWS	TGW
NTP	0.067ns								
LA	0.500ns	-0.33ns							
PL	0.618*	0.261ns	0.519ns						
SL	0.808**	-0.15ns	0.739*	0.681*					
NSS	0.223ns	-0.34ns	0.439ns	0.186ns	0.324ns				
NGS	0.353ns	-0.53ns	0.085ns	-0.17ns	0.152ns	0.655*			
GWS	0.285ns	0.071ns	-0.18ns	0.238ns	0.151ns	0.553ns	0.595ns		
TGW	0.399ns	0.034ns	0.280ns	0.198ns	0.130ns	0.776*	0.625*	0.474ns	
GYP	0.173ns	-0.13ns	0.079ns	0.223ns	-0.05ns	0.708*	0.616ns	0.562ns	0.810*

The grain weight per spike of 10 genotypes of bread wheat has been measured and by the analysis of variance obtained high variation among all genotypes concerning the grain weight per spike (Table 1). By the results of Tukey's test it was declared that the genotypes having various letters showed variation among them and the varieties having same letters did not show clear variation (Table 2). The maximum grain weight per spike was found for genotype Akbar-2019 (2.96g) and the minimum value was Chakwal-50 (1.57g). The grain weight of five random plants has been measured and calculated their means for further analysis. The RCBD analysis of variance has been practiced on calculated means that showed that grain yield per plant was significantly varied among all genotypes of bread wheat (Table 1). The means of all genotypes were compared under the statistical test that showed that the genotypes share any single letter with each other then the means of grain yield per plant were close to each other for all genotypes but if they did not share any letter then variation was there (Table 2). The genotypes of wheat such as Akbar-2019 (29.01g) showed maximum and Chakwal-50 (15.34g) minimum values for grain yield per plant.

The correlation analysis (Table 3) reveals significant relationships among various plant parameters that influence grain yield per plant (GYP). Notably, spike length (SL) shows a very strong positive correlation with plant height (PH) and a significant correlation with peduncle length (PL), suggesting that taller plants with longer peduncles also have longer spikes. Additionally, peduncle length correlates positively with leaf area (LA) and number of tillers per plant (NTP). The number of grains per spike (NGS) is positively associated with the number of spikelets per spike (NSS), indicating that more spikelets typically yield more grains. Crucially, the 1000 grain weight (TGW) exhibits a strong positive correlation with yield, highlighting its significance in overall productivity, along with correlations with NGS and grain weight per spike (GWS). These findings underscore the importance of plant height, spike length, and grain weight as key contributors to enhancing grain yield.

4 | DISCUSSION

Morphological Parameters

This research was conducted to study the variation among wheat genotypes in the context to the morphological and quality parameters. Research was conducted on correlation studies of some spring wheat varieties in the aspect of quantitative and qualitative parameters with grain yield and found the significant difference for all traits among all genotypes by analysis of variance that supported our results that different genotypes of wheat contained different plant height (Hussain et al., 2012). It was studied that the yield and yield-related traits by gene action analysis and the results of their experiment showed significant variation among all genotypes for all studied traits that affirm our results (Sami-ul-Allah et al., 2010). An experiment was conducted to analyze the biometric characters of bread wheat in the past and exhibited a clear variation for most of the studied traits for all genotypes of wheat that strongly matched our results of significant variation in spike length of ten genotypes of bread wheat (Safeer-ul-Hassan et al., 2004). It was reported an experiment in which they performed the analysis of grain yield and other traits that help to improve the bread wheat cultivars. It was concluded that a significant deviation was present among all genotypes of bread wheat that was similar to our results (Kumar et al., 2016). It studied that the yield and gluten traits in bread wheat in previous years and observed the considerable variation for all yield-contributing and quality traits among all the genotypes that was assist our results of variation in the number of spikelets per spike (Kumar et al., 2017). It studied the difference in yield, technological, milling and rheological traits in Egyptian wheat varieties and observed that the number of grains per spike of all genotypes was quite different which matched our results of variation for grains per spike in wheat genotypes (Seleiman et al., 2010). The nutritional composition of different wheat varieties of Pakistan concluded that the range of 1000 grain weight of selected wheat genotypes was 31.108g- 43.602g strongly related to our values for 1000 grain weight of 10 different wheat genotypes (Khan Ikhtiar and Zeb 2007). The relationship of physiological traits with yield in bread wheat. The

experiment exposed that there was a significant difference among all genotypes for the trait of grain weight per spike affirming our results (Ashfaq et al., 2003). The effect of water stress on physical and yield characters in the anthesis stage of spring wheat varieties and observed that there was a great difference among all wheat genotypes in grain yield per plant that supported our results (Jatoi et al., 2011).

The correlation studies reveal intricate relationships between various agronomic traits. Notably, grain yield per spike is positively associated with tillers per plant, spikelets per spike, awn length, and 1000-grain weight, underscoring the importance of these traits in enhancing yield. Conversely, plant height demonstrates a negative correlation with grain yield per plant, indicating that shorter plants may be more advantageous for higher yields. Other traits, such as spike length and flag leaf area, also exhibit significant correlations, although the strength and significance vary between genotypic and phenotypic levels (Masood et al., 2014).

Conclusion

This study demonstrated significant variation among wheat genotypes in terms of yield-contributing traits and quality parameters. The findings highlighted that Johar-2016 exhibited the highest plant height, while Chakwal-50 recorded the lowest. Notably, Aas-2011 displayed the longest peduncle and spike lengths, with the maximum leaf area found in both Chakwal-86 and Aas-2011. Maxi Pak-65 showed the highest number of tillers and grains per spike, while 36 ESWYT-142 had the lowest values for these traits. Additionally, Akbar-2019 consistently ranked highest for 1000 grain weight and grain weight per spike. The correlation analysis revealed significant relationships among various traits, underscoring that plants with longer spikes and peduncles tend to yield more grains. These insights can guide breeders in selecting high-yielding wheat varieties, ultimately contributing to improved wheat production and food security.

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