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AGROMORPHOLOGICAL TRAITS AND COMPARATIVE PERFORMANCE FOR BOOSTING YIELDS IN WHEAT (*TRITICUM AESTIVUM* L.) GERMPLASM AND CLUSTER ANALYSIS

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Abstract

In the present study forty nine wheat collections characterized agromorphologically revealed high magnitude of genetic variability in 19 traits. Descriptive statistics demonstrated number of tillers was high from 3.90 - 8.26 with Mean ± SE 5.67 ± 0.13 and SD 0.92. Iqbal 2002 was the early maturing variety with 176 days following Bahawalpur 79 took 191 days to mature. Potohar 70 produced highest yield/plant (19.05 g) while lowest by Iqbal 2002 (8.05 g). Selection could be made per plant yield for promising plants for breeding purposes. Analysis of variance showed that 16 quantitative traits were significant except 02 while six qualitative traits were also significant excluding 02. Two distinct clusters were formed based on Euclidean distances for dissimilarities. Two varieties Potohar 70 and ANZA+2NS were found to be best performer for yield and yield related traits hence are recommended for crop improvement programs.

Introduction

Bread wheat (*Triticum aestivum* L.) being the most important cereal crop due to its high nutritive value, adaptation and multiple uses meets nutritional requirement and a guarantee to food security. It is foremost staple food of Pakistan along rice and occupies a central position in policies of agriculture as well. Pakistan stands one among top wheat producing countries of the world and the country produced over 25 million tons in 2019 to meet its domestic needs and play a vital role in economic stability (FAO/GIEWS, 2020) while estimates for 2020 are 26 Mt whereas for world 2020/2021 will be 768.49 million metric tons (Anonymous 2020).

It is the cheapest source of calories and proteins, after food use 10 per cent is retained for seed and industry for producing starch, paste, malt, dextrose and gluten etc., (Nawaz *et al*. 2013). Wheat is adapted to temperate regions of the world and was one of the earliest crops to be cultivated some 10000 years ago. Bread wheat is an allohexaploid with genome constitution AABBDD resulted from hybridization (Devos and Gale 1997). Generally wheat is a rabbi season crop requiring 4-6 weeks cold temperature.

Improvement of wheat and quality seed production requires a diverse germplasm as prerequisite. To feed the increasing population there is a need of improving yield potential per unit area and wheat breeding programs around the world are mandated with better quality, agronomic performance and disease resistance (Zhang *et al*. 2011). Grain production is a complex phenomenon, involving several contributing factors directly or/and indirectly and the breeder is naturally interested in exploring the extent of association of such traits (Kashif and Khaliq 2004). Selection for grain yield improvement can only be effective if sufficient genetic variability is present in the genetic material (Ali *et al*. 2008). The present study aimed to characterize and compare a set of 49 wheat genotypes/varieties for yield and related traits to identify promising one for future crop improvement program.

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Materials and Methods

A set of 49 wheat genotypes and varieties were planted at Hazara University Mansehra, Pakistan during winter 2018-2019 in three replications using RCBD. Spacing of 30 cm was maintained intraspecific with two rows of same genotype while a meter distance was kept interspecifically. Thinning was done after proper germination to keep optimum population density. Five healthy plants were selected randomly from each genotype for recording observations like quantitative traits including flag leaf area (cm^2), plant height (cm), No. of tillers $plant^{-1}$ (number), peduncle length (cm), spike length (cm), awn length (cm), spikelets/spike (number), nodes/plant (number), days to 50% headings (days), grains/spikelet (number), grains/spike (number), stem diameter (mm), harvest index (days), days to maturity (days), 1000 grains weight (g), yield/plant (g), grain filling duration (days), test weight (g), and kernel length (mm). Qualitative traits *viz.*, awn colour, kernel colour, straw colour, glume hairiness, glume colour, spike density, lodging resistance and pest resistance were also observed. Data were recorded following descriptor developed by IPGRI (IBPGR 1985). Statistical analysis was performed using MS Excel Windows XP Professional for basic statistics while ANOVA and LSD were done through MSTATC. For cluster analysis SPSS version 16 was also used.

Results and Discussion

Agromorphological traits showed high variability like Flag leaf area ranged from 41.78 to 66.60 cm^2 with Mean ± SE value of 53.16 ± 0.98 cm^2 having standard deviation 6.86 (Table 1). Flag leaf area is an important contributing trait with respect to increased yield as it helps in efficient utilization of sunlight and manufacturing of food (Monyo and Whittington 1973). Plant height varied from 65.58 to 113.7 cm with Mean ± SE and CV% 11.70%, respectively. Among 49 collections highest plant height was recorded for SA 42, Punjab 81 and Chenab 96 which were 113.7, 112.4 and 110.3 cm, respectively whereas lowest for ANZA + 2NS, Janbaz 81 and Dirk that were 76.44, 81.97 and 82.60, respectively. The magnitude of variability for number of tillers was also high as it varies from 3.90 to 8.26 with Mean ± SE 5.67 ± 0.13, along SD 0.92. Bogale *et al.* (2011) found CV% as 20.1% while present study showed 16.26% that showed more stability in this trait.

Spikelets/spike was found to range from 16.93-25.50 with Mean ± SE 20.65 ± 0.31 while CV was 10.66%. Highest number of spikelets/spike was found in Wardad 85 (25.50) while lowest was in Kiran (16.95). Moayedi *et al*. (2010) reported highest value was 16 and lowest 14. Highly significant differences were observed among varieties for number of grains per spikelet and Number of grains/spike as revealed by ANOVA (Table 1). Highest number of grains per spike were observed in Zamindar 80 that was 92.15 and lowest for Kiran was 66.7 (Zecevic *et al*. 2010). CV% value obtained were of nearest to that reported by Moghaddam *et al.* (1997) who reported 12.67% while current results are 12.51%. Number of days to maturity indicated that Iqbal 2002 was the early maturing variety with 176 days to mature whereas Bahawalpur 79 took 191 days to mature. CV% showed the one of the best value for selection of trait for recommendation at farmers' field (Anwar *et al.* 2009). Range of 1000-grains weight was found to be 230.98 - 270.87 g. SD for this trait was 11.60 with CV% 4.68. This trait is very important for comparing seed quality characteristics like healthiness and rich in nutrients (Yang *et al*. 2005, Dagustu 2008, Moayedi *et al*. 2010). Likewise grain filling duration played important contribution towards grain maturity and it indicated utilization of available resources for plants efficiently and timely. Highest yield/plant was produced by Potohar 70 (19.05 g) and the lowest by Iqbal 2002 (8.05 g) (Inamullah *et al.* 2006). Selection could be made per plant yield for promising plants and varieties/genotypes that will help to start comprehensive breeding program not only for this trait

Table 1. Descriptive statistics and Analysis of variance (ANOVA) for agromorphic traits in 49 wheat collections.

Varieties	Units	Mean±SE	SD	Min.	Max.	CV (%)	Replication (MS)	Genotype (MS)	Error (MS)	Probability	LSD values
Flag leaf area	Cm^2	53.16 ±0.98	6.86	41.78	66.60	12.91	131.72	84.20**	46.40	0.01	11.04
Plant height	Cm	93.14 ± 1.58	10.90	76.46	113.7	11.70	105.03	90.19**	43.76	0.00	10.72
No. of tillers/plant	Number	5.67 ± 0.13	0.92	3.90	8.26	16.26	0.35	1.08**	0.54	0.00	1.19
Peduncle length	Cm	35.37 ± 0.54	3.75	27.84	46.76	10.61	8.68	15.96**	10.00	0.03	5.13
Spike length	Cm	13.27 ± 0.25	1.76	9.00	16.50	13.29	0.69	7.33**	0.94	0.00	1.56
Awn length	Cm	6.95 ± 0.16	1.12	4.60	10.50	16.07	0.00	3.35**	0.39	0.00	1.02
Spikelets /spike	Number	20.65 ± 0.31	2.20	16.93	25.50	10.66	16.58	30.61*	19.04	0.025	7.07
Nodes/ plant	Number	3.50 ± 0.06	0.43	3.00	4.50	12.21	0.02	0.43**	0.23	0.00	0.77
Days to 50% headings	Days	137.93 ± 0.63	4.42	131.00	148.50	3.20	155.36	49.16^{NS}	59.72	0.07	-
Grains /spikelet	Number	4.21 ± 0.10	0.70	3.00	6.00	16.56	0.100	0.77**	0.44	0.01	1.07
Grains/spike	Number	76.86 ± 1.37	9.62	60.41	95.00	12.51	7.12	154.85**	36.83	0.00	9.84
Stem diameter	Mm	2.96 ± 0.06	0.40	2.29	3.79	13.41	0.13	0.36**	0.14	0.00	0.61
Harvest index	Days	37.66 ± 0.93	6.49	28.32	55.35	17.24	14.99	25.95**	11.75	0.00	5.54
Days to maturity	Days	184.11 ± 0.51	3.56	176.00	191.00	1.93	29.66	53.86**	17.38	0.00	6.76
1000 grains weight	Gram	247.74 ± 1.66	11.60	230.98	270.87	4.68	15.17	23.61**	10.48	0.00	5.25
Yield /plant	Gram	13.24 ± 0.35	2.43	7.46	19.06	18.31	1.29	14.75**	0.17	0.00	0.67
Grain filling duration	Days	46.72 ± 0.81	5.70	33.17	58.17	12.20	29.66	53.86**	17.38	0.00	6.76
Test weight	Gram	1.25 ± 0.01	0.06	1.10	1.39	4.88	0.00	0.01**	0.00	0.00	0.08
Kernel length	Mm	6.69 ± 0.07	0.49	5.57	7.85	7.26	0.01	0.36**	0.16	0.00	0.66

SE; Standard error: SD; Standard deviation: CV (%); Coefficient of variation in percentage: Min; Minimum: Max; Maximum: MS: Mean square: ^{NS} Non significant,* significant at 0.05 level of significance, **significant at 0.01 level of significance (highly significant): LSD; Least significant difference.

but for other combinations too. ANOVA revealed significant difference for all of the traits except harvest index and days to 50% headings.

Considerable variability was also observed for qualitative traits (Table 2). Among eight qualitative traits, glume hairiness, lodging resistance and pest resistance were predominant. Selection can be made for desirable traits like spike density as it has been classified into 5 categories *viz.*, very lax 1 (2 %), lax 8 (16.32 %), intermediate 30 (61.22 %), dense 8 (16.32 %) and very dense 2 (4.08 %). Similarly selection for hybridization can be for glume colour [white amber in 21 (42.85 %), disease resistance 27 (55.10%), pest resistance 33 (67.35 %), glume hairiness 8 (16.32 %), lodging resistance 36 (73.47 %), awn color white and amber 26 (53.06 %), and straw colour in 19 (38.77 %) as yellow colour] (Jaradat and Shahid 2014).

Table 2. Qualitative descriptors for 8 morphological traits in 49 wheat collections.

Traits	Frequency (n)	Percentage (%)	Traits	Frequency (n)	Percentage (%)
Spike density			*Glume hairiness*		
Very Lax	1	2	Present	8	16.32
Lax	8	16.32	Absent	41	83.67
Intermediate	30	61.22	*Lodging resistance*		
Dense	8	16.32	Present	36	73.47
Very Dense	2	4.08	Absent	13	26.53
Glume colour			*Awn colour*		
Black	1	2	Black	1	2
Black and white	9	18.36	Black & white	2	4.08
Brown and white	6	12.2	Brown & white	6	12.2
Grey	1	2	Grey	3	6.12
Red	6	18.36	White & amber	26	53.06
White and amber	21	42.85	Yellow	11	22.11
Yellow	5	10.2	*Straw colour*		
Disease resistance			Red	3	6.12
Present	27	55.10	White & amber	25	51.02
Absent	22	44.89	Yellow	19	38.77
Pest resistance					
Present	33	67.35			
Absent	16	32.65			

Cluster pattern was obtained using average linkage (between groups) which was divided into two clusters at 50% Euclidean distance. Cluster 1 consisted of 34 varieties/genotypes while cluster 2 had 15 (Fig. 1). Diversity within cluster is also presented in Table 3. Cluster 1 constitutes those collections which produced highest values for spike length, spikelet per spike, kernel length, 1000-grains weight, days to 50% headings, number of nodes per plant, number of grains per spikelet, number of grains per spike, harvest index, days to maturity, yield per plant, grain filling duration and test weight. Whereas 15 genotypes present in cluster 2 showed best performance for flag leaf area, plant height, peduncle length, number of tillers per plant and stem diameter. Considerable genetic divergence was also observed among 70 genotypes for various agromorphological traits through cluster analysis (Sultana *et al*. 2007, Ali *et al*. 2008). Iqbal *et al*. (2014) reported high diversity based on clustering pattern technique for *Nigella sativa* L. germplasm and depict the

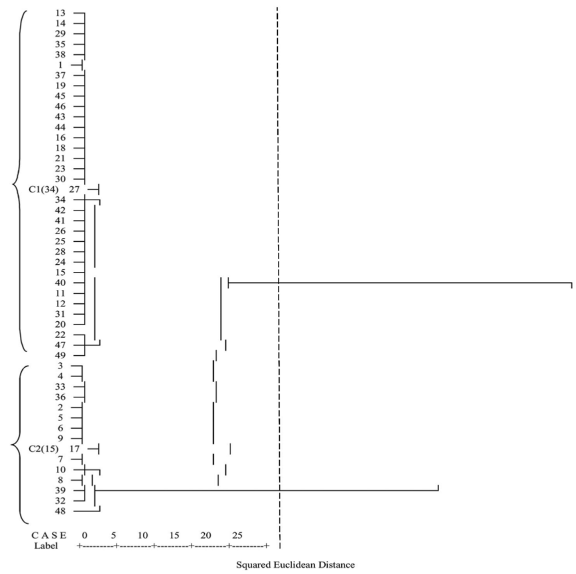

Fig. 1. Cluster diagram for 49 local wheat varieties based on agromorphological traits.

Table 3. Diversity within clusters obtained for agromorphological traits in 49 wheat collections.

Traits/ frequency	Cluster 1 (34 genotypes)	Cluster 2 (15 genotypes)
	Mean ± Sd.	Mean ± Sd.
Flag leaf area	56.89 ± 8.15	60.77 ± 8.49
Plant height	93.96 ± 12.49	102.63 ± 14.54
Peduncle length	35.53 ± 3.97	37.17 ± 5.0
Spike length	13.4 ± 2.0	13.24 ± 1.93
Spikelets/spike	21.22 ± 2.16	20.55 ± 2.17
Awn length	6.69 ± 1.18	6.97 ± 1.22
No. of tillers	5.74 ± 1.16	5.77 ± 0.99
Days to 50% headings	141.75 ± 10.0	138.86 ± 4.42
No. of nodes	3.48 ± 0.62	3.46 ± 0.51
No of grains/spikelet	4.31 ± 0.87	4.08 ± 0.77
No. of grains/spike	79.89 ± 14.52	75.51 ± 12.58
Stem Diameter	2.84 ± 0.51	2.86 ± 0.46
Harvest Index	38.18 ± 19.49	36.34 ± 6.28
Days to maturity	188.9 ± 7.98	184.73 ± 5.68
1000-grains weight	49.64 ± 4.07	48.38 ± 4.93
Yield/plant	8.85 ± 2.95	8.12 ± 1.7
Grain filling period	47.60 ± 12.42	46.66 ± 5.57
Test weight	1.26 ± 0.06	1.24 ± 0.05
Kernel length	6.68 ± 0.54	6.67 ± 0.40
Varieties/genotypes	Punjab 96, C-228, Shahkar 95, Punjab 88, Nuri 70, Punjab 81, C-591, C-250, Bahawalpur 79, Wardak 85, Kiran, Miraj 08, Sandal, FPD 08, Khyber 79, Sussi, Lasani 08, Pak 81, C-273, Pirsabak 85, Tandojam 83, Potohar 70, Potohar 93, SA-75, SA- 42, Marvat 01, C-518, Potohar 90, Blue silver, RWP-94, Sariab 92, Wafaq-2008, ANZA+2NS, and Janbaz.	Mummal 2002, Zamindar 80, Iqbal 2000, SH-2003, Anmol 94, LU-26, Chenab 96, Faisalabad 83, Zarghoon 79, C-228, Sutlag 86, Dirk, Barani 83, WL-711 and Lr51+YR.

usefulness of the technique for genetic resources conservation and management for crop improvement. Further, it also helps in selection even for single trait that can provide opportunities for future hybridization and breeding programs to obtain desirable results. Therefore it is suggested to use out performing genotypes/varieties with climatic adjustment for breeding purposes.

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