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Yield Performance and Factor Analysis for Superior Cultivars Identification in Wheat (*Triticum aestivum L.*)

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Abstract
The purpose of our study was to differentiate the varieties of wheat depending on their morphological traits relating to yield and to estimate those factors which are responsible for the highest yield plant $^{-1}$. The 26 different types of local wheat varieties were grown in the field conditions of Hazara University Mansehra, seeded in a Randomized Complete Block Design (RCBD) with 3 replications. Some of the Morphological traits were significant namely, spike length, flag leaf area, awn length, grains per spike, spikelets per spike, number of tillers, peduncle length, grains weight, and grain yield but others were non-significant such as, leaf angel, days to headings, days to maturity, plant height and harvest index. Kaghan-93 (7.77g plant^{-1}) was seen to be the highest production of yield and was observed best within 26 varieties. Factors examination exposed 5 essential factors that estimated 73.24% of the total differences, depending on principal component processes. One of these was awn length that seems to be 18.83% in the direction of the yield. While the second and third component were (16.38%) and (14.53%) for yield component and plant architecture respectively. The fourth factor was the growth factor which was estimated upto 12.86% and maturity parameters was 10.26%. Depending on these factors selection will be conducive to use highest yield genotypes and are suggested for further crop renovation programs.
Keywords: Wheat, morphological traits, varieties, harvest, parameters.

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INTRODUCTION

One the world's biggest wheat producing country is Pakistan with almost 23.42 million tons with its sophisticated region of 9.062 million hectare, while the production of grain obtained is 2585 kg/hectare (Anonymous, 2009). The increasing population day by day is one of the biggest factors to divert our attention towards the maximum yield of crops on sustainable foundations (Inamullah *et al.,* 2006). Agricultural characteristics are generally perceptible involving the grain production and responsible for the factors including either directly or indirectly (Khan and Dar, 2009; Ali *et al*., 2009). It is clearly implicit that grain yield in wheat included a variety of components and the factors such as cultivar appropriateness, husbandry and ecological circumstances affect these components. Thus, the aims of the propagation programs are to get the maximum production of grains (Inamullah *et al.,* 2006).

The Assortment method of yield and its component's relationship is difficult to understand, which can be easily understood by using different types of mathematical analysis (Guertin and Bailey, 1982). By using the multivariate technique it is reported that factor analysis is responsible for involvement of variables in fraction and giving additional information as compared to simple correlation matrix (Biabani and Pakniyat, 2008). Moreover, different types of variables are minimized to hidden factors by factor analysis and provide further knowledge and instructions (Azizi *et al*., 2001).

The present study was planned to differentiate the varieties of wheat depending on their morphological traits relating to yield and to estimate factors responsible for the highest yield plant $^{-1}$.

MATERIALS AND METHODS

The current study was conducted in investigational grassland of Department of Genetics, HUM (Pakistan) in 2010-2011 (the Rabi season). 26 different types of samples were grown-up in a RCBD with 3 types of study area. In investigational field each row having the distance of 30 cm between them was indicated as an experimental unit. 5 randomly special plants (not taking into account borders) were collected from all rows at the suitable development of plant, for diverse morphological characteristics. Number of tillers on each plant, days to 50% headings, flag leaf area, plant tallness, leaf position, peduncle, spike and awn length, spikelets per spike, days to maturity, number of grains per spike, harvest index, yield per plant and 1000 grains weight were the morphological characteristics. Data were calculated by LSD and ANOVA for demonstrating the results of significance and difference within traits which is being studied by utilizing statistical software namely 'MSTATC' while 'SPSS' (ver.16) was applied for factors analysis to demonstrate the results about contributory components.

RESULTS AND DISCUSSION

Genetic distinction was overdone by least significant differences within of 26 different types of local wheat samples as presented in Table 1. By applying ANOVA it was found that the traits were significant except for some factors such as, days to headings, leaf angle, plant tallness, harvest index and days to maturity. A trait that was noted to be non-significant should be abused further to get significant results. The seasonal circumstances such as rainwater, temperature variations, wetness contents accessibility, and suitable time of sowing should be in deliberation to achieve maximum productivity of traits that are important (Iqbal *et al*., 2010).

Table 1. Mean values for fourteen traits studied in twenty six local wheat varieties.

Sr. No.	VAREITIES	PARAMETER								
		Flag leaf area $(cm)^2$	No. of tillers/ plant	Spike length (cm)	Peduncle length (cm)	Awn length (cm)	Spikelets per Spike	Grains per spike	1000 Grains weight (g)	Yield per plant (g)
1	Kaghan 93	37.08^{CDEF}	5.000^{BCDE}	11.72^{BCDE}	36.45^{CDEFH}	5.790^{EF}	19.50^{AB}	35.58^{C}	43.43^{BCDEF}	7.773^{A}
2	Zamindar 80	30.84^{FG}	4.667^{BCDE}	11.27^{BCDEF}	38.21^{BCDE}	6.550^{BCDE}	17.50^{FGH}	32.16^{F}	42.27^{BCDEF}	6.310^{CD}
3	Rawal 87	37.67^{CDEF}	6.000^{ABC}	12.47^{ABC}	33.13^{GHI}	5.500^{EF}	20.00^{A}	35.41^{CD}	40.89^{BCDEFG}	5.843^{DEF}
4	Pak 81	35.02^{EFG}	4.667^{BCDE}	12.23^{ABCD}	33.30^{GHI}	6.423^{BCDE}	19.08^{BC}	35.92^{C}	1.073^{H}	5.850^{DEF}
5	Chenab 70	37.09^{CDEF}	7.000^{A}	10.37^{EF}	37.12^{CDEFGH}	6.390^{BCDE}	20.00^{A}	31.89^{FG}	41.57^{BCDEFG}	6.037^{CDE}
6	Za 77	39.20^{BCDE}	5.333^{ABCD}	11.23^{BCDEF}	37.18^{CDEFGH}	5.223 F	19.42^{AB}	24.21^{N}	41.68^{BCDEFG}	4.533^{HIJ}
7	Punjab 96	41.22^{ABCDE}	6.000^{ABC}	10.33^{EF}	33.37^{GHI}	5.833^{EF}	16.25^{J}	27.33^{K}	36.60^{FG}	6.510^{CD}
8	Bahawalpur 79	33.53^{EFG}	5.667^{ABCD}	11.56^{BCDEF}	43.38^{A}	6.957^{BCD}	18.15^{DEF}	30.62^{I}	45.06^{BCDEF}	5.817^{DEF}
9	Nuri 70	36.74^{CDEFG}	4.667^{BCDE}	10.60^{DEF}	41.92^{AB}	6.367^{BCDE}	17.17^{HI}	37.68^{B}	47.14^{BC}	7.260^{AB}
10	C 273	38.03^{BCDEF}	4.333^{CDE}	10.92^{BCDEF}	32.67^{HI}	6.567^{BCDE}	18.13^{DEF}	31.89^{FG}	46.75^{BCD}	4.093^{JKL}
11	Mumal2002	36.37^{CDEFG}	6.000^{ABC}	11.37^{BCDEF}	38.13^{BCDEF}	6.157^{CDEF}	17.33^{GHI}	37.69^{B}	40.58^{BCDEFG}	5.810^{DEF}
12	Wadanak 98	36.29^{CDEFG}	4.333^{CDE}	10.72^{CDEF}	36.33^{CDEFGH}	6.523^{BCDE}	16.58^{IJ}	26.06^{L}	44.03^{BCDEF}	4.340^{IJK}
13	Chenab 96	38.64^{BCDEF}	6.333^{AB}	9.800^{F}	38.89^{ABCD}	6.090^{CDEF}	18.58^{CD}	31.15^{GHI}	39.56^{CDEFG}	5.470^{EFG}
14	Zarghoon 79	35.47^{CDEFG}	4.333^{CDE}	11.09^{BCDEF}	34.30^{EFGHI}	6.103^{CDEF}	17.58^{EFGH}	25.72^{LM}	33.29^{G}	4.843^{GHI}
15	Tandojam 83	36.85^{CDEF}	4.333^{CDE}	11.23^{BCDEF}	33.94^{EFGHI}	7.353^{AB}	18.17^{DEF}	34.62^{DE}	37.55^{EFG}	6.687^{BC}
16	Potohar 93	35.37^{DEFG}	4.000^{DE}	11.97^{ABCDE}	40.62^{ABC}	6.407^{BCDE}	18.08^{DEFG}	30.90^{HI}	39.87^{CDEFG}	5.467^{EFG}
17	Khyber 83	36.18^{CDEFG}	5.000^{BCDE}	11.69^{BCDE}	38.32^{BCDE}	6.183^{CDEF}	19.15^{BC}	33.86^{E}	49.17^{AB}	5.537^{EFG}
18	Shalimar 88	43.32^{ABC}	5.000^{BCDE}	12.10^{ABCDE}	33.54^{GHI}	8.050^{A}	18.30^{DE}	35.87^{C}	43.46^{BCDEF}	5.177^{FGH}
19	Iqbal 2000	47.21^{A}	4.000^{DE}	12.74^{AB}	36.99^{CDEFGH}	6.060^{CDEF}	18.17^{DEF}	21.07^{P}	45.94^{BCDE}	3.480^{LM}
20	Wadanak 85	43.07^{ABCD}	4.000^{DE}	13.75^{A}	34.88^{DEFGHI}	6.967^{BC}	19.92^{A}	31.69^{FGH}	38.76^{CDEFG}	5.517^{EFG}
21	Anmol 91	45.63^{AB}	4.667^{BCDE}	11.22^{BCDEF}	40.50^{ABC}	5.500^{EF}	18.07^{DEFG}	21.28^{OP}	37.91^{DEFG}	3.170^{M}
22	Sh 2003	34.68^{EFG}	4.333^{CDE}	11.35^{BCDEF}	37.45^{BCDEFG}	7.057^{ABC}	16.19^{J}	30.94^{HI}	57.67^{A}	4.457^{HIJ}
23	Potohar 70	34.88^{EFG}	4.667^{BCDE}	11.52^{BCDEF}	34.43^{DEFGHI}	5.857^{EF}	17.42^{FGH}	25.08^{M}	40.65^{BCDEFG}	4.080^{JKL}
24	Drawar 96	37.41^{CDEF}	4.667^{BCDE}	12.22^{ABCD}	33.61^{FGHI}	6.157^{CDEF}	18.42^{CD}	29.02^{J}	38.15^{DEFG}	4.357^{IJK}
25	Barani 70	36.95^{CDEF}	3.333^{E}	10.56^{DEF}	34.42^{DEFGHI}	5.883^{DEF}	16.17^{J}	21.99^{O}	42.80^{BCDEF}	3.907^{JKLM}
26	Faisalabad 85	28.93^{G}	4.333^{CDE}	12.07^{ABCDE}	31.18^{I}	6.257^{CDEF}	16.83^{HIJ}	40.39^{A}	41.78^{BCDEFG}	3.707^{KLM}
	LSD value	**7.897**	**1.755**	**1.848**	**4.579**	**1.075**	**0.7622**	**0.7967**	**8.973**	**0.7407**

Table 2. Analysis of variance (ANOVA) for 14 traits in 26 local wheat varieties.

Sr. No.	Traits	Mean Square			Probability
		Replication	Genotype	Error	
1	Flag leaf area	313.774	49.549*	23.188	0.0112
2	Number of tillers	6.705	2.162*	1.145	0.0280
3	Leaf angle	269.751	27.807 NS	28.773	
4	Number of days to 50% headings	28.167	8.558 NS	5.888	0.1886
5	Plant height	54.995	56.928 NS	38.190	0.113
6	Peduncle length	15.801	28.755**	7.796	0.0000
7	Spike length	2.827	2.187*	1.270	0.0510
8	Awn length	1.234	1.118**	0.430	0.0020
9	Spikelets per spike	0.184	4.075 **	0.216	0.0000
10	Number of days to maturity	48.154	11.307 NS	11.007	0.4539
11	Grains per spike	0.235	85.724**	0.236	0.0001
12	Yield per Plant	0.190	4.162 **	0.204	0.0000
13	Harvest Index	50.588	89.212 NS	114.394	
14	Thousand (1000) Grains Weight	41.896	69.438**	29.936	0.0057

NS Non-significant, *Significant at 0.05 level of significance, **Significant at 0.01 level of Significance (Highly significant).

Table 3. Contribution of five factors towards yield in 26 local wheat varieties.

Sr. No.	Traits	Component 1	2	3	4	5
1	Flag leaf area				.616	
2	Numbers of tillers		.718			
3	Leaf angle			.705		
4	Spike length					.675
5	Plant height			.515		
6	Spikletes per Spike			.335	.555	
7	Peduncle length				.494	
8	Awn length	.771				
9	Harvest Index				.413	
10	Gains per spike	.	.620			
11	Days to heading					.347
12	Grains weight				.301	
13	Days to maturity				-.	.311

Table 4. Total variance explained in 26 local wheat varieties.

Component	Initial Eigen values			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.448	18.831	18.831	2.448	18.831	18.831
2	2.131	16.389	35.220	2.131	16.389	35.220
3	1.889	14.532	49.752	1.889	14.532	49.752
4	1.672	12.863	62.615	1.672	12.863	62.615
5	1.381	10.626	73.240	1.381	10.626	73.240
6	.747	5.748	78.988			
7	.691	5.312	84.300			
8	.614	4.727	89.027			
9	.506	3.893	92.920			
10	.370	2.843	95.763			
11	.232	1.783	97.546			
12	.173	1.330	98.875			
13	.146	1.125	100.000			

The significant value for the biggest flag leaf area was illustrated in table 2 (Iqbal-2000) while Chenab-70 seemed to be the highest number of tillers. Wadanak-85 was noted having highest spike length while in Bahawalpur-96 highest peduncle length was noted. In Shalimar-88 longest awn length was recorded and elevated number of spikelets on each spike were recorded in ZA-77 and Chenab 70, respectively, While highest grains per spike was noted in Faisalabad-85, highest 1000 grain weight was seen in SH-2003 and maximum yield per plant in Kaghan-93. In Chenab-70 (7.00) the maximum number of tillers was obtained and these conclusions are sustained by the results of Kahrizi *et al.,* (2010).

The findings about the grains quantity on each spike were greatest in Faisalabad-85 (40.39g) which are in accordance to Hussain et al. (1997). Furthermore, Jabbar et al. (1999) illustrated that grain number is varying within the range 40-59 grains per spike among different genotypes of wheat. 1000 grain weights seemed to be considerable in the SH-2003 (57.67g), which is in agreement with the conclusion of previous researchers (Afzal and Nazir, 1986; Sharar *et al*., 1989). There is maximum plant height of 70-100 cm, reported by Fischer and Quail (1990) and Richards (1992) which is in agreement with our results. These best quality varieties are important and could be utilized for broad choice of hybridization and breeding programs.

To conclude the traits relationship and to discover the traits that are hidden, factor analysis was implemented (Table 3). As factor analysis can be integral of stage regression analysis and path coefficient analysis citing supplementary information (Azizi *et al*., 2001). Each factor is influenced by some traits which is resultant of characteristics (Mansouri *et al*., 2004). 5 factors represents 73.24% of total deviations was calculated by factor examination (Table 3). The first one indicated 18.83% of production of grains and awn length (Table 4). These findings are in agreement with Vahid *et al*., 2011. The contribution of number of tillers and grains per spike indicated that the second one was 16.38% of yield component. Some factors (the length of spike, peduncle and fertile tiller) are called plant growth factor (Vahid *et al* 2010).

Third factor was 14.53% of variation (plant height, leaf angle and spikelets per spike) which was recognized as plant structural design. The fourth factor in which included the flag leaf region, spikelets on each spike, peduncle extent, harvest index and grains weight and called as growth factor (12.86% to yield). The fifth factor (Spike length, days to development and days to 50% headings) was maturity parameters with 10.62% involvement in the direction of yield.

CONCLUSION AND SUGGESTIONS

The current study suggested that the best genotype according to the highest yield is Kaghan-93 especially in Hazara region circumstances. In propagation potential, selection of such genotypes ought to be prepared depending on several factors namely, awn length, number of tillers, plant height and production of grain yield to fulfill the highest production of grain needs in the kingdom.

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CONFLICT OF INTEREST

The authors confirm that this article content has no conflict of interest.

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