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Performance of Recently Released Wheat Cultivars

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Abstract: Evaluation of newly brad and released wheat cultivars is critical in formulating production recommendations about a particular cultivars. Nine wheat cultivars (Nowshera- 96, Sulman-96, and Saleem-2K, Dera-98, Daman-98, Raj', and Naseer 2K, Tatara, and Fakhre Sarhad) released during the past seven years were evaluated at Agricultural Research Institute Tarnab, Peshawar, during 2000-2001 and 2001-2002 crop seasons. A Randomized Complete Block Design with three replicates was used during each year. Each experimental plot had four rows, spaced 0.30 m apart and 3.5 m long. Sowing was done on November 8, 2000 and November 5, 2001, using a seeding rate of 90 kg ha^{-1}. Soil type was clay loam, wherein 120 kg N (half at sowing time and remaining half at flag leaf stage), 90 kg P and 60 kg K ha^{-1} was applied each year. Highly significant genetic difference were observe among cultivars for biomass, straw and grain yield, spikes m^{-2}, grains $spike^{-1}$, and 1000 cyrain weight during both years. Cultivars were highly consistent in performance across years for plant height (r= 0.97, P < 0.01), biomass (r = 0.98, P < 0.01), grains $spike^{-1}$ (r= 0. 99, P < 0. 0 1) and 1000 grain weight (r= 0. 74, P < 0. 0 1). Fakhre Sarhad had consistently out standing performance among cultivars, producing 67 and 69% more biomass, 68 and 63% more straw, and 64 and 79% more grains than the lowest yielding cultivars during 2001 and 2002, respectively. Fakhre Sarhad also produced comparatively more spikes m^{-2} , and grains $spike^{-1}$ than other cultivars during both years. Highly significant and positive correlation of plant height vs. biomass (r-> 0, 7 1, P < 0. 0 1), and biomass vs. straw yield (r-> 0. 90, P < 0. 0 1) was contributing component (r-> 0.87, P < 0.02), but relationship among the yield components was not existent.

Key words: Wheat cultivars, performance, central region, NWFP

Introduction

The total area of wheat in the North West Frontier Province (NWFP) during 1976-77 was 0.707 m ha it a total production of 0.687 in tons, which has increased to 861 m ha and 1215 m tons during 1998-99. This is equivalent to 22 and 77% increase in the total area and production during the past 25 years. Similarly, the average grain yield has increased from 972 kg ha^{-1} in 1976-77 to 1409 kg ha^{-1} in 1998-99 (Govt. of Pak. 1999-2000), representing a 45% increase. This increase in total production and h^{-1} yield is due to the release of high yielding, fertilizer responsive, and disease resistant wheat cultivars. However, the current average yield of wheat in NWFP is still not only lower than other wheat producing countries of the world but also other provinces of Pakistan. Non availability of certified seed of the recommended wheat cultivars for different agro ecological regions of the province is one of the major reasons for low wheat yields. The government of NWFP has recently established the Frontier Seed Industry to ensure timely supply of certified quality seed of the newly released cultivars to the growers for boosting up wheat production in the province.

Grain yield is a function of yield components: namely, the number of spikes $unit^{-1}$ area, the number of grains $spike^{-1}$, and the weight $grain^{-1}$ (Krenzer, 2000). Subsequent research has shown that cultivars differ in these genetically determined yield components (Grafius, 1956; Akbar *et al*., 2000). Significant interactions between cultivars and years for grain yield and other components have been reported (Briggs and Aytenfisu, 1979). It has been suggested that new wheat cultivars, particularly if they differed from existing cultivars, should be tested at a wide range of seeding dates, seeding rates, fertilizer rates, and years/locations to determine their optimum yield potential and stability across environments(Briggs and Aytenfisu, 1979; Faris and De Pauw, 1981). Delayed planting past the optimum time, very low or high seeding and fertilizer rate than the recommended, and inappropriate environment leads to reduced grain yield and poor performance. However, these recommendations have not changed since they were established well before the introduction of the first semi-dwarf cultivars more than 30 years ago. Furthermore, these recommendations were never intended for use with specific cultivars. The agronomic performance characteristics of wheat have changed considerably with the introduction of the semi-dwarf growth habit.

The objective of this study was to know the relative performance of recently released wheat cultivars in the central region of NWFP. We also wanted to compare the

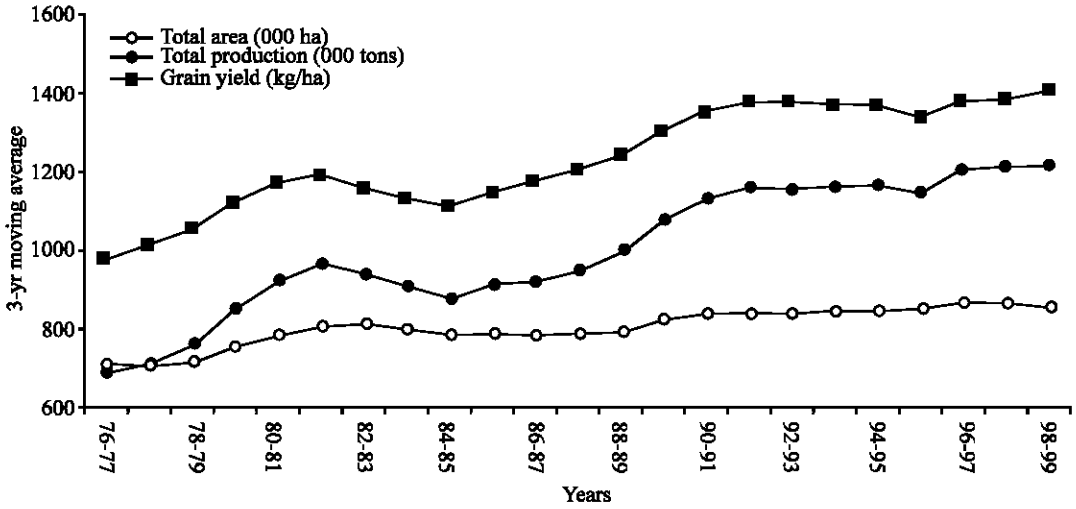

Fig. 1: Three-year moving average area, production, and grain yield of wheat in NWFP, 1976-1977 to 1998-1999 (Mean of 1976-77 is the average of 1975-76, 1976-77 and 1977-1978 to reduce the environmental bias due to years)

wheat cultivars released by different breeding programs of the province for various morphological and yield traits under identical management practices.

Materials and Methods

This study was conducted at Agricultural Research Institute, Tarnab, Peshawar, during the crop seasons 2000-2001 and 2001-2002 (hereafter referred to as 2001 and 2002, respectively). Nine wheat cultivars released during the past 7 years by the wheat breeding programs at the Cereal Crops Research Institute (CCRI), Pir Sabak, Nowshera, Agricultural Research Institute (ARI), DI. Khan, and Nuclear Institute for Food and Agriculture (NIFA), Tarnab, Peshawar, were evaluated. These cultivars were Nowshera-96, Suleman-96, and Saleem-2K (released by CCRI, Pir Sabak), Dera-98, Daman-98, Raj, and Naseer-2K (released by ARI, DI. Khan), and Tatara, and Fakhre Sarhad (NIFA, Peshawar); hence representing three different and independent breeding programs of NWFP.

A Randomized Complete Block Design with three replicates was used both during 2001 and 2002. Each plot had four rows, spaced 0.30 m apart and 3.5 m long. Planting dates for 2001 and 2002 Experiments were November 8, 2000, and November 5, 2001, respectively, using a seeding rate of 90 kg ha^{-1}. The previous crop during both years was maize. The soil was clay loam (35.0% clay, 40.4% silt and 24.6% sand) with a pH of 8.1 to 8.7 and average organic matter of 0.50 to 0.58% during 2001 and 2002, respectively. A basic dose of 120 kg N, 90 kg P and 60 kg K was used during both years. Nitrogen was applied in splits, half at sowing time and the remaining half at the flag leaf stage.

Data were recorded on plant height (average height of five randomly selected plants at physiological maturity in each plot); bio-mass (total weight of ground harvested wheat from the whole plot), grain yield (weight of grains after threshing the sun dried wheat bundle from each plot), straw yield (biomass minus grain yield), spikes m^{-2} (number of spikes in two random measurements of one square meter), grains $spike^{-1}$ (average number of grains from ten randomly selected spikes), and 1000-grain weight (average weight of 200 whole grains from each plot times five). Data were analyzed for each year independently, and protected least significant difference (LSD) values were calculated for comparison of cultivars means using MStat-C. Within year and across years phenotypic correlations wee also estimated to know the relationship among different traits and cultivars performance across years.

Results and Discussion

Highly significant genetic difference were observed among cultivars for all traits during both years, except the number of grains $spike^{-1}$ in 2002 as given in Table 1 and 2. The error mean squares and coefficients of variation (CVs) were comparatively larger during 2002 than 2001. Genetic differences among cultivars were also observed when data were analysed across years; however, cultivar by year interaction was not existent for any trait indicating consistent performance of cultivars across the two years. The strong correlation among years for all traits ($r = 0.74$-0.98, $P<0.01$) also indicates the absence of cultivars x year interaction, confirming the consistent performance of cultivars across year as mentioned in Table 4.

Weather conditions were comparatively more conducive for wheat growth and development during 2002 than 2001

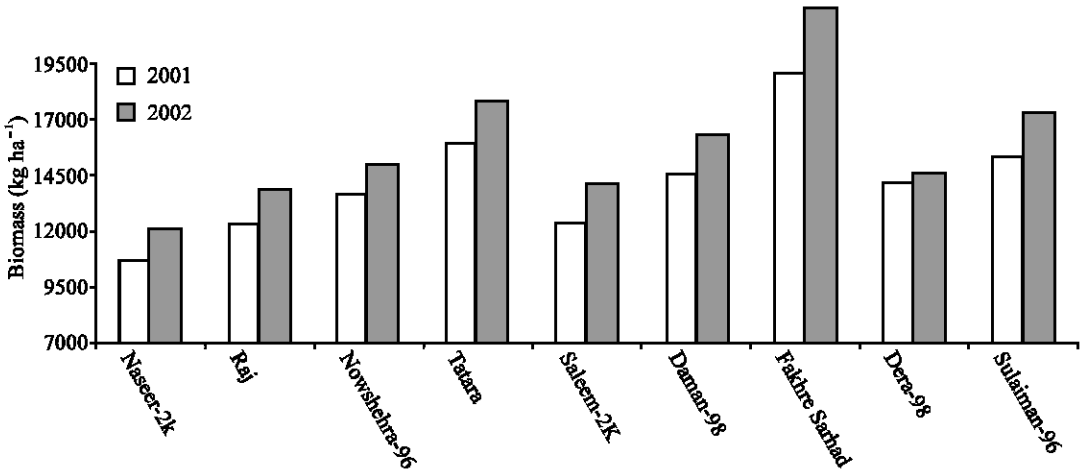

Fig. 2: Biomass (kg ha^{-1} of 9 wheat cultivars; evaluated during 2001 and 2002 at Agricultural Research Institute, Tarnab, Peshawar ($LSD_{(0.05)}$ for comparing cultivars during 2001 and 2002 is 488 and 2157 kg ha^{-1}, respectively)

Table 1: Mean squares and coefficients of variation (C.V.) for plant height, biomass, and straw yield of nine wheat cultivars evaluated at Agricultural Research Institute, Tarnab, Peshawar during 2001 and 2002

Source of Variation	df	Plant height		Biomass		Straw yield	
		2001	2002	2001	2002	2001	2002
		--cm--		--kg ha^{-1} x10 3 --		--kg ha^{-1}x 10^{3}--	
Cultivar	8	307.2**	273.8**	11060.2**	15626.7**	5697.0**	7003.1**
Error	16	6.9	28.3	79.3	1552.3	72.2	2520.8
C.V. (%)	--	2.8	5.5	2.2	8.8	3.2	17.6

Significant at 1%

Table 2: Mean squares and coefficients of variation (C.V.) for grain yield, spikes m^{-2}, grains spike^{-1}, and 1000-grain weight of nine wheat cultivars evaluated at Agricultural Research Institute, Tarnab, Peshawar, during 2001 and 2002

Source of Variation	df	Grain yield		Spikes m^{-2}		Grains spike^{-1}		1000-grain wt..	
		2001	2002	2001	2002	2001	2002	2001	2002
		-- kg ha^{-1}x103 --		-- no--	-- no --	--g--			
Cultivar	8	1157.3**	2063.5**	7229.0**	7926.5*	50.2**	44.4ns	35.4**	53.7**
Error	16	2.2	456.4	131.4	100.7	0.2	17.3	5.4	7.7
C.V. (%)	-	1.3	13.1	8.8	3.2	0.7	9.8	6.1	6.9

NS.*.** Non-significant, significant at 5% and 1% respectively

Table 3: Means for plant height, straw yield, spikes m^{-2}, grains spike^{-1}, and 1000-grain weight of wheat cultivars evaluated during 2001 and 2002 at Agricultural Research Institute, Tarnab, Peshawar

Cultivar	Plant height		Straw yield		Spikes m^{-2}		Grains spike^{-1}		1000-grain weight	
	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002
	-- Cm --		-- kg ha-1 --		--- no.---		---- no.----		----g----	
Nasecr-2K	75	78	6553	7568	217	225	42	44	32.4	33.8
Raj	89	91	7301	7943	215	232	38	41	36.8	45.9
Nowshera-96	91	93	8083	8549	292	325	36	39	38.8	39.8
Tatara	102	105	9430	9863	332	352	41	43	37.8	38.6
Saleem-2K	82	90	6736	7568	308	335	41	44	33.9	33.4
Daman-98	102	102	8565	9397	302	331	43	45	40.3	41.0
Fakhre Sarhad	10 1	104	10977	12407	362	373	47	49	42.6	42.5
Dera-98	95	99	8343	8399	272	312	36	38	39.3	39.8
Suleman-96	103	108	8665	9623	314	338	34	37	42.0	44.2
Mean	93	97	8295	9035	290	314	40	32	38.2	39.9
LSDI	5	9	465	2748	20	17	1	7	4.0	4.8

resulting in consistently higher biomass of all cultivars in 2002 as shown in Fig. 2. Biomass of cultivars ranged form 9946 to 16566 kg ha^{-1} during 2001 and 11227 to 18961 kg ha^{-1} during 2002. This represents a difference of 67 and 69% between the lowest and highest biomass producing cultivars during 2001 and 2002, respectively. Average across cultivars, biomass was 12844 kg ha^{-1} in 2001 and 14176 kg ha^{-1} in 2002. Naseer-2K had the lowest, while Fakhre Sarhad the highest biomass during both years. Plant height of cultivars ranged from 75 to 103 cm in 2001,

averaging 93 cm across cultivars. During 2002, plant height ranged form 78 to 108 cm, averaging 97 cm across cultivars. Naseer-2K was the shortest, while Tatara, Daman-98, Fakhre Sarhad and Sulemen were the tallest cultivars during both years.

Variation among cultivars for straw yield was more obvious during 2001 than 2002. During 2001, Naseer-2K and Saleem-2K produced the lowest and statistically similar straw yield of 6553 and 6736 kg ha^{-1}, respectively, while Fakhre Sarhad produced the highest straw (10977 kg ha^{-1}). This is equivalent to 4423 kg ha^{-1} or 68% difference between the highest and lowest straw producing cultivars. During 2002, Fakhre Sarhad and Tatara had the highest and statistically similar straw yield of 12408 and 9863 kg ha^{-1}, respectively. The remaining seven cultivars were similar in straw yield even though their straw yield ranged from 7568 (Naseer-2K and Saleem-2K) to 9623 kg ha^{-1} (Suleman-96). Average across cultivars, straw yield was 8295 kg ha^{-1} in 2001 and 9035 kg ha^{-1} in 2002, showing a 9% more straw production during 2002.

The data given in Table 4 showed that mean height, biomass and straw yield of cultivars during 2001 were plotted against man height, biomass and straw yield during 2002 and correlation coefficients 0 were estimated to know cultivars performance across years following Falconer and Mackay (1996). Cultivars were highly consistent in height ($r = 0.97$, $P < 0.01$), biomass ($r = 0.98$, $P < 0.01$), and straw yield ($r = 0.97$, $P < 0.01$) across two years. As expected, plant height of cultivars had strong relationship with biomass ($r > 0.78$, $P < 0.01$) and straw yield ($r > 0.831$, $P < 0.01$) both during 2001 and 2002. this shows that taller wheat cultivars produce more biomass as well as straw.

Similar trends in performance of cultivars were also observed for grain yield and yield components during 2001 and 2002. Like vegetative traits (plant height, biomass and straw yield), all cultivars had higher grain yield during 2002 than 2001 as shown in Fig. 3. The same was also true for 2 yield components like spikes m^{-2}, grains $spike^{-1}$ and 1000-grain weight as given Table 3. Genetic difference among cultivars for grain yield were more during 2001 than 2002. During 2001. During 2001, cultivar Fakhre Sarhad had an, average grain yield of 5588 kg ha^{-1} (Fig. 3). Its close competitors were Suleman-96 and Tatara with an average yield of 5139 and 4740 kg ha^{-1}, respectively. Grain yields of all cultivars were significantly different from each other during 2001 except that of Saleem-2K (4640 kg ha^{-1}) and Daman-98 (4574 kg ha^{-1}). Naseer-2K, released by ARI DI khan, had the lowest grain yield of 3393 kg ha^{-1}, about 65% less grain production than Fakhre Sarhad. Like 2001, Naseer-2K was also the lowest grain producer during 2002 (3659 kg ha^{-1}). This may be due to non-adaptation of Naseer-2K to the irrigated conditions of Peshawar. Similarly, Fakhre Sarhad had the maximum grain yield of 6553 kg ha^{-1} during 2002 (Fig. 3). Its close competitors were Tatara and Suleman-96 with grain yield of 5871 and 5678 kg ha^{-1}, respectively. Averaged across cultivars, grain yield was 4549 and 5141 kg ha^{-1} during 2001 and 2002, respectively. This is equivalent to 592 kg ha^{-1} or 13% difference in grain yield between the two years. In spite of genetic differences among cultivars for biomass and grain yield, harvest index (grain yield/biomass) of cultivars did not differ from each other in either year (data not shown). Harvest index ranged from 33.3 (Tatara) to 40.7% (Saleem-2K) during 2001, averaging 35.5% across cultivars. During 2002, harvest index ranged from 33.0 (Naseer-2K) to 41.0% (Saleem-2K), averaging 36.7% across cultivars.

The yield components that determine grain yield include the number of plants $unit^{-1}$ area, number of spikes $plant^{-1}$, number of grains $spike^{-1}$ and weight $grain^{-1}$. A decrease in any of these factors can decrease wheat yield. However, wheat has a tremendous capability to compensate among these yield components (Krenzer, 2000). All yield components, spikes m^{-2}, grains $spike^{-1}$ and 1000-grain weight, were consistently lower during 2001 than 2002 (Table 3). During 2001, the lowest spikes m^{-1} were produced by cultivar Raj (215) and Naseer-2K (217), while the maximum spikes of 362 m^{-2} were produced by Fakhre Sarhad. During 2002, similar and lowest number of spikes m^{-2} were also recorded for Naseer-2K (225) and Raj (232), while Fakhre Sarhad had the maximum spikes m^{-2} (373), Averaged across cultivars, spikes m^{-2} were 290 during 2001 and 314 during 2002. This indicates 8% reduction in spikes m^{-2} due to year to year environmental variation. Drought stress during the tillering phase reduces number of tillers. If stress occurs when a certain tiller begins to develop, that tiller may abort and never appear. This greatly reduces the number of tillers that will ultimately form spikes (Krenzer, 2000).

All cultivars produced 2-3 less grains $spike^{-1}$ during 2001 than 2002 (Table 3). During 2001, cultivars Suleman-96 produced the lowest grains $spike^{-1}$ (34). In contrast, Fakhre Sarhad produced the maximum grains of 47 $spike^{-1}$ during 2001. Grains $spike^{-1}$ ranged from 37 (Suleman-96) to 49 (Fakhre Sarhad) during 2002, however, these differences among cultivars were not statistically significant (Table 3). Fakhre Sarhad has comparatively longer spikes than its contemporary cultivars, resulting in more grains $spike^{-1}$. Averaged across cultivars, grains $spike^{-1}$ were 40 during 2001 and 42 during 2002.

The minimum standard for 1000-grain weight for cultivar selection in wheat breeding programs is 28 g (Khalil *et al*., 2002). All cultivars had a 1000-grain weight of 33 g or

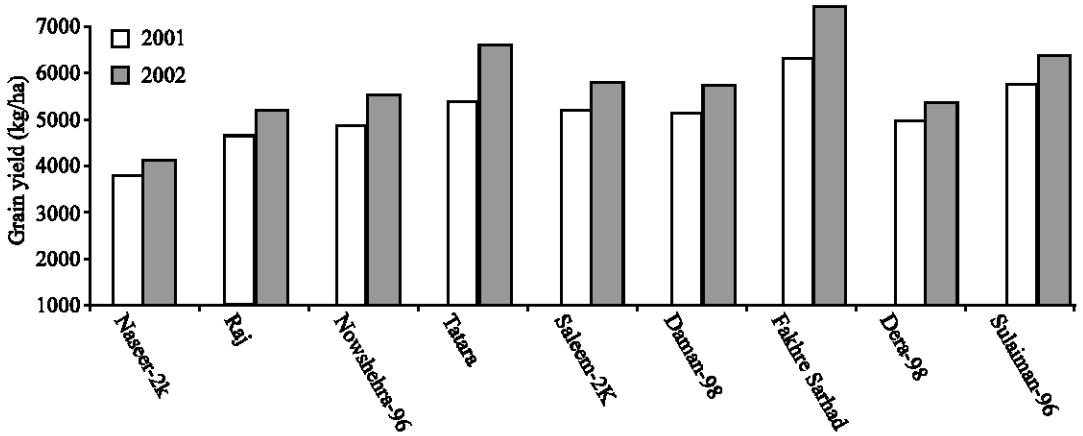

Fig. 3: Grain yield (kg ha^{-1}) of nine wheat cultivars evaluated during 2001 and 2002 at Agricultural Research Institute, Tarnab, Peshawar ($LSD_{(0.05)}$ for comparing cultivars during 2001 and 2002 is 81 and 1169 kg ha^{-1}, respectively)

Table 4: Phenotypic correlations and P-values (in parenthesis) among various agronomic traits during 2001 (above diagonal), 2002 (below diagonal), and between 2-yeas (on diagonal) of 9 wheat cultivars evaluated at Agricultural Research institute, Tarnab, Peshawar

Trait	Plant	Bio-mass	Straw yield	Grain yield	Spikes m^{-2}	Grains spike^{-1}	1000-grain weight
Plant height	0.97	0.84	0.83	0.77	0.68	-0.03	0.91
	(0.01)	(0.01)	(0.01)	(0.04)	(0.04)	(0.94)	(0.01)
Biomass	0.78	0.98	0.90	0.91	0.85	0.31	0.85
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.41)	(0.01)
Straw yield	0.71	0.98	0.97	0.86	0.78	0.34	0.83
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.38)	(0.01)
Grain yield	0.83	0.94	0.82	0.96	0.91	0.21	0.79
	(0-01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.59)	(0.01)
Spikes m^{-2}	0.78	0.78	0.70	0.87	0.98	0.20	0.09
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.61)	(0.82)
Grains spike^{-1}	0.12	0.39	0.43	0.28	0.33	0.99	-0.08
	(0.74)	(0.29)	(0.24)	(0.47)	(0.37)	(0.01)	(0.85)
1000-grain wt.	0.58	0.44	0.44	0.39	0.62	-0.30	0.74
	(0.09)	(0.23)	(0.23)	(0.29)	(0.06)	(0.44)	(0.01)

higher during both years, well above the standard weight of 28 g 1000^{-1} grains. During 2001, Naseer-2K had the lowest 1000-grain weight of 32.4 g, while Fakhre Sarhad had the highest 1000-grain weight of 42.6 g; this is equivalent to a difference of 10.2 g in weight of I 000-grains. Using least significant difference (LSD) value at 5% as a standard for mean separation, cultivars Nowshera-96, Daman-98, Fakhre Sarhad, Dera-98 and Suleman-96 had statistically similar 1000-grain weight during 2001 (Table 3). During 2002, Saleem-2K had the lowest 1000-grain weight (33.4 g), while cultivar Raj had the highest 1000-grain weight (45.8 g). Based on LSD value at 5%, Raj, Daman-98, Fakhre Sarhad and Suleman-96 had similar grain weight during 200 1. Averaged across cultivars, 1000-grain weight was 38.2 g during 2001 and 39.9 g during 2002.

Like vegetative traits, cultivars also had very consistent performance for grain yield and yield components across years. This is evident from the perfect positive correlation coefficient of grain yield in 2001 vs. grain yield in 2002 ($r = 0.96$, $P < 0.01$), spikes m^{-2} in 2001 vs. spikes m^{-2} in 2002 ($r = 0.98$, $P<0.01$), grains spike^{-1} in 2001 vs. grains spike^{-1} in 2002 ($r = 0.99$, $P < 0.01$) and 1000-grain weight in 2001 vs. 1000-grain weight in 2002 ($r = 0.74$, $P < 0.01$). Positive correlation of grain yield and yield components have been reported by previous researchers (Sultana *et al*., 2002) Grain yield of cultivars was strongly correlated with the number of spikes m^{-2} ($r = 0.91$, $P < 0.01$) and 2002 ($r=0.87$, $P < 0.01$). Through grain yield of cultivars had strong relationship with the 1000-grain weight during 2001 ($r = 0.79$, $P <0.01$), but this relationship was not significant during 2002 ($r=039$, $P = 0.29$). similarly, relationship among grain yield and number of grains spike^{-1} was not existent during the year ($r < 0.29$, $P > 0.47$). Hence, the number of spikes m^{-2} was the most important contributing component to grain yield during both years. Moreover, no relationship was observed within the yield components (spike m^{-2}, grains spike^{-1} and 1000-grain weight in either year as verified from Table 4.

Grain yield of recently released wheat varieties ranged from 3393 to 5871 kg ha^{-1} during the two years of study. This is equivalent to 2000 to 4500 kg ha^{-1} more yield than the average provincial yield. The existing yield gap can be reduced by popularizing the recently released wheat cultivars among wheat growers and educating them about the proper sowing timing, fertilizer dosage and time of application, and other management techniques.

References

Akbar, H.A., M. Ali, B. Shari, J. Ahmad, Bakht and H. Saeed, 2000. Comparative study of agronomic traits of old and new wheat varieties. Sarhad J. Agri., 16: 1-5.

Briggs, K.G. and A. Aytenfisu, 1979. The effects of seeding rate, seeding date and location on grain yield, maturity, protein percentage and protein yield of some spring wheats in central Alberta. Can. J. Plant Sci., 59: 1139-1145.

Falconer, D.S. and T.F.C. Mackay, 1996. Introduction to quantitative genetics. 4th ed. Longman Scientific and Technical, England.

Faris, D.G. and R.M. De Pauw, 1981. Effect of Seeding rate on growth and yield of three spring wheat cultivars. Field Crops Res., 3: 289-301.

Govt. of Pak., 1999-2000. Agricultural Statistics of Pakistan 1999-2000. Government of Pakistan. Ministry of Food, Agriculture and Livestock, Islamabad.

Grafius, J.E., 1956. Components of yield in oats: a geometrical interpretation. Agron. J., 48: 419-423.

Khalil, I.H., B.F. Carver, E.G. Krnzer, C.T. Mackown and G.W. Horn, 2002. Genetic trends in winter wheat yield and test weight under dual-purpose and grain-only management systems. Crops Sci., 42: 710-715.

Krenzer, E.G., 2000. Wheat growth, development and yield components. P 5-9. In T. A. Royer and E.G. Krenzer (ed.) Wheat management in Oklahoma. Oklahoma Coop., Ext. Serv. And Oklahoma Agric. Exp. Stn., E-83 1.

Sultana, S., M.A. Islam, MR. Islam and M.M. Morshed, 2002. Correlation and regression analysis for heading date, yield and yield contributing characters in wheat under water and phosphorus stress. Pak. J. Bio. Sci., 5: 149-15 1.