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ASSESSMENT OF YIELD CRITERIA IN BREAD WHEAT THROUGH CORRELATION AND PATH ANALYSIS

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ABSTRACT

The study was conducted at wheat Research Institute, Faisalabad during 2006-2008. Significant genotypic differences were existed among the genotypes. Correlation coefficients were computed for grain yield plant^{-1}, tillers plant^{-1}, spikelets spike^{-1}, 1000 grain weight, spike length, days to heading, days to maturity and plant height from the F1 crosses developed from four lines and three testers including their parents. The results revealed that grain yield plant^{-1} was positively and significantly correlated with number of tillers plant^{-1} and days to maturity at genotypic level but non-significantly correlated at phenotypic level. Days to maturity had positive genotypic correlation with grain yield plant^{-1}, number of tillers plant^{-1} and 1000-grain weight. Days to maturity and tillers plant^{-1} had positive direct effect on grain yield plant^{-1} also. Therefore, more days to maturity and more tillers plant^{-1} would be important selection criteria for improved grain yield plant^{-1} in the breeding material studied.

Keywords: Bread wheat; yield criteria, characters associations, path analysis

INTRODUCTION

Bread wheat is the most important and widely consuming cereal of Pakistan. Pakistan is one of the wheat producing countries of the world. The area under wheat cultivation in world during 2007-08 was 221 million ha, production 683 million tones and average yield 2750 kg ha^{-1} (USDA, 2009) where as Pakistan area under this crop in Pakistan was 9.062 million ha, production 23.42 million tones and grain yield 2585 kg ha^{-1} (Anonymous, 2009). To fulfill the gap between world yield and Pakistan yield there is a dire need to develop higher yielding varieties for vertically increasing population of the Pakistan.

Manifestation of wheat yield fluctuates widely as a result of its interaction with environment because grain yield is a complicated quantitative parameter and is the product of several contributing factors affecting grain yield directly or indirectly. Wheat production can be increased through development of productive genotypes/varieties for various agro-climatic conditions and stresses. Selection for grain yield improvement can only be effective if sufficient genetic variability is present in the genetic material (Ali *et al*., 2008). Genotypic and phenotypic correlations are important in determining the degree of association of various yield contributing parameters with grain yield with knowledge of their direct positive and negative effects in new genotypes for adopting suitable selection strategy.

Genotypic association is important in determining the degree to which various yield-contributing parameters are associated with grain yield plant^{-1} (Ali *et al*., 2009). Many earlier researchers studied genotypic correlation coefficients of various grain yield components with grain yield for its genotypic improvement (Shahid *et al*., 2002; Aycecik and Yildirim, 2006; Akram *et al*., 2008). Several researchers reported that grain yield was positively correlated with 1000-grain weight (Akram *et al*., 2008). Earlier researchers (Kashif and Khaliq, 2004) also concluded that yield components like tillers plant^{-1} had significantly contributed in grain yield development. They also concluded that number of heads m^{-2}, grains spike $^{-1}$ and 1000 grain weight are main contributors to grain yield in wheat. It was reported that grain yield plant^{-1} showed significant positive association with number of productive tillers plant^{-1} both at genotypic and phenotypic levels (Aycecik and Yildirim, 2006). It was reported that positive genotypic and phenotypic correlation of grain yield with number of tillers plant^{-1}, plant height, 1000-grain weight and spike length. Earlier researcher reported (Akram *et al*., 2008) that spike length had significant positive genotypic correlation with grain yield per plot, while plant height showed a strong negative genotypic correlation with grain yield per plot. Negative correlation of plant height with grain yield was e also reported (Shahid *et al*., 2002).

The number of spikelets spike $^{-1}$ was negatively associated with 1000-grain weight. It was reported that grain yield exhibited highly significant and positive correlation with tillers plant^{-1}; spikelets spike $^{-1}$ both at genotypic and phenotypic levels (Lad *et al*., 2003). Other breeders (Kashif and Khaliq, 2004) reported that plant height, spike length, spikelets spike $^{-1}$ and 1000-grain weights were positively and significantly correlated with grain yield at genotypic level. The present study was conducted to get information on the correlation of yield components with yield in wheat under normal irrigated conditions in the present breeding material for effective selection in segregating generations to find out transgressive segregates

MATERIALS AND METHODS

The present research was carried out Wheat Research Institute, Faisalabad during 2006-2008 under irrigated conditions. Nineteen wheat genotypes developed during Rabi season 2006 from crossing of four lines and three testers including the lines and testers were planted on November 19, 2007 in plot size of 2.5 meter single row in triplicate randomized complete block design. Spacing between plants and rows were kept as 15 and 30 cm, respectively. The cropping scheme was wheat-fallow-wheat for the experimental field. The land was prepared by two deep ploughing followed by plankings. The fertilizer rate was kept in the ratio 120:90:0 Kg of N: P: K per hectare. The field was irrigated prior to sowing as "rauni" and after attaining the proper soil moisture sowing was completed. First irrigation was applied the crop after 35 days and subsequent irrigations were applied at the start of flowering, anthesis and filling stages. The weeds were controlled chemically. At maturity ten guarded plants were randomly selected from each plot and data were collected for days to heading and maturity, plant height, number of tillers plant^{-1}, spike length, number of spikelets spike $^{-1}$, 1000-grain weight and grain yield plant^{-1}. The data were statistically analyzed using method of Steel *et al*. (1997). Data for the eight traits depicting significant difference were further analyzed and phenotypic and genotypic correlation coefficients and path coefficient analysis were computed according to Dewey and Lu (1959).

RESULTS AND DISCUSSION

Correlation among different traits is generally due to the presence of linkage and pleotropic effect of different genes. Environment plays an important role in the development of phenotypic correlation (Ali *et al*., 2009). In some cases, environment affects both the traits simultaneously in same direction or some time in different directions. Phenotypic correlation is the net result of genetic and environmental correlation. The dual nature of phenotypic correlation makes it clear that the magnitude of genetic correlation cannot be determined from phenotypic correlation.

The genotypic mean squares (Table-1) depicts that differences among the breeding material for days to heading, days to maturity, plant height, tillers plant^{-1}, spike length, spikelets spike^{-1}, 1000-grain weight and grain yield plant^{-1} were highly significant. The variety "FAISALABAD 2008" and the cross "FAISALABAD 83 × P B W 65 / ROER / 3 / PB6 / /MIRLOW/BUC" had highest grain yield per plant due to higher tillers per plant and higher grain weight while the later one had higher spikelets per plant, higher 1000- grain weight and more number of days taken to 50% maturity. The line PBW502 and the crosses "FAISALABAD 83×PBW502" and FAISALABAD 85 × PBW 65 / ROER / 3 / PB6 // MIRLOW/BUC were also good yield producers due to either one or the other grain yield components (Table-1). Table-2 further revealed that number of tillers plant^{-1} had positive genotypic correlation with grain yield plant^{-1} at 0.05 probability level. Similar results have been reported earlier (Usman *et al*. 2006). Days to 50% maturity had also significant positive genotypic correlation with grain yield plant. Grain yield per plant would increase if the genotype having higher number of tillers per plant and long duration in maturity would be selected. All other traits had non-significant genotypic and phenotypic correlation with grain yield plant^{-1}. Number of tillers plant^{-1} had significant genotypic correlation only with days to 50% maturity. This trait had non-significant correlations with all other traits.

Spikelets spike^{-1} had significantly negative genotypic correlation only with days to 50% heading while it had non significant correlation with all other traits at both genotypic and phenotypic levels.1000 grain weight had significant genotypic correlation only with days 50% to maturity. This genotypic association was also good association for grain yield improvement. It is further revealed that selection of long duration genotypes would have higher 1000-grain weight compared to short duration genotype in the breeding material under study. Spike length had significantly negative genotypic correlation only with days to 50% maturity. It would be decreased in long maturity genotypes. The correlations of days to 50% heading had non significant either negative or positive correlation with days to maturity but spike length had non-significant correlation with grain yield per plant so this negative association had ignorable hurdle in selection of long duration genotype for grain yield improvement. Similarly days to 50% maturity had also non-significant correlations with plant height. These results are in accordance with the earlier findings (Akram *et al*., 2008). Table-3 exhibited that all the traits exerted positive direct effect on grain yield but indirect negative effects exerted by others traits made genotypic association non significant in most of the cases. Spikelets spike exerted major direct effects on grain yield but all indirect effects made this association negative and non significant due to their negative indirect effects. Spike length also contributed positive direct effect but indirect effects exerted by number of tillers plant and days to 50% heading made this association non-significant and negative.

Days to 50% heading and plant height also contributed directly in the development of grain yield per plant but indirect effects through other traits made these associations non-significant, therefore these traits would not be nominated for effective selection in grain yield improvement. However, higher number of tillers per plant and more days taken to 50% maturity were the nominated traits for effective selection of genotypes for grain yield improvement.

The results concluded that of higher yielding genotypes may be selected by concentrating upon the more number of days to 50 % maturity and more number of tillers plant^{-1}. The variety "FAISALABAD 2008" had maximum grain yield plant due to maximum number of tillers plant and higher days to taken to 50% maturity followed by PBW502. The crosses "FAISALABAD 83 ×PBW65/ROER/3/PB6//MIRLOW/BUC" followed by FAISALABAD85×Faisalabad 2008 and FAISALABAD 85×PBW502 had higher grain yield plant^{-1} along with better tillers plant^{-1} and more days taken to 50 % maturity. All the phenotypic correlation with grain yield plant were non significant perhaps due to negative influence of environment on grain yield plant^{-1} .All the traits exerted positive direct effect on grain yield but indirect negative effects exerted by others traits made genotypic association non significant in most of the cases.

Table-1: Mean performances and ANOVA of 19 bread wheat genotypes evaluated during 2007-08

Genotypes	Grain yield plant^{-1}	Tillers plant^{-1}	Spikelets spike^{-1}	1000 grain wt	Spike length	Days to heading	Days to maturity	Plant Height
HI666/PVN"S"×PBW65/ROER/3/PB6//MIRLOW/BUC	15.20	9.93	23.65	31.33	12.43	101.33	151.33	95.00
HI666/PVN"S"×FAISALABAD 2008	13.40	10.50	20.67	30.72	11.97	103.33	152.00	93.00
HI666/PVN"S"×PBW502	13.67	9.07	18.13	33.80	11.10	107.00	151.67	93.33
HUBARA"S"×PBW65/ROER/3/PB6//MIRLOW/BUC	13.53	8.83	20.63	33.20	12.75	106.00	152.00	96.67
HUBARA"S"×FAISALABAD 2008	13.80	10.27	20.73	31.97	11.40	105.00	150.67	91.67
HUBARA"S"×PBW502	11.33	8.70	22.57	28.17	11.23	105.67	151.00	94.00
FAISALABAD 85×PBW65/ROER/3/PB6//MIRLOW/BUC	18.00	10.02	20.87	39.38	11.55	105.33	153.33	96.00
FAISALABAD 85×FAISALABAD 2008	13.87	10.67	19.63	33.40	11.83	105.67	153.67	99.00
FAISALABAD 85×PBW502	17.53	11.28	20.2	33.92	10.10	108.67	154.67	92.33
FAISALABAD 83×PBW65/ROER/3/PB6//MIRLOW/BUC	21.27	10.57	21.73	39.90	13.63	104.00	153.67	98.33
FAISALABAD 83×FAISALABAD 2008	11.70	10.77	20.47	34.20	13.42	103.00	153.33	96.33
FAISALABAD 83×PBW502	18.33	10.00	19.13	31.43	11.77	103.33	153.00	109.00
HI666/PVN"S" (L1)	15.87	9.40	23.13	26.97	12.70	106.33	149.67	94.00
HUBARA"S" (L2)	15.20	9.60	20.87	29.33	10.92	106.00	154.67	87.00
FAISALABAD 85 (L3)	16.60	11.17	20.33	34.43	10.17	105.67	153.67	101.67
FAISALABAD 83 (L4)	16.80	10.13	21.53	31.28	13.60	102.67	154.33	93.00
PBW65/ROER/3/PB6//MIRLOW/BUC (T1)	16.00	8.58	21.50	31.97	11.87	105.33	153.67	95.00
FAISALABAD 2008 (T2)	21.40	12.95	19.53	30.80	11.27	110.33	153.33	96.67
PBW502 (T3)	18.47	9.43	19.67	35.30	10.47	110	153.33	96.33
MS (Genotypes)	25.083	3.332	5.578	31.582	3.065	16.792	5.868	60.55
MS (Error)	0.242	0.40	0.938	0.255	0.165	0.78	2.205	2.078
F. Ratio	103.556**	8.333**	5.944**	123.748**	18.604**	21.541**	2.661*	29.138**
S.E.	0.284	0.365	0.559	0.292	0.234	0.51	0.857	0.832

Table-2: Phenotypic (rp) and genotypic correlation (rg) coefficients of some traits with grain yield in 19 bread wheat genotypes.

Trait		*Grain yield plant^{-1}*	*Tillers plant^{-1}*	*Spikelets spike^{-1}*	*1000 grain weight*	*Spike length*	*Days to 50% heading*	*Days to 50% maturity*
Tillers plant^{-1}	**r_P**	0.4105^{NS}	1					
	r_g	0.4872*	1					
Spikelets spike^{-1}	**r_P**	-0.094^{NS}	-0.1721^{NS}	1				
	r_g	-0.1433^{NS}	-0.3517^{NS}	1				
1000 grain wt.	**r_P**	0.3843^{NS}	0.1788^{NS}	-0.2586^{NS}	1			
	r_g	0.3885^{NS}	0.1872^{NS}	-0.3231^{NS}	1			
Spike length	**r_P**	-0.0931^{NS}	0.0025^{NS}	0.3349^{NS}	0.1338^{NS}	1		
	r_g	-0.0681^{NS}	-0.1103^{NS}	0.3989^{NS}	0.1361^{NS}	1		
Days to 50% heading	**r_P**	0.3364^{NS}	0.1491^{NS}	-0.3645^{NS}	-0.0083^{NS}	-0.6216^{NS}	1	
	r_g	0.3519^{NS}	0.2449^{NS}	-0.5045*	0.0159^{NS}	-0.6605**	1	
Days to 50% maturity	**r_P**	0.2963^{NS}	0.2071^{NS}	-0.3338^{NS}	0.3237^{NS}	-0.0476^{NS}	0.1426^{NS}	1
	r_g	0.5011*	0.4732*	-0.4343^{NS}	0.5621*	0.0192^{NS}	0.1564^{NS}	1
Plant height	**r_P**	0.2876^{NS}	0.1636^{NS}	-0.2643^{NS}	0.2607^{NS}	0.0748^{NS}	-0.14000^{NS}	0.0629^{NS}
	r_g	0.3260^{NS}	0.191^{NS}	-0.3048^{NS}	0.2788^{NS}	0.0458^{NS}	-0.1382^{NS}	0.1119^{NS}

Table-3: Direct and indirect effects of various traits on grain yield in 19 genotypes studied during 2007-08

Trait	*Tillers plant^{-1}*	*Spikelets Spike^{-1}*	*1000 grain wt*	*Spike length*	*Days to 50% heading*	*Days to 50% maturity*	*Plant height*	*Grain yield plant^{-1}*
Tillers plant^{-1}	(**0.2392**)	-0.2108	0.0295	-0.012	0.1631	0.1902	0.0881	**0.4872***
Spikelets spike^{-1}	-0.0841	(**0.5994**)	-0.0509	0.0434	-0.3359	-0.1745	-0.1406	-0.1433 ^{NS}
1000 grain wt.	0.0448	-0.1937	(**0.1576**)	0.0148	0.0106	0.2259	0.1286	0.3885 ^{NS}
Spike length	-0.0264	0.2391	0.0214	(**0.1087**)	-0.4398	0.0077	0.0211	-0.0681 ^{NS}
Days to heading	0.0586	-0.3024	0.0025	-0.0718	(**0.6659**)	0.0629	-0.0637	0.3519 ^{NS}
Days to maturity	0.1132	-0.2603	0.0886	0.0021	0.1042	(**0.4018**)	0.0516	**0.5011***
Plant height	0.0457	-0.1827	0.0439	0.005	-0.092	0.0449	(**0.4612**)	0.326 ^{NS}

Therefore; selection of the genotypes (homozygous lines and the plants in segregating population of the crosses) should be done very carefully keeping in view higher grain yield plant^{-1} along with more number of tillers plant^{-1} and more days taken to 50% maturity. The lines may be used in further hybridization program and these crosses may yield more transgressive segregants for these traits for grain yield improvement.

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