GENETIC VARIABILITY, CORRELATION AND PATH ANALYSIS IN BREAD WHEAT (*Triticum aestivum*L.) GENOTYPES UNDER LIMITED WATER FOR TIMELY SOWN CONDITION

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ABSTRACT

A set of forty genotype of wheat were used to estimate genetic variability, correlation coefficients and path coefficients for twelve components. A wide range of variation was observed for important yield components. The estimates of heritability were observed high for grain weight per main spike, ear length, plant height, number of grains per main spike, days to maturity, days to 50 per cent flowering, 100 grain weight, grain filling period, number of productive tillers per plant, grain yield per plant and biological yield per plant. Values of genetic advance expressed as percentage of mean were found high for number productive tillers per plant, grain yield per plant and biological yield per plant. The estimates of genotypic correlation were higher than the corresponding phenotypic correlation. The grain yield per plant showed significant and positive correlation with biological yield per plant, number of productive tillers per plant, harvest index, number of grains per main spike, grain filling period, grain weight per main spike and days to maturity at genotypic and phenotypic levels. The path coefficient analysis revealed high positive direct effects of biological yield per plant, harvest index and grain weight per main spike towards the grain yield per plant. The most of the characters contributed indirectly to grain yield through biological yield per plant. Based on correlation and path analysis, biological yield per plant, number of productive tillers per plant and harvest index was identified as the most important components of grain yield per plant.

KEY WORDS: Correlation, path analysis, variability, wheat

INTRODUCTION

Wheat is the second most important staple food next to rice, consumed by nearly 35 per cent of the world population and providing 20 per cent of the total food calories. It is the most widely cultivated food crop of the world. India accounts an area, production and a productivity of 29.9 million ha, 93.9 million metric tonnes and 3140 kg/ha, respectively (Anonymous, 2012). Grain yield is a complex trait and highly influenced by many genetic factors and environmental fluctuations. In plant breeding programme, direct selection for yield as such could be misleading. A successful selection depends upon the information on the genetic variability and association of morpho-agronomic traits with grain yield. Correlation studies along with path analysis provide a better understanding of the association of different characters with grain yield. The correlation coefficient measure the mutual relationship between various plant characters and determine the component character on which selection can be based for improvement of yield (Sharma *et al.* 2006; Monpara 2009; Iftikhar *et al.* 2012; Singh *et al.* 2012). In study aim to know relationship between grain yield and its component traits in wheat under limited water condition, Mohammadi *et al.* (2012) reported grain yield was positively correlated with plant height, spike length and test weight.

Path coefficient analysis separates the direct effects from the indirect effects through other related characters by partitioning the correlation coefficient (Dixet and Dubey, 1984). According to Singh *et al.* (2012) and Gelalcha and Hanchinal (2013), path analysis not measure the direct effect of one variable, but also partition both direct and indirect effects, this assist plant breeder to identify traits that are useful as selection criteria to improve yield. Hence, in this investigation, exotic as well as local genotypes were used and an attempt was made to generate information on inheritance, relationships of yield and its components and their implication in selection of better genotypes of wheat for the development or improvement of cultivars and germplasm as well.

MATERIALS AND METHODS

The experimental material consisted of forty diverse genotypes of wheat (*Triticum aestivum* L.) representing different geographic origins. The pure seeds of these genotypes were obtained from the Research Scientist (Wheat), Wheat Research Station, Junagadh Agricultural University, Junagadh. These genotypes were sown at normal time under limited irrigation (stopping irrigation 65 days after sowing) condition in a Randomized Block Design with three replications during *Rabi* 2013-2014. Each entry was accommodated in a single row of 2.0 m length with a spacing of 22.5 cm. The recommended agronomical practices and plant protection measures were followed for the successful raising of the crop. Five competitive plants per genotype in each replication were selected randomly and observations were recorded on different characters except days to 50 per cent flowering and days to maturity, which were measured on plot basis and their averages values were used for statistical analysis. The phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) was estimated as per the formula suggested by Burton (1952). Heritability in broad sense and genetic advance at 5 per cent selection intensity was calculated by using the formula suggested by Allard (1960). This data were also used to determine the genotypic and phenotypic correlation coefficients between all possible pairs of the characters from the genotype means through the method given by Al-Jibouri *et al.* (1958) and the path coefficient analysis as described by Dewey and Lu (1959).

RESULTS AND DISCUSSION

The genotypes differed significantly for all the twelve characters included in the study indicated the presence of wide variation in the material evaluated. The results on genetic variability parameters are presented in Table 1. The values of phenotypic coefficient of variation were higher than genotypic coefficient of variation indicating the influence of environmental factors. The high value of GCV was observed for grain yield per plant followed by number of tillers per plant and biological yield per plant, which was earlier reported by Singh *et al.* (2012) and Talebi and Fayyaz (2012). High magnitude of GCV indicated the presence of wide variation for the characters under study, which allow further improvement by selection of the individual traits. High heritability (broad sense) values were observed for days to 50 per cent flowering, grain weight per main spike, number of grains per main spike, days to maturity, ear length, plant height, grain filling period, 100 grain weight, number of productive tillers per plant, biological yield per plant and grain yield per plant. High magnitude of heritability has been reported for days to 50 per cent flowering (Singh *et al.* 2012), grain weight per spike and number of grains per spike (Jagshorani, 1995), days to maturity (Singh *et al.*, 2012), 100 grain weight (Jagshoran, 1995), number of productive tillers per plant, biological yield per plant and grain yield per plant (Jagshoran, 1995 and Singh *et al*. 2012). The genetic advance expressed as percentage of mean was the high for grain yield per plant followed by number of productive tillers per plant and biological yield per plant, which was earlier reported by Jagshoran (1995). In the present study, high estimates of heritability coupled with high genetic advance expressed as percentage of mean were observed for number of productive tillers per plant, grain yield per plant and biological yield per plant which may be attributed to the preponderance of additive gene action and possess high selective value and thus, selection pressure could profitably be applied on these characters for their rationale improvement (Panse, 1957).

The association analysis revealed that, in general, the values of genotypic correlation were higher than their phenotypic correlation (Table 2) indicating the inherent association among the traits. Similar were the finding of Iftikhar *et al.* (2012) and Singh *et al.* (2012). In the present investigation, grain yield per plant was found to be significantly and positively correlated with biological yield per plant, number of productive tillers per plant, harvest index, number of grains per spike, grain filling period, grain weight per main spike and days to maturity at both the genotypic and phenotypic levels. The positive genotypic association has been reported between grain yield per plant and biological yield per plant, number of productive tillers per plant, harvest index, number of grains per main spike by Singh *et al*., (2012) and Gelalcha and Hanchinal, (2013). The grain yield per plant has positive correlation with plant height has been reported by Iftikhar *et al.*, (2012). The 100 grain weight was positively correlated with grain yield per plant, which confirms the earlier findings of Monpara (2009). The days to 50 per cent flowering showed positive and significant correlation with days to maturity and plant height and positive and significant genotypic and phenotypic association was found for days to maturity with biological yield per plant and number of grains per main spike, which was conformed to earlier finding of Sharma *et al.* (2006). Number of productive tillers per plant was found to be positively correlated with biological yield per plant (Sharma *et al.*, 2006 and Munir *et al.*, 2007) and number of grains per spike (Munir *et al.*, 2007) at both genotypic and phenotypic levels. Number of grains per main spike exhibited significant and positive correlation with grain weight per main spike (Munir *et al.*, 2007 and Talebi and Fayyaz, 2012), biological yield per plant (Sharma *et al.*, 2006) and harvest index (Talebi and Fayyaz, 2012) at both genotypic and phenotypic levels. The present results on correlation coefficients thus, revealed that the biological yield per plant, grain weight per spike, number of grains per spike, number of productive tillers per plant, 100 grain weight and harvest index were the most important traits and may contribute considerably towards higher grain yield. The interrelationship among yield components would help in increasing the yield levels and therefore, more emphasis should be given to these components while selecting better types in wheat.

The results obtained for direct and indirect effects of different characters on grain yield are presented in Table 3. In the present study, path coefficient analysis revealed that the grain weight per main spike, biological yield per plant and harvest index exhibited high and positive direct effects on grain yield per plant. Thus, these characters turned-out to be the major components of grain yield. The characters like days to maturity, grain filling period, number of grains per spike exerted low and negative direct effects on grain yield per plant. Singh *et al*. (2012) and Gelalcha and Hanchinal, (2013) reported high and positive direct effect of biological yield per plant and harvest index on grain yield per plant in wheat. The negative direct effect of days to maturity on grain yield has been reported earlier by Singh *et al.* (2012). The number of tillers per plant and 100 grain weight showed negative direct effect on grain yield as reported earlier by Singh *et al.* (2012). The number of grains per main spike also exhibited negative direct effect on grain yield per plant as reported by Talebi and Fayyaz (2012). The direct effect of biological yield per plant on grain yield was high and positive. This character also contributed indirectly by exhibiting positive effect *via* days to maturity, grain filling period, number of productive tillers per plant, number of grains per spike, grain weight per main spike and harvest index. The character harvest index showed positive direct effect and also contributed indirectly by grain filling period, number of productive tillers per plant, number of grains per main spike, grain weight per main spike, biological yield per plant and 100 grain weight. The character days to maturity exhibited high negative direct effect but contributed indirectly by exerting positive indirect effect via 100 seed weight.

CONCLUSION

Considering the genetic variability parameters, interrelationships and path analysis for grain yield and its components, an ideal plant type in wheat will be the one with biological yield per plant, grain weight per spike, number of grains per spike, number of productive tillers per plant and harvest index accompanied with early flowering and maturity under limited irrigated condition. Therefore, more emphasis should be given to those components while making selection for higher yield in wheat.

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Table 1: Phenotypic and genotypic coefficients of variation, heritability and genetic advance for various characters in wheat under limited water condition

Characters	Range of Variation	Coefficient of Range (%)	Mean	Phenotypic Coefficient of Variation (PCV) (%)	Genotypic Coefficient of Variation (GCV) (%)	Heritability in Broad Sense (%)	Genetic Advance	Genetic Advance Expressed as Percentage of Mean
Days to 50 Per Cent Flowering	46.00 - 69.00	20.00	56.07	12.44	12.29	97.63	14.03	25.02
Days to Maturity	89.33 - 106.67	8.85	99.45	5.23	5.13	96.36	10.32	10.37
Grain Filling Period (Days)	31.33 - 51.67	24.51	43.38	10.64	10.25	92.82	8.83	20.34
Plant Height (cm)	50.37 - 77.37	21.14	67.71	9.44	9.21	95.24	12.54	18.52
Number of Productive Tillers per Plant	1.80 - 5.20	48.57	3.28	25.41	23.56	85.96	1.47	45.00
Ear Length (cm)	5.99 - 10.70	28.22	8.46	15.02	14.72	95.98	2.51	29.71
Number of Grains per Main Spike	23.33 - 65.53	47.49	46.65	18.57	18.27	96.73	17.26	37.01
Grain Weight per Main Spike (g)	1.15 - 2.62	38.99	1.64	18.96	18.66	96.84	0.62	37.83
Grain Yield per Plant (g)	2.40 - 9.83	60.75	5.45	30.93	27.03	76.41	2.65	48.68
Biological Yield per Plant (g)	6.53 - 18.73	48.33	12.10	24.86	22.23	80.00	4.96	40.96
Harvest Index (%)	31.28 - 52.59	25.41	44.72	13.99	11.49	67.45	8.69	19.44
100 Grain Weight (g)	2.46 - 5.07	34.66	3.59	15.85	15.21	92.04	1.08	30.06

Table 2: Genotypic (r_g) and phenotypic (r_p) correlation coefficients among 12 characters in wheat under limited water condition.

Characters		Days to 50 Per Cent Flowering	Days to Maturity	Grain Filling Period (Days)	Plant Height (cm)	Number of Productive Tillers per Plant	Ear Length (cm)	Number of Grains per Main Spike	Grain Weight per Main Spike (g)	Biological Yield per Plant (g)	Harvest Index (%)	100-Grain Weight (g)
Grain Yield per Plant (g)	r_g	-0.1242	0.2295*	0.4558**	0.0130	0.8151**	-0.0443	0.4782**	0.3893**	0.8926**	0.6169**	0.0573
	r_p	-0.0906	0.2029*	0.3654**	0.0062	0.7446**	-0.0374	0.4318**	0.3250**	0.8771**	0.6325**	0.0650
Days to 50 Per Cent Flowering	r_g		0.7645**	-0.6731**	0.4821**	0.0338	-0.0645	0.1531	-0.1423	0.0591	-0.4149**	-0.4834**
	r_p		0.7498**	-0.6671**	0.4675**	0.0355	-0.0582	0.1549	-0.1419	0.0617	-0.3192**	-0.4616**
Days to Maturity	r_g			-0.0378	0.5404**	0.3260**	0.0410	0.3519**	-0.1422	0.4106**	-0.2633**	-0.6526**
	r_p			-0.0074	0.5181**	0.3047**	0.0428	0.3409**	-0.1461	0.3680**	-0.2143*	-0.6134**
Grain Filling Period (Days)	r_g				-0.1274	0.3216**	0.1470	0.1664	0.0574	0.3794**	0.3410**	0.0007
	r_p				-0.1232	0.2895**	0.1362	0.1498	0.0500	0.3210**	0.2411**	0.0071
Plant Height (cm)	r_g					-0.0369	0.3436**	0.2384**	0.0497	0.1956*	-0.3431**	-0.3835**
	r_p					-0.0486	0.3326**	0.2336*	0.0506	0.1669	-0.2811**	-0.3589**
Number of Productive Tillers per Plant	r_g						-0.2027*	0.2473**	0.0354	0.9381**	0.1709	-0.1469
	r_p						-0.1744	0.228*	0.0212	0.8601**	0.1717	-0.1253
Ear Length (cm)	r_g							0.1643	0.4175**	-0.0123	-0.1265	-0.016
	r_p							0.1661	0.4015**	-0.0094	-0.0985	-0.0097
Number of Grains per Main Spike	r_g								0.4444**	0.4232**	0.3220**	-0.5424**
	r_p								0.4284**	0.3731**	0.2985**	-0.5039**
Grain Weight per Main Spike (g)	r_g									0.2073*	0.5309**	0.3623**
	r_p									0.1755	0.4227**	0.3433**
Biological Yield per Plant (g)	r_g										0.2153*	-0.1841*
	r_p										0.2045*	-0.1408
Harvest Index (%)	r_g											0.4885**
	r_p											0.3943**

***, ** Significant at 5 % and 1% levels, respectively**

Table 3: Genotypic path coefficient analysis showing direct (diagonal) and indirect effects of different characters on grain yield per plant in wheat under limited water condition.

Characters	Days to Maturity	Grain Filling Period (Days)	Number of Productive Tillers per Plant	Ear Length (cm)	Number of Grains per Main Spike	Grain Weight per Main Spike (g)	Biological Yield per Plant (g)	Harvest Index (%)	100-Grain Weight (g)
Days to Maturity	**-0.1712**	0.0065	-0.0558	-0.0602	0.0243	-0.0703	0.0451	0.1117	0.2295*
Grain Filling Period (Days)	0.0043	**-0.1128**	-0.0363	-0.0188	-0.0065	-0.0428	-0.0385	-0.0001	0.4558**
Number of Productive Tillers per Plant	-0.1595	-0.1573	**-0.4892**	-0.121	-0.0173	-0.4589	-0.0836	0.0719	0.8151**
Number of Grains per Main Spike	0.2456	-0.1161	-0.1726	**-0.698**	-0.3101	-0.2954	-0.2247	0.3786	0.4782**
Grain Weight per Main Spike (g)	-0.0317	0.0128	0.0079	0.099	**0.2227**	0.0462	0.1182	0.0807	0.3892**
Biological Yield per Plant (g)	0.5695	0.5263	1.3013	0.5871	0.2876	**1.3872**	0.2986	-0.2554	0.8926**
Harvest Index (%)	-0.2293	0.2969	0.1488	0.2803	0.4623	0.1874	**0.8707**	0.4253	0.6169**
100 Grain Weight (g)	0.4929	-0.0005	0.111	0.4097	-0.2737	0.1391	-0.3689	**-0.7553**	0.0573

, ** significant at 5% and 1% levels, respectively** ***Residual effect, R= 0.0665

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