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Research Note

Genetic Variability, Character Association and Path Coefficient Analysis in Durum Wheat (*Triticum durum* Desf.)

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Abstract
Genetic variability, correlation and path coefficient analysis was studied for grain yield and its components in 28 diverse genotypes of durum wheat. The analysis of variance revealed the significant differences among the genotypes for all the traits indicating presence of sufficient variability among the genotypes for various traits. The high GCV and PCV were observed for grain yield per plant, number of effective tillers per plant, spike length and 1000 grain weight indicated wider genetic variation for these traits. The high heritability combined with high genetic advance as per cent of mean was observed for grain yield per plant indicated that selection may be effective for this character. The results of correlation studies indicated that genotypic correlation coefficients were higher in magnitude than their corresponding phenotypic correlation coefficients for most of the traits. Grain yield per plant had significant and positive correlation with grain filling period, effective tillers per plant and 1000 grain weight at both genotypic and phenotypic levels indicating that these three traits were main yield attributing traits. The path analysis indicated that effective tillers per plant had maximum direct effect on grain yield followed by grain filling period and 1000 grain weight should be given for yield improvement in durum wheat.

Keywords: Durum wheat Genetic variation, correlation, path analysis

Information of genetic variability in the genetic system of a particular crop is sought as pre-requisite with any crop improvement programme. Although increased grain yield is the ultimate goal of the plant breeders, grain yield itself is a product of interaction of many component traits which influence it directly or indirectly. Therefore, variability existing within each component trait must be exploited by selection to realize maximum gain in grain yield. Correlation and path coefficient analyses together give a clear cut picture of interrelationships and relative contribution of independent characters on dependent variable which enables to a plant breeder to apply suitable selection procedures for crop improvement. The present investigation was, therefore, conducted to find out the major yield contributing traits in durum wheat.

The experimental material comprised of 28 diverse genotypes of durum wheat (*Triticum durum* Desf.) collected from Wheat Research Station, Junagadh Agril. University, Junagadh, Gujarat. The field experiment was laid out in randomized block design with three replications at Wheat Research Station, Junagadh Agril. University, Junagadh during *Rabi* 2009-10. Each entry was sown in a single row of 2 m length with inter and intra row spacing of 22.5 cm and 10 cm, respectively. The recommended agronomic practices and plant protection measures were followed timely for the successful raising of the crop. Five random plants were selected from each plot for recording the observations on seed yield/plant and its component traits. The coefficient of variation was calculated as suggested by Burton and DeVane (1953). The heritability in broad sense and expected genetic advance were calculated using the formula suggested by Allard (1960). The data were subjected to association analysis as per method given by Al-Jibouri *et al.* (1958) and path coefficient analysis according to Dewey and Lu (1959).

The analysis of variance revealed highly significant differences among the genotypes for all the characters studied. The phenotypic range, general mean, phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), broad sense heritability (h^2) and genetic advance (GA) given in Table 1 indicated a wide range of variability for most of the characters.

The estimates of PCV were higher than their respective GCV for all the traits. Among all the traits studied, number of effective tillers per plant, spike length and number of spikelets per spike had difference between their respective estimates of phenotypic and genotypic coefficient of variation. This may be either due to interaction of genotypes x environments or environmental factors influencing the expression of these three traits.

While the rest of the traits were least influenced by environmental factors. The maximum value of GCV and PCV was observed for grain yield per plant followed by number of effective tillers per plant, spike length and 1000 grain weight indicated wider variation to allow further improvement by selection of these individual traits. High estimates of GCV and PCV have been reported for grain yield per plant by Subhashchandra *et al* (2009). The moderate value of GCV and PCV was observed for effective tillers per plant, It was comparatively low for maturity period, number of spikelets per spike, peduncle length, ear head emergence, grain filling period, plant height, spike length and 1000 grain weight.

The heritability estimates help the breeders in selection based on the phenotypic performance. In the present study, high values of heritability were observed for 1000 grain weight, grain yield per plant, plant height, ear head emergence and grain filling period which indicated that the selection was effective. But this selection is misleading because Johnson *et al.(*1955) reported that heritability estimate along with genetic advance is more useful than the heritability value alone for improving a particular trait. The high heritability combined with high genetic advance as per cent of mean was observed for grain yield per plant indicated that selection will be effective for these characters (Panse, 1957). Therefore, grain yield per plant can be better exploited through simple selection (Subhashchandra *et al.,* 2009). On the other hand, high heritability with moderate genetic gain as per cent of mean was observed for 1000 grain weight, plant height, ear head emergence, grain filling period, maturity period, number of effective tillers per plant, spike length and peduncle length. This revealed that selection would be less effective for these traits.

The genotypic and phenotypic correlation coefficients among different pairs of characters are presented in Table 2. Genotypic correlation coefficients were higher in magnitude than their corresponding phenotypic values which indicated strong inherent association between various pairs of traits, as was also observed by Bhowmik *et al.* (1989) and Mhmood *et al*. (2006). Lower degree of associations between two variables at phenotypic level might be due to the masking or modifying effect of environment on the association of traits. Grain yield per plant had significant and positive correlation with grain filling period, effective tillers per plant and 1000 grain weight at both genotypic and phenotypic levels indicating that these three traits were main yield attributing traits. Similar results were reported for grain filling period byGebeyehou *et al*. (1982), for effective tillers per plant by Sharma et al. (2006) and for 1000 grain weight by Mhmood *et al*. (2006). Among the yield contributing traits, ear head emergence had significant and positive association with days to maturity period (Patel, 2003) suggested that earliness may lead to short length of total growing period. Plant height had significant and positive association with spike length and peduncle length at both levels. Similar results was reported by Sidharthan and Malik (2006). Likewise, significant and positive association was observed between grain filling period and 1000 grain weight; effective tillers per plant and number of spikelets per spike; spike length and peduncle length; number of spikelets per spike and peduncle length.

The genotypic correlation coefficients were further divided into direct and indirect effects (Table 3). It revealed that grain filling period, effective tillers per plant and 1000 grain weight had the high positive direct effect on grain yield per plant. Hence, these three traits turned out to be the major components of grain yield and direct selection on these traits may be effective. Moderate negative direct effect was recorded by peduncle length. High and negative indirect effect ws recorded by spikelets per spike, peduncle length and 1000 grain weight via effective tillers per plant on grain yield. Moderate and negative indirect effect was recorded by number of spikelets per spike via spike length; by peduncle length via plant height; by 1000 grain weight via maturity period, plant height and spike length. The indirect effects of grain filling period via 1000 grain weight; effective tillers per plant via number of spikelets per spike as well as 1000 grain weight through grain filling period were positive and moderate in magnitude. The unexplained variation in genotypic path was only 0.2613. It predicted that 73.87 per cent variation in grain yield at genotypic level had been determined by the studied traits.

Therefore, it can be concluded from variability parameters, correlation and path coefficient analyses that grain filling period, effective tillers per plant and 1000 grain weight are the most important yield contributing traits and due emphasis should be given to these traits for genetic improvement of grain yield in durum wheat.

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Table 1. Estimates of genetic variability, heritability and genetic advance for different characters in durum wheat

Character	Phenotypic range	Mean	PCV (%)	GCV (%)	h^2 (%)	GA	GA (% mean)
Ear head emergence	56.00 to 71.66	64.65	6.34	5.83	84.4	9.14	14.14
Grain filling period	33.00 to 44.00	39.33	8.11	7.37	82.5	6.95	17.68
Maturity period	113 to 122	118.9	2.67	2.12	63.2	5.30	4.46
Plant height (cm)	59.00 to 79.90	65.49	8.82	8.39	90.5	13.80	21.07
No. of effective tillers per plant	6.26 to 8.40	7.07	16.98	11.16	43.2	1.37	19.37
Spike length (cm)	4.46 to 7.43	6.05	12.26	8.46	47.6	0.93	15.41
No. of spikelets per spike	13.76 to 16.66	15.05	7.78	3.81	24.0	0.74	4.93
Peduncle length (cm)	27.36 to 34.86	31.02	7.78	6.46	69.1	4.40	14.18
1000 grain weight (g)	40.30 to 56.59	46.83	10.56	10.21	93.6	12.22	26.10
Grain yield per plant (g)	7.30 to 18.49	12.33	25.03	23.99	91.8	7.48	60.69

Table 2. Estimates of genotypic (r_g) and phenotypic (r_p) correlation coefficients for different characters in durum wheat

Characters		Ear head emergence	Grain filling period	Maturity period	Plant height (cm)	No. of effective tillers per plant	Spike length (cm)	No. of spikelets per spike	Peduncle length (cm)	1000 grain weight (g)
Grain yield per plant (g)	r_g	0.09	0.44**	-0.06	0.05	0.52**	-0.17	0.25	-0.11	0.39**
	r_p	0.08	0.40**	-0.05	0.04	0.38**	-0.04	0.14	-0.07	0.38**
Ear head emergence	r_g		0.03	0.53**	0.28*	0.30	0.09	0.37	0.03	-0.51**
	r_p		0.04	0.41**	0.22*	0.17	0.04	0.15	0.02	-0.44**
Grain filling period	r_g			-0.19	-0.19	-0.22	0.06	-0.02	0.05	0.33*
	r_p			-0.19	-0.17	-0.02	0.04	0.12	0.11	0.31*
Maturity period	r_g				-0.08	0.21	0.14	0.42	-0.07	-0.35**
	r_p				-0.02	0.07	0.04	0.12	0.03	-0.28**
Plant height (cm)	r_g					0.27	0.40**	0.21	0.49**	-0.24
	r_p					0.15	0.23*	0.11	0.38**	-0.23
No. of effective tillers per plant	r_g						-0.13	-0.11	-0.02	-0.40*
	r_p						-0.13	0.33*	0.18	-0.13
Spike length (cm)	r_g							0.15	0.33*	-0.53**
	r_p							0.15	0.30*	-0.31*
No. of spikelets per spike	r_g								-0.08	-0.25
	r_p								0.28**	0.02
Peduncle length (cm)	r_g									-0.16
	r_p									0.04

*, ** Significant at 5 and 1 per cent probability levels, respectively.

Table 3 . Path coefficient analysis showing direct (diagonal and bold) and indirect effects of different traits on grain yield per plant based on genotypic correlation in durum wheat

Character	Ear head emergence	Grain filling period	Maturity period	Plant height (cm)	Effective tillers per plant	Spike length (cm)	No. of spikelets per spike	Peduncle length (cm)	1000 grain weight (g)	Phenotypic correlation with grain yield per plant
Ear head emergence	0.13	0.01	0.06	0.03	0.02	0.01	0.02	0.00	-0.06	0.08
Grain filling period	0.01	0.34	-0.07	-0.06	-0.01	0.01	0.04	0.04	0.11	0.40**
Maturity period	0.02	-0.01	0.07	0.00	0.01	0.00	0.01	0.00	-0.02	-0.05
Plant height (cm)	0.05	-0.04	-0.01	0.21	0.30	0.05	0.02	0.08	-0.05	0.04
No. of effective tillers per plant	0.08	-0.01	0.04	0.07	0.45	0.06	0.15	0.08	-0.06	0.38**
Spike length (cm)	0.02	0.02	0.00	0.01	0.01	0.06	0.01	0.02	-0.20	-0.04
No. of spikelets per spike	-0.01	-0.01	-0.01	-0.01	-0.20	-0.10	-0.05	-0.01	0.00	0.14
Peduncle length (cm)	-0.01	-0.03	0.00	-0.10	-0.50	-0.08	-0.07	-0.26	0.10	-0.07
1000 grain weight (g)	-0.21	0.15	-0.13	-0.11	-0.60	-0.15	0.01	-0.02	0.47	0.38**

Residual effect = 0.2613
*, ** Significant at 5 and 1 per cent probability levels, respectively.