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Inter-relationship and Path Coefficient Analysis for Biometric Traits in Drought Tolerant Wheat (*Triticum aestivum* L.)

A.J. Khan, F. Azam, A. Ali, M. Tariq and M. Amin
Nuclear Institute for Food and Agriculture, P.O. Box 446, Tarnab, Peshawar, Pakistan

Abstract: Ten elite wheat breeding lines were evaluated for yield and yield components under rainfed conditions at Peshawar. Genotypic and phenotypic associations between the characters and their direct and indirect effects on grain yield were analyzed. Plant height showed positive correlation only with spikelets per spike and was negatively correlated with the other studied characters. Positive correlation of tillers per plant was observed with all the traits except spikelets per spike. Spike length was found to be positively correlated with spikelets per spike and grain yield and negatively so with 1000-grain weight. Significantly negative correlation of spikelets per spike was observed with 1000 grain weight and grain yield. Correlation coefficient between 1000-grain weight and grain yield ha^{-1} was positive and significant. Overall tillers per plant, spike length and 1000-grain weight showed significant positive correlation with grain yield while plant height and spikelets per spike were negative and significantly ($p<0.05$) correlated with grain yield. Path analysis indicated that tillers per plant had the highest positive direct effect on grain yield followed by spikelets per spike and 1000-grain weight, whereas plant height and spike length had negative direct effect on this parameter.

Key words: Correlation, path coefficient, drought tolerant, wheat

INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the most abundant sources of energy and proteins for the world population. Quantitatively inherited plant characters such as grain yield in wheat are controlled by a complex mechanism and many genes are involved for their expression. Information regarding genotypic and phenotypic correlations between quantitatively inherited plant characters and their direct and indirect effects on grain yield as a result of varietal response proved to be a useful tool for increasing the yield per unit area through selection. Simple correlation analysis indicates the degree of association between traits but it cannot provide reasons of association. Therefore, simple correlation coefficients are not always effective in determining the real relationship among traits. Researchers emphasize the need for component analysis[1]. A path coefficient is a standardized partial regression coefficient and as such measures the direct effect of one trait upon other and permits the separation of correlation coefficient into coefficient of direct and indirect effects[2].

Wadington *et al.*[3] reported that 1000-grain weight was reduced slightly in modern high grain number cultivars. In the pre-green revolution era the major factor of low yield of varieties was their tallness which is negatively correlated with yield[4]. Thus the lines with medium height and higher harvest index would have potential for higher grain yield. Shahid *et al.*[5] reported a strong negative genotypic correlation of plant height with grain yield. Belay *et al.*[6] while studying correlation between seed yield and nine components in durum wheat genotypes noted that it had a strong positive association with all characters except days to heading and harvest index.

In order to accumulate optimum combination of yield contributing characters in a single genotype, it is essential to quantify the contribution of various agronomic characters towards yield and interrelationship/s of various characters. The present study, therefore, was undertaken with the objective of developing some suitable criterion based on different characters in wheat, using correlation and path analysis techniques.

MATERIALS AND METHODS

The present study was conducted in the experimental fields of Nuclear Institute for Food and Agriculture, Tarnab-Peshawar Pakistan during 2003-2004 growing season. The experimental material comprised of eight advanced elite wheat breeding lines, i.e., NRL-9708, NRL-9918, NRL-9930, NRL-2005, NRL-2009, NRL-2017,

Corresponding Author: A.J. Khan, Nuclear Institute for Food and Agriculture, P.O. Box 446, Tarnab, Peshawar, Pakistan
Fax: +92-912964059

Table 1: Correlation coefficients among six characters of wheat

	r	Plant height	Tillers per plant	Spike length	Spikelets per spike	1000-grain weight	Grain yield
Plant height	r_g	1	-0.173	-0.417	0.320	-0.383	-0.770**
	r_p	1	-0.124	-0.212	0.210	-0.327	-0.505
Tillers per plant	r_g		1	0.041	-0.864**	0.836**	0.607**
	r_p		1	0.021	-0.382	0.508	0.261
Spike length	r_g			1	0.668*	-0.302**	0.447**
	r_p			1	0.159	-0.175	0.214
Spikelets per spike	r_g				1	-0.931**	-0.673*
	r_p				1	-0.498	-0.223
1000-grain weight	r_g					1	0.727*
	r_p					1	0.500
Grain yield	r_g						1
	r_p						1

* Significant at 5% level, ** Significant at 1% level, r: Correlation coefficient, r_p: Phenotypic correlation, r_g: Genotypic correlation

Table 2: Genotypic correlation into direct and indirect effects by path coefficient analysis

	Plant height	Tillers per plant	Spike length	Spikelets per spike	1000-grain weight	r_g
Plant height	-0.722	-0.104	0.043	0.166	-0.154	-0.770
Tillers per plant	0.125	0.600	-0.004	-0.446	0.335	0.607
Spike length	0.301	0.025	-0.103	0.345	-0.121	0.447
Spikelets per spike	-0.231	-0.517	-0.069	0.520	-0.373	-0.673
1000-grain weight	0.277	0.501	0.031	-0.481	0.401	0.728

r_g: Genotypic correlation

NRL-0117, NRL-0116 along with two commercial checks (Takbeer and Tatara). The experiments were laid out according to Randomized Complete Block Design with four replications. Six rows of 5 m length per entry were sown. Rows were kept 30 cm apart. Recommended doses of fertilisers were applied at the time of sowing. No irrigation was applied during the growing season. Data was recorded on plant height, tillers per plant, spike length, spikelets per spike, 1000-grain weight and grain yield per hectare. At maturity, four central rows were harvested to determine grain yield.

The data was statistically analyzed. LSD was used for mean separation among different genotypes. Genotypic and phenotypic variances, analysis of covariance was carried out for all the pair of characters[7].

Genotypic correlations were calculated by genotypic variances and covariance, phenotypic correlations by using phenotypic variances and covariance. The genotypic and phenotypic correlations thus calculated were tested for significance[8]. The path coefficient analysis was carried out for genotypic correlations[2].

RESULTS AND DISCUSSION

Correlation: Since the selection of characters has to be made in the light of their genetic behavior, only genotypic correlation values are used for further analysis. Genotypic correlation coefficients were higher than the respective phenotypic correlation coefficients indicating that phenotypic correlations were slightly influenced by environmental effects (Table 1).

The relationship of plant height was negative with tillers per plant, spike length, 1000-grain weight and grain yield per plant while it correlated positively with spikelets per spike (Table 1). These results are in agreement with Ahmad *et al.*[9], Shahid *et al.*[5], Okuyama *et al.*[10] and Khaliq *et al.*[11]. This may be due to the smaller number of tillers per plant and higher lodging in taller plants. Tillers per plant had positive genotypic correlation with spike length, 1000-grain weight and grain yield whereas it had negative correlation with spikelets per spike. Similar results were reported by Khaliq *et al.*[11] and Okuyama *et al.*[10]. Association studies between spike length, spikelets per spike and grain yield indicated a tendency of spike length to increase with increasing of spikelets per spike and grain yield. Similar results were also verified by Ahmad *et al.*[9], Mohan *et al.*[12] and Khaliq *et al.*[11]. Spikelets per spike was negatively correlated with 1000-grain weight and grain yield. The results of the present study coincided with the findings of Shahid *et al.*[5] and Okuyama *et al.*[10]. This may be due to reduction in grain weight and ultimately grain yield under rainfed conditions. Positive correlation was resulted between 1000-grain weight and grain yield. These results confirmed the findings of Shahid *et al.*[5], Khaliq *et al.*[11] and Okuyama *et al.*[10]. The highest positive genotypic correlation of 0.836 was appeared between tillers per plant and 1000-grain weight whereas the lowest positive correlation of 0.041 was expressed between tiller per plant and spike length.

Path coefficient analysis: Path coefficient analysis helps to determine the contribution of various components of yield to over all grain yields in the genotypes under study. It provides an effective way of finding out direct and indirect sources of correlation.

Plant height Vs. grain yield: Plant height directly affected the grain yield in negative direction (Table 2). Similar results were reported by Chowdhry *et al.*[13]. It is due to high percentage of dry matter accumulation towards the height of the plant in tillers per plant affecting the grain yield. Indirect effects of plant height via. spike length and spikelets per spike was positive whereas it was negative through tillers per plant and 1000-grain weight (Table 2).

Tillers per plant Vs. grain yield: The correlation between tillers per plant (0.607) and the grain yield is almost equal to its direct effect (0.600), thus it shows true relationship and direct selection for higher number of tillers per plant would be enough to increase grain yield (Table 2). These results are similar to those obtained by Shamsuddin[14] and Simane[15]. The indirect effect through plant height and 1000-grain weight was positive while it was negative through spike length and spikelets per spike.

Spike length Vs. grain yield: The direct effect of spike length on grain yield is negative (-0.103). The correlation coefficient between spike length and grain yield is positive (0.447). Spike length affects the grain yield positively via plant height, tillers per plant and spikelets per spike and negatively through 1000-grain weight (Table 2). In this situation the indirect factors seems to be the cause of correlation and to be considered for selection.

Spikelets per spike Vs. grain yield: The direct effect of spikelets per spike on grain yield is positive and high (0.520) (Table 2). It affects grain yield negatively via. plant height, tillers per plant, spikelets per spike and 1000-grain weight. Under this condition restrictions are to be imposed to nullify the undesirable indirect effects in order to make use of the direct effect[16].

1000-grain weight Vs. grain yield: The correlation between these two characters was positive (0.728). The direct effect of 1000-grain weight was positive (0.401). However, indirect effects through spikelets per spike was negative (-0.481) while it was positive through plant height, tillers per plant and spike length (Table 2).

CONCLUSIONS

Path analysis showed that the relationship between grain yield and its components and plant traits are different from that presented in the simple analysis of correlation. Correlation studies showed that 1000-grain weight was the main plant trait related to grain yield increase, while in the path analysis its importance was secondary. Correlation simply identifies the mutual relationship among the parameters while path analysis allows the relative magnitude of each effect. When the objective was to establish relationships among the variables that affect grain yield, path coefficient analysis was more efficient method than the correlation analysis[2]. Thus the results of the present study shows that higher number of tillers per plant, greater number of spikelets per spike and maximum 1000-grain weight should be considered as selection criteria for wheat yield important.

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