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Cause and Effect Relationship for Some Biometric Traits in Bread Wheat

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Abstract. Genotypic and phenotypic correlations and path coefficient analyses were conducted for grain yield and some biometric traits in 25 cross-combinations of bread wheat under the rainfed conditions. Significant positive genotypic and phenotypic association was observed between grain yield per plant, and the yield components, such as productive tillers per plant, spike-length, spikelets per spike, grains per spike and 1000-grain weight. The path coefficient analysis revealed that the number of grains per spike and 1000-grain weight had the maximum direct effect on grain yield. These traits may be considered as the selection criteria for developing high yielding wheat genotypes for rainfed areas.

Keywords: bread wheat, biometric traits, grain yield, correlation coefficient, path coefficient analysis, rainfed wheat crop

Introduction

Development of high yielding wheat cultivars has been one of the major objectives of wheat breeding programmes throughout the world. Grain yield is a complex trait, which is the combined effect of many causal factors or plant parameters. Knowledge of association among various traits is important to make improvement in the overall crop yield. Determination of correlation coefficients between various characters helps in obtaining the best combinations of attributes in wheat crop for the highest grain yield returns per unit area.

Cause and effect relationship, or the path coefficient analysis, is a handy technique which elaborates the extent of relationship among different plant characters. It is an index to predict the basis for allocation of weightage to each contributing component in deciding upon suitable selection criteria for the genetic improvement of complex characters, such as yield (Rehman *et al.,* 1998). Many workers have studied the relationship between grain yield and various yield contributing components in wheat under different environmental conditions. Hussain and Khan (1990) and Zaheer *et al.* (1987) observed positive and direct effect of the number of grains per spike and 1000-grain weight on yield.

Bahadur *et al.* (1993) observed that correlation coefficients at the genotypic level were higher than phenotypic correlation coefficients and observed that grain yield was highly and positively associated with tillers per plant, the ear-length, spikelets per ear, grains per ear, and 1000-grain weight. Uddin *et al.* (1997) evaluated genotypic and phenotypic correlation for grain yield per plant and other quantitative characters in 21wheat varieties and found that grain yield per plant was positively and significantly correlated with spikes per plant, spikelets per spike, and 1000-grain weight. Nabi *et al.* (1998) estimated phenotypic and genotypic correlation coefficients among various morphological characters and reported that grains per spike had positive and significant genetic and phenotypic correlation with grain yield. Dhonde *et al.* (2000) recorded nine yield-related components in 40 genotypes. Higher genotypic and phenotypic correlation coefficients were observed for productive tillers per plant, plant height, grains per ear and grain yield per plant. Number of grains per ear and grain weight per ear had the highest direct effect on grain yield.

Shukla *et al.* (2000) evaluated 25 cross-combinations of wheat for yield related components and recorded significant positive association of desirable traits, such as grains per ear, tillers per plant and 1000-grain weight. The present study was undertaken to evaluate the relationship amongst different biometric traits and their direct and indirect effect on grain yield in bread wheat under rainfed conditions.

Materials and Methods

Twenty-five cross-combinations comprising five parents, namely, GPW-235, GPW-273, GPW-272, GPW-36 and GPW-37, ten F-1s, and ten reciprocals were evaluated for establish-

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ing cause and effect relationship in bread wheat under medium rainfall conditions (annual rainfall 350-500 mm). The study was carried out at the Barani Agricultural Research Institute, Chakwal, Pakistan, during the 2002-2003 crop season. The material was sown using randomized complete block design with three replications. Each entry comprised a single row of 3 m length, whereas row to row distance was kept at 30 cm and plant to plant distance was kept at 5 cm. Normal agronomic practices were carried out during the crop season. At maturity, ten guarded plants, excluding the border ones, were randomly selected for recording data for the number of productive tillers per plant, spike-length (cm) of the main tiller, spikelets per spike, grains per spike, 1000-grain weight (g) and grain yield per plant (g).

The data were subjected to analysis of variance following Steel and Torrie (1980). Genotypic and phenotypic correlation coefficients were calculated as followed by Al-Jibouri *et al.* (1958). Path coefficient analysis was carried out as illustrated by Singh and Chaudhary (1985).

Results and Discussion

Parents and their cross-combinations exhibited significant differences ($p < 0.01$) for all the traits studied, i.e., productive tillers per plant, spike-length, spikelets per spike, grains per spike, 1000-grain weight, and grain yield per plant (Table 1). Genotypic and phenotypic correlation coefficients (Table 2) revealed that productive tillers per plant had significant positive genotypic correlations with spike-length, spikelets per spike and grain yield per plant, but non-significant positive genotypic correlations with the number of grains per spike and 1000-grain weight. This trait showed significant positive phenotypic correlations with grain yield per plant, but non-significant positive phenotypic association with spike-length, number of spikelets per spike, number of grains per spike, and 1000-grain weight.

Spike-length showed significant positive genotypic, as well as phenotypic correlations with spikelets per spike, number of grains per spike, 1000-grain weight, and grain yield per plant, whereas significant positive genotypic but non-significant positive phenotypic association was observed between spike-length and productive tillers per plant. The number of spikelets per spike had significant positive genotypic and phenotypic correlations with spike-length, 1000-grain weight and grain yield per plant; significant positive genotypic but non-significant positive phenotypic correlations were noted with the number of productive tillers per plant; whereas non-significant positive genotypic as well as phenotypic association was observed between the number of spikelets per spike and the number of grains per spike. The number of grains per spike showed significant positive genotypic, as well as phenotypic correlations with spike-length and grain yield per plant, but non-significant positive correlations with the number of productive tillers per plant, the number of spikelets per spike, and 1000-grain weight.

The 1000-grain weight had significant positive genotypic, as well as phenotypic correlations with spike-length, the number of spikelets per spike and grain yield per plant. This trait showed non-significant positive correlations with the number of productive tillers per plant and the number of grains per spike. Significant positive genotypic, as well as phenotypic association was observed between grain yield per plant and all the traits studied, i.e., the number of productive tillers per plant, spike-length, the number of spikelets per spike, the number of grains per spike, and 1000-grain weight.

Table 1. Mean squares for tillers per plant, spike-length, spikelets per spike, grains per spike, 1000-grain weight, and grain yield per plant in wheat under rainfed conditions

Source of variation	df	Tillers/ plant	Spike-length	Spikelet/ spike	Grains/ spike	1000-Grain weight	Grain yield/plant
Genotypes	24	1.298 **	1.676 **	3.650 **	33.178 **	16.186 **	3.163 **
Replications	02	0.168 ns	0.161 ns	0.587 ns	11.232 *	0.382 ns	0.020 ns
Error	48	0.223	0.192	0.986	3.225	1.249	0.235
Total	74						
cv (%)		9.61	3.88	4.86	3.19	2.80	5.83
lsd 5 (%)		0.775	0.731	1.630	2.948	1.835	0.796
lsd 1 (%)		1.034	0.975	2.175	3.933	2.448	1.062

ns = non-significant; *, ** significant at 5% and 1% level of probability, respectively; cv = coefficient of variation; lsd = least significant difference; df = degree of freedom

Table 2. Genotypic (r_g) and phenotypic (r_p) correlation coefficients among tillers per plant, spike-length, spikelets per spike, grains per spike, 1000-grain weight, and grain yield per plant in wheat under rainfed conditions

Biometric traits		Tillers/ plant	Spike-length	Spikelet per spike	Grains/ spike	1000-Grain weight
Spike-length	r_g	0.505 **				
	r_p	0.227 ns				
Spikelets per spike	r_g	0.562 **	0.802			
	r_p	0.277 ns	0.504 **			
Grains per spike	r_g	0.111 ns	0.447 **	0.262 ns		
	r_p	0.093 ns	0.389 **	0.233 ns		
1000-Grain weight	r_g	0.277 ns	0.353 *	0.434 **	0.096 ns	
	r_p	0.127 ns	0.296 *	0.361 *	0.109 ns	
Grain yield per plant	r_g	0.438 **	0.643 **	0.631 **	0.638 **	0.517 **
	r_p	0.365 *	0.457 **	0.348 *	0.472 **	0.366 *

ns=non-significant; *,**=significant at 5% and 1% level of probability, respectively

Table 3. Direct (in parenthesis) and indirect effect of tillers per plant, spike-length, spikelets per spike, grains per spike, and 1000-grain weight, on grain yield per plant in wheat under rainfed conditions

Biometric traits	Tillers/ plant	Spike-length	Spikelet per spike	Grains/ spike	1000-Grain weight	Genotypic correlation coefficient
Tillers per plant	(0.132)	0.007	0.157	0.057	0.085	0.438
	30.14	1.60	35.84	13.01	19.41	
Spike-length	0.066	(0.014)	0.224	0.231	0.108	0.643
	10.26	2.18	34.84	35.92	16.80	
Spikelets per spike	0.074	0.011	(0.279)	0.135	0.132	0.631
	11.73	1.74	44.21	21.40	20.92	
Grains per spike	0.014	0.006	0.073	(0.517)	0.028	0.638
	2.19	0.94	11.44	81.03	4.40	
1000-Grain weight	0.036	0.005	0.121	0.049	(0.306)	0.517
	6.96	0.97	23.40	9.48	59.19	

*figures in the second row of each biometric trait indicate the effect in percentage

Path coefficient analysis (Table 3) revealed that the number of productive tillers had considerable direct effect (30.14%), as well as indirect effect via the number of spikelets per spike (35.84%), on grain yield. Spike-length had negligible direct effect on grain yield, but considerable indirect effect via the number of spikelets per spike (34.84%), and the number of grains per spike (35.92%). The number of spikelets per spike had substantial direct effect (44.21%) and some indirect effect through the number of grains per spike (21.40%) and 1000-grain weight (20.92%) on grain yield. The number of grains per spike and 1000-grain weight exhibited the maximum direct effect (81.03% and 59.19%, respectively) on grain yield, and some indirect effect via the number of spikelets per spike.

Significant differences were observed for different biometric traits in the cross-combinations of wheat investigated. All the traits studied, i.e., productive tillers per plant, spike-length, number of spikelets per spike, number of grains per spike and 1000-grain weight showed significant positive genotypic and phenotypic association with grain yield per plant. Similarly, most of the yield components exhibited significant positive genotypic, as well as phenotypic association amongst themselves. Positive and significant genotypic and phenotypic correlations amongst yield and different yield contributing components have been observed by Dhonde *et al.* (2000), Shukla *et al.* (2000), Nabi *et al.* (1998), Uddin *et al.* (1997), and Bahadur *et al.* (1993). It was also observed that genotypic correlation coefficients were higher in all the traits, as compared to the phenotypic correlation coefficients. Similar findings were reported by Bahadur *et al.* (1993).

Dhonde *et al.* (2000), Hussain and Khan (1990), and Zaheer *et al.* (1987) have reported positive direct effect of number of grains per spike and 1000-grain weight on grain yield. The present studies revealed that the number of grains per spike had the highest direct effect on grain yield per plant under rainfed conditions followed by 1000-grain weight, number of spikelets per spike and the number of productive tillers per plant. These plant characters may be used as the selection criteria for developing high yielding wheat varieties for the rainfed areas.

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